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Doctoral Thesis in Sustainable Energy Systems, supervised by Professor Carlos Alberto Henggeler de Carvalho Antunes and Professor Fausto Miguel Cereja Seixas Freire, submitted to the Department of Mechanical Engineering, Faculty of Sciences and Technology of the University of Coimbra.

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UNIVERSIDADE DE COIMBRA

A HYBRID INPUT-OUTPUT MULTI-OBJECTIVE MODEL TO ASSESS ECONOMIC-ENERGY-ENVIRONMENT TRADE-OFFS: AN APPLICATION TO BRAZIL AND PROSPECTIVE SUGARCANE BIOETHANOL TECHNOLOGIES

Ariovaldo Lopes de Carvalho

PhD Thesis in Sustainable Energy Systems
Energy for Sustainability (EfS/MIT Portugal Program)

Doctoral Thesis in Sustainable Energy Systems, submitted to the Department of Mechanical Engineering, Faculty of Sciences and Technology of the University of Coimbra to obtain the Doctor degree

Supervisors

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You're not going to accumulate knowledge and experience without taking a few knocks. You're going to meet people who will discourage you, you're going to have to make some choice about what's important, you're going to encounter some things that in the end you will reject because they're false.

You're going to have to be ready to meet those tough times with determination, with a passion for what you're going after, and you're going to have to find people who will say,

"Yes, you should do this, and you can."
Believe me. "Cause I've done all that.

Bertice Berry

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ABSTRACT

The study and assessment of the relationships between energy consumption, economic growth and environmental impacts is determinant for the policy making process. Input-Output Analysis (IOA) has been used to study inter/intra-relationships among different sectors in the economic system and extended to account for energy and environmental impacts. Multi-objective Linear Programming (MOLP) models using the Input-Output (IO) framework has also been developed to study economic-energy-environment trade-offs. The IO-MOLP models are able to capture the complexity and conflicting nature of real world problems allowing obtaining insightful information that would not be possible to achieve with a separated application of both methodologies. This combination of multi-objective models with IOA plays a supplementary role in understanding the interactions between the economic and energy systems, and the corresponding impacts on the environment, offering a consistent framework for assessing the effects of distinct policies.

A MOLP model based on a hybrid IO framework with monetary and physical units is presented in this thesis. This model aims at assessing the trade-offs between economic, energy, environmental and social objectives in the Brazilian economic system. Firstly, the IO tables for Brazil are reorganized to include the National Energy Balance, creating a hybrid IO framework. This framework is extended to assess different Greenhouse Gas (GHG) emissions, which are then aggregated into a single indicator (CO_2eq), and the employment level.

Two versions of the MOLP model are defined: a version with deterministic values and another one in which interval programming techniques are used for tackling the uncertainty in some coefficients of the model. The deterministic version of the model has 443 variables (including the total output of sectors and energy commodities and several economic variables) and a set of 490 (defining and bound) constraints. The objective functions considered are the maximization of GDP and employment levels, and the minimization of energy consumption and GHG emissions. The STEM and TRIMAP interactive methods are applied to the deterministic version of the model, allowing the exploration of compromise solutions according to the preference information issued by the decision maker (DM). STEM allows an interactive solution search process through the reduction of the feasible region based on the specification of relaxation quantities for the already satisfactory objective functions, thus providing information about the trade-offs that are at stake between the competing objectives in different regions of the search space. The TRIMAP interactive method offers a flexible search for solutions in a user-friendly graphical environment based on the display of indifference regions associated with vertex efficient solutions on the parametric diagram,

allowing a progressive and selective exploration of compromise solutions. Both methods have provided relevant decision support information to a hypothetical DM assisting him/her in understanding the trade-offs at stake and identifying compromise solutions to the MOLP models.

The interval version of the hybrid IO-MOLP model, which includes 518 constraints and 473 variables, is analyzed with an interactive approach involving the formulation of surrogate deterministic models for the interval MOLP model (based on the minimization of the worst possible deviation of the interval objective functions to their corresponding interval ideal solutions) and an interactive phase in which a synergy between the algorithm (providing information to the DM) and the DM (processing the information and providing guidelines for the computation process). This approach has allowed a reference point searching process based on the closeness of the values of the interval solution in relation to the ideal interval solution. Optimistic and pessimistic perspectives have been considered in order to search for solutions using different decision alternatives.

Finally, impacts of different sugarcane cultivation and first-generation (1G) and second-generation (2G) bioethanol production processes on the Brazilian economic system and domestic bioethanol supply in prospective scenarios are analyzed with the deterministic version of the MOLP model. Technical coefficients for different configurations of combined 1G+2G bioethanol plants and sugarcane cultivation are estimated and introduced into the Brazilian technical coefficient matrix. The objective functions are the maximization of GDP and employment level, and the minimization of total energy consumption and GHG emissions. The maximization of the total bioethanol production in the country in each scenario is also considered. Non-dominated solutions are computed by minimizing a Tchebycheff distance to the ideal solution in each scenario. Extending the analysis to the whole economic system has complemented the process design and process-based analysis of prospective bioethanol production, contributing to identify indirect effects that can counterbalance the benefits.

This thesis provides models, methodologies and knowledge based on the assessment of the solutions obtained in the different computation processes that is essential for the development of integrated approaches for prospective analysis of economic-energy-environmental trade-offs in a country and a specific sector.

Keywords: Greenhouse Gas (GHG), Input-Output Analysis (IOA), Multi-objective linear programming (MOLP), Multi-sectoral economy-energy-environment models, interactive methods, lignocellulosic bioethanol.

RESUMO

As relações entre o consumo de energia, o crescimento econômico e os impactos ambientais são determinantes para o processo de formulação de políticas. A Análise Input-Output (AIO) tem sido usada para estudar inter/intra-relações entre os diferentes setores económicos, bem como estendida para a análise dos sistemas energético e ambiental. Modelos de Programação Linear Multi-objetivo (PLMO) utilizando a estrutura Input-Output (IO) também vêm sendo desenvolvidos para estudar os compromissos (*trade-offs*) entre os sistemas económico, energético e ambiental. Os modelos IO-PLMO são capazes de captar a complexidade e natureza conflituosa dos problemas do mundo real, permitindo a obtenção de um informação relevante que não seria possível conseguir com uma aplicação separada de ambas as metodologias. Esta combinação de modelos de PLMO e AIO desempenha um papel complementar na compreensão das interações entre os sistemas económicos e energéticos, e os correspondentes impactos ambientais, oferecendo um quadro consistente para avaliar os efeitos de políticas distintas sobre estes sistemas.

Um modelo de PLMO baseado em uma estrutura IO híbrida com unidades monetárias e físicas é apresentado nesta tese. Este modelo tem como objetivo avaliar os *trade-offs* entre objectivos económicos, energéticos, ambientais e sociais no sistema económico brasileiro. Primeiramente, as tabelas IO para o Brasil são reorganizadas para incluir o Balanço Energético Nacional, criando uma estrutura IO híbrida com unidades físicas e monetárias. Este quadro é estendido para avaliar diferentes Gases de Efeito Estufa (GEE), que são então agregados em um único indicador (CO_2eq), e o nível de emprego.

Duas versões do modelo de PLMO são definidas: uma versão com valores determinísticos e outra em que a programação intervalar é usada para tratar a incerteza em alguns coeficientes do modelo. A versão determinística do modelo tem 443 variáveis (incluindo a produção dos setores e produtos energéticos e várias variáveis econômicas) e um conjunto de 490 restrições (definidoras e limitadoras). As funções objetivo consideradas são a maximização dos níveis do PIB e do emprego, bem como a minimização do consumo de energia e emissões de GEE. Os métodos interativos STEM e o TRIMAP são aplicados para tratar a versão determinística do modelo, permitindo a exploração de soluções de compromisso de acordo com as informações de preferência emitidas pelo decisor. O STEM permitiu um processo de busca de solução interativa através da redução da região admissível baseada na especificação de quantidades de relação para as função objetivo com valores já satisfatórios, fornecendo informações sobre os *trade-offs* entre os objetivos conflitantes em diferentes regiões da região admissível. O método interativo TRIMAP ofereceu uma pesquisa flexível de soluções através de um ambiente gráfico amigável baseada na visualização das

regiões de indiferença associadas a soluções vértices eficientes no diagrama paramétrico, permitindo uma exploração progressiva e seletiva de soluções de compromisso. Ambos os métodos forneceram informações de apoio à decisão relevante para um decisor hipotético, ajudando-o na compreensão dos *trade-offs* em jogo e na identificação de soluções de compromisso para os modelos de PLMO.

A versão intervalar do modelo IO-PLMO híbrido, que inclui 518 restrições e 473 variáveis, é analisada com uma abordagem interativa que envolve a formulação de modelos determinísticos substitutos para o modelo de PLMO intervalar (baseado na minimização do pior desvio possível das funções objetivo intervalar em relação as suas soluções ideais intervalares correspondentes) e de uma fase interativa em que a sinergia entre o algoritmo (prestando informações ao decisor) e o decisor (processando as informações e fornecendo orientações para o processo de cálculo) facilitando um processo de pesquisa com base na proximidade dos valores da solução intervalar em relação à solução intervalar ideal. Perspectivas otimistas e pessimistas foram consideradas a fim de procurar soluções com diferentes alternativas de decisão.

Finalmente, os impactos de diferentes processos de cultivo de cana de açúcar e de produção de bioetanol de primeira (1G) e segunda geração (2G) sobre o sistema económico brasileiro e a oferta doméstica de bioetanol em cenários prospetivos foram analisados com a versão determinística do modelo de PLMO. Coeficientes técnicos para diferentes configurações de usinas de bioetanol de produção combinada de 1G + 2G e sistemas de cultivo da cana foram estimados e introduzidos na matriz de coeficientes técnicos. As funções objetivo foram a maximização do PIB e do emprego, e a minimização do consumo de energia e das emissões totais de GEE. A maximização da produção total de bioetanol no país em cada cenário também foi considerado. Soluções não-dominadas foram calculadas através da minimização da distância de Tchebycheff para a solução ideal em cada cenário. A extensão da análise envolvendo todo o sistema económico veio complementar o desenho e a análise baseada em processos potenciais de produção de bioetanol, contribuindo para identificar efeitos indiretos que podem contrabalançar os benefícios.

Esta tese fornece modelos, metodologias e conhecimento baseado na avaliação das soluções obtidas com diferentes processos de cálculo, que é essencial para o desenvolvimento de abordagens integradas para a análise prospetiva dos *trade-offs* económico-energético-ambiental em um país e em um setor específico.

Palavras-chave: Gases com Efeito Estufa (GEE), Análise Input-Output (AIO), Programação Linear Multi-objetivo (PLMO), Modelos económico-energético-ambiental multi-setoriais, métodos interativos, bioetanol ligno-celulósico.

CONTENTS

CHAPTER 1 INTRODUCTION

Energy and environmental concerns have gained a significant role in public policy agenda. The relationships between energy consumption, economic growth and environmental impacts have been widely studied in energy economics literature (e.g. Warr & Ayres, 2010; Acaravci & Ozturk, 2010; Lai *et al*., 2011), including in Pao & Fu (2013) who have applied a co-integration test to investigate the causal relationship between renewable and non-renewable energy consumption and economic growth in Brazil over the period 1980–2009. Even though this causal relationship is not consensual (e.g. Fallahi, 2011; Al-mulali & Sab, 2012; Saboori & Sulaiman, 2013) the correlation between these indicators is determinant for the energy and economic policy making process. On one hand, economic growth usually leads to an increase of energy consumption and consequently environmental impacts, since the current patterns of energy consumption heavily rely on fossil fuels, which are finite resources and important sources of Greenhouse Gas (GHG) emissions. On the other hand, energy and environmental policies may lead to constraining effects on economic growth and social welfare. Hence, it is relevant to assess the interactions and trade-offs between economic, energy and environmental (E3) indicators in order to provide reliable tools for planners and decision makers (DMs) (Oliveira & Antunes, 2004).

The recent period of economic growth in Brazil has influenced positively the social welfare and energy consumption in the country. Between 2000 and 2012, Brazil's economic growth exceeded the population growth. While the population increased at an annual rate of 1.06%, GDP has presented an annual growth rate of 3.16% during the same period. In 2013 Brazil's GDP achieved US$ 2.190 trillion (R$ 4.783 trillion) and a value per capita of US$ 10,957.61 (R$ 23,927.13), while in 2000 Brazil's GDP achieved US$ 644.73 trillion (R$ 1,179 trillion) and a value per capita of US$ 3,696.33 (R$ 6,762.10) – all values in current prices (IMF, 2014; IPEA, 2014). Brazil has also been improving the energy supply and the contribution of renewable sources in the energy mix, which represented 42.4% of the domestic energy supply in the country in 2012 (EPE, 2013). Almost 85% of the Brazilian electricity derived from renewable sources in 2012, in which the domestic hydro generation accounted for 70% of the supply whereas the production of electricity from wind power increased 87% between 2011 and 2012. Moreover, 23,476,667 m³ of bioethanol and 2,717,483 m³ of biodiesel were consumed in the country in 2012, representing approximately 27% and 5% of the total energy consumed in light and heavy vehicles, respectively (EPE, 2013). However, the fossil fuel production has also risen due to the exploitation of new oil extraction areas in order to satisfy this economic growth, achieving a record production of 2.23 million barrels per day in January 2012 (ANP, 2014a).

The average daily production of natural gas achieved 70.6 million m³ per day in 2012 (which represents 11.5% of the energy produced in the country). Although the largest share of CO_2 emissions in Brazil results from land use change (LUC) (representing 79% of the total CO_2 emissions in 2005), the energy sector was the second major emission source in 2005 (20% of the total) mainly due to road transportation and industry (responsible for 39% and 27% of the emissions of this sector, respectively). Since fossil fuels represent a significant part (almost 57% in year 2012) of the final energy consumption in the country, the impacts of GHG emissions are a drawback for the current and prospective economic growth (MCT, 2010; EPE, 2013).

Input-Output Analysis (IOA) has been traditionally used to study the inter/intra-relationships among different sectors in the economic system, describing the relationships between the inputs used and the outputs produced (Leontief, 1985; Miller & Blair, 2009). IO models have been modified to account for environmental impacts (Miller & Blair, 2009): generalized IO models including additional rows and columns within the IO system to incorporate the environmental impacts (Leontief, 1970; Munksgaard & Pedersen, 2001); economic-ecologic models using intra/inter-sector sub-matrices linking the economic and environmental sectors (Daly, 1968; Isard *et al*., 1972); and commodity-by-industry models considering the ecological commodities as products (Victor, 1972). Moreover, the IO environmental modeling framework can also be extended in order to incorporate the environmental impacts in the traditional IO framework following a different approach. In this approach an external expansion of the traditional IO framework is made in which the environmental impacts are estimated by assuming a proportional relation between the output of the sectors and the corresponding impact levels (Yabe, 2004; Suh & Huppes, 2005).

IO models have also been modified for the explicit analysis of the energy sector (see e.g. Yuan *et al*. (2010), Tang *et al*. (2012) and Logar & Bergh (2013)), whereas different studies have extended the conventional IO models to analyze E3 interactions (see e.g. Lenzen & Dey (2002); Nässén *et al*. (2007) and Huang & Hu (2013)). Some studies have applied IO models using hybrid frameworks considering the monetary values regarding the energy sectors in equivalent physical units (Daly, 1968; Chen, 2001). Energy and environmental extensions of the input-output model have been applied to the Brazilian economic system (Oliveira, 2011; Munasinghe *et al*., 2006). There are also some studies using hybrid IO models to assess energy and environmental subjects related to the Brazilian economic system: to estimate the amount of energy and/or carbon embodied in the non-energy exports, imports and goods and services purchased by households of different income levels (Schaeffer & Sá, 1996; Machado *et al*., 2001; Cohen *et al*., 2005); to estimate energy and/or carbon dioxide intensities of the domestic economy and exports (Perobelli *et al*., 2007; Carvalho & Perobelli, 2009; Figueiredo *et al*., 2009; Firme & Perobelli, 2012); to assess carbon dioxide intensities and applying a structural decomposition analysis to verify the impacts of technological changes on the carbon dioxide emissions (Carneiro, 2010); to assess the carbon and energy intensity, as well as the impacts of a set of environmental policies on production and employment levels (Hilgemberg, 2004; Hilgemberg & Guilhoto, 2006). Although some of these studies have developed hybrid IO frameworks with similar characteristics of the model proposed in this thesis, some differences can be identified beforehand. All models address a reduced number of sectors and fuels, only GHG emissions from energy combustion are computed in the majority of them, and the simulations of economic shocks on final demand are applied exclusively for the year of analysis, whereas the model herein proposed will encompass more (energy and non-energy) sectors, GHG emissions of different sources and will be focused on a prospective analysis. It is important to refer that other studies such as Mattos *et al*. (2008) and Santiago *et al*. (2011) have also been developed to address long term projections of energy consumption in Brazil combining the input-output framework with econometric approaches. Despite the usefulness for energy projections, both studies are limited to a reduced number of sectors and fuels, while the employment and GHG emissions issues have not been considered.

Since the seminal work by Dorfman *et al*. (1958), several studies have used linear programming (LP) models coupled with the traditional IO framework for different purposes (see e.g. Ebiefung & Kostreva (1993), Zhu *et al*. (2009) and Strømman (2009)). The generalization of the IO model using LP enables investigating efficient combinations of inputs and outputs on the boundary of the production possibility frontier (Christ, 1955). Some studies have introduced environmental and energy (and combinations of both) objectives into IO-LP models, either as the only objective function or combined with economic objectives (Muller, 1979; Moulik *et al*., 1992; Hristu-Varsakelis *et al*., 2010). Nevertheless, models become more able to capture the complexity of real world problems if multiple, conflicting and incommensurable axes of evaluation of distinct potential policies are explicitly considered, such as Multi-Objective LP (MOLP) models. MOLP models enable to exploit the trade-offs between the competing objectives and analyze a larger set of diversified non-dominated solutions (i.e. solutions for which no other feasible solution exists improving the value of a given objective function without worsening the value of, at least, other objective function; in general, the concept of efficiency refers to the decision variable space and the concept of non-dominance refers to the objective function space).

Since, in general, energy, economic, environmental and social concerns have conflicting interactions, a broad scrutiny of these evaluation aspects and a thorough appraisal of the trade-offs at stake are required to assess the merits of adopting distinct policies associated with different non-dominated solutions to the MOLP model. In this context, MOLP models coupled with the IO framework have also been developed to assess energy, environmental and economic objectives and their trade-offs: to assess the dynamic relationships between economic development, water pollution and the subsequent waste-load allocation (Ni *et al*., 2001); to analyze alternative development options for a national economy (Kravtsov & Pashkevich, 2004); to study the impact of regional policies on the employment, water pollution and energy consumption (Cho, 1999); to investigate the impact of mitigating CO_2 emissions associated with energy consumption and GDP (Chen, 2001); to analyze the interactions of the energy system with the economy (Antunes *et al*., 2002); to analyze how targets for GHG emissions, waste emissions, energy requirements, employment and output levels may be reached and can affect the composition of production activity (San Cristóbal, 2012).

The lack of information for accurately specifying the coefficients of the objective functions and constraints in mathematical models, as well as inaccuracies and variability in the data supplying the models are sources of uncertainties. Furthermore, there is an inability of models in representing with total confidence the reality due to simplifications and assumptions considered (Zadeh, 1965; Zimmermann, 1987, 1996; Antunes, 1991; Gal & Greenberg, 1997). Thus, it is convenient to consider an extension of the mathematical models in order to include the treatment of uncertainty. Five techniques used to deal with uncertainty in mathematical programming models are: sensitivity analysis (Cruz, 1973), robust programming (Pye, 1978; Rosenhead, 1980), fuzzy programming (Zimmermann, 1976), stochastic programming (Kolbin, 1977) and interval programming (Bitran, 1980). Three different approaches have been used for uncertainty modeling in input-output models: the stochastic (or probabilistic) approach (e.g. West (1986); Raa & Steel (1994)); the fuzzy (or possibilistic) approach (e.g. Buckley (1989)); and the interval approach (e.g. Jerrell (1995, 1997)). In fact, specifying *probabilistic* distributions (as in stochastic programming) or *possibilistic* distributions (as in fuzzy programming) associated with all elements of national input-output tables can be an unaffordable task; therefore, interval programming has been considered as a suitable approach for carrying out the treatment of uncertainty intrinsic to the models applied to real problems (Jerrell, 1995, 1997).

IO MOLP models incorporating the treatment of uncertainty using interval programming has been developed (Henriques, 2008; Oliveira & Antunes, 2009; Henriques & Antunes, 2012). Henriques (2008) and Oliveira & Antunes (2009) have developed an interactive approach involving the formulation of surrogate deterministic models for the interval MOLP model (based on minimization of the worst possible deviation of the interval objective functions from their corresponding interval ideal solutions) and an interactive phase in which a synergy between the algorithm (providing information to the DM) and the DM (obtaining the information and making judgments leading to choosing the subsequent search paths) allows a searching process of good compromise solutions based on the closeness of the values of the interval solution with respect to the ideal interval solution. This model allows: getting a simpler mathematical formulation of the interval model; a strong integration of the DM with the algorithm, with not very demanding information requirements; dealing with uncertainty in terms of all the model coefficients; review the searching options for solutions considered interesting by the DM. The applicability of this algorithm in MOLP models with interval coefficients with realistic dimensions, as in Henriques (2008) and Oliveira & Antunes (2011), has vouched the option to apply this method for uncertainty treatment in the model developed in this study.

Since 1903 the bioethanol based entirely on the fermentation of sugar juice from sugarcane and/or molasses (the so-called first generation (1G) bioethanol) has been used as fuel to engines in Brazil (Moreira & Goldemberg, 1999). The 1970s worldwide oil crisis impelled Brazil to increase the production and consumption of bioethanol as an alternative fuel in the transportation sector. For this purpose, in 14th November of 1975 the Brazilian National Alcohol Program (PROALCOOL) was created. After some decades, the policies in the scope of the PROALCOOL have been responsible to consolidate not only the agriculture and industrial supply but also an important domestic market for this fuel. Nowadays, Brazil is the world second major bioethanol producer country, with approximately 390 bioethanol (autonomous distilleries or sugar-bioethanol mixed) plants (MAPA, 2014). The autonomous distilleries produce exclusively bioethanol, while the sugar-bioethanol mixed plants (which are the majority of the plants) produce both bioethanol and crystallized sugar. In the 2013/2014 season 653.4 million tons of sugarcane has been produced in Brazil, resulting in 12.2 and 15.3 billion liters of anhydrous and hydrous bioethanol, respectively (a total of 27.5 billion liters) (UNICA, 2014). Nowadays, sugarcane is the third major agriculture crop in the country, with approximately 9.75 million hectares cultivated in 2012, only lower than the areas cultivated with soy and corn (IBGE, 2014).

Both autonomous distilleries and sugar-bioethanol mixed plants produce a lignocellulosic residue called bagasse as a result of the sugarcane processing. The bagasse is burnt in boilers to generate heat and electricity that are used in the bioethanol plant. Electricity surplus can also be exported to the national electricity system. More efficient and expensive boilers for the combustion of bagasse have improved the capacity of the plants in generating electricity surpluses, therefore increasing the returns from each plant (Macedo *et al*., 2001; Ensinas *et al*., 2010).

Prospective technologies for lignocellulosic bioethanol production, also referred to as the second-generation (2G) bioethanol, also increase the role of bagasse in the process (Dwivedi *et al.*, 2009; Mosqueira-Salazar *et al.*, 2013). The use of bagasse as a raw material for bioethanol production can expand the total capacity of production by unit of sugarcane used. The 2G technologies can contribute for lower environmental impacts on the sugarcane bioethanol life cycle, which already has presented lower impacts in terms of GHG emissions (not including the land use change effects) when compared to other alternative bioethanol production processes (Coelho *et al.*, 2006; CGEE, 2008).

The 2G technologies also improve the role of the sugarcane leaves and tops in the bioethanol life cycle. Instead of being burnt in the field or discarded as residues of the mechanical harvesting, these materials can be used to replace the bagasse burnt in the boilers or used as raw materials in the 2G bioethanol production because of their lignocellulosic nature. The 2G technologies have not been commercially competitive in Brazil due to high production costs (compared to the 1G technology) and some bottlenecks regarding the conversion of lignocellulose into fermentable sugars, and the downstream processing poses a challenge for this option in the near future (Rosillo-Calle & Walter, 2006; Hahn-Hägerdal *et al.*, 2006; Galbe *et al.*, 2007; Cardona *et al.*, 2010). However, it is important to refer that the first commercial 2G bioethanol plant in Brazil has been finalizing the test phase and was recently authorized by the national oil, gas and biofuels regulatory agency to start operating (ANP, 2014b). Therefore, the commercial production of 2G bioethanol in Brazil is supposed to initiate even until the end of 2014, and is expected to increase gradually in the future with potential investments.

Some studies have developed basic and extended IO models to assess the interactions of the Brazilian bioethanol sector with the overall Brazilian economic system for different purposes, namely assessing: the impacts of the mechanization process on the employment level (Guilhoto *et al.*, 2002); the impacts of sugar and bioethanol exports (Burnquist *et al.*, 2004; Costa *et al.*, 2006); the impacts of new bioethanol factories (Terciote, 2006); prospective demand increase (Filho & Filho, 2009); the impacts on socioeconomic indicators from different prospective technological mixes (Scaramucci & Cunha, 2006, 2008; Cunha & Scaramucci, 2006). However, most of these studies have just performed an economic analysis, and, in a small number of cases, applied in some extent an analysis of the employment level. Unfortunately, these studies have not deeply assessed the energy and GHG aspects related to the bioethanol sector and the whole economic system. Other studies using the IO framework have also addressed environmental and energy issues. Cómpean & Polenske (2011) developed an environmentally extended interregional input-output model using hybrid units accounting energy- and carbon-intensities to analyze the direct and indirect impacts of different bioethanol production technologies. However, this study has a limited number of sectors and fuels, the model does not include the employment analysis and the impacts from 2G bioethanol have not been assessed. Watanabe *et al.* (2013) applied the so-called Economic Input-Output Life-Cycle Analysis (EIO-LCA) to the assessment of economic and GHG emissions of different 1G and 2G sugarcane based bioethanol production technologies in Brazil. However, this study has not addressed the effects on the employment level, as well as the impacts on the energy intensities and on the composition of the national energy mix.

It is noteworthy that, as far as this study has searched, there is a lack of studies applying an input-output framework integrating economic, energy, environmental (specially GHG emissions) and social (specially employment levels) analysis of the Brazilian economic system and, specifically, to the Brazilian bioethanol sector. I.e., in all studies beforehand presented, at best three of those subjects have been jointly analyzed, whereas generally one or more of those subjects are disregarded. In addition, there is also a lack of studies applying input-output models integrated with linear programming (either for single and multiple objectives) and also including the treatment of uncertainty (such as interval, fuzzy, or stochastic programming approaches) for the Brazilian economy. Hence the identified gaps in the current literature regarding to IO, MOLP and interval programming modeling and analysis are open for further investigation.

Therefore, the model proposed in this study intends to provide a tool for prospective analysis of the Brazilian economic system and the bioethanol sector in Brazil taken advantage of the strengths in applying extended and hybrid input-output frameworks with mathematical programming models in modeling complex interrelationships between economic and physical systems. The main objective of this thesis is to develop deterministic and interval formulations of a MOLP model based on extended hybrid input-output framework to analyze a set of economic, social, energy and environmental indicators according to different prospective scenarios for the Brazilian economy and technological options of the Brazilian bioethanol sector. This objective can be translated in specific objectives such as:

1. Develop an MOLP model to the Brazilian economic system based on the one proposed by Henriques (2008);

2. Refine this model to take into account the specific characteristics of the Brazilian economic system, energy production/consumption structure and GHG emission sources. This adaptation will include: consideration of land use change and forestry (LUCF) GHG emissions as an exogenous variable; inclusion of the computation of GHG emissions from rice cultivation; modifications in the calculation of direct and indirect GHG emissions from agriculture and manure management sources; modifications in the calculation of GHG emissions from wastewater and waste treatment and discharge; modifications in the computation of the energy consumption and associated GHG emissions; expansion of the number of sectors and energy sources analyzed;

3. Develop both deterministic and interval formulations of the MOLP model (therefore considering as intervals several model coefficients to account for their uncertain nature in a "unknown but bounded" approach). An extensive data collection from a cluster of sources will be carried out in order to develop the MOLP model as close as possible to the Brazilian reality;

4. Analyze economic, social, energy and environmental policies using the deterministic formulation of the MOLP model. For this purpose the interactive STEP and TRIMAP methods will be applied;

5. Analyze economic, social, energy and environmental policies using the interval formulation of the MOLP model. For this purpose the interactive method developed by Henriques (2008) will be applied;

6. Improve the scope of the analysis by considering an additional step devoted to assess the impacts of different prospective bioethanol production technologies on economic, social, energy and environmental indicators. In this step the impacts of the maximization of the total (anhydrous and hydrous) bioethanol production and the minimization of the Tchebycheff distance to the ideal solution of the MOLP model (setting the same amount of bioethanol produced and GDP levels) will be considered. This expansion of the scope of the analysis will be made by considering different technical coefficients for each prospective technology using as basis the methodology provided by Scaramucci & Cunha (2006) to incorporate these coefficients into the IO framework. Each technical coefficient will be estimated using a life cycle perspective, considering: the data from AGRAFNP (2010) and IBGE (2014) and the methodology provided by Macedo *et al*. (2004) for each step in the cultivation, harvesting and transportation of sugarcane; data from PECEGE (2010) and CONAB (2012) for each step of the industrial processing of 1G bioethanol; and

data provided by Macrelli *et al*. (2012) for different configurations of combined 1G+2G plants.

This thesis is therefore divided in seven chapters in which some of them are based on beforehand studies papers presented in conferences and presently submitted for publication in international journals:

In Chapter 2 main concepts and assumptions underlying the input-output models will be briefly presented in order to outline the most important characteristics, as well as a critical analysis of its suitability for policy analysis.

In Chapter 3 a succinct overview of the basic input-output model and extended versions of the traditional input-output model to deal with both environmental and energy issues will be presented, including the relationships between the input-output model and other methods such as Life Cycle Analysis and mathematical programming.

In Chapter 4 interactive methods, such as STEM and TRIMAP, for enabling a progressive and selective search of efficient solutions in MOLP models will be described. In addition, an interactive approach to uncertainty treatment in MOLP models with interval coefficients developed by Henriques (2008) and Oliveira & Antunes (2009) will be summarily presented.

In Chapter 5 both deterministic and interval formulations of an MOLP model based on a hybrid Input-Output framework will be presented. The description of variables and parameters of the model are shown in Appendix A, while the numerical specification of the model will be presented in Appendix B.

In Chapter 6 some illustrative results obtained using the interactive methods presented in Chapter 3 enabling a progressive and selective search of efficient solutions in the deterministic and interval formulations of the MOLP model will be outlined. An additional analysis regarding the bioethanol sector considering the deterministic formulation of the MOLP model will be also presented. The main results are analyzed and discussed in this chapter emphasizing the usefulness of the proposed approach in decision support. The procedures used to estimate the technical coefficients for sugarcane and bioethanol scenarios will be outlined in Appendices C and D, while the results for all variables will be presented in Appendix E.

Finally, in Chapter 7, the main conclusions of this work are outlined, its contributions are identified and suggestions for future works are presented.

CHAPTER 2 INPUT OUTPUT ANALYSIS – ORIGINS AND MAIN CONCEPTS.

2.1. THE ORIGINS OF THE INPUT OUTPUT ANALYSIS

Input–output analysis is a method developed by Professor Wassily Leontief in the 1930s (Leontief, 1936; Leontief, 1941) to analyze the interrelationships between different sectors in an economy (Miller & Blair, 2009). According to the own Leontief's definition:

"Input-output analysis is a practical extension of the classical theory of general interdependence which views the whole economy of a region, a country and even of the entire world as a single system and sets out to describe and to interpret its operation in terms of directly observable basic structural relationships" (Leontief, 1987).

The input–output analysis utilizes structural coefficients to describe in quantitative terms the relationships between the inputs used and the output produced for a sector and a set of linear equations to describe the balances (or distributions) between inputs and outputs and the interdependence between sectors (Eurostat, 2008). Nowadays, the input–output analysis has a broad sphere of applications and is one of the most widely applied methods in economics (Baumol, 2000).

The most widely held view of the origins of the input–output analysis referred to in the literature[1] is related to the seminal concepts depicted in the "Tableau Économique" developed by the French economist François Quesnay (Quesnay, 1758)[2]. This study is considered as the first theoretical explanation of the economic interdependence in which a graphical representation of the French economy considering three sectors (productive class, sterile class and proprietors of land and natural resources) is utilized (Kurz & Salvadori, 2000; Ruiz & Pellet, 2010). This framework is the core of the foundations used by Leontief to formalize the basic concepts of income flows between economic sectors (Miller & Blair, 2009).

The input–output model is also characterized as an approximation of the Walras' generalized model (Walras, 1874), which utilized "*a system of simultaneous equations representing the demand for goods by consumers, the supply of goods by producers, and the equilibrium condition that supply equal demand on every market*" (Arrow & Debreu, 1954)[3].

Leontief described the input–output analysis as "*an attempt to apply the economic theory of general equilibrium – or better, general interdependence – to an empirical study of interrelations among the different parts of a national economy as revealed through covariations of prices, outputs, investments, and incomes*" (Leontief, 1937)[4].

According to Kuenne (1954) and Dorfman (1973) Leontief applied several important simplifications of Walras' equations which allowed the empirical implementation of a theory of general equilibrium. The simplification consisted in going back to the Walras' early model in order to establish some important assumptions to the input–output model:

- *Homogeneity*: reducing Walras' number of outputs and considering only one by each sector (or industry[5]), i.e. each sector produces a single output with a single input structure, ruling out substitution (for a period) between the outputs of different sectors and between inputs in the same sector;

[1] See Polenske & Skolka (1976), Stone (1984) and Kurz & Salvadori (2000) for more detailed historical accounts of the early development of input–output analysis. A fairly complete history of applications of input–output analysis since Leontief's introduction of it is provided in Rose & Miernyk (1989).
[2] See Charles (2003) for a historical review of the Quesnay's Tableau Économique.
[3] A more detailed description of the Walras model can also be found in Kuenne (1954), Arrow & Debreu (1954) and Davar (2000).
[4] Some other discussion about the origins of the Leontief's model can also be found in the literature. See e.g. Morgenstern (1954); Clark (1984), Kurz & Salvadori (2000), Aroche (2007) and Ruiz & Pellet (2010).
[5] It is important to refer that in some cases the term industry is henceforth used to include all economic activities.

- *Proportionality and Fixity of coefficients*: considering a fixed proportionality between the inputs required and the level of output of each sector (and fixity over time);
- *Linearity of coefficients*: the total effect of carrying out production in several sectors is the sum of the separate effects, which implies absence of economies of scale;
- *Infinite and elasticity supply*: this assumption claims unrestricted productive capacity (O'Connor & Henry, 1975; Folloni & Miglierina, 1994; Barata, 2002; Ruiz & Pellet, 2010)[6].

The input–output analysis has also been characterized as a particular form of the (linear) activity analysis model as far as the production structure is concerned (Proops *et al.*, 1993). The activity analysis originates from the John von Neumann's model (Neumann, 1937) with further contributions by "Neo-Walrasians" economists as Koopmans (1951; 1957) (Morgenstern, 1954)[7]. Baumol (1958) defines activity analysis as the applications of linear programming methods to general equilibrium theory. Koopmans (1957) states activity analysis "*as a mathematical specialization of the theory of competitive equilibrium… although its mathematical structure permits a wider range of interpretation and application"*. In the context of the theory of competitive equilibrium, the activity analysis model has mainly focused on a description of the supply side (or the production structure) of the economy. In the activity analysis, the neoclassical "production function" of the economy is substituted by "production activities", providing a moderately more flexible approach to the representation of technological possibilities of firms, sectors or, in a broad sense, the "technology" of an economy (as the collection of all the activities, or more accurately as "the set of all known process in that period") (Proops *et al.*, 1993)[8].

As long as several alternative processes of production are available in different sectors, the activity analysis model can be more "desirable" than the conventional input-output formulation, because producers can choose among a small, finite number of distinct production processes "or activities". However, it is more difficult to obtain engineering estimates for all production functions for the various alternatives processes and formulate all economic choices in terms of linear relationship among the unknowns, as required by the activity analysis framework (Manne, 1961).

[6] These concepts will be further referred to in the next sections.
[7] Activity analysis production theory is summarized in Chipman (1953), Makower (1957), Baumol (1958), Dorfman *et al*., (1958) and Gale (1960).
[8] See Koopmans (1951, 1957) and Chipman (1953) for a more complete exposition.

Dorfman (1973) states that the most remarkable contributions provided by Leontief's work in comparison to all his predecessors regards the practicality in estimating the input–output coefficients and performing the algebraic manipulations, as well as the applicability of his method in a wide variety of practical economic questions. In other words, Leontief developed a practical system joining implicit theorization and empiricism, in which the theoretical concept of economic interdependence is equipped with empirical foundations (Miller & Blair, 2009).

The increasing availability of high-speed computers and the standardization of the economic accounts system[9] within the input–output framework (which since 1957 has been increasingly developed for many countries around the world) have disseminated the application of input–output analysis for economic analysis at many geographic levels. Despite the limitations of the input–output analysis assumptions (and, in some cases, a lack of proper information)[10], the basic input-output framework has been extended or connected with other kinds of economic analysis tools to take into account other spheres of evaluation (such as energy, environmental and social accounts), as well as supporting prospective analysis (Miller & Blair, 2009).

In the next sections of this chapter the basic input–output analysis framework as originally developed by Leontief will be presented. Some features of the model regarding basic dynamic formulations, the relationship with the System of National Accounts, as well as some remarks about the strengths and weaknesses of its application, mainly in the scope of this study, will be also presented.

2.2. STATIC INPUT OUTPUT MODEL

Firstly, it is important to state that since the main concepts of input-output analysis (herein also referred to as input-output model) have been thoroughly discussed in the literature (see e.g. Leontief, 1966; O'Connor and Henry, 1975; Proops *et al*., 1993; Miller & Blair, 2009), only a brief review of the input-output analysis will be presented in the next sections of this chapter. Therefore, for a more exhaustive analysis it is recommended to consult those studies.

Input-output Analysis is a method to study the interdependence between producers and consumers in a given economic system which can be as large as a country, a region, the entire

[9] See for e.g. United Nations (2009).
[10] This topic will be discussed in detail in the next sections.

world or even a single company (Leontief, 1985). In the input-output models the economic structure is defined in terms of industries (or sectors) producing goods and services (or commodities) for intermediate consumption or final demand[11].

The input-output model can be classified as a “closed” or “open” model according to the endogenous or exogenous characteristics of the final demand. In both cases, the inter-industry structure is considered as endogenous, i.e., its behavior is determined within the system (Barata, 2002). In the closed model the final demand (or the components of it) is considered as a ‘sector’ and is incorporated into the inter-industry matrix trough new row and column vectors to describe how its output is used by different sectors and how its purchase structure is delivered by different sectors (Cruz, 2002). In contrast, in the open model the ‘final demand sector’ is considered exogenous, as a result the corresponding decisions are made outside of the system (Leontief, 1985; Barata, 2002). It is noteworthy that the choice (and the usefulness) between ‘closed’ or ‘open’ model depends on the specific objectives of the analysis (Cruz, 2002).

The input-output model can also be characterized as “static” or “dynamic”. In the first case, the model accounts the structural relationships between inputs and outputs of the economy that have occurred in a defined period of time, which is usually one year (Duchin, 1998). The dynamic input-output model derives from the static input-output model through consideration of lags or rates of change over time of sectoral interdependences. In the dynamic input-output model the investments are taken endogenously into the system in order to establish structural relations between additions to the stocks of durable capital goods, expansion of productive capacity and in the level of outputs (Kurz & Salvadori, 1998)[12].

The basic input-output model is generally constructed from observed economic data for a specific system (or geographic region) which describes the economic flows between all economic activities. The input-output model requires three main steps: construction of the transactions table, derivation of the technical coefficients and the interdependence coefficients (sometimes called total coefficients) (O’Connor & Henry, 1975). These steps will be briefly described in the next sections.

[11]The final demand usually aggregates the consumption of households and non-profit institutions serving households, public consumption, investments (which can be defined as gross fixed capital formation and stock changes) and exports.

[12] A further discussion about dynamic input output models will be presented in a special section of this chapter.

2.2.1 Transactions Table

The fundamental table of the input-output system is known as the transactions table, in which the economic flows within an economic system during a particular base year are computed. This table (if expressed in value terms) can be considered essentially as a version of the system of National Accounts, in which the economy is divided up to into a number of subsystems (sectors or activity branches) in order to represent the various economic flows and inter-industry relations (Leontief, 1985). It is considered that each subsystem demands inputs from other systems in order to produce its own output, which then is supplied to attend the intermediate demand of other sub-systems (or to final demand). For this purpose the output of each sector is distributed along a row of the table while the corresponding column records the inputs of this sector (O'Connor & Henry, 1975; Barata, 2002; Henriques, 2008).

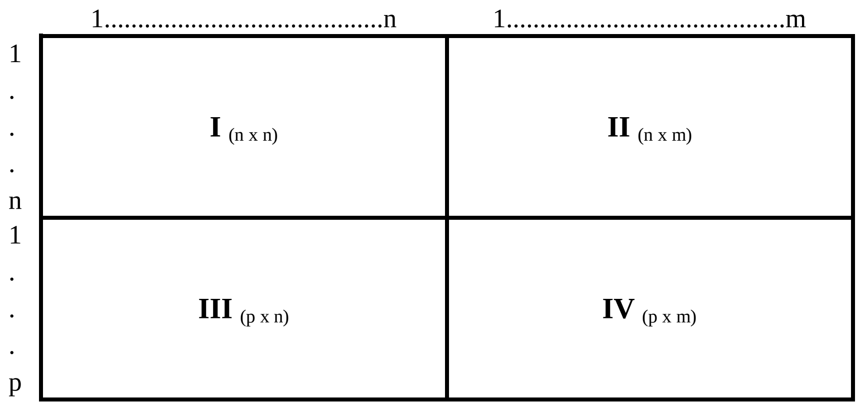

Figure 2.1 - Schematic layout of the transactions table (O'Connor & Henry, 1975).

National input-output tables have been widely published for national accounting purposes, representing a powerful database regarding structural characteristics of the economic activity in a country (Cruz, 2002). The simplified scheme of the standard national input-output table is depicted in Figure 2.1. This table has a rectangular form with four non-zero quadrants[13]. The left part represents the inputs to the production process of the productive sectors and the right one the sales to the final demand components. The upper part contains the intermediate inputs and the lower part the primary ones. In order to complement the explanation about the composition of the transaction table, a basic input-output table with algebraic formalization will be illustrated in the Table 2.1. In this table four matrices can be defined according to the notation in the Figure 2.1 for the quadrants I, II, III and IV (Figure 2.1), respectively: **X** (matrix of inter-industry transactions), **Y** (matrix with the inputs from

[13] In this simplified scheme a column (and eventually a row, if expressed in monetary terms) of totals is omitted.

sectors to the final demand components), **Z** (matrix with the primary inputs for industrial sectors) and a matrix with primary inputs to the final demand components (which will be considered as null in Table 2.1). Each of these quadrants will be better described as follows[14]:

- The quadrant I illustrates the inter-industry transactions (or the intermediate demand), i.e. the flows of goods and services which are both produced and consumed among sectors. Thus, the inputs to each sector are recorded in columns and the outputs from each sector are distributed along the corresponding row, which makes each inter-industry flow be simultaneously an input and an output. In the schematic layout in the Table 2.1 this quadrant is represented by a square[15] matrix **X**[16], in which the generic element x_{ij} represents the 'value' of input from sector *i* to sector *j*[17];
- The quadrant II shows the various elements of Final Demand such as production for consumption (of households and governments), investments (e.g. fixed capital formation and changes in stocks) or exports[18]. In the schematic layout of the Table 2.1 this quadrant is represented by the matrix **Y**, in which each generic element y_{ij} describes the deliveries from sector *i* to each final demand element *j*;
- The quadrant III demonstrates the distribution of primary inputs (also called primary factors or non-produced goods) such as labor, capital, entrepreneurship or natural resources to the productive sectors. In the schematic layout of the Table 2.1 this quadrant is represented by the matrix **Z**, in which the generic element z_{ij} describes the use of the primary input *i* by the sector *j*;

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[14] Here and throughout this chapter we use lower-case bold letters for vectors and upper case italic letters with subscript indices to denote its elements; upper case bold letters for matrices, and lower case italic letters with subscript indices to denote its elements; and lower case italic letters are used to denote scalars.

[15] As stated by O'Connor & Henry (1975) an essential characteristic of the transactions table in the traditional input-output model is that in quadrant I the number of both rows and columns have to be the same, i.e. this quadrant must always be a square matrix, since only square matrices can be inverted (this is an important feature in the core of the traditional input-output analysis as we will see in the next section). However, it is important to refer that some alternative models have utilized rectangular input-output matrices as will be outlined in a subsequent section of this thesis.

[16] Here *i* represents the number of the row and *j* the number of the column.

[17] In the original model the amount of goods of a specific industry used in their own production is deducted from the total quantity produced (Dorfman et. al, 1958). Even though this assumption may seem irrelevant in the static model, in a dynamic model the inclusion of intra-sector supplies into the inter-industry transactions matrix turns the model more realistic (Henriques, 2008).

[18] It is important to note that the imports sometimes are represented as a final demand component through a column with negative values or as a row in the primary inputs quadrant. The other alternative is to itemize the imports of each commodity by each sector, i.e. to obtain a matrix of imports classified by product and by industry as provided by the Brazilian System of National Accounts. Further considerations regarding the imports, as well as the matrices provided by the Brazilian System of National Accounts will be described in special sections of this chapter.

- In the quadrant IV the primary inputs delivered directly to the final demand sectors are usually recorded. As stated before for reasons of simplicity this quadrant will be considered as null in the schematic layout of the Table 2.1 (and hereafter).

Table 2.1- Schematic representation of a common input-output table (in algebraic form)[19]

Inputs ↓	Outputs →	Intermediate Demand				Final Demand				
		Sectors				*Final demand items*				*Total Outputs*
		1	*2*	...	*n*	*1*	*2*	...	*m*	
Sectors	*1*	x_{11}	x_{12}	...	x_{1n}	y_{11}	y_{12}	...	y_{1m}	X_1
	2	x_{21}	x_{22}	...	x_{2n}	y_{21}	y_{22}	...	y_{2m}	X_2
	⋮	⋮	⋮	...	⋮	⋮	⋮	...	⋮	⋮
	n	x_{n1}	x_{n2}	...	x_{nn}	y_{n1}	y_{n2}	...	y_{nm}	X_n
Primary Inputs[20]	*1*	z_{11}	z_{12}	...	z_{1n}					
	2	z_{21}	z_{22}	...	z_{2n}					
	⋮	⋮	⋮	...	⋮					
	p	z_{p1}	z_{p2}	...	z_{pn}					
Total Inputs[21]		X_1	X_2	...	X_n					$^{n}_{i=1}\ {}_{i} = \sum^{n}_{j=1}\ {}_{j}$

Even though in principle the input-output table can record the transactions between and among all sectors either in physical or monetary[22] terms (or even a combination of physical and value units), in practice input-output tables are mostly prepared in monetary terms (which facilitates the comparison of the inputs and outputs of different sectors) (Leontief, 1985; Miller & Blair, 2009)[23]. In the input-output table in monetary terms (in which the values are at current prices) the row and column totals are equal, as well as the total of the row sums equals the total of the column sums (see Table 2.1) (Proops *et al*., 1993;

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[19] This table is adapted from Cruz (2002).

[20] The entries in the quadrant III (the matrix **Z**) can represent the so-called value-added if the table is expressed in monetary terms.

[21] A row with the total inputs can be added to the input-output transactions table only if the table is in monetary terms, because it is not possible to sum units of different (physical) magnitudes (e.g. monetary values and physical quantities).

[22] The former Leontief formulation assumed that the inter-relationships are expressed in physical terms, by linking physical requirements of inputs and physical requirements of outputs. Leontief also established the equivalence between the physical relationships and the price ones by utilizing input coefficients and (base year) unit prices to convert the physical table to a table in value terms (Leontief, 1951a, 1951b; Miller & Blair, 2009).

[23] As stated by Miller & Blair (2009):

> *"While the physical measure is perhaps a better reflection of one sector's use of another sector's product, there are substantial measurement problems when sectors actually sell more than one good... For these and other reasons, then, accounts are generally kept in monetary terms, even though this introduces problems due to changes in prices that do not reflect changes in the use of physical inputs".*

Duchin & Steenge, 1999)[24]. Therefore, the total output (production) of each sector *i* (X_i) is the sum (through the rows) of the outputs delivered for intermediate and final demand and can be estimated by the output equation (2.1):

$$X_i = \sum_{j=1}^{n} x_{ij} + \sum_{j=1}^{m} y_{ij} \qquad (2.1)$$

Thus, the total output for all sectors can be estimated by the system of *n* linear equations (2.2):

$$\begin{array}{ccccccccccccccccc} x_{11} & + & x_{12} & + & \cdots & + & x_{1n} & + & y_{11} & + & y_{12} & + & \cdots & + & y_{1m} & = & X_1 \\ x_{21} & + & x_{22} & + & \cdots & + & x_{2n} & + & y_{21} & + & y_{22} & + & \cdots & + & y_{2m} & = & X_2 \\ \vdots & + & \vdots & + & \cdots & + & \vdots & + & \vdots & + & \vdots & + & \cdots & + & \vdots & = & \vdots \\ x_{n1} & + & x_{n2} & + & \cdots & + & x_{nn} & + & y_{n1} & + & y_{n2} & + & \cdots & + & y_{nm} & = & X_n \end{array} \qquad (2.2)$$

Additionally, the total input of each sector *j* (X_j) is the sum (through the columns) of the inputs from other productive sectors and primary inputs (or value-added) and can be estimated by an input equation (2.3) (stressing that X_j can only be estimated if the table is ‘totally’ in money values):

$$X_j = \sum_{i=1}^{n} x_{ij} + \sum_{i=1}^{p} z_{ij} \qquad (2.3)$$

Therefore, the total input for all sectors can be estimated by the system of *n* linear equations (2.4):

$$\begin{array}{ccccccccccccccccc} x_{11} & + & x_{21} & + & \cdots & + & x_{n1} & + & z_{11} & + & z_{21} & + & \cdots & + & z_{p1} & = & X_1 \\ x_{12} & + & x_{22} & + & \cdots & + & x_{n2} & + & z_{12} & + & z_{22} & + & \cdots & + & z_{p2} & = & X_2 \\ \vdots & + & \vdots & + & \cdots & + & \vdots & + & \vdots & + & \vdots & + & \cdots & + & \vdots & = & \vdots \\ x_{1n} & + & x_{2n} & + & \cdots & + & x_{nn} & + & z_{1n} & + & z_{2n} & + & \cdots & + & z_{pn} & = & X_n \end{array} \qquad (2.4)$$

In spite of providing an interesting descriptive information source about the interrelations in the structure of a single economy or even for comparisons between economies of different countries, the transactions table cannot be considered in itself as a satisfactory tool for economic analysis purposes[25]. In other words, the transactions table can

[24] If the input-output table is in physical units, it is only possible to sum the outputs.
[25] For example, in the assessment of the effects of exogenous shocks in the economic system.

be seen as the statistical core of the input-output system and the basis for the economic model which will be described in the next section[26] (O'Connor & Henry, 1975; Proops *et al*., 1993).

2.2.2 Technical Coefficients

After preparing the transactions table, the next step in developing the input-output model is to estimate the 'input' or 'technical' or 'technological' coefficient matrix (O'Connor & Henry, 1975). This matrix describes the sectoral technologies in terms of the required inputs per unit of output, i.e., the fraction of the output of sector *i* absorbed by sector *j* per unit of its total output *j* (Leontief, 1985; Duchin & Steenge, 1999). Therefore, considering the assumptions (described in section 1) regarding inputs and outputs is possible to express the inputs to a sector by the linear relations (2.5) and (2.6):

$$a_{ij} = \frac{x_{ij}}{X_j} \qquad x_{ij} = a_{ij}X_j \tag{2.5}$$

$$w_{ij} = \frac{z_{ij}}{X_j} \qquad z_{ij} = w_{ij}X_j \tag{2.6}$$

where a_{ij} is the technical or technological coefficient defined as the delivery from sector *i* to *j* per unit of sector's *j* output and w_{ij} is the technical or technological coefficient defined as the required use of the primary input *i* by the sector *j* per unit of sector's *j* output (Proops *et al*., 1993).

Utilizing the relation in (2.5) it is possible rewrite (2.1) replacing the generic element x_{ij} by $a_{ij}X_j$:

$$X_i = \sum_{j=1}^{n} a_{ij}X_j + \sum_{j=1}^{m} y_{ij} \tag{2.7}$$

From the expression (2.7) (which represents the supply of a generic sector *i*) it is possible to generalize a system of *n* (linear) simultaneous equations (each one describing the distributions of one sectors product through the economy) to represent the productive system of a country as follows[27]:

[26] It is important to stress that even the input-output table can record the transactions between all sectors either in physical or monetary terms, the analysis in the subsequent sections will be presented in physical terms, and otherwise it will be stated.
[27] In the same way, utilizing the relation in (2.5) and (2.6) it is possible rewrite (2.3) replacing the generic element x_{ij} by $a_{ij}X_j$ and z_{ij} by $w_{ij}X_j$ as follows:

$$\begin{array}{ccccccccccccccccc} a_{11}X_1 & + & a_{12}X_2 & + & \cdots & + & a_{1n}X_n & + & y_{11} & + & y_{12} & + & \cdots & + & y_{1m} & = & X_1 \\ a_{21}X_1 & + & a_{22}X_2 & + & \cdots & + & a_{2n}X_n & + & y_{21} & + & y_{22} & + & \cdots & + & y_{2m} & = & X_2 \\ \vdots & + & \vdots & + & \cdots & + & \vdots & + & \vdots & + & \vdots & + & \cdots & + & \vdots & = & \vdots \\ a_{n1}X_1 & + & a_{n2}X_2 & + & \cdots & + & a_{nn}X_n & + & y_{n1} & + & y_{n2} & + & \cdots & + & y_{nm} & = & X_n \end{array} \tag{2.8}$$

This set of linear equations can also be represented in a matrix form (2.9). For simplicity purposes, the final demand components are aggregated in a single total column vector in which each element Y_i represents the total of each final demand row as follows:

$$\begin{bmatrix} a_{11} & a_{12} & \cdots & a_{1n} \\ a_{21} & a_{22} & \cdots & a_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ a_{n1} & a_{n2} & \cdots & a_{nn} \end{bmatrix} * \begin{bmatrix} X_1 \\ X_2 \\ \vdots \\ X_n \end{bmatrix} + \begin{bmatrix} Y_1 \\ Y_2 \\ \vdots \\ Y_n \end{bmatrix} = \begin{bmatrix} X_1 \\ X_2 \\ \vdots \\ X_n \end{bmatrix} \tag{2.9}$$

Equation (2.9) can also be presented in condensed form, as follows:

$$\mathbf{Ax} + \mathbf{y} = \mathbf{x} \tag{2.10}$$

where[28]:

$$\mathbf{A} = \begin{bmatrix} a_{11} & a_{12} & \cdots & a_{1n} \\ a_{21} & a_{22} & \cdots & a_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ a_{n1} & a_{n2} & \cdots & a_{nn} \end{bmatrix} \qquad = \begin{bmatrix} X_1 \\ X_2 \\ \vdots \\ X_n \end{bmatrix} \qquad \mathbf{y} = \begin{bmatrix} Y_1 \\ Y_2 \\ \vdots \\ Y_n \end{bmatrix}$$

This set of equations explicit the dependence of the total outputs of each sector on the inter-industry flows and the final demand (of that sector) in an economic system (Miller & Blair, 2009). If the set of technological coefficients is considered fixed and known, this set of equations can be solved by either specifying the set of total outputs or the set of final demands (Proops *et al.*, 1993). I.e. in the first case, for a given set of total output (and a_{ij} are known

$$X_j = \sum_{i=1}^{n} a_{ij}X_j + \sum_{j=1}^{m} w_{ij}X_j \tag{a}$$

From the expression (a) it is possible to generalize a system of *n* (linear) simultaneous equations to represent the input requirements structure of a country as follows:

$$\begin{array}{ccccccccccccccccc} a_{11}X_1 & + & a_{21}X_1 & + & \cdots & + & a_{n1}X_1 & + & w_{11}X_1 & + & w_{21}X_1 & + & \cdots & + & w_{p1}X_1 & = & X_1 \\ a_{12}X_2 & + & a_{22}X_2 & + & \cdots & + & a_{n2}X_n & + & w_{12}X_2 & + & w_{22}X_2 & + & \cdots & + & w_{p2}X_2 & = & X_2 \\ \vdots & + & \vdots & + & \cdots & + & \vdots & + & \vdots & + & \vdots & + & \cdots & + & \vdots & = & \vdots \\ a_{1n}X_n & + & a_{2n}X_n & + & \cdots & + & a_{nn}X_n & + & w_{1n}X_n & + & w_{2n}X_n & + & \cdots & + & w_{pn}X_n & = & X_n \end{array} \tag{b}$$

[28] The vector **x** is the vector of total output, **y** is the vector of total final demand and **A** is the matrix of technical coefficients.

coefficients), the system will have a possible solution for the *n* unknowns referring to the total final demand of each sector. On the other hand, for a given set of final demand (and a_{ij} are known coefficients), the system will have a possible solution for the *n* unknowns referring to the outputs of each sector (X_1, X_2,…, X_n). The last system has been useful in solving many important practical problems, assessing the impacts from exogenous variations in the final the demand over the outputs (or on the production level of each sector) in an economic system (Miller & Blair, 2009).

2.2.3 Interdependency coefficients

The system of linear equations presented in the previous section is able to estimate the direct impacts (or first order effects) from exogenous variations in the final the demand over the outputs in an economic system. However, variations in the final demand of a specific sector lead to indirect effects throughout the system which can affect the outputs of most (or perhaps all) of the other sectors of the economy. Therefore, instead of using the technical coefficients, other operators known as total or interdependence coefficients are required to study second and higher-order effects (O'Connor & Henry, 1975).

Hence, from (2.8), transferring all the *X*'s to the left-hand side and re-grouping we get (2.11)[29]:

$$\begin{array}{ccccccc}
(1-a_{11})X_1 & -a_{12}X_2 & \cdots & -a_{1n}X_n & = & Y_1 \\
-a_{21}X_1 & (1-a_{22})X_2 & \cdots & -a_{2n}X_n & = & Y_2 \\
\vdots & \vdots & \cdots & \vdots & = & \vdots \\
-a_{n1}X_1 & a_{n2}X_2 & \cdots & (1-a_{nn})X_n & = & Y_n
\end{array} \qquad (2.11)$$

Equations (2.11) can be written in matrix form as:

$$\begin{bmatrix} (1-a_{11}) & a_{12} & \cdots & a_{1n} \\ a_{21} & (1-a_{22}) & \cdots & a_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ a_{n1} & a_{n2} & \cdots & (1-a_{nn}) \end{bmatrix} \begin{bmatrix} X_1 \\ X_2 \\ \vdots \\ X_n \end{bmatrix} = \begin{bmatrix} Y_1 \\ Y_2 \\ \vdots \\ Y_n \end{bmatrix} \qquad (2.12)$$

Thus, considering the structure in (2.10) it is possible to write (2.12) in a condensed form utilizing the identity matrix **I** as follows[30]:

---

[29] As in (2.9) the final demand components are aggregated in a single vector in which each element Y_i represents the total of each final demand row.

$$\mathbf{(I - A)\ x = y} \tag{2.13}$$

Since in the input-output analysis the final demand is usually assumed to be exogenous (or given), it is necessary to rearrange (2.13) to determine the vector of outputs. Thus, both sides are multiplied by $(\mathbf{I} - \mathbf{A})^{-1}$, which is the inverse of $(\mathbf{I} - \mathbf{A})$, to obtain (2.14)[31]:

$$\mathbf{x} = (\mathbf{I} - \mathbf{A})^{-1}\ \mathbf{y} \tag{2.14}$$

This expression is the fundamental matrix representation of input-output analysis, which makes clear the dependence of each of the gross outputs on the values of each of the final demands. The inverse matrix $(\mathbf{I} - \mathbf{A})^{-1}$ is known as the 'Leontief inverse' or the total requirements matrix, in which each ij^{th} element represents the total amount of commodity i required both directly and indirectly to deliver one unit of final demand of commodity j (Duchin & Steenge, 1999; Miller & Blair, 2009). Hence, this matrix shows all direct and indirect requirements for production in the economy, in order to satisfy a certain final demand (Gay & Proops, 1993). The economic meaning of this matrix will be further scrutinized in the next section (Proops *et al*., 1993; Miller & Blair, 2009).

2.2.4 The Leontief Inverse – economic interpretation

The matrix $(\mathbf{I} - \mathbf{A})^{-1}$ as shown in (2.14) is like a 'big black box' apparently without much economic meaning, and it is therefore important to explain its economic meaning (United Nations, 2009). As referred to in the previous section, in input-output analysis, usually an exogenous shock in the final demand[32] of one sector causes a long chain of interaction in the production processes throughout direct and indirect effects. I.e., since the final demand for the output of a specific sector increases, the inputs requirements of that sector will necessarily be increased. Since the inputs in one sector are outputs of other sectors, the increase in the inputs requirements from one sector also causes the increase in the outputs from the supply sectors. As a result, this new round of increases in outputs will affect the

[30] The box containing the a_{ij}'s is referred to a square matrix and can be written as $(\mathbf{I} - \mathbf{A})$.

[31] In this deduction, the inverse of $(\mathbf{I} - \mathbf{A})$ is assumed to exist and is also supposed that matrix $\mathbf{A}$ satisfies the Hawkins-Simon conditions. For a detailed algebra description, see for e.g. O'Connor & Henry (1975), Proops *et al*. (1993) and Miller & Blair (2009).

[32] This assumption is made mainly for the sake of simplicity of exposition. In fact, the first shock can happen anywhere, for example: an increase in domestic production of intermediate consumption to replace imports, an increase in indirect taxes, a change in technology represented by changes in input structures, etc (United Nations, 2009).

inputs from other sectors and so forth, resulting in a chain of interactions that goes into infinity. In summary, direct effects initially result in the requirement for direct inputs which then require a chain of indirect inputs. The sum of all these chained reactions is determined from the value of the 'Leontief inverse' (Barata, 2002; United Nations, 2009).

In order to complement the explanation, it is useful to decompose the direct and indirect effects (i.e. isolating the first order, second order, third order, etc. effects) by considering the progressive incremental outputs to satisfy the increase in net final demand (O'Connor & Henry, 1975). Therefore the total output from the final demand vector, **y**, is the direct (first order) effect plus the indirect (second, third, etc.) effects, which is the sum of the final demand **y** (the direct effect) and rounds 1 to infinity of the progressive incremental outputs (the indirect effects):

$$\mathbf{x} = \mathbf{y} + \mathbf{Ay} + \mathbf{A}^2\mathbf{y} + \mathbf{A}^3\mathbf{y} \ldots \tag{2.15}$$

where: **Ay** is the 'first round' indirect requirement (the incremental output to meet the increase in net final demand); $\mathbf{A}^2\mathbf{y}$ (or $\mathbf{A}(\mathbf{Ay})$) the 'second round' (the incremental output to meet the input requirement of production to meet the increase in net final demand); $\mathbf{A}^3\mathbf{y}$ (or $\mathbf{A}(\mathbf{A}^2\mathbf{y})$) the 'third round' (the incremental output to meet the input requirement of the incremental output of the second round). The number of rounds goes on to infinity.

Using the identity matrix, **I**, it is possible rewriting (2.15) as:

$$\mathbf{x} = (\mathbf{I} + \mathrm{A} + \mathbf{A}^2 + \mathbf{A}^3 \ldots)\, \mathbf{y} \tag{2.16}$$

From (2.14) and (2.16) it is possible to get the following relationship:

$$(\mathbf{I} - \mathbf{A})^{-1} \approx (\mathbf{I} + \mathrm{A} + \mathbf{A}^2 + \mathbf{A}^3 \ldots) \tag{2.17}$$

Hence, it is possible to conclude that the inverse matrix $(\mathbf{I} - \mathbf{A})^{-1}$ is able to capture all the infinite strings of direct and indirect effects on the outputs of the different sectors from an exogenous increase in final demand as do the equivalent round-by-round iterative approach outlined in equation (2.16)[33]. Hence, this matrix is useful to unveil the technological interdependence of the productive system and to delineate the generation of output demand

[33] As referred by O'Connor & Henry (1975) the vector of output **x** obtained by the inverse matrix is effectively the same as that obtained in the iterative approach for a sufficient higher order effect (indeed after five rounds the values are nearly identical).

from final consumption which is part of net final demand throughout the system. It is then possible to estimate what and how the output levels would be required to satisfy certain levels of net final demand (Barata, 2002; United Nations, 2009)[34].

2.2.5 Competitive imports adjustments

In the previous section the basic formulations of the input-output model were shown highlighting the role of the interdependence coefficients in determining the output levels for the different sectors in an economic system as a result of an exogenous shock in the final demand. Since input-output models are usually interested in the consequences *on the domestic* (or regional or local) *economy*, in these formulations it was considered that the inter-sectoral flows are domestically produced and all imports were included in a primary input row (O'Connor & Henry, 1975; Miller & Blair, 2009)[35]. However, treating all imports in a primary input row without any distinction has the disadvantage of concealing its nature. Therefore it is helpful to make a distinction between what are called competitive and non-competitive imports (O'Connor & Henry, 1975).

Imports are generally classified into two categories: "competitive" and "non-competitive" imports (or "competing" and "non-competing")[36]. *Competitive imports* are goods that have a domestic counterpart, i.e. imports of commodities that are also domestically produced or have a close substitute domestically produced. On the other hand, a non-competitive import is one for which there is no domestic counterpart, i.e. imports of commodities that are either not producible or not yet produced in the country (O'Connor & Henry, 1975; United Nations, 2009; Miller & Blair, 2009).

Though various methods are available for incorporating imports into the transactions table (and consequently in the input-output model), probably a helpful option is to allocate the non-competitive imports as inputs to sectors aggregated into a single row[37] in the primary inputs (as it has been considered for convenience in the previous formulations) and the competitive imports included in a special column with negative entries on the right of total final demand as presented in Table 2.2 (United Nations, 2009; Miller & Blair, 2009).

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[34] For a more detailed explanation of the relation between the Leontief Inverse and the round-by-round approach, see Proops *et al*. (1993) and Miller & Blair (2009).

[35] Generally in the preparation of an input-output table exports present no problem, since they are treated as a final demand and are entered (usually at producer prices) in a separate column of this section of the table. However, the treatment of imports requires special mention (O'Connor & Henry, 1975).

[36] The non-competitive imports are also called complementary imports (United Nations, 2009).

[37] In order to show more detail in the input-output table instead of only one row it is possible creating as many rows as there are non-competitive imported commodities (United Nations, 2009).

Table 2.2 - Schematic representation of an input-output table with competitive imports (in algebraic form).

Inputs ➔ / Outputs ➔		**Intermediate Demand**				**Final Demand**				*Competitive Imports*	*Total Outputs*
		Sectors				*Final demand items*					
		1	*2*	...	*n*	*1*	*2*	...	*m*		
Sectors	*1*	x_{11}	x_{12}	...	x_{1n}	y_{11}	y_{12}	...	y_{1m}	$-M_1$	X_1
	2	x_{21}	x_{22}	...	x_{2n}	y_{21}	y_{22}	...	y_{2m}	$-M_2$	X_2
	⋮	⋮	⋮	...	⋮	⋮	⋮	...	⋮	⋮	⋮
	n	x_{n1}	x_{n2}	...	x_{nn}	y_{n1}	y_{n2}	...	y_{nm}	$-M_n$	X_n
Primary Inputs	*1*	z_{11}	z_{12}	...	z_{1n}						
	2	z_{21}	z_{22}	...	z_{2n}						
	⋮	⋮	⋮	...	⋮						
	p	z_{p1}	z_{p2}	...	z_{pn}						
Total Inputs		X_1	X_2	...	X_n						$_{i=1}^{n} X_i = \sum_{j=1}^{n} X_j$

Since imports are treated as being competitive, the intermediate demand contains both (competitive) imported and domestic commodities. Thus, some adjustments are necessary in the input-output model in order to determine the proper level of output from the system, since by definition the imports are not included in the (domestic) output. In order to make the necessary adjustments, firstly the values of each M_i element of the competitive imports vector **m** are deducted from the correspondent row of the final demand vector **y** in equation (2.10). This operation will generate a new vector (**y** – **m**) which is used in the subsequent formulations of the input-output model until obtaining the interdependence coefficients as follows:

$$\mathbf{Ax} + (\mathbf{y} - \mathbf{m}) = \mathbf{x} \Leftrightarrow \mathbf{x} - \mathbf{Ax} = \mathbf{y} - \mathbf{m} \Leftrightarrow (\mathbf{I} - \mathbf{A})\,\mathbf{x} = \mathbf{y} - \mathbf{m} \qquad \mathbf{x} = (\mathbf{I} - \mathbf{A})^{-1}(\mathbf{y} - \mathbf{m}) \qquad (2.18)$$

2.2.6 Prices in input-output model

Since input–output data collected in reality generally refer to values of outputs and inputs and input–output studies are generally carried out in monetary (value) units, it is noteworthy to encompass values with input-output models. Given that 'Value = Quantity x Price', thus an input-output representation of price formation is also possible (Proops *et al.*, 1993).

The original Leontief's input–output model (such as the one presented in the previous section) was developed in physical units and then converted to a model in value terms by using (base year) unit prices. In an open input-output model framework prices are determined from a set of equations, which establish an equality relation between the totals outlays incurred of the production costs (i.e. from intermediate and primary inputs) of a sector with the respective price received per unit of its outputs (Leontief, 1985).

The first step to obtain the price formation in input-output models is to introduce prices into the quantity equations (2.1) and (2.3) in order to 'convert' those equations to value terms. For this purpose a column vector **p** in which each element P_i represents the price (per unit) for the commodities produced in sector *i* and a column vector **r** in which each element R_i represents the remuneration or value (per unit) of the primary input (or non-produced factor) *i* are considered. Thus, applying P_i into the equation (2.3), an output equation expressed in value terms may be written as:

$$P_iX_i = {}_{j=1}^{n} P_i x_{ij} + \sum_{j=1}^{m} P_i y_{ij} \qquad (2.19)$$

This equation can be represented by the set of *n* simultaneous equations (2.20) for the whole economy as follows:

$$\begin{array}{ccccccccccccccccc} P_1x_{11} & + & P_1x_{12} & + & \cdots & + & P_1x_{1n} & + & P_1y_{11} & + & P_1y_{12} & + & \cdots & + & P_1y_{1m} & = & P_1X_1 \\ P_2x_{21} & + & P_2x_{22} & + & \cdots & + & P_2x_{2n} & + & P_2y_{21} & + & P_2y_{22} & + & \cdots & + & P_2y_{2m} & = & P_2X_2 \\ \vdots & + & \vdots & + & \cdots & + & \vdots & + & \vdots & + & \vdots & + & \cdots & + & \vdots & = & \vdots \\ P_nx_{n1} & + & P_nx_{n2} & + & \cdots & + & P_nx_{nn} & + & P_ny_{n1} & + & P_ny_{n2} & + & \cdots & + & P_ny_{nm} & = & P_nX_n \end{array} \qquad (2.20)$$

An input equation expressed in value terms can also be defined from equation (2.4) as:

$$P_jX_j = {}_{i=1}^{n} P_i x_{ij} + \sum_{i=1}^{p} R_i z_{ij} \qquad (2.21)$$

This equation can be represented by the set of *n* simultaneous equations (2.22) for the whole economy as follows:

$$\begin{array}{ccccccccccccccccc} P_1x_{11} & + & P_2x_{21} & + & \cdots & + & P_nx_{n1} & + & R_1z_{11} & + & R_2z_{21} & + & \cdots & + & R_nz_{p1} & = & P_1X_1 \\ P_1x_{12} & + & P_2x_{22} & + & \cdots & + & P_nx_{n2} & + & R_1z_{12} & + & R_2z_{22} & + & \cdots & + & R_nz_{p2} & = & P_2X_2 \\ \vdots & + & \vdots & + & \cdots & + & \vdots & + & \vdots & + & \vdots & + & \cdots & + & \vdots & = & \vdots \\ P_1x_{1n} & + & P_2x_{2n} & + & \cdots & + & P_nx_{nn} & + & R_1z_{1n} & + & R_2z_{2n} & + & \cdots & + & R_nz_{pn} & = & P_nX_n \end{array} \qquad (2.22)$$

Considering the same assumptions as in (2.5) and (2.6) regarding input and output proportionality to define the technical coefficients and substituting those equations in (2.21) and canceling X_j (dividing both sides of the equation by X_j) the input equation becomes:

$$P_j X_j = \sum_{j=1}^{n} P_i a_{ij} X_j + \sum_{j=1}^{m} R_i w_{ij} X_j \qquad P_j = {}_{j=1}^{n} P_i a_{ij} + \sum_{j=1}^{m} R_i w_{ij} \qquad (2.23)$$

This equation can be represented by the set of *n* simultaneous equations (2.24) for the whole economy as follows:

$$\begin{array}{ccccccccccccccccc} P_1a_{11} & + & P_2a_{21} & + & \cdots & + & P_na_{n1} & + & R_1w_{11} & + & R_2w_{21} & + & \cdots & + & R_nw_{p1} & = & P_1 \\ P_1a_{12} & + & P_2a_{22} & + & \cdots & + & P_na_{n2} & + & R_1w_{12} & + & R_2w_{22} & + & \cdots & + & R_nw_{p2} & = & P_2 \\ \vdots & + & \vdots & + & \cdots & + & \vdots & + & \vdots & + & \vdots & + & \cdots & + & \vdots & = & \vdots \\ P_1a_{1n} & + & P_2a_{2n} & + & \cdots & + & P_na_{nn} & + & R_1w_{1n} & + & R_2w_{2n} & + & \cdots & + & R_nw_{pn} & = & P_n \end{array} \qquad (2.24)$$

The price equation (2.23) and the system of simultaneous equations for the price model (2.24) can be rewritten using a condensed matrix representation as follows[38]:

$$\mathbf{p}^T = \mathbf{p}^T\mathbf{A} + \mathbf{r}^T\mathbf{W} \qquad (2.25)$$

where $\mathbf{p}^T$ denotes the transposed of the vector of prices per unit (nx1), **A** the technical coefficient matrix (n×n), $\mathbf{r}^T$ the transposed of the vector of factor costs per unit (p×1), and **W** the matrix of the primary inputs technical coefficients (p×n). Thus, from this expression it is possible to identify that the price (or total cost) of produced commodities depends on the use of intermediate inputs, at the production price ($\mathbf{p}^T\mathbf{A}$), and the value of the non-produced factors (or primary inputs) used ($\mathbf{r}^T\mathbf{W}$) (Proops *et al.*, 1993). I.e. this equation reveals that the price of each commodity can be built up from the prices of all of the inputs that are used to produce that commodity (Barata, 2002).

If the technical coefficients are assumed to be constant and the use of non-produced factors as an exogenous (or given) variable, it will be possible to determine the price (or the cost of production) for each commodity (Cruz, 2002). Thus, reorganizing (2.25) it is possible to obtain (2.26):

$$\mathbf{p}^T = \mathbf{p}^T\mathbf{A} + \mathbf{r}^T\mathbf{W} \qquad \mathbf{p} - \mathbf{p}^T\mathbf{A} = \mathbf{r}^T\mathbf{W} \qquad \mathbf{p}^T(\mathbf{I}-\mathbf{A}) = \mathbf{r}^T\mathbf{W} \qquad \mathbf{p}^T = \mathbf{r}^T\mathbf{W}(\mathbf{I}-\mathbf{A})^{-1} \qquad (2.26)$$

This equation is the general matrix representation of the Leontief input-output price model (or the dual problem of the physical input-output condition), in which prices of the commodities produced are a linear function of the price of the primary factors (or the non-produced commodities) and being entirely independent of demand. In this sense, the dual

[38] Hereafter the superscript letter T jointly used with a vector or matrix indicates the transpose of that vector or matrix respectively.

problem of the input-output model enables to derive the total costs per unit (or price) of each commodity from the knowledge of the primary input cost per unit (Proops *et al.*, 1993; Cruz, 2002). The logic is that primary input price changes lead to changes in sectoral unit costs (and therefore output prices, not output quantities) via the fixed production recipes in matrix **A** (Miller & Blair, 2009)[39]. Therefore, this model can also be considered as a *cost-push input–output price model* and opposed to the *demand-pull input–output quantity model* described in the previous section (Oosterhaven, 1996; Dietzenbacher, 1997). For a further discussion regarding price models' properties and formulations, see e.g. Miller & Blair (2009). For a discussion about the hypothesis of price formation in input-output tables see e.g. Folloni & Miglierina (1994). For a discussion about the relations between the *cost-push input–output price model* and the *demand-pull input–output quantity model* see e.g. Oosterhaven (1996) and Dietzenbacher (1997).

2.3. DYNAMIC INPUT-OUTPUT MODEL

In the previous sections the static input-output model was presented, in which a matrix **A** of technical coefficients derived from the flows of goods (or commodities) between sectors utilized to attend current production needs during a particular period of time is considered. However, some infrastructure, buildings, machinery and equipments that are essential for the production process are not immediately used up during that production process, i.e. a sector has a certain capital stock that is also necessary for production (Miller & Blair, 2009). In addition, the model presented in the previous sections are considered as 'open', in which the investment requirements are fully accounted for as part of final demand and any constraint imposing a consistent relationship between those requirements and the future capacity to produce are not defined (Duchin & Steenge, 1999).

Dynamic input-output models can be formulated in order to represent the demand for capital goods on the part of each producing sector and provides a sectoral detail for the input requirements for resources and products to produce the capital goods, which are also useful to distinguish the technological structures at different points in time (Leontief, 1970; Duchin, 2004). The basic Leontief dynamic model retains many of the features of the static input-output model but at the same time is capable of explaining capacity-expanding investments. This feature is important to get some insights about alternative options available for the

[39] It is important to refer that to achieve simultaneous equilibrium the price vector progressively adjusts through a ('round by round') process similarly to (15).

economic growth and structural changes associated with development (Duchin & Steenge, 1999).

In the basic Leontief dynamic model the vector of investment allocated as a final demand element (in an open static model) is replaced by an expression where investment flows can be calculated using a capital coefficient matrix. I.e. in the dynamic input-output model investment decisions are considered as endogenous (or a closure is considered with respect to investments) (Duchin & Steenge, 1999; Duchin, 2004). The dynamic input-output model is formulated in terms of a difference equation with dated coefficient matrices. A matrix **C** of capital requirements is included in the model, in which each generic element c_{ij} represents the amount of sector *i's* products held as capital stock for production of one unit worth of output by sector *j* (or the quantity of good *i* required to increase the capacity to produce good *j* by one unit) (Duchin & Steenge, 1999; Miller & Blair, 2009). The common assumption behind the dynamic input output model is that the amount of new production from sector *i* for capital stocks in sector *j* in determined time period (*t+1*) will be given by $c_{ij}(X_j^{t+1} - X_j^t)$ (where the superscripts denote time periods, e.g. years). In other words, the amount of sector *i* production necessary to attend the additional demand in sector *j* for goods from sector *i* as capital stocks for the subsequent year's production is obtained by the observed capital coefficient (c_{ij}) multiplied by the change in sector *j* output between the base and subsequent years ($X_j^{t+1} - X_j^t$) (Miller & Blair, 2009)[40]. Thus, considering the relation in (2.7)[41] the typical equation for the output of sector *i* in period *t* can be written as follows:

$$\sum_{j=1}^{n} a_{ij}X_j^t + \sum_{j=1}^{n} c_{ij}(X_j^{t+1} - X_j^t) + Y_i^t = X_i^t \qquad (2.27)$$

or:

$$X_i^t - \sum_{j=1}^{n} a_{ij}X_j^t + \sum_{j=1}^{n} c_{ij}(X_j^{t+1} - X_j^t) = Y_i^t \qquad (2.28)$$

In matrix form, the equation (2.28) can be rearranged to obtain (2.29) as follows[42]:

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[40] Here is assumed that production is at (or close to) the effective capacity in sector *j*, since the anticipated increase in production, if ($X_j^{t+1} - X_j^t$) is positive, requires new capital goods (Miller & Blair, 2009).

[41] It is important to refer that here the final demand deliveries (excluding investments) are aggregated in a total column vector.

[42] From (2.29) it is possible to derive either a "forward looking" expression in which each period's outputs depend on the outputs of the following period (and current period final demand) or a "backward looking" expression in which each period's outputs depend on the outputs from the previous period (and current period final demand). See Miller & Blair (2009) for a description of this formulation.

$$(\mathbf{I} - \mathbf{A})\mathbf{x}_t - \mathbf{C}(\mathbf{x}_{t+1} - \mathbf{x}_t) = \mathbf{y}_t \quad \text{or} \quad (\mathbf{I} - \mathbf{A} + \mathbf{C})\mathbf{x}_t - \mathbf{C}\mathbf{x}_{t+1} = \mathbf{y}_t \tag{2.29}$$

It is noteworthy that (2.29) is a linear system (since the values of the variables are related for different periods of time via the coefficients in **A** and **C** and the final demand) that could still be represented by a matrix and its inverse. However, this version of the model has features that limit its usefulness for empirical investigation, since this approach requires that matrix **C** be nonsingular and, in fact, the singularity of C matrix cannot in general be assured (Duchin, 2004; Miller & Blair, 2009)[43]. In addition, capacity is assumed to be fully utilized during each period. This constraining assumption is relaxed in the Duchin & Szyld (1985) specification, but the new model introduced a non-linearity by allowing for unused capacity when output is falling (Duchin, 2004)[44].

In spite of the advantages of the dynamic formulation in prospective analysis by accounting time variability of capital goods, the non-singularity limitation and the non-linearity of the alternative formulation proposed by Duchin & Szyld (1985) turns difficult its application to the linear model proposed in Chapter 5. Furthermore, the empirical implementation of a dynamic model often requires the analyst to deal with changing input structures and, in some cases, it is necessary to develop a number of different scenarios. However, constructing the projections of all exogenous variables and parameters for each scenario poses a substantial challenge, since technical information on input structures coming from a wide variety of sources are required and these data may not be available (Duchin & Steenge, 1999). These drawbacks have also influenced the decision in applying an open static formulation in this study instead of a dynamic one.

2.4. INPUT-OUTPUT ANALYSIS AND THE SYSTEM OF NATIONAL ACCOUNTS

The transactions table of the input-output system described in the previous sections can be derived from the System of National Accounts (SNA) framework. The SNA consists of '*a comprehensive, consistent and flexible set of macroeconomic accounts, balance sheets and tables based on a set of internationally agreed concepts, definitions, classifications and accounting rules*', which has been useful to meet the needs of government and private-sector analysts, policy makers and decision takers (United Nations, 1993, 2009).

[43] For a further discussion about the problems issues, see Steenge (1990).
[44] Applications of this model can be found in Leontief & Duchin (1986) and Costa (1988). For a discussion of the stability of this non-linear dynamic formulation see e.g. Fleissner (1990).

As previously referred to the SNA framework includes flow accounts and balance sheets, as well as an integrated set of Supply and Use tables (or matrices). The Supply and Use tables draw upon detailed data from industrial censuses or surveys providing an accounting framework regarding the domestic and imported origins of supplies of different kinds of goods and services (commodities) and how those supplies are allocated between the intermediate or final demand (United Nations, 2009).

The Supply table describes the supply of commodities to the economy by the different sectors, i.e. it shows both the value of different goods and services produced in every industry in the economy measured at basic prices and the total supply of every commodity in both basic prices and purchasers' prices[45]. The Use table describes the use of commodities and other primary factors by different sectors, as well as the derivation of value added. The Use table shows both the "cost of production" in every sector and the use of every commodity at purchasers' prices in the economy. The basic principles in deriving these two tables are that the total supply of every commodity must be equal to the total use of that commodity (when measured in the same price) and the output of a sector must be equal to its cost of production. These two principles are used in balancing the Supply and Use tables (United Nations, 1999).

The Supply and Use tables (which can be considered a special non-symmetric format of the input-output table) also provide the basic information for the derivation of symmetric input-output tables [46]. Some modifications are necessary in order to suit the Supply and Use tables to the characteristics of an input-output transaction table. The basic version of the Use matrix usually considers the total value of goods and services in the intermediate and final demand without distinguishing between domestic and imported production. Since the input-output model is used to estimate the impacts on the production level from exogenous shocks in the final demand of national products, it is necessary to breakdown the intermediate and final demand according to its origins.

Other important modification to suit those matrices for an input-output model regards the derivation of tables at basic prices from the Make and Use matrices[47]. Since the technical

[45] A discussion about the set of prices utilized in the System of National Accounts framework will be presented later in this section.

[46] This set of tables may be used for various statistical and analytical purposes. They provide a framework for: checking the consistency of statistics on flows of goods and services obtained from diversified statistical sources; ensuring the consistency of the definitions and classifications; ensuring the numerical consistency of data drawn from different sources; calculating much of the economic data contained in the national accounts and detecting weaknesses. As an analytical tool, input-output data are useful for macroeconomic models in order to analyze the relations between final demand and output levels (United Nations, 1993).

[47] Usually the Use matrix is valued at consumer prices.

coefficients of the input-output model describe the relationship between the quantities consumed and produced, the tables at basic prices are useful to homogenize[48] the values and diminish the effects of other price components. I.e. the tables at basic prices exclude taxes, subsidies and distribution margins on products (from the tables at consumer prices), which are subject to variations not related to the production process. For this purpose the tables at consumer prices have to be transformed by deducting the amounts regarding trade and transport margins, as well as the taxes and subsides (IBGE, 2000).

The *Instituto Brasileiro de Geografia e Estatística* (*IBGE*)[49] has provided a set of input-output tables valued at consumer and basic prices for both national and imported products. These matrices are useful to overcome the need of decomposition regarding the origins of the production, as well as the effects of non-productive inputs. It is important to stress that in this work the input-output tables provided by Guilhoto & Sesso Filho (2010) will be used as basis of the development of the model presented in Chapter 5, since they are more recent than the last official input-output system recorded by *IBGE*. In addition, Guilhoto & Sesso Filho (2010) provide a more complete set of input-output tables including intermediate and final demand matrices for different taxes and distribution margins, which is useful for the development of the model proposed in this study. In Table 2.3 the set of matrices published by *IBGE* and Guilhoto & Sesso Filho (2010) are outlined, which are based on the National Accounts System. Two additional matrices to represent the distribution (trade and transport) margins for intermediate and final demand provided by Guilhoto & Sesso Filho (2010) are also included in Table 2.3:

Table 2.3 – Basic composition of the information from the Brazilians Make and Use tables.

	Commodities	Sectors	Final Demand	Total output
Sectors	**V**			**x**
Commodities (National)		**Un**	**Yn**	**q**
Value added		**z**		

[48] Since the same goods and services can be measured by different price systems in the market and since homogeneity is one of the most important underlying assumptions of input-output economics, it is recommended measuring the products as homogeneously or uniformly as possible in the system of input output tables. Therefore, there is a preference for a valuation at basic prices over producers' prices, since the former provides the most homogeneous valuation along the rows; it is the most useful when a system of VAT or similar deductible tax is in operation; and it records the amounts available to the producer. Producers' prices may be used when valuation at basic prices is not feasible, since it is more homogeneous than purchasers' prices (United Nations, 1999, 2009).

[49] The governmental institute responsible for the compilation and reproduction of official statistical data in Brazil.

Total output	$\mathbf{q}^T$	$\mathbf{x}^T$		
Commodities (Imports)		**Um**	**Ym**	
Commodities (Taxes – subsidies)		**Ut**	**Yt**	
Commodities (Distribution margins)		**Ud**	**Yd**	
employees		**e**		

where:

V – Production (or Make) (sector by commodities) matrix at basic prices, in which each element v_{ij} shows the value of the output of commodity *j* that is produced 'domestically' by sector *i*;

x – Column vector with the total output of each sector at basic prices;

Un – Matrix (commodity by sector) of the National intermediate consumption at basic prices, in which each element un_{ij} shows the domestic inputs of each commodity *i* by each sector *j*;

Yn – Matrix of final demand for domestic commodities at basic prices (shows the value of inputs of domestic origins consumed in the *m* categories of final demand[50]);

q – Column vector with the total output by product (or commodity) at basic prices;

z – Row vector with the total value added generated by each sector[51];

Um – Matrix (commodity by sector) of imported intermediate consumption at FOB prices, in which each element um_{ij} shows the imported inputs of each commodity *i* by each sector *j*;

Ym – Matrix of final demand for imported commodities at FOB prices (shows the value of commodities of external origins consumed in the *m* final demand elements);

Ut – Matrix (commodity by sector) that shows the allocation of taxes and subsidies in the intermediate demand. Here each element ut_{ij} shows taxes and subsidies regarding each commodity *i* in each sector *j*;

Yt – Matrix of taxes and subsidies on the final demand (shows the allocation of taxes and subsidies on products consumed by the *m* final demand elements);

Ud – Matrix (commodity by sector) that shows the allocation of distribution margins in the intermediate demand. Each element ud_{ij} shows the distribution margins regarding each commodity *i* in each sector *j*;

[50] Consumption of general government, consumption of non-profit institutions serving households, consumption of households, exports, gross fixed capital formation and stock changes.

[51] For reasons of simplification, the value added is considered as a vector. However, in practice it is a Matrix with a row per each sector which contains: the value added at factors cost and basic prices; wages, which includes wages and social contributions; gross operating surplus (obtained by balance); and taxes and subsidies on production by sectors.

Yd – Matrix of distribution margins on the final demand (a matrix that shows the allocation of distribution margins on products consumed by the *m* final demand elements);

e – An additional row vector with the total (formal and informal) employees in each sector is also provided in the input output tables of IBGE and Guilhoto & Sesso Filho (2010). However, a new row vector with only total formal employees by each sector was derived from the Brazilian official employee database to be utilized in the model proposed in Chapter 5, in order to overcome the inability of the model in capturing the substitution process between formal and informal employees overtime.

It is important to refer that three different price concepts are used in the System of National Accounts to value the inputs and outputs depending upon how taxes and subsidies on products, and also transport charges, are recorded, as follows[52]:

a) Basic prices = cost of goods and services used in the production process + remuneration of production factors + other taxes on production – other production subsidies;

b) Producers' prices = Basic prices + taxes on products excluding invoiced *Value Added Taxes* (VAT) (or similar deductible tax) - subsidies on products;

c) Purchasers' prices = Producers' prices + VAT not deductible by the purchaser + trade and transport margins (Henriques, 2008; United Nations, 2009)[53].

The exports and imports of commodities are usually valued according to international standards at the exporter's customs frontier, i.e. at the point of exit from the exporter's economy and computed as free-on-board (FOB) price. Border valuation of commodities has consequences for the recording of freight and insurance in the System of National Accounts. Therefore, the values of imports have to be adapted in order to obtain imports valued at prices

[52] According to the United Nations (2009) definition:

*"The **basic price** is the amount receivable by the producer from the purchaser for a unit of a good or service produced as output minus any tax payable, and plus any subsidy receivable, on that unit as a consequence of its production or sale. It excludes any transport charges invoiced separately by the producer. The **producer's price** is the amount receivable by the producer from the purchaser for a unit of a good or service produced as output minus any VAT, or similar deductible tax, invoiced to the purchaser. It excludes any transport charges invoiced separately by the producer. The **purchaser's price** is the amount paid by the purchaser, excluding any VAT or similar tax deductible by the purchaser, in order to take delivery of a unit of a good or service at the time and place required by the purchaser. The **purchaser's price** of a good includes any transport charges paid separately by the purchaser to take delivery at the required time and place".*

[53] The VAT (or similar deductible taxes) system has blurred the traditional concept of the "market" price, because there may be two different prices for a single transaction according to seller's or purchaser's point of view depending upon whether or not the tax is deductible. Therefore, it is recommended in the System of National Accounts to avoid the term "market prices" when referring to the value added, which is specified according to a specific price system (basic, producers' or purchasers' prices) to avoid ambiguity (United Nations, 2009).

at the point of entry into the importing economy, i.e. at the importer’s customs frontier and computed as cost, insurance and freight (CIF) price. For this purpose some global CIF/FOB adjustments are made in the scope of the Supply and Use tables. Other adjustments have also to be taken in both the Supply and the Use tables for: trade and transport margins, purchases of residents abroad and purchases of non-residents at home. For a detailed overview of this adjustments see e.g. United Nations (1999, 2009) and IBGE (2008).

The Supply and Use tables are not usually computed as (or required to be) square matrices and generally have a rectangular form, in which the number of commodities may be more than the number of sectors (industries) and vice versa. For that reason, two methods have been used to combine the Supply and Use matrices mathematically in order to obtain the traditional symmetric (or square) input-output matrix, since only a square matrix can be inverted to obtain the Leontief inverse. These methods are based on either the commodity technology assumption or the industry (or sector) technology assumption, in which both product-by-product or industry-by-industry matrices can be generated.

The commodity technology assumption assumes that a given product is produced by the same technology with the same input structure no matter the sector in which it is produced. On the other hand, the industry technology assumption assumes homogeneity in the input structure, i.e. inputs are consumed in the same proportions by every (principal and secondary) product produced by a given industry, which uses the same technology (United Nations, 1999).

The commodity technology assumption is thought economically more reasonable than the industry technology assumption, but the latter is attractive because the method always generates positive symmetric input-output tables that are not guaranteed in the former (which can also requires additional methods to adjust the data) (United Nations, 1999). Since the number of commodities is greater than the number of sectors in the Brazilian Supply and Use matrices, the model calculations have to be restricted to the industry technology assumptions (IBGE, 2000).

According to IBGE (2000) there are no implicit properties that allow considering either formulation superior between them and only the objectives of the study indicate which of the two should be used. Hence, in the model presented in Chapter 5, the simple sector technology model without considering byproducts is utilized. The methods and procedures used in this study to combine the Supply and Use matrices mathematically in order to obtain the traditional symmetric (or square) input-output matrix will be presented in Appendix B.

In spite of the derivation of the symmetric input-output tables, the Supply and Use tables are also a useful device to estimate the economic aggregates. In the input-output framework the value added can be measured according to different price systems. Firstly, it is important to stress that the value added can be classified as gross value added (defined as the value of output less the value of intermediate consumption) or net value added (defined as the value of output less the values of both intermediate consumption and consumption of fixed capital). Since only the gross value added will be estimated in the scope of this study, the following explanation will be restricted to this account, although the corresponding conclusions for net value added can be made in a similar way.

The gross value added at basic prices can be computed by the sum of the primary inputs at factor cost (compensation of employees, other taxes less subsidies on production, gross mixed incomes and gross operating surplus) from each sector or defined as the total output valued at basic prices less the total intermediate consumption valued at purchasers' prices. The gross value added at producers' prices is calculated by subtracting the total intermediate consumption of each sector at purchasers' prices from its output valued at producers' prices or summing to the gross value added at basic prices the taxes on products excluding invoiced *Value Added Taxes (VAT)* (or similar deductible tax) and subtracting the subsidies on products[54]. In spite of not being a concept explicitly used in the System of National Accounts, the gross value added at factor cost can be derived from gross value added at basic prices by subtracting other taxes less subsidies on production (United Nations, 2009). In the Brazilian input-output system, the gross value added is computed at basic prices. This economic aggregate is useful to measure other important economic concept, the Gross Domestic Product (GDP).

The input-output framework is useful to account the GDP at purchasers' prices according to three different approaches: expense, production and income. In the expense approach GDP is estimated by the sum of the final demand components measured at purchasers' prices, less the value of imports of goods and services. In the production approach the GDP is estimated by the total output at basic prices less the intermediary consumption at

[54] As referred to by United Nations (2009):

> *"In the absence of VAT, the total value of the intermediate inputs consumed is the same whether they are valued at producers' or at purchasers' prices, in which case this measure of gross value added is the same as one that uses producers' prices to value both inputs and outputs. It is an economically meaningful measure that is equivalent to the traditional measure of gross value added at market prices. However, in the presence of VAT, the producer's price excludes invoiced VAT, and it would be inappropriate to describe this measure as being at 'market' prices".*

consumers' prices (or the gross value added at basic prices) plus the total of taxes on products, less subsides on products which are not included in the production. In the income approach the GDP is estimated by the sum of the primary incomes distributed by resident producer units, i.e. the total of primary inputs (or the gross value added at basic prices) and the total of taxes less subsides on products which are not included in the production (IBGE, 2000; United Nations, 2009).

2.5. FINAL REMARKS

The usefulness of input-output analysis regards the analytical and modeling framework provided to explore direct and indirect structural interactions in the economy in a detailed level such as sectors or commodities. In addition, input-output tables can be considered as an important statistical data source for most countries and also a useful tool in the construction and checking processes of economic statistics and national accounts. Furthermore, the dual relationship between prices and quantities in the input-output model provides a powerful tool to investigate the influences on the supply and/or the demand of specific sectors (Cruz, 2002; Barata, 2002).

The input-output methodology is an interesting and flexible tool for the theoretical or empirical investigation of a wide range of applications encompassing the analysis of more aggregated or disaggregated systems, depending on the objectives of the study (Barata, 2002). Indeed, input-output analysis has been applied for a variety set of specific problems such as inflation, energy, transportation requirements, environmental pollution (e.g. Leontief, 1973), disarmament and military spending (e.g. Leontief & Hoffenberg, 1961), depletion of non-fuel mineral resources (e.g. Leontief *et al*., 1983), impacts on the employment (e.g. Leontief & Duchin, 1986), among others. This methodology has been applied at different micro and macro level of analysis (Hawdon & Pearson, 1995; Proops *et al*., 1993; Barata, 2002; Cruz, 2002), such as:

- *National economic planning*: analyzing direct and indirect impacts from changes in certain elements of the economic system; analyzing the consequences in the entire economy from policies implemented at a sectoral level; and the effects of different policy measures for selected scenarios[55] (Ciaschini, 1988; Førsund, 1985; Pearson, 1989).

[55] The formulation of scenarios faces some limitations regarding the database and the mathematical formulation of the model used (Duchin & Steenge, 1999). This problem can be overcome by appropriate models and data

- *Regional planning*: in the assessment of region's dependence on its internal and external resources, allowing to demonstrate the trade-offs between national and regional policies, i.e. analyzing contrasting effects of policies at the national and regional level, since they can lead to different impacts in each one (O'Connor & Henry, 1975).
- *Analysis of a specific sector*: analyzing the factors influencing the supply and/or demand for certain sectors; studying the interrelationship of sub-sectors of an industry; for planning purposes regarding project plans and resource requirements (O'Connor & Henry, 1975; Cruz, 2002).
- *Study of company's economy*: characterizing the production techniques used in a specific company in order to study the impacts from changes in the prices of inputs, the technical production or final demand (Brito, 1985; Henriques, 2008);

On the other hand, some limitations in the input-output model can also be identified mainly regarding to the assumptions and simplifications of the model. As referred to in a previous section, input-output analysis establishes a set of assumptions such as fixity of coefficients, constant returns to scale, homogeneity of production, as well as exogenous final demand (despite infinite and perfectly elasticity of the supply are also considered). These assumptions impose a set of criticism about the exclusion of joint production, the uniqueness of technological process to each sector, capacity of economic agents in responding to exogenous shocks and the 'smoothness' of the equilibrium condition in assuring only the balance between supply and demand (Barata, 2002).

However, as referred to by Bickneel *et al*. (1998) "*assumptions only become limitations when they compromise the integrity of the conclusions that are being drawn from the research*". Thus, it is possible or to eliminate some of these problems or to avoid them applying some adjustments (Cruz, 2002). Hence, while the homogeneity assumption possibly has some impacts for an application of the input-output model to a particular firm or product, there may not impose a strict limitation at a macro-level (Bickneel *et al*., 1998). In addition, establishing no substitution between factors and the time invariability of the technology can restrict input-output models to short-run economic analysis, since assuming the input-output coefficients as the same in medium-long term can be considered a strong assumption (Zhang & Folmer, 1998)[56]. However, the model could be suitable for such medium-to-long term

developed for a specific application in which the implications of each scenario are analyzed and can be compared with reference to multiple attributes (Barata, 2002).

[56] Even though technological options for short-term are generally limited and probably do not allow significant substitutions in inputs, in the long-term probably an industry will have the opportunity to choose among different

analysis, if such limitations are overcome by some updating mechanisms that are able to introduce or forecast the changes in the technological coefficients (Proops *et al*., 1993). In this context it is also important to refer that if in a model used for long-run studies the choice of technology is endogenous, it is necessary to describe the *ex-ante* production function, such as the difference between production with a technology that is already installed (*ex-post* production function) and the choice among several technologies that could be installed (*ex-ante* production function). Nevertheless, if the long-run options are described with exogenous technology scenarios the input-output production function can be sufficient (Wilting *et al*., 2004).

Furthermore, the requirements for detailed and comprehensive data can also be a limitation to the model, since data is always subject to error (and the errors can be multiplicative) and cannot be accurate in some extent. In addition, the time lag associated with the publication of input-output tables can limit the potential of the model, since radical changes in the economic system may occur in a faster way skewing the information for practical policy decisions (Speck, 1994; Barata, 2002). Usually input-output data aggregates diverse individual firms in a sector considering 'average' prices and commodities, which smudge the determination of adequate demand and/or supply functions. However, some methods exist considering input-output rectangular matrices in which a sector producing more than one commodity can be considered (see e.g. Stone (1961, 1966)).

In sum up, in this chapter some basic concepts and assumptions underlying the input-output models were briefly presented in order to outline the most important characteristics and a critical analysis of its suitability for policy analysis. In fact, despite some limitations described above, the most important feature of the input-output methodology regards to its practicality and usefulness as an analytical tool for empirical research supporting the policy making in a wide variety of problems. Furthermore, as will be shown in the next chapter, the possibility of extending and integrating the input-output modeling with other methods in order to assess the interactions between the economic activities, energy requirements and the environment is particularly appealing to the subject of our research. Thus, a brief literature review of the main contributions to the environmental and energy extensions of the basic input-output modeling, as well as the integration of the input-output framework with other

technological options with different input structures. Thus, for a long-run study it is desirable to incorporate technological changes in the input-output model (Wilting *et al*., 2004).

methods such as mathematical programming models and Life Cycle Analysis (with emphasis in the bioethanol production) will be presented in the following chapter.

CHAPTER 3 EXTENSIONS OF INPUT-OUTPUT MODEL AND HYBRID METHODS

In the previous chapter the basic input-output framework was presented, which has been traditionally used to study the inter/intra-relationships among different sectors in the economic system (Leontief, 1985; Miller & Blair, 2009). Some extensions and combination of this model with other methods have been developed in order to broad its application to different topics, such as energy and environmental issues. This chapter offers a succinct overview of the basic foundations and contributions regarding some input-output models to deal with both environmental and energy issues, as well as the relationships between the input-output model with other methods such as Life Cycle Analysis and linear programming[1].

[1] Detailed surveys of environmental input-output models, with many references, including theoretical extensions and applications are provided, e.g., by: Richardson (1972), Victor (1972), Johnson & Bennet (1981), Førsund (1985), Pearson (1989), Huang *et al*. (1994), Hawdon & Pearson (1995), Duchin & Steenge (1999) and Miller & Blair (2009). Detailed surveys of energy input-output analysis are presented, e.g., by: Casler & Wilbur (1984) and Miller & Blair (2009).

Thus, a brief review of the literature concerning environmental input-output modeling will be presented in section 3.1, while the consideration of energy issues in the input-output framework will be outlined in section 3.2. Furthermore, the interactions between the input-output framework and linear programming will be summarized in section 3.3, while some concluding remarks will be made in section 3.4.

3.1 ENVIRONMENTAL INPUT-OUTPUT MODEL

The development of extensions of input-output models has allowed modeling complex systems regarding economic and physical relations (Hawdon & Pearson, 1995). Cumberland (1966) is recognized as one of the first studies regarding input-output models that incorporate economic and environmental interactions (Victor, 1972). Basically, in the model proposed by Cumberland (1966) extra rows and columns are added to the traditional input-output table to account for environmental cost and benefits associated with the economic activity and distribute these by sectors (Victor, 1972; Richardson, 1972; Huang *et al.*, 1994; Duchin & Steenge, 1999). The study of Ayres & Kneese (1969) is also recognized as a seminal contribution underlying the environmental analysis in the input-output framework (Victor, 1972). The main feature of this model is attempting to incorporate externalities into a Walrasian general equilibrium model. Based upon the 'First Law of Thermodynamics', this study introduced the fundamental idea of 'materials balance' in which it is established that all environmental resources extracted and used in the economy are accounted for by remaining within the economy system (as durable goods, recycled inputs, etc.) or disposed of in the environment as residuals (Førsund, 1985). The major contribution of this consideration is the concept of 'closed-flow' of environmental impacts, in which the environmental externalities are an ever-present by-product of the consumption and production process (Barata, 2002).

According to Miller & Blair (2009) the vast numbers of input-output environmental models can be categorized as: generalized input-output models, which include additional rows and columns within the input-output system to incorporate the environmental impacts (Leontief, 1970, 1973; Munksgaard & Pedersen, 2001); economic ecological-models, which utilize intra/inter-sector sub-matrices linking the economic and environmental sectors (Daly, 1968; Isard *et al.*, 1972); and commodity by industry models, which consider the ecological commodities as products (Victor, 1972). The input-output environmental modeling framework can also be extended in order to incorporate the environmental impacts in the traditional input-output framework following a different approach (see Yabe, 2004; Lin &

Sun, 2010). According to this method an external expansion of the input-output model is made, in which the environmental impacts are estimated by assuming a proportional relation between the output of the sectors and the corresponding impact levels (Hendrickson *et al*., 2006; Suh & Huppes, 2005). Some of those models will be briefly discussed in the next sections.

3.1.1 Generalized input-output model

The generalized input-output models, also referred to as 'pollution generation-elimination models' or 'augmented Leontief models', stem from the seminal studies of Leontief (1970, 1973) and Leontief & Ford (1972). The main feature of these models is the introduction of pollution generation and abatement/eliminating sectors into the traditional input-output framework through additional rows (in physical units) and columns in the technical coefficients matrix. This model allows the estimation of the output level of pollutants associated with any vector of final demand considering the pollutants as a function of each industry's output (Cruz, 2002; Barata, 2002).

In the basic version of the generalized input-output model the outputs of pollutants are accounted in physical units, while the other entries are accounted in monetary values. In this model pollution-eliminating coefficients represent the inputs to pollution-elimination activities by unit of pollutant eliminated into the pollution-eliminating sectors, while the pollution generation ones correspond to the (physical) quantity of a specific pollutant generated by unity worth of industrial sectors output (Leontief, 1970; Victor, 1972). Due to the hybrid unit features of the matrices only the rows sums are obtainable (even when the table is represented in monetary flows), since the incommensurability of (physical and monetary) units in the different column 'terms' is verified (Gloria, 2000). It is also important to refer that rows for the outputs of the pollution-eliminating sectors are not accounted for, since the output of those sectors are used to compensate the overall economic pollution, and therefore are not used as input in other sectors (Cruz, 2002). On the other hand, as referred to by Leontief (1970) prices for commodities and abatement services can be calculated if the expenses of each industry with goods and externalities are taken into account. Therefore, if the prices of the all economic and pollutant outputs are accounted for, the whole augmented input-output framework can be valued at monetary units (Henriques, 2008).

Table 3.1- Generic schematic representation of the augmented input-output table to include the generation and elimination of pollutants[2]

Inputs ↓	Outputs →	Intermediate Demand								Final Demand				Total Outputs
		Economic Sectors				*Pollution-eliminating Sectors*				*Final demand items*				
		1	*2*	...	*n*	*1*	*2*	...	*k*	*1*	*2*	...	*m*	
Economic Sectors	*1*	a_{11}	a_{12}	...	a_{1n}	h_{11}	h_{12}	...	h_{1k}	y_{11}	y_{12}	...	y_{1m}	X_1
	2	a_{21}	a_{22}	...	a_{2n}	h_{21}	h_{22}	...	h_{2k}	y_{21}	y_{22}	...	y_{2m}	X_2
	⋮	⋮	⋮	...	⋮	⋮	⋮	...	⋮	⋮	⋮	...	⋮	⋮
	n	a_{n1}	a_{n2}	...	a_{nn}	h_{n1}	h_{n2}	...	h_{nk}	y_{n1}	y_{n2}	...	y_{nm}	X_n
Pollutants	*1*	g_{11}	g_{12}	...	g_{1n}	f_{11}	f_{12}	...	f_{1k}	r_{11}	r_{12}	...	r_{1m}	T_1
	2	g_{21}	g_{22}	...	g_{2n}	f_{21}	f_{22}	...	f_{2k}	r_{21}	r_{22}	...	r_{2m}	T_2
	⋮	⋮	⋮	...	⋮	⋮	⋮	...	⋮	⋮	⋮	...	⋮	⋮
	k	g_{k1}	g_{k2}	...	g_{kn}	f_{k1}	f_{k2}	...	f_{kk}	r_{k1}	r_{k2}	...	r_{km}	T_k
Primary Inputs	*1*	w_{11}	w_{12}	...	w_{1n}	l_{11}	l_{12}	...	l_{1k}	-				-
	2	w_{21}	w_{22}	...	w_{2n}	l_{21}	l_{22}	...	l_{2k}					
	⋮	⋮	⋮	...	⋮	⋮	⋮	...	⋮					
	p	w_{p1}	w_{p2}	...	w_{pn}	l_{p1}	l_{p2}	...	l_{pk}					
Total Inputs		X_1	X_2	...	X_n	S_1	S_2	...	S_k	-				-

For the generic representation of a version of the classical environmental augmented input-output model presented in Table 3.1, columns of pollution-eliminating sectors and rows of pollutant outputs are included into the schematic representation presented in Table 2.1. For this purpose, definitions (2.5) and (2.6) are considered, as well as additional matrices and vectors are also defined as follows[3]:

H – direct input coefficient matrix of the pollution-eliminating sectors in which each generic element h_{ij} represents the inputs of commodities of the economic sector i ($i = 1,\dots,n$) per unit of pollutant eliminated into the pollution-eliminating sector j ($j = 1,\dots,k$) (positive value) or commodity outputs of pollution-eliminating sectors j utilized in the economic sector i per unit of pollutant eliminated into the pollution-eliminating sector j (negative value);

G – an industry direct pollutant coefficient matrix in which each generic element g_{rj} represents the outputs of pollutant r ($r = 1,\dots,k$) per output unit of the economic sector j

[2] For reasons of simplicity, as stated before in the schematic layout of the Table 1, the quadrant which usually records the primary inputs delivered directly to the final demand sectors will be also considered as null in this schematic layout.

[3] For a more detailed description of this model see for e.g. Leontief (1973), Pan & Kraines (2001) and Henriques (2008).

(positive value) or the input of pollutant r per unit of the economic sector j ($j = 1,\ldots,n$) output (negative value);

F – a matrix of pollutant reduction coefficients of the pollution-eliminating sectors in which each generic element f_{rj} represents the output of pollutant r per unit of pollutant eliminated into the pollution-eliminating sector j (negative values) or the amount by which pollutant r is reduced per unit of pollutant eliminated into the pollution-eliminating sector j (positive values);

R – a matrix of pollutants of the final demand items in which each generic element r_{rl} represents the outputs of pollutants r by the final demand items l (positive physical values);

L – a matrix of direct coefficients of primary inputs of the pollution-eliminating sectors in which each generic element l_{ij} represents the primary factor inputs i ($i = 1,\ldots,p$) per unit of pollutant eliminated into the pollution-eliminating sector j (positive values);

t – a vector in which each generic element T_r accounts the net outputs of pollutant r;

s – a vector in which each generic element S_j accounts the total of pollutant j eliminated by the pollution-eliminating sector j; $\mathbf{s}^{T}$ is a transposed vector of **s**;

Thus, it is possible to establish the equilibrium equations (3.1) and (3.2) of the monetary and physical spheres of the augmented input-output model presented in Table 3.1 as follows[4]:

$$\mathbf{Ax} + \mathbf{Hs}^{\mathbf{T}} + \mathbf{y} = \mathbf{x} \tag{3.1}$$

$$\mathbf{Gx} + \mathbf{Fs}^{\mathbf{T}} + \mathbf{r} = \mathbf{t} \tag{3.2}$$

It is noteworthy that the sum of ($\mathbf{Gx} - \mathbf{Fs}^{\mathbf{T}}$) is supposed to be less than or equal to **Gx** in order to reflect the effect of the pollution-eliminating sectors on reducing the total pollutant emissions to the environment (Pan & Kraines, 2001). Nevertheless an important drawback of this model is neglecting material inputs from the environment to the economy and interrelationships within the environment itself, making no use of the materials balance principle (Cruz, 2002; Barata, 2002). This fact points out that this approach can be considered only as a partial economic environmental account framework (Johnson & Bennett, 1981). In addition, due to intricate task of compiling **H** and **F** matrices, empirical applications of this model are limited (Allan *et al.*, 2004).

[4]As in (9) the final demand components are aggregated in a single total column vector **y**. The same procedure is applied to the matrix of pollutants of the final demand items **R** obtaining a total column vector **r**.

3.1.2 Economic-ecologic input-output models

Daly (1968) and Isard *et al*. (1968, 1972) have been recognized as the first studies in the so-called (fully integrated) economic-ecologic input-output model category (Victor, 1972; Miller & Blair, 2009). The main feature of both studies is to combine input-output flows within and between the economic and environmental systems (Huang *et al*., 1994; Pearson, 1989). Both studies augmented the basic input-output framework including ecosystem sub-matrices, where flows are recorded within and between economic and ecological sectors, in a scope similar to the typical interregional input-output models (Miller & Blair, 2009). Those models can be generically represented by the Tables 3.2 and 3.3, respectively.

Table 3.2- Generic schematic representation of the economic-ecologic input-output model of Daly (1968).

Inputs ↓	Outputs ➔	*Economic Sectors*				*Ecologic Processes*			
		1	*2*	...	*n*	*1*	*2*	...	*k*
	1	x_{11}	x_{12}	...	x_{1n}	$h^{\#}_{11}$	$h^{\#}_{12}$	...	$h^{\#}_{1k}$
Economic Sectors	2	x_{21}	x_{22}	...	x_{2n}	$h^{\#}_{21}$	$\dot{e}_{22}$	...	$h^{\#}_{2k}$
	⋮	⋮	⋮	...	⋮	⋮	⋮	...	⋮
	n	x_{n1}	x_{n2}	...	x_{nn}	$h^{\#}_{n1}$	$h^{\#}_{n2}$	...	$h^{\#}_{nk}$
	1	$g^{\#}_{11}$	$g^{\#}_{12}$	...	$g^{\#}_{1n}$	$f^{\#}_{11}$	$f^{\#}_{12}$	...	$f^{\#}_{1k}$
Ecologic Processes	*2*	$g^{\#}_{21}$	$g^{\#}_{22}$	...	$g^{\#}_{2n}$	$f^{\#}_{21}$	$f^{\#}_{22}$	...	$f^{\#}_{2k}$
	⋮	⋮	⋮	...	⋮	⋮	⋮	...	⋮
	k	$g^{\#}_{k1}$	$g^{\#}_{k2}$	...	$g^{\#}_{kn}$	$f^{\#}_{k1}$	$f^{\#}_{k2}$	...	$f^{\#}_{kk}$

In the model of Daly (1968) a table divided into four quadrants according to economic and ecological sectors is considered, which results in the four sub-matrices generically represented in Table 3.2 as follows:

X – the traditional inter-industry table in which each generic element x_{ij} represents the economic flows from sector *i* to sector *j*;

$\mathbf{H}^{\#}$ – a matrix (with the generic element $h^{\#}_{ij}$) representing the flows (outputs of pollutants or 'the externalities') from the economic sectors to the ecologic sectors;

$\mathbf{G}^{\#}$ – a matrix (with the generic element $g^{\#}_{ij}$) representing the flows (input of resources or 'the free goods') from the environment to the economic sectors;

$\mathbf{F}^{\#}$ – a matrix (with the generic element $f^{\#}_{ij}$) representing the flows within the ecological system.

Table 3.3- Generic schematic representation of the economic-ecologic input-output model of Isard *et al*. (1968, 1972).

Inputs ↓	Outputs →	*Economic Sectors*				*Ecologic Process*			
		1	*2*	...	*n*	*1*	*2*	...	*k*
Economic commodities	1	b_{11}	b_{12}	...	b_{1n}	h^*_{11}	h^*_{12}	...	h^*_{1k}
	2	b_{21}	b_{22}	...	b_{2n}	h^*_{21}	h^*_{22}	...	h^*_{2k}
	⋮	⋮	⋮	...	⋮	⋮	⋮	...	⋮
	i	b_{i1}	b_{i2}	...	b_{in}	h^*_{n1}	h^*_{n2}	...	h^*_{nk}
Ecologic commodities	*1*	g^*_{11}	g^*_{12}	...	g^*_{1n}	f^*_{11}	f^*_{12}	...	f^*_{1k}
	2	g^*_{21}	g^*_{22}	...	g^*_{2n}	f^*_{21}	f^*_{22}	...	f^*_{2k}
	⋮	⋮	⋮	...	⋮	⋮	⋮	...	⋮
	φ	$g^*_{\varphi 1}$	$g^*_{\varphi 2}$	...	$g^*_{\varphi n}$	$f^*_{\varphi 1}$	$f^*_{\varphi 2}$	...	$f^*_{\varphi k}$

Since the industry-by-industry square matrix is not consistent with the multiple concomitant generation of wastes and pollutants in the economic production processes, Isard *et al*. (1968, 1972) redefined the scheme used by Daly (1968) adopting an alternative accounting framework, usually designated as commodity-by-industry approach (Stone, 1961, 1966), which allows the consideration of multiple (economic and ecological) commodities produced by a single sector. Another important difference of the model of Isard *et al*. (1968, 1972) in comparison to the model of Daly (1968) is that the first uses (fixed) technical coefficients estimated directly from the technical data, whereas the second turned initially to the accounting data from which the coefficients are derived (Victor, 1972). This difference proposed by Isard *et al*. (1968, 1972) is fundamental to overcome the problems in the determination of the technical coefficients for the sub-matrices representing non-economic flows (Cruz *et al*., 2004). The model proposed by Isard *et al*. (1968, 1972) can be generically represented by considering a table divided into four quadrants according to economic and ecological sectors (and commodities), which results in the four sub-matrices outlined in Table 3.3 as follows:

B – a commodity-by-sector matrix (with the generic element b_{ij}) representing the economic flows;
H* – a matrix (with the generic element h^*_{ij}) representing the flows of commodities (outputs of pollutants or ‘the externalities’) from the economic to the ecologic sectors;
G* – a matrix (with the generic element g^*_{ij}) representing the flows of commodities (input of resources or ‘the free goods’) from the environment to the economic sectors;
F* – a matrix (with the generic element f^*_{ij}) representing the inputs and outputs exchanged within the ecological system.

Although Isard *et al*. (1968, 1972) have refined some questionable aspects of the model proposed by Daly (1968), both present conceptual as well as practical problems. First, there is a difficult to fully construct both models due to the data shortages mainly related to the ecological sub-matrix. As pointed by Forssell & Polenske (1998), due to the fact that in the Daly's model ecological commodities have no market prices (such as economic commodities), the units are non-comparable turning this model useful for descriptive and not analytical purposes. In addition the assumption of the fixity of the coefficients in the ecological system is more difficult to be valid than in the economic system, since ecological processes have in some extent non-linear (input-output) relations (Richardson 1972; Victor 1972; Johnson & Bennet, 1981; Pearson, 1989; Forssell & Polenske, 1998; Miller & Blair, 2009).

3.1.3 Commodity-by-Industry Models

The environmental commodity-by-industry models, also referred to as 'limited economic-ecological models', incorporate ecological commodities into a commodity-by-industry input-output framework utilizing rows of ecological inputs and columns of ecological outputs (Victor, 1972; Miller & Blair, 2009). The study of Victor (1972) is one of the most representative examples of this modeling category. In this model the ecological inter-processes are excluded, i.e. only flows of ecological commodities from the environment into the economy (resources) and flows of commodities from the economy into the environment (residuals) are accounted for. This fact reduces the scope of the model, as well as the complexity and great data requirements compared to the 'fully integrated economic-ecological models' (Cruz, 2002; Barata, 2002).

The main feature of this model is to account a conventional input-output commodity-by-industry framework in which the economic flows are expressed in monetary units, whereas the ecological flows are expressed in appropriate physical units (Victor, 1972)[5]. As referred to in the previous section, the commodity-by-industry approach allows the existence of joint production, as well as the utilization of hybrid units without facing the problem of summation of incommensurables. In addition, this model conforms to the principles of consistent input-

[5]Some analytical models using the commodity-by-industry accounts can be found in Stone (1961, 1966) and Rosenbluth (1968). A discussion of the introduction of ecologic commodities into both models can be found in Victor (1972).

output accounting for both the economic and ecological system, by which the materials balance concept is adopted (Richardson, 1972; Barata, 2002; Cruz, 2002).

Table 3.4 – Generic schematic representation of the environmental commodity-by-industry model of Victor (1972).

	Commodities	Sectors	Final Demand	Total output	Ecologic Commodities
Sectors	**V**			**x**	**Os**
Commodities (National)		**U**	**Y**	**q**	**Oc**
Value added		**z**			
Total output	$\mathbf{q}^T$	$\mathbf{x}^T$			
Ecologic Commodities	**Ic**	**Is**			

A generic schematic representation of this model is presented in Table 3.4 utilizing a similar framework as presented in Table 2.3 and some additional matrices representing the ecologic flows as follows[6]:

Os – a matrix that shows the outputs (or discharge) of the ecologic commodities (or residuals) by (economic) sector;

Oc – a matrix that shows the outputs (or discharge) of the ecologic commodities (or residuals) associated with the final demand;

Is – a matrix that shows the inputs of the ecologic commodities (or resources) used by (economic) sector;

Ic – a matrix that shows the inputs of the ecologic commodities (or resources) used in conjunction with the final demand.

In spite of the more limited scope than the 'fully integrated economic-ecological models', the major accomplishment of the model proposed by Victor (1972) accrues exactly from this feature, which is providing an environmental input-output model empirically feasible (Richardson, 1972). However, the ecological flows can also lead to some problems of implementation due to data shortages (Barata, 2002; Cruz, 2002).

3.1.4 Extended input-output model

In the environmental input-output models presented in the previous sections of this chapter additional rows and columns (or matrices) are included in the input-output framework to obtain technical coefficients with endogenous resource utilization and environmental

[6]The same account identities as used in table 3 can be considered in table 7. However, the matrices **U** and **Y** represent generic 'use' and 'final demand' matrices respectively in table 7.

impacts. However, an ‘external’ expansion of the input-output models is also feasible, in which the resource use and the environmental impacts are considered independently from the technical coefficient matrix, in the so-called externally expanded input-output (EE-IO) models (Hendrickson *et al.*, 2006). The extension of the input-output model is made by assuming that the amount of environmental intervention associated with a sector is proportional to the amount of output of that sector and the identity of the environmental interventions and the ratio between them are fixed (Suh & Huppes, 2005; Tukker *et al*., 2006). According to Miller & Blair (2009) and Hendrickson *et al*. (2006), if correctly implemented these models lead to analogous results compared to the endogenous methods. One of the most distinctive examples in this category is the Economic Input-Output Life Cycle Assessment (EIO-LCA) models which will be briefly presented in the next section.

3.1.4.1 Economic Input-Output Life Cycle Assessment (EIO-LCA) and Hybrid Input-Output Life Cycle Assessment models

The ISO 14040 norm defines a Life Cycle Assessment (LCA) as ‘*a compilation and evaluation of the inputs, outputs and potential environmental impacts from a productive system throughout its life cycle*’ (ISO, 1997). In sum, the LCA methodology helps to estimate and evaluate the environmental impacts (climate change, ozone layer depletion, eutrophication and acidification, toxic diseases affecting human health and ecosystems, water sources depletion, among others) related to the life cycle of some product (Rebitzer *et al*., 2004; Narayanaswamy *et al*., 2002). This methodology has an important role on public and private environmental management, comparing alternative products or helping in the development of new products (Guinée *et al*., 2001). However, setting tight boundaries in the supply chain of the analyzed system as required by the LCA approach can restrict the analysis, since upstream and downstream impacts that can propagate through the economy are neglected. The cost and time required for (full and exhaustive) LCA studies are other shortcomings of this methodology, which have also strengthen the research of methods that are able to simplify the analysis while still providing consistent information to satisfy the overall assessment goals (Matthews & Small, 2000). In this sense, the environmental extended input-output models can be a useful approach to overcome some weaknesses of LCA studies, since the overall environmental impact of an entire sector of the economy can be accounted for.

Moriguchi *et al*. (1993) is pointed as one of the first studies in the application of input-output analysis to LCA utilizing the completeness of the upstream system boundary definition of Japanese input-output tables for LCA of an automobile (Suh, 2004; Suh & Huppes, 2005). Among the several models further developed worldwide for performing such type of approach[7], one of the most referred to in the literature is the Economic Input-Output Life Cycle Assessment (EIO-LCA) method operationalized by researchers at the Green Design Institute of Carnegie Mellon University (CMU) (Matthews & Small, 2000). As referred to by CMU (2013):

"The Economic Input-Output Life Cycle Assessment (EIO-LCA) method estimates the materials and energy resources required for, and the environmental emissions resulting from, activities in our economy. It is one technique for performing a life cycle assessment, an evaluation of the environmental impacts of a product or process over its entire life cycle."

The former CMU models utilized a square[8] input-output matrix of 485 sectors for the United States, which were augmented with corresponding estimates of resource use and environmental flows and emissions supplied by a variety of public sources (Matthews & Small, 2000). That is, information about industry transactions (such as purchases of materials by one industry from other industries) and information about direct environmental emissions of industries are combined to estimate the total emissions throughout the supply chain of the sectors (CMU, 2013).

The basic EIO-LCA model, which also uses the assumption of linear technology, can be represented by the equation (3.3). Initially, an environmental intervention matrix ***Q*** is defined, which shows (after some rearrangements and normalization) the amount of pollutants or natural resources emitted or consumed to produce a monetary unit of output of each sector. Afterward, the total direct and indirect pollutant emissions and natural resources consumption by domestic industries implied in satisfying a certain amount of final demand ***y*** can be calculated by (Hendrickson *et al*., 1998, 2006; Gloria, 2000; Tukker *et al*., 2006):

$$\mathbf{m} = \mathbf{Q}\,(\mathbf{I} - \mathbf{A})^{-1}\,\mathbf{y} \qquad (3.3)$$

[7] See for example Lave *et al*. (1995), Treloar (1997), Marheineke *et al*. (1998), Hendrickson *et al*. (1998), Joshi (2000) and Suh (2004).
[8] EIO-LCA models can be developed using industry-by-industry, commodity-by-commodity or commodity-by-industry matrices according to the objectives of the study (Henriques, 2008).

where **m** is the total domestic direct and indirect vector of environmental burdens, **y** the final demand vector[9] and $(\mathbf{I} - \mathbf{A})^{-1}$ is the Leontief's inverse matrix[10].

The advantages over the LCA comes from the capability of the EIO-LCA models in capturing all the intra-sector flows (both direct and indirect) without ''double counting'', less resources and time requirements and inclusion of emissions caused by services and machinery (Suh *et al*., 2004; Flemmer & Flemmer, 2007; Nakamura & Kondo, 2009). The main strength of EIO-LCA model compared to LCA is to provide a more complete supply chain of economic activity needed to produce any commodity in the economy, therefore extending the boundaries of the analysis to the entire economy (Matthews & Small, 2000). For that reason, as referred to by Jeswani *et al*. (2010), this method can be viewed as a macro-level LCA covering the ''cradle to gate'' portion of the life cycle that is potentially more useful to support high-level (e.g. national) policy decision-making rather than for decision-making on specific products or processes.

On the other hand, some limitations of EIO-LCA (also derived from the assumptions of the basic input-output model) can be identified as well: the model often assumes the same production technology for imported and domestic products; problems related with the homogeneity and linearity assumptions in which each sector produces a single commodity using a single technology; proportionality between environmental loads and economic flows for sectors with different characteristics; problems of aggregation [11]; the use and the end-of-life stages are neglected; and problems regarding reliable and up-to-date data (Matthews & Small, 2000; Suh, 2004; Hendrickson *et al*., 2006).

Is important to refer that rather than being substitutes the EIO-LCA and detailed LCA models can be considered complementary to each other. As it was stressed by Williams *et al*. (2009), one approach can be used to evaluate the strengths and weaknesses of the other, especially in defining the boundaries of the analyses (Majeau-Bettez *et al*., 2011).

Nevertheless, production and consumption systems are best represented by a combination of bottom-up and top-down perspectives in a model that reveals the

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[9] If the vector ***y*** is replaced in (3.3) with a diagonal matrix with the values of ***y*** at the main diagonal, it is possible to obtain a matrix of environmental burdens in which each column gives the burdens attributed to the corresponding category of final demand instead of a vector with totals (Tukker *et al*., 2006).

[10] It is important to refer that (3.3) does not include the emissions caused outside national boundaries ('emissions embodied in imports') (Peters & Hertwich, 2008). However, the EE-IO framework can be constructed in order to include in the national estimates the emissions embodied in imports, as well as remove the emissions embodied in exports (Matilla *et al*., 2011).

[11] Those problems are related with the inability of input-output models in representing all different production technologies used to make different products within the same sector, since the economic system is represented by a limited number of sectors.

microstructure of the important parts of a product system and, at the same time, covers the entire economic system (Majeau-Bettez *et al.*, 2011; Suh, 2004). As a result, hybrid methods have been proposed to combine process-based life cycle inventories and environmentally extended input–output inventories in order to use the strengths of both (Udo de Haes *et al*., 2004). The term "hybrid" herein represents not only the integration of input-output and process based data, but also the combined use of both physical (process-based) and monetary (input-output-based) data, which opens the possibility of combining environmental and economic aspects (Suh *et al*. 2004; Lee & Ma, 2013; Jeswani *et al.*, 2010). Those models are able to provide more complete system definition, while preserving more accurate and detailed process information with a relatively small amount of additional information and inventory data (Rebitzer *et al*., 2004).

The hybrid approaches can be categorized into three groups: the tiered hybrid model, the input–output-based hybrid model, and the integrated hybrid model (Suh *et al*. 2004). The concept of tiered hybrid analysis appears from Bullard & Pillati (1976) and Bullard *et al*. (1978) with further developments by Moriguchi *et al*. (1993) and Marheineke *et al*. (1998), who applied this method in a case study of a freight transport activity. Basically, the tiered hybrid analysis utilizes process-based analysis for the use and disposal phase as well as for several important upstream processes, and then the remaining input requirements are imported from the input-output inventories, i.e. this approach can be performed simply by adding process based with input-output based results. In the input-output based hybrid approach the industry sectors focus of analysis are disaggregated in the input-output table, and so the tiered hybrid method is applied for the use and end-of-life stages of the product life cycle (Suh & Huppes, 2005). Some examples of this model are Treloar (1997) who applied this approach for the analysis of energy requirements in Australia and Joshi (1999) who employed this method for LCA of fuel tanks. Finally, the integrated hybrid analysis was proposed by Suh (2004) and Suh & Huppes (2005), in which the process data are represented as a matrix in physical units that combines with input–output tables using monetary units (Lee & Ma, 2013). Some studies that have applied this approach are Suh & Huppes (2001), Vogstad *et al*. (2001) and Strømman (2001). For a more detailed discussion of these hybrid methods see for e.g. Suh & Huppes (2005) and Joshi (1999).

As stated by Majeau-Bettez *et al*. (2011) the lack of quantitative assessments of the presumed advantages of hybrid approaches relatively to LCA and EE-IO models may partly explain their slow adoption. In this sense the authors propose that life cycle databases should also incorporate hybrid perspectives, rather than a strictly process-based approach. The inclusion of economic aspects in life cycle databases will allow the progressive compilation of hybrid inventories.

Suh & Huppes (2005) have compared all methods described in this section considering different criteria (data requirements, uncertainty of source data, upstream system boundary, technological system boundary, geographical system boundary, available analytical tools, time and labor intensity, simplicity of application, required computational tools and available software tools) and concluded that it is not possible to classify a model superior to all others. As stated before, the advantages of input-output based approaches are the relatively fast construction and expansion of the system boundaries in a macro perspective, while the process-based approach provides more accurate and detailed process information with a relatively more recent data and hybrid approaches have complementary advantages. On the other hand, each one of those methods presents some drawbacks, such as neglecting end-of-use stages, data truncation, or complexity in implementing. Therefore the selection among those different options implies taking into account the goal and scope of the study, as well as the availability of resources and time (Suh & Huppes, 2005).

3.1.5 SAM, NAMEA, SAMEA, SESAME and SEEA.

As stated in the previous sections of this chapter, the lack of reliable data for environmental aspects steadily available for practitioners is one of the problems in applying environmental input-output models. However, significant improvements have been done for developing databases helping facing the challenge of extending traditional input-output applications, namely through the construction of the so-called ‘Satellite accounts’ (Cruz, 2002). In parallel with some ‘independent initiatives’ for natural resource accounts (see, for example, Vincent, 1997; Hellsten *et al.*, 1999; Hubacek & Giljum, 2003; Lange *et al.*, 2003), it is possible to identify an evolution in accounting systems for different purposes and subjects, which will be briefly outlined in this section. It is important to refer that this section does not intend to be a full and exhaustive literature review of those systems, and therefore only the main statistical characteristics of them will be presented. For a deeper review of those systems and their use in modeling applications such as simulation models and input-output analysis see e.g. Stone (1970), Bos (1992), Haan & Keuning (1995), Thorbecke (2000), United Nations (2003, 2012).

The Social Account Matrix (SAM), originated from the pioneering works on social accounts developed by Richard Stone, can be considered as one of the first contributions for the compilation of expanded input-output databases (Thorbecke, 2000). The evolution of the SAM framework is part of a set of improvements provided by Stone since the end of the 1940s and beginning of the 1950s with the introduction of a new presentation of the results of national accounting in a matrix format rather than exclusively in T-accounts (see e.g. Stone 1948, 1951-52, 1955). Some years later, with the publication of the first SAM for Great Britain, Stone and his team of the Cambridge Growth Project provided some improvements in the conceptual framework of such matrix presentation (Stone 1962). As referred to by Stahmer (2002) the main features of this new matrix representation were the use of different statistical units (e.g. commodities, establishments, institutional units) in the system for describing the variety of economic activities which provided the baseline concepts for the System of National Accounts (SNA) (United Nations, 1968)[12]. Finally, in the 1970s a 'reformulation' of the SAM system changed its meaning, which started being '*used for a type of national accounting matrix especially describing the interrelationships of income and transfer flows between the different institutional units*' (Stahmer, 2002).

The SAM can be considered as a data framework to represent income (and expenditure) distribution in a generalized input-output format on the basis of social and demographic factors or, as defined by Stone (1986), '*the systematic quantitative description of social systems, particularly in their economic aspect*' (Duchin, 1998; Breisinger *et al*., 2009). A possible generic representation of the basic structure of a SAM is outlined in Table 3.5, in which the dark grey cells represent economic flows, while blank cells have null values[13]. In this schematic representation it is possible to verify that a SAM has a square matrix format in which each row and column is called an 'account'. Each sub-matrix of the table represents a different account that, by convention, represents a flow from a column account to a row account. The basic feature of this matrix is the double-entry accounting system, which is used in order to equal the total revenue and total expenditure (Breisinger *et al*., 2009)[14].

[12] In the SNA's context '*a SAM is defined as the presentation of SNA accounts in a matrix which elaborates the linkages between a supply and use table and institutional sector accounts*' (United Nations, 1993a).
[13] For a more detailed discussion of the accounts presented in Table 3.5 see United Nations (1993a).
[14] For a more detailed discussion of formalizations in a SAM see for e.g. Pyatt & Thorbecke (1976), Thorbecke (1995, 1998).

Table 3.5 – Generic schematic representation of a possible basic structure of a Social Account Matrix (SAM)[15].

Account (Classifications)		Expenditure Columns										
		Goods and services	**Production**	**Generation of income**	**Allocation of primary income**	**Secondary distribution of income**	**Use of income**	**Capital**	**Fixed capital formation**	**Financial**	**Rest of the world**	**Total**
Income rows	**Goods and services** (products)	■	■				■	■	■		■	■
	Production (industries)	■										■
	Generation of income (Value added categories)		■								■	■
	Allocation of primary incomes (institutional sectors)	■		■	■						■	■
	Secondary distribution of income (institutional sectors)				■	■					■	■
	Use of income (institutional sectors)					■	■				■	■
	Capital (institutional sectors)						■	■		■	■	■
	Fixed capital formation (industries)		■					■				■
	Financial (financial assets)							■			■	■
	Rest of the world (current and capital)	■		■	■	■	■	■			■	■
	Total	■	■	■	■	■	■	■	■	■	■	■

The SAM's framework is also used as basis for new developments and extensions to include other subjects such as in the National Accounting Matrices including Environmental Accounts (NAMEA)[16] developed by researchers of the Central Bureau of Statistics of the Netherlands (*Centraal Bureau voor de Statistiek* - CBS) (De Boo *et al*., 1991; Keuning, 1992, 1993, 1996). In the NAMEA three accounts (or sub-matrices) on the environment represented in physical units are included in the conventional national accounting matrix: a substances account (e.g. pollutants and natural resources), an account for global environmental themes (e.g., greenhouse effect, ozone layer depletion) and an account for national environmental themes (e.g., acidification, eutrophication) (Hann & Keuning, 1996; Cruz, 2002). A generic representation of the basic structure of the former NAMEA for Netherlands is presented in Table 3.6 for illustrative purpose, in which the dark grey cells represent economic flows, light grey cells represent physical flows and other blank cells have null values. For a more detailed description of each sub-matrix of this table see e.g. Hann *et al*. (1993).

[15] This matrix was adapted from United Nations (1993a).
[16] The NAMEA's concept and application originated from De Boo *et al*. (1991) and Keuning (1993).

Table 3.6 – Generic representation of the basic structure of the National Accounting Matrices including Environmental Accounts (NAMEA)[17].

Account (Classifications)		Expenditure Columns										
		Goods and Services	Consumption (Purposes)	Production (Activities)	Income Generation	Income Distribution	Capital	Rest of world	Substances	Global Themes	National Themes	Total
Income rows	Goods and Services											
	Consumption (Purposes)											
	Production (Activities)											
	Income Generation											
	Income Distribution											
	Capital											
	Rest of world											
	Substances											
	Global Themes											
	National Themes											
	Total											

The Statistics Netherlands integrated the SAM and NAMEA frameworks into a so-called Social Accounting Matrix including Environmental Accounts (SAMEA). As referred to by Keuning & Haan (1996) '*at the aggregate level, the only difference of a SAMEA with the NAMEA concerns a breakdown of the distribution and use of income account into three sub-accounts*', which are not distinguished in the NAMEA[18].

In the scope of the System of National Accounts 1993 (United Nations, 1993a) the elaboration of a System of Economic and Social Accounting Matrices and Extensions (SESAME) was proposed, which is another initiative attempting to reconcile the SAM and related data that are available from different sources (United Nations, 1993b; Keuning & Verbruggen, 2003). The SESAME, which has been referred to in the literature mainly in some studies of the Central Bureau of Statistics of the Netherlands (see e.g. Keuning, 1994; Keuning & Timmerman, 1995; Keuning & Verbruggen, 2003), is a broader information system for economic, social and environmental statistics containing an integrated set of

[17] This matrix was adapted from Hann *et al*. (1993).
[18] As referred to by Morilla *et al*. (2007) from an economic point of view, the SAMEA contains a SAM in which the economic flows are expressed in monetary units, whereas from an environment point of view, the SAMEA contains matrices expressed in physical units.

satellite tables or sub-modules[19] in matrix format with detailed statistical information of a set of core economic, social and environmental macro-indicators such as: GDP, government debit, innovation and research indicators, environmental performance indicators, employment indicators, social cohesion, among others. In parallel with the SESAME proposal an international environmental accounting reference handbook was launched for statistical offices, national governments and international organizations called the System of Environmental-Economic Accounting (SEEA). The SEEA is a joint initiative of the European Commission/Eurostat, International Monetary Fund, OECD, United Nations and World Bank and was adopted later as an international standard for environmental-economic accounting by the United Nations Statistical Commission (UNSC) (United Nations, 1993b, 2000, 2003, 2012). The main objective of the SEEA is to provide '*internationally agreed standard concepts, definitions, classifications, accounting rules and tables for producing internationally comparable statistics on the environment and its relationship with the economy'* consistent with the SNA structure and adaptable to each countries' priorities and policy needs (United Nations, 2012).

The central framework of SEEA organizes and integrates the information on the various stocks and flows of the economy and the environment in a series of tables and accounts:

- Supply and Use tables – flows of natural inputs, products and residuals (in physical and monetary terms);
- asset accounts – record stocks of environmental assets and changes in these stocks over an accounting period (in physical and monetary terms);
- economic accounts – highlights depletion adjusted economic aggregates (e.g. payments of rents for the extraction of natural resources, payments of environmental taxes, and payments of environmental subsidies and grants from government units to other economic units to support environmental protection activity - monetary terms);
- functional accounts – record transactions and other information about economic activities undertaken for environmental purposes (e.g. expenditures on environmental

[19] In the SESAME for Netherlands four different modules are considered: the National accounts module, the R&D module, the environmental module (NAMEA), and the SAM and socio-demographic module (Keuning & Verbruggen, 2003).

protection and resource management; and environmental taxes and subsidies)[20] (United Nations, 2012).

Some Social Account Matrices for Brazil have been constructed by a number of 'independent initiatives' (see e.g. Bulmer-Thomas (1982), Fonseca & Guilhoto (1987), Willumsen (1990), Cavalcanti (2001), Tourinho *et al*. (2006), Tourinho (2008) and Kureski (2009)). However, there is a lack of 'official' and 'independent' studies providing environmental extensions of the Social Accounting Matrix in both monetary and physical units for Brazil. One of the few initiatives in this field is the study of Young *et al*. (2000), in which monetary estimates for a NAMEA considering only three areas are presented: mineral resource depletion, industrial pollutant emissions, and wood resource depletion related to the Amazon forest deforestation. Other example is the study of Lenzen & Schaeffer (2004), which has compiled an environmentally extended Social Accounting Matrix in both monetary and physical units also quantifying some linkages between economic activities, natural resource use, and pollution by calculating various types of multipliers in a generalized input-output framework. Hence, overcoming the existent gap in this area through a more progressive production of statistics will be a challenge, but could be beneficial for modeling applications such as simulation models and input-output modeling approaches applied to the Brazilian economy.

3.2 EXTENDED ENERGY INPUT-OUTPUT MODELS

In the early 1970s the energy crisis (caused by the supply shortages following embargoes imposed mainly by the Organization of Petroleum Exporting Countries) and the simultaneous growing public concern over the environmental impacts associated with increasing energy use revealed a dangerous dependency of several countries on this critical production factor and its negative effects on nature, highlighting the role of energy in the economic system[21]. Since energy is directly or indirectly present in every good and service produced and consumed, it should be considered as a limiting input of economic activity (Odum, 1971; Bullard *et al*., 1976; Brown & Herendeen, 1996). Since then an increasing literature has been focused on 'Energy Analysis'[22], as well as extensions of the input-output

[20] The analysis of these data can also be extended by linking the tables and accounts to relevant employment, demographic and social information (United Nations, 2012).
[21] For a discussion of the historical root and development of the concept of energy see e.g. Lindsay (1971).
[22]The "Energy Analysis" is referred to as '*the process of determining the energy required directly and indirectly to allow a system (usually an economic system) to produce a specified good or service*' (Brown & Herendeen,

model to more explicitly account for energy and related environmental activities (Costanza, 1980; Miller & Blair, 2009).

As stated in the previous chapter, generally implementing physical input-output frameworks is an unwieldy task, so that usually the input-output data as well as input-output studies have been carried out in some extent in value terms (with implicit fixed prices). However, generalizations of input-output analysis have incrementally extended the input-output framework in the direction of employing physical units to account for environmental (and social) flows as stated in the previous sections, but also for energy analysis (or even for a joint analysis of both issues which will be discussed in a further section of this chapter).

The studies of Strout (1967), Herendeen (1973), Wright (1974), Pick & Becker (1975), Herendeen & Bullard (1974); Bullard & Herendeen (1974) and Proops (1977)[23] can be considered as the earlier modeling efforts in applying energy extensions (using physical accounts) to the Leontief framework, in which three basic methods have been proposed. In the first method, which is considered the simplest and most straightforward of the energy extensions to the Leontief framework, the energy use is explicitly accounted for by adding a set of linear energy coefficients that define energy use per monetary worth of output of 'industrial' sectors. Albeit such type of formulation is frequently applied in the literature (with somewhat variations in the approaches used in each study), a number of methodological and practical limitations can be identified[24] (Miller & Blair, 2009). The second method, which uses the so-called 'hybrid units' approach, allows overcoming the principal weaknesses in the first approach with relation to the problems in ensuring the 'energy conservation conditions'. The third approach designated as the 'energy coefficient' method was developed by Proops (1977), in which an energy dissipation table expressed in physical units is constructed through the corresponding monetary input-output table (Cruz, 2002). This method presents some advantages in determining the 'energy intensities' with fewer assumptions compared to the alternative approaches. However, it is constrained by its data requirements, since the

1996). The 'Energy Analysis' methodologies can be broadly classified in two categories: process analysis and input-output analysis. In spite of the similarities of both methods regarding the input data requirements and results (input-output analysis can even be considered as a particular form of process analysis), the process analysis is more suitable for specific processes, products, or manufacturing chains, while the input-output analysis is well suited for nationwide problems (Bullard *et al*., 1976; Gowdy & Miller, 1987).

[23] Other former examples of input-output models focused on energy use are the studies of Cumberland (1966), Ayres & Kneese (1969), Griffin (1976) and Blair (1979, 1980).

[24] The use of this model even in contemporary studies is mainly due to the difficulty in obtaining useful data necessary to overcome the key weaknesses of ensuring internal consistency in accounting for energy supply and use throughout the economy. For a more detailed discussion of the strengths and weaknesses of these early approaches see Proops (1977) and Miller & Blair (2009).

necessary data are not usually available in the required form at the national level (Herendeen & Bullard, 1974; Herendeen, 1978; Cruz, 2002). For that reason, in this study only the two former approaches will be presented[25].

Though the mathematical formulation of both energy input-output methods beforehand mentioned use the structure of the classical Leontief model discussed in earlier chapters, some specific concepts have also been considered in order to ensure consistency between the levels of energy consumption (measured in physical units) and the economic activity (measured in monetary units) (Miller & Blair, 2009). Therefore, before describing both models some basic concepts regarding energy input-output analysis will be presented in the next section. It is important to mention that the purpose of the subsequent sections is to provide a succinct overview of the models and concepts that have been considered in the energy input-output modeling. For a more complete discussion regarding energy input-output analysis see e.g. Proops (1977), Miller & Blair (2009) and Hannon (2010).

3.2.1 Energy intensities

The underlying purpose of the energy input-output analysis is estimating the total (direct and indirect) energy requirements of sectors to deliver a product (good or services) to final demand. The amount of energy required by a sector to deliver a product to final demand or the so-called 'energy intensity' usually includes the energy consumed directly in the 'production process', but also the energy indirectly used in the form of 'energy embodied' in the inputs used in that process. In other words, the total energy requirements of a product results of rounds of energy and non-energy inputs consumed in that specific process and upstream processes. In order to better explain these direct and indirect accounts it will be useful to evoke the so-called process analysis utilized in engineering. In the first step of this method a set of energy and non-energy products utilized in the process of the target product is identified. Afterwards the energy and non-energy inputs used to produce these non-energy products are traced back in the upstream processes. This procedure is subsequently repeated tracing inputs back to primary resources. Finally, the total energy requirement of the target product is obtained by the summation of the energy used directly in the first round and the indirect uses calculated in every iteration (Bullard & Herendeen, 1974; Proops, 1977; Miller

[25] For a more detailed discussion of this method and the comparative advantages and disadvantages in relation to the alternative approaches see e.g. Proops (1977) and Cruz (2002).

& Blair, 2009). This concept will be fundamental to enlighten the 'energy conservation condition' and the 'energy-balance condition' in the next sections.

3.2.2 The 'energy conservation condition'

The structure of the energy input-output model is somewhat analogous to the traditional input-output model, but some assumptions are generally included in the scope of the energy input-output models in order to guarantee the internal consistency of the model[26]. Establishing those assumptions in the model, to some degree, arises from the constraints imposed by the first and second laws of thermodynamics, which generally have lead to a systematic incorporation of material balance concepts into theories of the flow of physical materials (Cruz, 2002; Miller & Blair, 2009).

The first law of thermodynamics or the principle (or law) of 'conservation of energy' states that the total energy of an isolated system is constant, i.e. the energy can be transformed from one form to another, but cannot be created or destroyed (Velthuijsen & Worrell, 1999). The second law states that "*in any isolated system entropy always increases or, in reversible processes, remains constant (it can never decrease)*" (Faber *et al*., 1996).

The implications of these laws on the energy flows can be illustrated by using a distinction between primary and secondary energy sectors in a simple closed system. The secondary energy sectors receive primary energy as an input and convert it into secondary energy forms. Thus, according to the first law the total primary energy required to produce an industry's output should equal the total secondary energy required to produce the same industry's output. However, the processes of converting primary energy to secondary energy forms is constrained by the second law, since the energy efficiency is dissimilar between different conversion processes and losses can occur in each conversion process. These insights have been used by energy analysts to include a slightly version of the 'energy conservation condition' (usually ignoring the efficiency effects)[27] in the energy input-output formulation in order to establish that '*the total primary energy intensity of a product should equal the total secondary energy intensity of the product plus any amount of energy lost in energy conversion or used for some other purpose*' (Miller & Blair, 2009). This condition

[26] Since the energy flows are usually accounted in physical units (e.g. ton of oil equivalent (toe), British thermal units (BTUs), Joules (J), etc.), rather than in value terms.

[27] In general, the effects of energy conversion efficiencies are ignored in the scope of energy input-output modeling, in which a unitary efficiency factor (i.e. one hundred per cent of efficiency) is established (Cruz, 2002; Miller & Blair, 2009). However, other approaches have been developed to account for conversion efficiencies in the model (for a further discussion of these formulations see e.g. Miller & Blair, 2009).

implies the idea of the 'conservation of embodied energy', i.e. the energy burned or lost by a sector of the economy is passed on, embodied in the product (Bullard & Herendeen, 1975). Hence, as referred to by Cruz (2002) '*it is important to clarify that what is really considered in mainstream energy input-output analysis is not exactly the first law of thermodynamics, but rather an hypothesis of 'energy balance'*[28].

3.2.3 The 'energy-balance condition'

In the energy input-output formulation the 'energy balance' assumption can be represented formally by the equation (3.4) for each *n* sector (assuming that the energy required in the inputs to sector *j*, plus the energy consumed in that sector, is passed on as part of *j*'s output; and unit efficiency) as follows (Bullard & Herendeen, 1975; Machado *et al*., 2001):

$$\ddot{a}_{kj}X_j = \sum_{i=1}^{n} \ddot{a}_{ki}x_{ij} + \ddot{e}_{kj} \qquad (3.4)$$

where $\ddot{a}_{kj}$ is the generic element of the matrix $\ddot{\mathbf{A}}$ that represents the amount of energy required to produce a monetary worth of sector *j*'s output (or the embodied energy intensity of type *k* per unit of X_j); X_j is the total output (in monetary units) of sector *j* ($j = 1,\ldots, n$); x_{ij} is the generic element of Matrix **X** representing the monetary value of sector *i*'s product consumed by sector *j*; $\ddot{e}_{kj}$ is the generic element of the matrix $\ddot{\mathbf{E}}$ that represents the external direct energy input of type *k* ($k = 1,\ldots, m$) to sector *j* (i.e. the amount of energy of type *k* extracted from the earth[29] by sector *j*, which is non-zero only for primary energy sectors that are placed along the principal diagonal (where $k = j$)[30]. Thus, for a generic sector *n*, the 'energy balance equation' will be:

$$\ddot{a}_{kn}X_n = \ddot{a}_{k1}x_{1n} + \ddot{a}_{k2}x_{2n} + \ldots + \ddot{a}_{kn}x_{nn} + \ddot{e}_{kn} \qquad (3.5)$$

[28] As Brown & Herendeen (1996) states, '*the balance of embodied energy is an assumption*' with the intention of calculating indirect effects; however, '*has nothing fundamental to do with any thermodynamic law*'. In addition, as referred to by Proops (1977), the notion of embodied energy is a strictly formal accounting identity, because '*the energy actually embodied in a good, in terms of its physical structure, will usually be much less*' than the product of the energy intensity of the good and the quantity purchased.

[29] It is important to refer that for simplicity purpose the term 'earth' is utilized here to 'close' the system, although in the real world a significant part of the energy comes from outside the earth system, such as solar energy.

[30] For this discussion, $\ddot{e}_{kn}$ has been restricted to be the total energy output of only primary energy sectors. In addition, the term 'earth' is used as a way to consider a closed system, which has not hold in real conditions, since the Sun is an important source of energy.

where, for example, $\ddot{a}_{k1}x_{1n}$ is the energy equivalent of the input from sector 1 to sector *n*, the term ($\ddot{a}_{k1}x_{1n} + \ddot{a}_{k2}x_{2n} + ... + \ddot{a}_{kn}x_{nn}$) is the total embodied energy used as inputs, $\ddot{e}_{kn}$ is the primary energy extracted from the earth, and $\ddot{a}_{kn}X_n$ is the energy of type *k* embodied in the output of sector *n* (Casler & Wilbur, 1984). Hence, the energy conservation conditions for all economic sectors *j* can be described as: the 'energy embodied' in any sector output X_j is equal to the amount of 'energy embodied' in all that sector's inputs x_{ij} (for $i = 1,\dots, n$) plus any primary energy input $\ddot{e}_{kn}$ (which is nonzero only for primary energy sectors) (Miller & Blair, 2009). Therefore, it is possible to rewrite (3.4) in condensed matrix form as[31]:

$$\mathbf{\ddot{A}\hat{x} = \ddot{A}X + \ddot{E}} \qquad (3.6)$$

Finally, given the identity $\mathbf{X} = \mathbf{A\hat{x}}$, it is possible to substitute $\mathbf{X}$ in the equation (3.6), and rearranging terms to derive the matrix of *total energy requirements* (3.7) as follows:

$$\mathbf{\ddot{A}\hat{x} = \ddot{A}A\hat{x} + \ddot{E}} \Leftrightarrow \mathbf{\ddot{A}(I - A)\,\hat{x} = \ddot{E}} \Leftrightarrow \mathbf{\ddot{A}(I - A) = \ddot{E}\hat{x}^{-1}} \Leftrightarrow \mathbf{\ddot{A} = \ddot{E}\hat{x}^{-1}(I - A)^{-1}} \qquad (3.7)$$

3.2.4 The basic energy-based input-output formulation

Earlier formulations of energy input-output models have been proposed e.g. by Stout (1967) and Wright (1974) in a so-called 'direct (impact) coefficient' methodology. In order to present this formulation of the earlier energy input-output model, an economy with *n* economic sectors of which *m* are energy sectors is considered. Since the energy input-output formulation mirrors the traditional input-output model, a matrix **E** and vectors, $\mathbf{\ddot{y}}$ and $\mathbf{\ddot{e}}$ analogous to **X**, **x** and **y** are also established to compute the energy flows (in physical inputs of energy). **E** is a ($m \times n$) matrix in which each row represents flows from the energy-producing sectors *m* to all sectors *n* as consumers of energy, $\mathbf{\ddot{y}}$ a ($m \times 1$) vector of energy deliveries to final demand and $\mathbf{\ddot{e}}$ a vector of total energy consumption ($m \times 1$), all measured in physical units (e.g., ton of oil equivalent - *toe*). Thus, a basic accounting relationship analogous to (2.1) can be defined as follows:

$$\mathbf{Ei} + \mathbf{\ddot{y}} = \mathbf{\ddot{e}} \qquad (3.8)$$

Next, the matrix **E** and the diagonal matrix $\mathbf{\hat{x}}$ (with the values of the vector of total output **x** in the main diagonal and null values in all other entries) in monetary terms are used

[31] Here $\mathbf{\hat{x}}$ is a (nxn) diagonal matrix of the total outputs (with X_j on the main diagonal).

to obtain a *direct energy coefficient* matrix $\mathbf{D}^{\#}$ in (3.9)[32], in which each generic element $d^{\#}_{kj}$ represents the amount of energy type k ($k = 1, \ldots, m$) required directly to produce a monetary value of each producing sector's output j ($j = 1, \ldots, n$).

$$\mathbf{D}^{\#} = \mathbf{E}\hat{\mathbf{x}}^{-1} \Leftrightarrow \mathbf{E} = \mathbf{D}^{\#}\hat{\mathbf{x}} \tag{3.9}$$

Further a matrix $\mathbf{P}^{\#}$ of *implied energy prices*[33] is defined, in which each element $p^{\#}_{kj}$ defined as $p^{\#}_{kj} = x_{kj}/e_{kj}$ (only for $e_{kj} \neq 0$) represents the monetary value paid per unit of energy of type k delivered to consuming sector j. Therefore, the *direct energy coefficients* $\mathbf{D}^{\#}$ can also be derived using the implied prices as $d^{\#}_{kj} = a_{kj}/p_{kj}$[34]. Thus, from the equation (3.8) and considering the relation in (3.9) and the expression $\mathbf{x} = (\mathbf{I} - \mathbf{A})^{-1}\mathbf{y}$ presented in (2.14), it is possible to obtain a matrix of *total energy coefficients* as follows[35]:

$$\mathbf{Ei} + \ddot{\mathbf{y}} = \ddot{\mathbf{e}} \Leftrightarrow \mathbf{D}^{\#}\hat{\mathbf{x}}\mathbf{i} + \ddot{\mathbf{y}} = \mathbf{Ei} + \ddot{\mathbf{y}} \Leftrightarrow \mathbf{D}^{\#}\mathbf{x} + \ddot{\mathbf{y}} = \mathbf{D}^{\#}\hat{\mathbf{x}}\mathbf{i} + \ddot{\mathbf{y}} \Leftrightarrow \mathbf{D}^{\#}(\mathbf{I} - \mathbf{A})^{-1}\mathbf{y} + \ddot{\mathbf{y}} - \ddot{\mathbf{y}} = \mathbf{D}^{\#}\hat{\mathbf{x}}\mathbf{i} \Leftrightarrow$$
$$\Leftrightarrow \mathbf{D}^{\#}\mathbf{x} = \mathbf{D}^{\#}(\mathbf{I} - \mathbf{A})^{-1}\mathbf{y} \tag{3.10}$$

The matrix $\mathbf{D}^{\#}(\mathbf{I} - \mathbf{A})^{-1}$ is defined as the matrix of *total inter-industry energy coefficients*.

The next step is defining the implied energy prices for the energy delivered to the final demand $\mathbf{p^y} = [P^y_k]$ and $P^y_k = \left(\frac{Y_k}{\ddot{Y}_k}\right)$, where Y_k represents the final demand in monetary terms for the output of energy sector k and P^y_k is the corresponding implied energy price measured in monetary units of final demand per unit of energy type k (defined for $\ddot{Y}_k \neq 0$, while for $\ddot{Y}_k = 0$ will be set $P^y_k = 0$). Thus rearranging the relation of the implied energy prices just defined, it is possible to obtain $\ddot{Y}_k = \left(\frac{1}{P^y_k}\right) Y_k$ or in matrix terms as follows:

$$\ddot{\mathbf{y}} = \hat{\mathbf{Y}}\mathbf{y} \tag{3.11}$$

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[32]This relation is directly analogous to the direct input coefficients of matrix **A**, except that $\mathbf{D}^{\#}$ will in general not be square since the number of sectors are greater than the energy products ($m < n$) (Miller & Blair, 2009).

[33]As stated by Miller & Blair (2009) '*these prices are "implied" since the prices calculated in this way generally do not necessarily correspond to the price actually paid for energy*'.

[34] This is equivalent to the previous definition of $\mathbf{D}^{\#}$, since $d^{\#}_{kj} = \left(\frac{a_{kj}}{p_{kj}}\right) = \left(\frac{x_{kj}}{X_j}\right)\left(\frac{e_{kj}}{x_{kj}}\right) = \left(\frac{e_{kj}}{X_j}\right)$.

[35] It follows that substituting (3.9) in (3.8) it is possible to obtain $\mathbf{D}^{\#}\hat{\mathbf{x}}\mathbf{i} + \ddot{\mathbf{y}} = \ddot{\mathbf{e}}$. Since $\hat{\mathbf{x}}\mathbf{i} = \mathbf{x}$, thus it is possible to get $\mathbf{D}^{\#}\mathbf{x} + \ddot{\mathbf{y}} = \ddot{\mathbf{e}}$, which is directly analogous to $\mathbf{Ax} + \mathbf{y} = \mathbf{x}$ of the traditional Leontief model.

where $\hat{\mathbf{Y}} = [\hat{y}_k]$ is an $(m \times n)$ matrix of implied inverse energy prices for final demand whose elements are defined as $\hat{y}_k = \frac{1}{P_k^y}$ when energy sector k and sector j describe the same sector and $\hat{y}_k = 0$ otherwise[36].

Finally, from (3.8), (3.11) and using the expression $\mathbf{x} = (\mathbf{I} - \mathbf{A})^{-1}\mathbf{y}$ presented in (2.14) it is possible to obtain a matrix of total (inter-industry plus final demand) energy coefficients as follows:

$$\mathbf{Ei} + \ddot{\mathbf{y}} = \ddot{\mathbf{e}} \Leftrightarrow \mathbf{D}^{\#}\hat{\mathbf{x}}\mathbf{i} + \ddot{\mathbf{y}} = \ddot{\mathbf{e}} \Leftrightarrow \mathbf{D}^{\#}\mathbf{x} + \hat{\mathbf{Y}}\mathbf{y} = \ddot{\mathbf{e}} \Leftrightarrow \mathbf{D}^{\#}(\mathbf{I} - \mathbf{A})^{-1}\mathbf{y} + \hat{\mathbf{Y}}\mathbf{y} = \ddot{\mathbf{e}} \Leftrightarrow$$
$$\Leftrightarrow [\mathbf{D}^{\#}(\mathbf{I} - \mathbf{A})^{-1} + \hat{\mathbf{Y}}]\,\mathbf{y} = \ddot{\mathbf{e}} \qquad (3.12)$$

The term $[\mathbf{D}^{\#}(\mathbf{I} - \mathbf{A})^{-1} + \hat{\mathbf{Y}}]$ can be defined as $\boldsymbol{\mathcal{E}}$ representing a matrix of *total energy coefficients* (analogous to $\ddot{\mathbf{A}}$ defined in the course of developing the energy conservation conditions), which expresses the total (direct and indirect) amount of energy required of each energy type $\ddot{\mathbf{e}}$ as a function of final demand $\mathbf{y}$[37].

Nevertheless, it is important to mention that the use of monetary, rather than physical, units for the description of energy flows leads to some inconsistencies in this formulation. The model simply yields the output of the traditional Leontief model multiplied ('*a posteriori*') by a set of conversion factors (the implied prices), instead of applying this conversion directly and immediately in the monetary input-output table (Casler & Blair, 1997; Cruz, 2002). As referred to by Proops (1977) and Miller & Blair (2009) this formulation violates the energy-balance condition and provides internally consistent results only when the new final demand is not substantially different from the basic data from which the model was derived or under the condition of uniform energy prices across all consuming sectors (including final demand) for each energy type. Albeit this assumption can hold for some specific economies it is a strong constraint that is not usually verified in reality (Machado *et al*., 2001; Miller & Blair, 2009)[38].

Simultaneously to, but independently of, this basic energy-based input-output formulation, Herendeen (1973) and Bullard & Herendeen (1974) proposed a slightly different

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[36] There will, of course, be at most m nonzero elements in $\hat{\mathbf{Y}}$ since there are only m elements in $\ddot{\mathbf{y}}$ (Miller & Blair, 2009).

[37] As referred by Miller & Blair (2009) although variations of this approach can be found in the literature (e.g. ignoring the energy consumed directly in final demand or assuming uniform energy prices across all consuming sectors), in almost all cases the direct energy coefficients are set in this manner (which implies ignoring or assuming away the technical energy conservation relationships between primary and secondary energy sectors).

[38] For a more detailed discussion of the drawbacks and limitations associated with the usage of direct coefficients formulation see e.g. Proops (1977), Casler & Blair (1997), Machado *et al.* (2001) and Miller & Blair (2009).

approach addressing this problem and overcoming shortcomings and limitations associated with the usage of direct coefficients over the Leontief inverse by including a hybrid formulation that will be presented next.

3.2.5 The hybrid-based energy Input–Output formulation

First of all, it is worth noting that the term "hybrid" here does not refer to the linkage among the Input-Output Analysis and Life Cycle Assessment methodologies as presented previously, but to the combination of physical and monetary units into the transaction and technical coefficients matrices in the input-output model. The underlying idea of the hybrid model is to substitute energy rows valued in monetary terms for energy rows expressed in physical units in the input-output table before recalculating the Leontief inverse matrix based on the adjusted flows[39].

In the basic version of this approach the rows (in monetary units) with energy sectors (or commodities) are substituted by rows in physical units to allocate the energy flows into the inter-sector transaction matrix and final demand (consequently in the total output). However, in a different version of this model that will be used in this study, new rows and columns with 'artificial' energy sectors can also be included in the model to allocate primary and secondary energy flows between the sectors. For simplicity purposes, only the basic version will be represented in this section since the generalization of this approach for several energy types can be seen for instance in Miller & Blair (2009) and Henriques (2008)[40]. In the second step of this approach, these new matrices are then utilized to generate new technical coefficient matrices. It is possible to represent these steps in mathematical terms considering for simplicity the matrix **E**, and vectors $\ddot{\mathbf{y}}$ and $\ddot{\mathbf{e}}$ in energy physical units (e.g. *toe*), while the transaction matrix **X** and vectors **y** and **x** in monetary units (represented here by the symbol *$*). Then, the next step is to define a new transaction matrix $\mathbf{X}^*$, including the matrix **E** into the matrix **X**, substituting the corresponding rows from monetary to energy units, i.e. x_{ij} where i is a non-energy sector and e_{kj} where k is an energy sector. In this new matrix the energy flows are measured in physical terms and other flows in monetary units:

[39] See for example Herendeen (1973), Bullard & Herendeen (1974), Griffin (1976), Proops (1977), Blair (1979), Hannon *et al*. (1983), Casler & Wilbur (1984), Hilgemberg (2004) and Miller & Blair (2009).
[40] This framework can also be adjusted to account for imports (see e.g. Herendeen & Bullard (1974)).

$$\mathbf{X}^{*}=\begin{bmatrix} \$ & \$ & \$ & \$ \\ \vdots & \vdots & \vdots & \vdots \\ \$ & \$ & \$ & \$ \\ \text{toe} & \text{toe} & \text{toe} & \text{toe} \\ \vdots & \vdots & \vdots & \vdots \\ \text{toe} & \text{toe} & \text{toe} & \text{toe} \end{bmatrix} \tag{3.13}$$

The same procedure is then applied in the final demand ('allocating' the vector $\ddot{\mathbf{y}}$ into the vector **y**) and the total output ('allocating' the vector $\ddot{\mathbf{e}}$ into the vector **x**), thus obtaining new vectors $\mathbf{y}^{*} = [Y_{\mathrm{i}}^{*}]$ (Y_i where i is a non-energy sector and $\ddot{Y}_k$ where k is an energy sector) and $\mathbf{x}^{*} = [X_{\mathrm{i}}^{*}]$ (X_i where i is a non-energy sector and $\ddot{E}_k$ where k is an energy sector):

$$\mathbf{y}^{*}=\begin{bmatrix} \$ \\ \vdots \\ \$ \\ \text{toe} \\ \vdots \\ \text{toe} \end{bmatrix} \tag{3.14}$$

$$\mathbf{x}^{*}=\begin{bmatrix} \$ \\ \vdots \\ \$ \\ \text{toe} \\ \vdots \\ \text{toe} \end{bmatrix} \tag{3.15}$$

Subsequently, the *hybrid direct coefficient matrix* can be defined as:

$$\mathbf{A}^{*} = \mathbf{X}^{*}\left(\hat{\mathbf{x}}^{*}\right)^{-1} \tag{3.16}$$

$$\mathbf{A}^{*}=\begin{bmatrix} \frac{\$}{\$} & \cdots & \frac{\$}{\$} & \frac{\$}{\text{toe}} & \cdots & \frac{\$}{\text{toe}} \\ \vdots & \ddots & \vdots & \vdots & \ddots & \vdots \\ \frac{\$}{\$} & \cdots & \frac{\$}{\$} & \frac{\$}{\text{toe}} & \cdots & \frac{\$}{\text{toe}} \\ \frac{\text{toe}}{\$} & \cdots & \frac{\text{toe}}{\$} & \frac{\text{toe}}{\text{toe}} & \cdots & \frac{\text{toe}}{\text{toe}} \\ \vdots & \ddots & \vdots & \vdots & \ddots & \vdots \\ \frac{\text{toe}}{\$} & \cdots & \frac{\text{toe}}{\$} & \frac{\text{toe}}{\text{toe}} & \cdots & \frac{\text{toe}}{\text{toe}} \end{bmatrix} \tag{3.17}$$

From (3.16) it is possible to get:

$$\mathbf{A}^{*}\mathbf{x}^{*} + \mathbf{y}^{*} = \mathbf{x}^{*} \tag{3.18}$$

After some algebraic arrangements we have:

$$\mathbf{x}^{*} = (\mathbf{I} - \mathbf{A}^{*})^{-1}\,\mathbf{y}^{*} \tag{3.19}$$

Despite the similarities of the direct requirements matrix $\mathbf{A}^*$ and the total requirements matrix $(\mathbf{I} - \mathbf{A}^*)^{-1}$ with the matrices $\mathbf{A}$ and $(\mathbf{I} - \mathbf{A})^{-1}$ of the traditional Leontief model, some features in the latter cannot be verified in the former. Firstly, the coefficients in the former matrices are accounted with hybrid units instead of accounting relations from uniquely monetary or physical entries. Furthermore, the column sums in $\mathbf{A}^*$ are meaningless since the units are not consistent (e.g. monetary values and physical quantities) and therefore they are not necessarily less than unit as in the traditional model. In addition, both $\mathbf{A}^*$ and $(\mathbf{I} - \mathbf{A}^*)^{-1}$ will have the same units except, of course, $\mathbf{A}^*$ computes the (direct) requirements (toe or dollars) per unit (toe or dollar) of total output and $(\mathbf{I} - \mathbf{A}^*)^{-1}$ the (total) requirements per unit of final demand.

A further development can also be made to obtain both the *direct energy requirements matrix* $\ddot{\mathbf{D}}^*$ and *total energy requirements matrix* $\ddot{\mathbf{A}}^*$. For this purpose, the energy rows have to be 'extracted' from $\mathbf{A}^*$ and $(\mathbf{I} - \mathbf{A}^*)^{-1}$, respectively, through a straightforward procedure that is constructing the matrix $\ddot{\mathbf{E}}$ and then the product of $\ddot{\mathbf{E}}(\hat{\mathbf{x}}^*)^{-1}$ analogously to the matrix product defined earlier as $\ddot{\mathbf{E}}\hat{\mathbf{x}}^{-1}$ but with a special property. Recall that nonzero elements of $\ddot{\mathbf{E}}$ are the elements of $\ddot{\mathbf{e}}$ that are energy sectors. Since the nonzero elements of $\ddot{\mathbf{e}}$ (equivalently to $\ddot{\mathbf{e}}^*$) are identical to the corresponding values in $\mathbf{x}^*$**,** the result of this product is a matrix of ones and zeros, where the ones denote the locations of energy sectors (Miller & Blair, 2009). Therefore, the direct and total energy coefficients matrices $\ddot{\mathbf{D}}^*$ and $\ddot{\mathbf{A}}^*$ can be obtained by (3.20) and (3.21)[41], respectively, as follows:

$$\ddot{\mathbf{D}}^{*} = \ddot{\mathbf{E}}(\hat{\mathbf{x}}^{*})^{-1}\mathbf{A}^{*} \tag{3.20}$$

$$\ddot{\mathbf{A}}^{*} = \ddot{\mathbf{E}}(\hat{\mathbf{x}}^{*})^{-1}(\mathbf{I} - \mathbf{A}^{*})^{-1} \tag{3.21}$$

[41] This formulation can also be derived using a similar procedure as presented in (3.7):

$$\ddot{\mathbf{A}}^{*}\hat{\mathbf{x}}^{*} = \ddot{\mathbf{A}}^{*}\mathbf{A}^{*}\hat{\mathbf{x}}^{*} + \ddot{\mathbf{E}} \Leftrightarrow \ddot{\mathbf{A}}^{*}(\mathbf{I} - \mathbf{A}^{*})\,\hat{\mathbf{x}}^{*} = \ddot{\mathbf{E}} \Leftrightarrow \ddot{\mathbf{A}}^{*}(\mathbf{I} - \mathbf{A}^{*}) = \ddot{\mathbf{E}}(\hat{\mathbf{x}}^{*})^{-1} \Leftrightarrow \ddot{\mathbf{A}}^{*} = \ddot{\mathbf{E}}(\hat{\mathbf{x}}^{*})^{-1}(\mathbf{I} - \mathbf{A}^{*})^{-1} \tag{3.21b}$$

Furthermore, as noted earlier in (3.6), the energy conservation conditions can be expressed as $\ddot{\mathbf{A}}\hat{\mathbf{x}} = \ddot{\mathbf{A}}\mathbf{X} + \ddot{\mathbf{E}}$. In the hybrid units formulation, **x**, **X**, and $\ddot{\mathbf{E}}$ in (3.6) are replaced by corresponding values of $\mathbf{x}^*$ and $\mathbf{X}^*$ and $\ddot{\mathbf{E}}$ to obtain:

$$\ddot{\mathbf{A}}^*\hat{\mathbf{x}}^* = \ddot{\mathbf{A}}^*\mathbf{X}^* + \ddot{\mathbf{E}} \tag{3.22}$$

In addition, from (3.22) and considering the relation in (3.18) it is possible to obtain an overall balance (since the sector-by-sector conservation of embodied energy leads to overall conservation for the entire system) as follows (Cruz, 2002):

$$\ddot{\mathbf{A}}^*\hat{\mathbf{x}}^* = \ddot{\mathbf{A}}^*\mathbf{X}^* + \ddot{\mathbf{E}} \Leftrightarrow \ddot{\mathbf{A}}^*(\mathbf{A}^*\hat{\mathbf{x}}^* + \hat{\mathbf{y}}^*) = \ddot{\mathbf{A}}^*\mathbf{A}^*\hat{\mathbf{x}}^* + \ddot{\mathbf{E}} \Leftrightarrow \ddot{\mathbf{A}}^*\mathbf{A}^*\hat{\mathbf{x}}^* + \ddot{\mathbf{A}}^*\hat{\mathbf{y}}^* = \ddot{\mathbf{A}}^*\mathbf{A}^*\hat{\mathbf{x}}^* + \ddot{\mathbf{E}} \Leftrightarrow$$
$$\Leftrightarrow \ddot{\mathbf{A}}^*\hat{\mathbf{y}}^* = \ddot{\mathbf{E}} \tag{3.23}$$

Finally, substituting (3.21) in (3.23) is possible to obtain:

$$\ddot{\mathbf{E}} = \ddot{\mathbf{A}}^*\hat{\mathbf{y}}^* \Leftrightarrow \ddot{\mathbf{E}} = \ddot{\mathbf{E}}(\hat{\mathbf{x}}^*)^{-1}(\mathbf{I} - \mathbf{A}^*)^{-1}\hat{\mathbf{y}}^* \tag{3.24}$$

Thus, as referred to by Proops (1977, 1988) this approach produces an energy intensity matrix that imputes all energy required in production to final demand, which is useful for planning the energy demand necessary to satisfy a projected level of final demand in an economy.

The use of the hybrid input-output formulation helps eliminating the effect of price distortion on the results, i.e. specifying the energy transactions in physical units in this hybrid formulation allows that the energy conservation conditions can be expressed as a set of physical relationships independently of the prices of energy (Chung *et al*., 2009). Hence the hybrid formulation is able to compute in all cases the total energy requirement for any arbitrary vector of final demand consistent with the energy conservation condition, while the basic formulation yields correct results only under specific conditions (albeit this condition is moot)[42] (Miller & Blair, 2009).

For a review of the applications of energy input-output models to several contemporary problems, such as net energy analysis, structural decomposition analysis, the impacts of new energy technologies and to compute the total energy costs of goods and services see e.g. Spreng (1988), Casler & Hannon (1989), Rose & Chen (1991), Lin &

[42] For a discussion see e.g. Arrous (2000).

Polenske (1995), Battjes *et al.* (1998), Albino *et al.* (2003), Kagawa & Inamura (2004), Giljum & Hubacek (2004), Lenzen *et al.* (2004), Bezdek & Wendling (2005), Dietzenbacher & Sage (2006), Weber (2009), Liu *et al.* (2010), Liang *et al.* (2010), Zhang *et al.* (2011), Chen & Chen (2013) and Li *et al.* (2013).

3.3 ENERGY-ECONOMIC-ENVIRONMENT INPUT-OUTPUT MODELING

In the previous sections two extensions of the input-output models have been presented: models particularly concerned with the relations between economic activity and the extraction and discharge of materials to the environment; and models focused primarily on the relations between the economic activity and energy consumption (and production). It is worth noting that the energy use is itself responsible for extraction of raw materials from the nature (as primary energy sources), but also for the discharge of pollutants to the environment (especially GHG emissions from energy combustion). These intrinsic features regarding economic activity, energy use and environment effects have also led to extensions of input-output models that combine both environment and energy modeling. As referred to by Faucheaux & Levarlet (1999) the so-called energy-economy-environment models are well suited to address the complex interactions between the process of energy production and consumption, the economy and the environment.

Generally, the energy-economy-environment input-output approaches apply a modified version of the energy input-output model to estimate pollution intensities, i.e. the total emissions per monetary unit of output for the producing sectors of the economy (Cruz, 2002). Usually, this analysis is performed using hybrid energy input-output tables dealing explicitly with both (physical) energy flows and emissions (e.g. of air pollutants – CO_2, CH_4 and N_2O)[43] from the energy sectors, considering also a 'pollution conservation condition' similarly to the energy conservation condition in the energy modeling approaches (Hawdon & Pearson, 1995; Casler & Blair, 1997; Casler & Rose, 1998)[44]. This model can be represented by considering a symmetric ($n \times n$) matrix $\boldsymbol{\lambda}$ with the emission factors of a specific GHG (e.g., CO_2, CH_4, N_2O) by type of energy resource, which is then included in (3.20) and (3.21) to calculate the direct emission/pollution intensity $\check{\mathbf{D}}$ and the total emission/pollution intensity $\breve{\mathbf{A}}$

[43] Although this work will frequently mention GHG or CO_2 emissions, the analysis can generally be applied to other kinds of pollutants.
[44] Chung *et al.* (2009) also calculated the direct GHG emissions intensity of the final demand sector, which includes a private sector and a government sector.

of the intermediate transaction sectors by energy use (both matrices of $m \times n$ dimension), respectively, as follows[45]:

$$\mathbf{\check{D}} = \mathbf{\ddot{E}}(\mathbf{\hat{x}}^{*})^{-1}\boldsymbol{\lambda}\mathbf{A}^{*} \tag{3.25}$$

$$\mathbf{\check{A}} = \mathbf{\ddot{E}}(\mathbf{\hat{x}}^{*})^{-1}\boldsymbol{\lambda}(\mathbf{I} - \mathbf{A}^{*})^{-1} \tag{3.26}$$

Thus, analogously to (3.24), it is possible to obtain a matrix $\mathbf{\check{E}}$ with the total emissions by fuel source produced by the economy:

$$\mathbf{\check{E}} = \mathbf{\ddot{E}}(\mathbf{\hat{x}}^{*})^{-1}\boldsymbol{\lambda}(\mathbf{I} - \mathbf{A}^{*})^{-1}\mathbf{\hat{y}}^{*} \tag{3.27}$$

Hence, the formulation presented in (3.27) allows tracing all of the direct and indirect environmental (and also energy) impacts throughout an economy from changes in final demand, which is useful for energy-economy-environment policy purposes (Cruz, 2002).

Proops *et al*. (1993) developed a slightly different approach for a structural analysis of anthropogenic CO_2 emissions by economies, relating this pollution with the use of fossil fuels[46]. The main steps of this formulation are summarily presented as follows.

Firstly, a (3 × 1) vector **ë** similar to (3.10) is defined, for simplicity, for the total output in energy terms (e.g. toe) of three fossil fuels (or primary energy sources) (oil, gas and coal) used in the economy. In addition, a (3 × 1) vector **č** with the emission factors (e.g. CO_2 emission factors) for each fuel is defined (e.g., measured in $\frac{CO_2}{\text{toe}}$). Thus, it is possible to estimate the total CO_2 emissions resulting from production activities c_{ind} by multiplying the vector of fuel used in the production **ë**, with the vector of CO_2 emission factors **č** as follows:

$$\mathbf{\check{c}}^{T}\mathbf{\ddot{e}} = c_{ind} \tag{3.28}$$

In the next step, the energy amount depicted in the vector **ë** is disaggregated throughout the economic sectors, considering that each element $\ddot{e}_{ij}$ represents the physical amount of fuel *j* used in the sector *i* (where i = *1*,…, *n*). In addition, the use of fuel in each sector is associated with the corresponding total output X_i, by assuming a proportional relation

[45] For further discussion of this model see for example Casler & Blair (1997), Casler & Rose (1998), Cruz (2002) and Chung *et al*. (2009).

[46] Further discussions and extensions of this approach can be seen in the studies of Gay & Proops (1993), Cruz (2002) and Cruz & Barata (2007).

between energy use and the total output of each sector. Thus a (n × 3) 'proportional' matrix $\mathbf{\check{R}}$ can be defined, where each element $\check{r}_{ij} = \frac{\ddot{e}_{ij}}{X_i}$ represents the intensity of a corresponding fuel *j* used by a economic sector *i* (e.g., measured in $\frac{toe}{\$}$). Therefore, according to the definition of $\mathbf{\check{R}}$, it is possible to obtain the vector of total energy production $\mathbf{\ddot{e}}$ by multiplying the transposed of $\mathbf{\check{R}}$ by the vector of total output $\mathbf{x}$:

$$\mathbf{\check{R}}^T\mathbf{x} = \mathbf{\ddot{e}} \tag{3.29}$$

In addition, from (3.29), multiplying both sides by $\mathbf{\check{c}}^T$ and using the definition in (3.28) is possible to obtain:

$$\mathbf{\check{R}}^T\mathbf{x} = \mathbf{\ddot{e}} \Leftrightarrow \mathbf{\check{c}}^T\,\mathbf{\check{R}}^T\mathbf{x} = \mathbf{\check{c}}^T\mathbf{\ddot{e}} \Leftrightarrow \mathbf{\check{c}}^T\mathbf{\check{R}}^T\mathbf{x} = c_{ind} \tag{3.30}$$

where the elements of $\mathbf{\check{c}}^T\mathbf{\check{R}}^T$ are referred to as CO_2 (emission) intensities, representing the quantity of CO_2 generated by output unit of each sector. Furthermore, substituting the relation $\mathbf{x} = \mathbf{(I - A)^{-1}}\,\mathbf{y}$ in (3.30) is possible to obtain:

$$\mathbf{\check{c}}^T\mathbf{\check{R}}^T\mathbf{(I - A)^{-1}}\,\mathbf{y} = c_{ind} \tag{3.31}$$

The term $\mathbf{\check{c}}^T\mathbf{\check{T}}^T\,\mathbf{(I - A)^{-1}}$ represents a new vector of CO_2 intensity, which is used to estimate the direct and indirect CO_2 emissions by unit of final demand. Moreover, since $(\mathbf{I} - \mathbf{A})^{-1} \approx (\mathbf{I} + \mathrm{A} + \mathbf{A}^2 + \mathbf{A}^3 \ldots)$ is possible to get:

$$\mathbf{\check{c}}^T\mathbf{\check{R}}^T\mathbf{(I - A)^{-1}} \approx \mathbf{\check{c}}^T\mathbf{\check{R}}^T(\mathbf{I} + \mathrm{A} + \mathbf{A}^2 + \mathbf{A}^3\ldots) = \mathbf{\check{c}}^T\mathbf{\check{R}}^T + \mathbf{\check{c}}^T\mathbf{\check{R}}^T\mathbf{A} + \mathbf{\check{c}}^T\mathbf{\check{R}}^T\mathbf{A^2} + \mathbf{\check{c}}^T\mathbf{\check{R}}^T\mathbf{A}^3\ldots \tag{3.32}$$

where $\mathbf{\check{c}}^T\mathbf{\check{R}}^T$ correspond to the direct effect of the outputs on CO_2 emissions; $\mathbf{\check{c}}^T\mathbf{\check{R}}^T\mathbf{A}$ is the CO_2 intensity corresponding to the first indirect effect; $\mathbf{\check{c}}^T\mathbf{\check{R}}^T\mathbf{A^2}$ is the CO_2 intensity corresponding to the second indirect effect; $\mathbf{\check{c}}^T\mathbf{\check{R}}^T\mathbf{A}^3$ is the CO_2 intensity corresponding to the third indirect effect, and successively. Therefore, the sum of all elements in this equation except the first one corresponds to the total indirect effects of the outputs on CO_2 emissions.

In a further step of this model a (3 × 1) vector $\mathbf{\ddot{y}}_d$ of *final demand energy requirements* is defined expressing the final demand in (physical) energy terms (e.g. toe) of the three fossil fuels (oil, gas and coal). Thus, it is possible to estimate the CO_2 emissions from final demand c_{fd} by multiplying the vector of fuels used in the final demand $\mathbf{\ddot{y}}_d$, with the vector of CO_2 emission factors $\mathbf{\check{c}}$ as follows:

$$\check{\mathbf{c}}^T\ddot{\mathbf{y}}_d = c_{fd} \tag{3.33}$$

In order to associate the vector $\ddot{\mathbf{y}}_d$ with the final demand vector $\mathbf{y}$ in (3.34) it is necessary to consider some additional matrices. Firstly, a (3 × n) matrix $\check{\mathbf{S}}$ of *energy intensities corresponding to direct consumption demand* is defined. This matrix has only three non-null values, one for each fuel type, expressing the (physical) quantity of fossil fuel use per unit of final demand (for fossil fuels). In addition, it is necessary to modify the final demand vector $\mathbf{y}$ to exclude the components in which the direct final demand of fossil fuels (or the energy embodied in those components) does not lead to CO_2 emissions (such as investments - GFCF and ‘‘changes in stocks’) or does not lead to CO_2 emissions at domestic level (such as exports). Hence, it is necessary to obtain a modified vector that considers only the final consumption, i.e. ‘final consumption of households’ plus ‘collective or public consumption’. For this purpose a ($n \times n$) diagonal matrix $\check{\mathbf{T}}$ with only three non-null values for each fuel sector is also defined. These values are the ratios of the sum of ‘final consumption of households’ and ‘collective or public consumption’ to total final demand for the three fossil fuel sectors (Proops *et al*., 1993; Cruz, 2002). Thus, finally the *final demand energy requirements* $\ddot{\mathbf{y}}_d$ can be obtained by the expression:

$$\ddot{\mathbf{y}}_d = \check{\mathbf{S}}\check{\mathbf{T}}\mathbf{y} \tag{3.34}$$

In addition, substituting (3.34) in (3.33) it is possible to get:

$$\check{\mathbf{c}}^T\check{\mathbf{S}}\check{\mathbf{T}}\mathbf{y} = c_{fd} \tag{3.35}$$

Therefore, the total (direct and indirect) CO_2 emissions in a economy is obtained by the summation of the total CO_2 emissions resulting from production activities c_{ind} and the CO_2 emissions from final demand c_{fd} as follows:

$$c_{tot} = c_{ind} + c_{fd} \Leftrightarrow c_{tot} = \check{\mathbf{c}}^T\check{\mathbf{R}}^T\,(\mathbf{I} - \mathbf{A})^{-1}\mathbf{y} + \check{\mathbf{c}}^T\check{\mathbf{S}}\check{\mathbf{T}}\mathbf{y} \Leftrightarrow c_{tot} = [\check{\mathbf{c}}^T\check{\mathbf{R}}^T\,(\mathbf{I} - \mathbf{A})^{-1} + \check{\mathbf{c}}^T\check{\mathbf{S}}\check{\mathbf{T}}]\;\mathbf{y} \tag{3.36}$$

As referred to by Cruz (2002) ‘*this expression makes clear the relation between the use of fuels and the emission of CO_2 with the vector of final demand*’. This feature is important for policy analysis, since the total CO_2 emissions by an economy are in fact ultimately attributed to final demand (or to ‘households’ purchases).

3.4 INPUT-OUTPUT MODELS AND LINEAR PROGRAMMING

The ancient theoretical roots of linear programming (LP) in economic models can be somewhat linked to the former mathematical descriptions of the economic system since the XVIII century with the *Tableu économique* of Quesnay (which could be referred to as a crude example of linear programming) and the (generalizations of) *Walrasian* models (due to the utilization of fixed coefficients)[47]. However, the early development of general linear programming model was mainly influenced by input-output analysis as a result of the empirical programming needs (such as practical planning and scheduling problems) of the American Air Force during (and after) the World War II, which found the possibility of generalizing the simple practical structure of the Leontief model to this end (Dantzig, 1963; Albers & Reid, 1986). Indeed, input-output models can be considered as a peculiar simple form of linear programming model (Dorfman *et al.*, 1958). The generalization of the Leontief's model with the linear programming enables investigating efficient combinations of inputs and outputs on the boundary of the production possibility frontier established in the input-output analysis (Christ, 1955).

A standard linear programming formulation contains a linear objective function maximizing or minimizing a set of nonnegative decision variables subject to a set of linear constraints (Dantzig, 1951). A general linear programming model can be formulated as follows:

$$\text{Max (or Min) } z(x) = \sum_{j=1}^{n} c_j x_j \qquad (3.37)$$

$$\text{Subject to:} \quad \sum_{j=1}^{n} a_{ij} x_j \begin{Bmatrix} \leq \\ = \\ \geq \end{Bmatrix} b_i, \qquad i = 1,\ldots, m$$

$$x_j \geq 0 \qquad j = 1,\ldots, n$$

where x_j are the decision variables, c_j are the objective function coefficients, a_{ij} are the constraint (technological) coefficients and b_i are the constraint's right hand side constant, n is the number of decision variables and m is the number of constraints.

There are several studies in the scientific literature using linear programming (LP) models coupled with the input-output framework for different purposes: analyzing the production capacity and import requirements needed through time to attain a set of

[47] For a further discussion of the origins of linear programming in the scope of economic models see Dantzig (1963, 2002) and Manne (1961).

development targets and sectoral investment planning (Clark & Taylor, 1971; Bergendorff *et al*., 1973); for the maximization of the value of a given bill of final demands and the minimization of labor input (Dorfman *et al*., 1958); to solve the problem of choosing new technologies (Ebiefung & Kostreva, 1993); to estimate regional impact from the policy changes (Zhu *et al*., 2009); for updating input–output matrices (see e.g. Jackson & Murray, 2004; Strømman, 2009), among others. In addition, it is also possible to identify some studies that have introduced environmental and energy (and combination of both) criteria in the input-output linear programming models, either as the only objective or combined with the economic objective. A sample selection of those studies describing the objectives of the model, general features, objective functions considered and the level and region of application is presented in Table 3.7.

Table 3.7 – List of some studies assessing economic, energy and environment objectives applying input-output linear programming models.

Author	Year	Objectives of the Model	General features	Objective Functions	Level/Region[48]
Economic-environmental models					
Rosenbluth	1968	Determine the desirable level of industry activities; Minimum level of economic commodities to be supplied to final demand	Commodity by industry; relation between industrial waste and industrial outputs; ecologic costs; economic-ecologic set of weights.	Min. Value added; Min. Ecologic costs; Min. Economic-ecologic costs	-
Kohn	1975	Regional environmental planning - evaluate the feasibility of incorporating a pollution control sector in the structure of IO model	Abatement multiplier; cost-effectiveness model; Emission targets.	Min. cost of reducing air pollution	R / St. Louis - USA
Muller	1979	Assess the impacts of air polluting sectors	Considering upper bounds for available labor resources and the output of the agriculture sector and a lower bound of outputs for other sectors.	Max. income	R / Rijnmond - Netherlands
Kazantzev	1985	Compare the level of production of sectors producing capital goods with the amounts of financial resources available for these sectors	Constraints in the production capacity for each sector, stocks and labor resources; investment restrictions; shadow-prices; 18 sectors.	Max. consumption of non-productive sectors	N / Russia
Lipinski	1985	Assess structural disproportions in the national economy	Simulation method; intensity coefficients; output capacity utilization constraints; 7 economic sectors; changes in values of most important IO coefficients.	Max. final demand attendance	N / Poland

[48] Here the letters represents: International (I), National (N), Regional (R) and Local (L).

Kondo & Takase	2003	Assess the impacts of alternative technologies for producing goods and alternative waste management strategies on the residual deposition	Waste IO linear programming model; Integration of good and residual flows; 80 goods-producing sectors, 5 treatment methods and 36 types of waste.	Min. residual deposition (CO_2 emissions)	N / Japan
Kondo & Nakamura	2005	Propose a systematic method for eco-efficiency analysis of waste management and recycling strategies	Waste IO linear programming model; Integration of good and residual flows; 80 goods sectors, 4 waste treatment sectors and 42 types of waste.	Min. residual deposition	N / Japan
Nansai *et al*.	2008	Find common features in a set of simulated Japanese household consumption patterns optimized to reduce different environmental burdens	399 commodity, 109 industrial sectors, 7 freight transport sectors, 2 trade and retail sectors and 2 municipal waste disposal sectors.	Min. Total domestic environmental burden generated directly and indirectly by household consumption	N / Japan
Vogstad	2009	Assess alternative technologies for the paper and pulp industry	External costs; Hybrid approach.	Min. cost of production (labor); Min. external costs (CO_2 and SO_2 emissions)	N / Norway
San Cristobal	2010	Analyze how targets for the emissions of GHGs may be reached and can affect production activity composition	Goal programming model; 51 sectors; carbon dioxide, methane, nitrogen oxide, sulphur fluoride, hydrofluorocarbons, and perfluorcarbons emissions.	Min. GHG emissions; Max. Output	N / Spain
McKenzie & Durango-Cohen	2010	Analyze the environmental impacts of print vs. online advertising of a newspaper	Hypothetical case study; EIO-LCA.	Min. GWP	L / Chicago - USA
Duchin & Levine	2012	Introduce rectangular IO matrices and a modeling framework for IO databases of the world economy	Extends the Rectangular Choice of Technology (RCOT) model and integrates it into an IO-LP model of the world economy - the World Trade Model (WTM).	Min. global factor usage; Max. consumption	I / World
Egilmez *et al*.	2013	Analyze the eco-efficiency of manufacturing sectors	Integration of Economic Input-Output Life Cycle Assessment (EIO-LCA) and Data Envelopment Analysis (DEA); aggregating different environmental pressures into a single eco-efficiency score.	Min. environmental impacts while obtaining the same level of total economic output	N / USA
Economic-energy models					
Moulik *et al*.	1992	Energy planning	Expanded IO table with disaggregated energy sectors.	Min. overall costs of the energy system	R / Gujarat, Kerala and Rajasthan - India
Economic-environmental-energy models					
Rose *et al*.	1996	Analyze the impacts of greenhouse gas mitigation policies on the growth of the economy over a 35 years time-horizon	Dynamic linear programming model; 33 sectors; strategies to stabilize CO_2 emissions; constraints relating to labor, capital, and energy resources.	Max. GDP (economic growth)	N / China
Dong	2008	Asses the industrial structure considering energy and environmental constraints for the economic development	Dynamic optimization model; energy-saving and emission-reducing constraints; 17 sectors.	Max. GDP	N / China

Hristu-Varsakelis *et al*.	2010	Assess the reallocation of production in order to meet overall demand constraints and GHG emissions targets	NAMEA; Energy consumption and GHG pollution constraints; Policy scenarios; 26 sectors.	Max. Gross Value of Production (GVP) or total outputs	N / Greece
Hristu-Varsakelis *et al*.	2012	Assess macroeconomic and sectoral effects that arise by optimizing production while meeting GHG and solid waste reduction targets	NAMEA; Energy use, GHG emissions, final demand and solid waste constraints; Policy scenarios; 26 sectors; bounds on production.	Max. Gross Value of Production (GVP) or total output	N / Greece

However, in general, energy, economic, environmental and social concerns have conflicting interactions. Therefore a broad scrutiny of these evaluation aspects and a thorough appraisal of the trade-offs at stake are required to assess the merits of adopting distinct policies. The complexity of real world problems can be better captured and models become more realistic if multiple, conflicting and incommensurable axes of evaluation of different potential policies are explicitly considered (rather than aggregated in a single indicator), which enables to exploit the trade-offs between those competing objectives. In this context, multi-objective linear programming (MOLP) models coupled with the input-output framework have been developed for different purposes, especially in economic and energy planning. The MOLP models allow capturing the diversity of evaluation aspects and a rational comparison of alternative compromising solutions, since there is no admissible solution that simultaneously optimizes all objective functions[49]. A sample selection of some studies that have used the MOLP in the scope of input-output framework considering economic, energy, environmental and social objectives are presented in Table 3.8 which highlights the objectives of each model, their general features, objective functions considered and the level and region of application.

[49] Therefore, in the MOLP context the terms efficient and/or non-dominated solutions are used instead of the optimal solution as in (single objective) linear programming (Steuer, 1986; Roy, 1990; Clímaco *et al*., 2003). These concepts will be further discussed in the next chapter.

Table 3.8 – List of some studies assessing economic, energy and environment objectives applying input-output MOLP models.

Author	Year	Objectives of the Model	General features	Objective Functions	Level/Region
Economic-environmental models					
Hsu *et al*.	1987	Assess the trade-offs between economic growth and energy use	Non-Inferior Set Estimations (NISE) method.	Max. GDP; Min. energy consumption	N / Taiwan
Ni *et al*.	2001	Assess the dynamic relationships between the rapid economic development, water pollution and the subsequent waste-load allocation in different economic sectors	Interactive algorithm based on the Tchebycheff procedure; 21 economic sectors; economic, environment and investment constraints.	Max. GDP; Min. total COD (chemical oxygen demand)	L / Shenzhen - China
Economic-energy models					
Martins	1983	Economic planning under energy rationing conditions	Interactive model with multiple decision makers (based on Steur's method); 5 energy sectors, 14 energy (commodity) sectors and 20 non-energy sectors.	Max. Private consumption; Max. employment level; Min. deficit in the current payment balance; Min. oil imports	N / Portugal
Quaddus & Holzman	1985	Macroeconomic planning and electric power generation planning	Interactive approach.	Max. GDP; Min. Commercial Balance Deficit; Max. The rate of employees in the active population	N / Bangladesh
Kananen *et al*.	1990	Assess the quantitative effects of political and economical crisis scenarios on the national economy	Visual Interactive Goal Programming (VIG); variables or combination between them are considered as objectives.	Max. Private consumption; Max. employment level; Min. Commercial balance deficit; Min. Total energy consumption	N / Finland
Alves *et al*.	1997	Regional Economic Planning	SOMMIX (Several-objective methods mixed) interactive environment; interactive methods (STEM and Zionts-Wallenius).	Max. employment level; Min. total energy consumption	R / Beira Interior - Portugal
Jesus	1998	Regional Economic Planning	SOMMIX (Several-objective methods mixed) interactive environment; 20 sectors.	Max. Private consumption; Max. Employment level; Max. Exports; Max. GAV; Min. The gap between the minimum and maximum output of the sectors	R / North Region - Portugal
Kravtsov & Pashkevich	2004	Analysis and choice of alternative versions of the development of the real sector of the national economy	Three-criteria linear model; Inter-branch (inter-sectoral) balance; Minimization of a weighted sum of the objective functions.	Max. GDP; Max. foreign trade balance; Min. fuel-and-energy resources	N / Belarus
Economic-environmental-energy models					
Chang & Juang	1998	Economic-environmental-energy policy analysis	Fuzzy model.	Max. GDP; Max. Energy efficient use; Min. Overall electricity production cost; Min. CO_2 emissions	N / Taiwan

Cho	1999	Economic-environmental-energy policy analysis	Interactive model (based on the STEP method) considering an economy with 12 sectors.	Max. Employment level; Min. Water pollution; Min. Energy consumption	R / Chungbuk - South Korea
Hsu & Chou	2000	Evaluate the impact of energy conservation policy on the cost of reducing CO2 emissions and undertaking industrial adjustment	Constraint method; 33 economic sectors and 1340 constraints; Intertemporal model.	Max. Value Added; Min. CO2 emissions	N / Taiwan
Chen	2001	Evaluate the economic impact of reducing CO2 emissions on the economy as a whole	33 industrial sectors; CO2 emissions of energy consumption.	Max. GDP; Min. CO2 emissions	N / Taiwan
Oliveira & Antunes	2002	Economic and Energy planning - Performs a progressive and selective learning of the efficient solutions in a interactive method	STEM interactive method; 21 economic sectors and 23 artificial (energy) sectors.	Max. Private consumption; Max. Employment level; Min. Energy imports; Max. GDP; Min. Co2 emissions; Max. Self-production of Electricity	N / Portugal
Antunes *et al*.	2002	Economic and Energy planning - Performs a progressive and selective learning of the efficient solutions in a interactive method	21 economic sectors and 23 artificial (energy) sectors; Trimap interactive method.	Max. Private consumption; Min. Energy imports; Max. Employment level	N / Portugal
Borges & Antunes	2003	Economic and Energy planning - Performs a progressive and selective learning of the efficient solutions in a interactive method	Fuzzy MOLP model; analysis of the decomposition of the parametric (weight) diagram into indifference regions; 21 economic sectors and 23 artificial (energy) sectors.	Min. energy imports; Max. self-production of electricity Min. CO2 emissions	N / Portugal
Oliveira & Antunes	2004	Assist DMs and planners in the evaluation of several important indicators involving economical, social, environment and energy sustainable concerns	Hybrid (energy-economic-physical) units; 45 sectors; NAMEA; EIO-LCA; Interactive approach - reference points.	Min. acidification potential; Max. self-power generation; Max. Employment; Max. GDP; Min. energy imports	N / Portugal
Chang	2005	Examine feasible approaches to achieve the integration of environmental concerns (CO2 abatement strategies in the national power sector) and to evaluate impacts on economic and energy sectors for each of these strategies	Fuzzy MOLP model; industrial structure, energy structure, power generation technologies and pollution emissions (CO2); energy (electricity and non-electricity) sectors; physical and monetary units.	Max. GDP; Min. Energy requirements (physical quantities of energy); Min. Least-cost planning in electric power system; Min. CO2 emission	N / Taiwan
Henriques	2008	Economic and Energy planning - Performs a progressive and selective learning of the efficient solutions in a interactive method	54 economic sectors, 4 energy sectors; 23 artificial (energy) sectors; EIO-LCA; interval programming; interactive method.	Min. energy imports; Min. global warming potential; Max. GDP: Max. Employment	N / Portugal
Oliveira & Antunes	2011	Perform a prospective analysis of the changes in the economic structure and the energy system, as well as to assess the corresponding environmental impacts	Hybrid (energy-economic-physical) units; 80 sectors; interval programming; environmental constraints (based on the IPCC guidelines); CO, NOx, N2O, CH4, COVNM, SO2, CO2, and NH3 emissions.	Min. GWP; Max. Employment; Max. GDP; Min. energy imports	N / Portugal

Henriques & Antunes	2012	Assess the influence of political measures on economic growth, social well-being, energy consumption and impacts on the environment	Hybrid (energy-economic-physical) units; interval programming; interactive approach; environmental constraints (based on the IPCC guidelines); CO, NOx, N2O, CH4, COVNM, SO2, CO2, and NH3 emissions; Scenarios 2020.	Max. Employment; Max. GDP; Min. energy imports	N / Portugal
San Cristobal	2012	Analyse how targets for the emissions of GHGs may be reached and can affect production activity composition	Goal programming model; 91 sectors; carbon dioxide, methane, nitrogen oxide, sulphur fluoride, hydrofluorocarbons, and perfluorcarbons emissions.	Min. GHG emissions; Min. Waste emissions; Min. Energy requirements; Max. Employment; Max. Output	N / Spain
Carvalho *et al.*	2012	Assess the trade-offs between economic, energy, environmental and social aspects in the Brazilian economic system	51 economic sectors, 6 energy producing sectors, 52 artificial (energy) sectors; Step method; emissions of energy combustion.	Max. GDP; Max. Employment level; Min. Energy consumption; Min. Global Warming Potential (GWP)	N / Brazil
Carvalho *et al.*	2013	Assess the trade-offs between economic, energy and environmental objectives in the Brazilian economic system	TRIMAP method; 51 economic sectors, 6 energy producing sectors, 52 artificial (energy) sectors.	Max. GDP; Min. Energy consumption; Min. Global Warming Potential (GWP)	N / Brazil
Carvalho *et al.*	2014	Assess the trade-offs between economic, energy, environmental (E3) and social objectives in the Brazilian economic system	51 economic sectors, 6 energy producing sectors, 52 artificial (energy) sectors; Step method; emissions from a range of sources.	Max. GDP; Max. Employment level; Min. Energy consumption; Min. Global Warming Potential (GWP)	N / Brazil

Nevertheless, a range of uncertainty sources in the input-output models can be identified especially as a result of the inconsistency of the statistical data gathered from different sources, the assumptions inherent to the input-output analysis (linearity and proportionality, for example), as well as allocation and aggregation problems. In sum, these uncertainties can be derived from: changes in price levels over time; changes in the structure of the economy and in the technology of producing goods and services; changes in the matrix of energy intensities due to sectoral aggregation; inaccuracy of data due to economic accounting conventions; errors in collecting and processing the basic data on the technology of producing goods and services, among others. In addition, the lack of information and uncertainty associated with the specification of the coefficients of the objective functions and constraints can also be a drawback of the mathematical programming models (Bullard *et al.*, 1978; Lenzen, 2001; Rocco & Guarata, 2002). Therefore, it is useful to extend the mathematical models to explicitly include the treatment of uncertainty.

Basically, three different approaches can be used to deal with uncertainty in the scope of input-output models: a probabilistic (or stochastic) approach assuming probability distributions associated with the coefficients (e.g. West (1986); Raa & Steel (1994)), the fuzzy (or *possibilistic*) approach, in which membership functions are assigned to all uncertain factors (e.g. Buckley (1989)), and the interval approach (also called *unknown but bounded* approach) in which upper and lower limits on the uncertain coefficients are considered without a probability or possibility structure (e.g. Jerrell (1995, 1997); Rocco & Guarata (2002)).

Some studies have developed MOLP models based on input-output analysis incorporating explicitly the uncertainty treatment: Chang & Juang (1998) and Chang (2005) have applied a MOLP model with fuzzy coefficients in the objective function; Borges & Antunes (2003) have developed a MOLP with fuzzy coefficients in the objective function and in the right hand side vector; Henriques (2008) and Henriques & Antunes (2012) have applied an MOLP model with interval coefficients in the objective function, the right hand side vector and also in technical coefficients.

Indeed, estimating likelihood and fuzzy membership functions associated with all elements of national input-output tables can be an unaffordable task, which makes the interval approach more appropriate for tackling uncertainty in this type of model. I.e. in the interval approach it is only necessary to have information about the possible ranges of variation of some (or all) of the coefficients to specify the model, rather than specifying probability or *possibilistic* distributions as in stochastic or fuzzy programming (Jerrell, 1995, 1997; Henriques, 2008). For this reason, in this study a hybrid input-output MOLP model for economic, energy and environmental planning (considering the time frame of 2018) applied to the Brazilian economic system is developed, in which a (real or hypothetical) decision maker can also consider interval coefficients for dealing with uncertainty.

3.5 FINAL REMARKS

In this chapter an overview of extended versions of the traditional input-output model to deal with both environmental and energy issues has been presented, as well as the relationships between the input-output model with other methods such as Life Cycle Analysis and linear programming.

The extensions of the traditional input-output model combining energy and environmental data in physical units with input-output data in monetary units provides a consistent and systematic tool for the analysis of the energy-economy-environment interactions at national and sectoral levels. These models can be applied to evaluate the energy use and environmental impacts from economic shocks, the effects of environmental or energy regulatory policies throughout all sectors of the economy, the repercussions of changes in the outputs of specific sectors, among other purposes. In addition, the combination of those extended input-output models with mathematical programming models allows obtaining a framework within which technical, environmental, economic and policy constraints and feedbacks may be expressed, enabling to identify efficient combinations of inputs and outputs on the boundary of the production possibility frontier. Such combination of these different modeling approaches provides a 'complementary' feature for the analysis, enabling extracting additional information that is not possible to obtain by the isolated use of them (Faucheaux & Levarlet, 1999; Cruz, 2002; Henriques, 2008).

Energy and environmental extensions of the input-output model, as well as EIO-LCA models has also been applied to the Brazilian economy for different purposes. Munasinghe *et al*. (2006) and Oliveira (2011), for example, applied EIO-LCA models. The former analyzed air, soil and water pollutant emissions in domestic consumption and exports for the period between 1990 and 1996, while the later assessed a set of GHG emission sources considering an input-output table of 2005 with 17 sectors[50]. However, both models have not analyzed the impacts on the employment level and the energy intensities, as well as on the national energy mix.

There are also some studies using hybrid approaches to assess energy and environmental issues in the Brazilian economic system. Schaeffer & Sá (1996) used a hybrid energy-economic-environmental input-output model to estimate the amount of energy and carbon embodied in the non-energy exports and imports of Brazil for the period of 1970-1993. Machado *et al*. (2001) developed an extended input-output model in hybrid units to assess the energy and carbon embodied in imports and exports using an input-output table of 1995 with 19 commodities and 14 sectors. Cohen *et al*. (2005) applied an energy input-output model to calculate the energy embodied in goods and services purchased by households of different income levels in 11 capital cities of Brazil using the input-output table of 1995 with 80 sectors. Perobelli *et al*. (2007) developed a hybrid interregional energy-based input-output model to compute the energy intensities and the interactions between the energy consumption and levels of outputs between two-regions (Minas Gerais State and rest of Brazil) using input-output tables for 1996 with 14 activity sectors. Carvalho & Perobelli (2009) applied a hybrid interregional input-output analysis to estimate the carbon dioxide intensity of the domestic economy and exports resulting from the energy consumption in 15 sectors using an input-

[50] In this study the emissions of CO_2, CH_4 and N_2O (converted to CO_2eq) estimated in the Brazilian National Inventory of GHG emissions (MCT, 2010) were assigned to each sector considered in the study, and therefore divided by the total output of the corresponding sector in order to obtain the emission coefficients.

output table of 1996. Figueiredo *et al*. (2009) applied an input-output hybrid model to assess the energy and carbon dioxide intensities related to a specific region in Brazil using an interregional system of 14 sectors for 1999. Carneiro (2010) developed a hybrid input-output model to assess carbon dioxide intensities and applied a structural decomposition analysis to verify the impacts of technological changes on the carbon dioxide emissions of 22 sectors in the period between 2000 and 2005. Firme & Perobelli (2012) applied a hybrid energy input-output analysis to estimate the direct, indirect and total energy intensities in order to assess the structural changes into the Brazilian energy sector for two different years (1997 and 2002) using a system of 14 sectors. In spite of accounting for energy and, in some cases, for both energy and environmental issues, these models have not analyzed social aspects, such as the employment level.

Nevertheless, other studies such as Hilgemberg (2004) and Hilgemberg & Guilhoto (2006) developed extended interregional input-output models in hybrid units to assess the carbon and energy intensities, as well as the impacts of a set of environmental policies on the employment levels using an input-output table of 1999 with 18 sectors. Despite the interregional characteristic, these models developed a framework quite similar to the model proposed in this thesis. However, both studies encompassed a reduced number of sectors, addressed only GHG emissions from energy combustion and applied simulations of economic shocks on final demand, whereas the model herein proposed will encompass more (energy and non-energy) sectors, GHG emissions of different sources and will focus on a prospective analysis.

It is important to allude that all EIO-LCA and hybrid input-output models earlier described have not integrated the linear programming and uncertainty analysis into the models, which are the main value added of this research.

Other studies have also addressed long term projections of energy consumption in Brazil combining the input-output framework with econometric approaches. Mattos *et al*. (2008) and Santiago *et al*. (2011) are examples of these econometric input-output (EC+IO) models. Mattos *et al*. (2008) applied a model for the period between 2005 and 2010 using input-output tables calculated for 13 activity sectors in the period between 1997 and 2001. Santiago *et al*. (2011) applied a model for the period between 2008 and 2017 using a 2005 input-output table with 19 sectors. The main difference of this model compared to the former is estimating the input-output tables in hybrid units. Despite the usefulness for energy projections, both studies have not encompassed the employment and GHG emissions issues. In addition, both analyses are limited to a reduced number of sectors and fuels.

As referred to previously in Chapter 1, some studies such as Guilhoto *et al*. (2002), Burnquist *et al*. (2004), Costa *et al*. (2006a; 2006b), Terciote (2006), Scaramucci & Cunha (2006; 2008), Cunha & Scaramucci (2006), Moreira *et al*. (2007), CGEE (2009), Costa el. (2011) have developed basic and extended input-output models to assess the interactions between the Brazilian bioethanol sector and the Brazilian economic system. The analyses performed in these studies are based uniquely on economic input-output tables, applying in some extent an analysis for the employment level. These models have not assessed energy and/or GHG intensities related to the bioethanol sector and the whole economic system. Other studies, such as Watanabe *et al*. (2013) and Cómpean & Polenske (2011), although applying models addressing environmental and energy issues, also presented some weaknesses. Watanabe *et al*. (2013) applied an EIO-LCA to evaluate GHG emissions of different (first and second generation) sugarcane bioethanol production alternatives, but have not addressed the effects on the employment level, as well as the impacts on the energy intensities and the composition of the national energy mix. Cómpean & Polenske (2011) developed an environmentally extended interregional input-output model using hybrid units to account for energy- and carbon-intensities to analyze the direct and indirect impacts of different ethanol production technologies, but this is limited by the number of sectors and fuels included in the model, whereas the employment analysis was not included in the model and the impacts of the lignocellulosic bioethanol production was not assessed.

It is noteworthy that, observing all the studies previously presented and as far as this author has knowledge, there exists a lack of studies using input-output models to jointly analyze economic, energy, environmental (especially GHG emissions) and social (especially employment levels) aspects in Brazil (and of course, for the Brazilian bioethanol). I.e. in each of the studies beforehand presented, at best, three of those subjects have been analyzed jointly, while generally one of those spheres of evaluation is disregarded. In addition, as far as this study has searched, there is also a lack of studies applying input-output models integrated with linear programming (either for single and multiple objectives) and also including the treatment of uncertainty (such as interval, fuzzy, or stochastic programming) for the Brazilian economy.

Therefore, the model proposed in this study intends to provide a tool for prospective analysis of the Brazilian economic system and the bioethanol sector in Brazil taken advantage of the strengths in applying extended and hybrid input-output frameworks with multi-objective mathematical programming models in modeling complex interrelationships between economic and physical systems. The aim is to develop an MOLP model based on the extended input-output analysis, in which some coefficients are translated into intervals. This model will be utilized to analyze a set of economic, social, energy and environmental indicators according to different prospective scenarios for the Brazilian economy and technological options of the Brazilian bioethanol sector. Hence, before presenting the model, a brief review of the main concepts regarding MOLP and interval programming (used for the uncertainty treatment in this study) will be presented in the next chapter.

CHAPTER 4 MULTI-OBJECTIVE LINEAR PROGRAMMING MODELS AND UNCERTAINTY TREATMENT WITH INTERVAL PROGRAMMING

In the previous chapter, multi-objective linear programming (MOLP) models coupled with the input-output framework devoted to economic and energy planning (and, in some cases, accounting for environmental and social issues) were reviewed. The MOLP models allow capturing the diversity of evaluation aspects, enabling a rational comparison of alternative compromise solutions and exploiting the trade-offs between those competing objectives, since multiple, conflicting and incommensurable axes of evaluation of different potential policies are explicitly considered (rather than aggregated in a single indicator).

In general, there is no sufficient information for accurately specifying the coefficients of the objective functions and constraints in the mathematical models and different types of uncertainty can be identified, such as inaccuracies and variability in the data supplying the models. Furthermore, since the model is always an approximation of the reality and some simplifications are necessarily assumed, there is also an inability in modeling the reality in some extent (Zadeh, 1965; Zimmermann, 1987, 1996; Antunes, 1991; Gal & Greenberg, 1997). Thus, it is convenient to consider an extension of the mathematical models in order to explicitly include the treatment of uncertainty. There are basically five techniques to deal with uncertainty in mathematical programming models: sensitivity analysis (Cruz, 1973), robust programming (Pye, 1978; Rosenhead, 1980), fuzzy programming (Zimmermann, 1976), stochastic programming (Kolbin, 1977) and interval programming (Bitran, 1980). The modeling of uncertainty in input-output models can rely essentially on three different approaches: the stochastic (or probabilistic) approach (e.g. West (1986) and Raa & Steel (1994)); the fuzzy (or possibilistic) approach (e.g. Buckley (1989)); and the interval approach (e.g. Jerrell (1995, 1997)). Indeed, estimating likelihood and fuzzy membership functions associated with all elements of national input-output tables can be an unaffordable task. Thus, the interval approach may prove to be the most suitable for the treatment of uncertainty in this type of models (Jerrell, 1995, 1997).

Therefore, this chapter will provide a brief overview of the treatment of uncertainty in MOLP models with interval programming, since this is the approach applied for a specific analysis of the model developed in Chapter 5 of this thesis. However, before proceeding to the formulation and characterization of MOLP models with interval coefficients, some concepts regarding MOLP models will be presented[1].

4.1. MULTI-OBJECTIVE LINEAR PROGRAMMING

A Multi-Objective Linear Programming (MOLP) model can be formulated from (3.37) including *p* objective functions. I.e. the MOLP model consists in optimizing *p* linear objective functions subject to a set of linear constraints:

[1] For a more detailed discussion of this topic see e.g. the studies of Steuer (1986), Yu (1985), Zeleny (1982) and Climaco *et al*. (2003).

$$\text{Max (or Min) } z_1 = z_1(\mathbf{x}) = \sum_{j=1}^{n} \quad {}_{j}\, x_j \tag{4.1}$$

$$\text{Max (or Min) } z_p = z_p(\mathbf{x}) = \sum_{j=1}^{n} \quad {}_{pj}\, x_j$$

$$\text{S.t.:} \quad \sum_{j=1}^{n} a_{ij}\, x_j \begin{Bmatrix} \leq \\ = \\ \geq \end{Bmatrix} b_i, \qquad i = 1,\ldots, m$$

$$x_j \geq 0 \qquad j = 1,\ldots, n$$

or in matrix form[2]:

$$\text{Max} \quad \mathbf{z}(\mathbf{x}) = \mathbf{Cx} \tag{4.2}$$

$$\text{S.t.:} \quad \mathbf{x} \in \mathbf{X} = \{\mathbf{x} \in \Re^n : \mathbf{x} \geq 0, \mathbf{Ax} \leq \mathbf{b} \in \Re^n\}.$$

4.1.1 Efficient solution and non-dominated solutions

In models with a single objective function its optimal value is *unique*, even if alternative optimal solutions exist. Whenever multiple objective functions are at stake, in general, there is no feasible solution, $\mathbf{x} \in \mathbf{X}$, which simultaneously optimizes all objective functions. Thus, the concept of *optimal solution* is substituted by the concept of *efficient* (or Pareto optimal) or *non-dominated* solution.

A *feasible solution* to a MOLP model is *efficient if* and *only if* there is no other feasible solution that improves the value of a given objective function without worsening the value of, at least, other objective function.

The set of *efficient solutions* may be defined as follows:

$$\mathbf{X}_E = \{\mathbf{x} \in \mathbf{X}: \nexists \mathbf{x}' \in \mathbf{X}: \mathbf{z}(\mathbf{x}') \geq \mathbf{z}(\mathbf{x}) \text{ and } \mathbf{z}(\mathbf{x}') \neq \mathbf{z}(\mathbf{x})\} \tag{4.3}$$

i.e., $\mathbf{x} \in \mathbf{X}$ is *efficient if* and *only if* there is no other $\mathbf{x}' \in \mathbf{X}$ such that $\mathbf{z}_k(\mathbf{x}') \geq \mathbf{z}_k(\mathbf{x})$ for all k and $\mathbf{z}_k(\mathbf{x}') > \mathbf{z}_k(\mathbf{x})$ for at least one k (k = 1,..., p).

The objective function vector $\mathbf{z} = \mathbf{z}(\mathbf{x})$ is *non-dominated* when $\mathbf{x} \in \mathbf{X}_E$, i.e., the *non-dominated solutions* set in the objective function space is given by:

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[2] Here, generically, the objective functions are considered to be maximized and the constraints as "≤" type. Therefore, for objective functions to be minimized and constraints of "≥" and "=" types, it is necessary to make the convenient conversions.

$$\mathbf{F}_E = \{\mathbf{z} = \mathbf{z}(\mathbf{x}) \in \mathbf{F}: \mathbf{x} \in \mathbf{X}_E\} \quad (4.4)$$

where $\mathbf{F} = \{\mathbf{z}(\mathbf{x}) \in \Re^p: \mathbf{x} \in \mathbf{X}\}$.

The concept of *non-dominance* usually refers to the objective function space, while the concept of *efficiency* refers to the decision variables space, i.e., the image of an *efficient solution* is a *non-dominated solution* (Clímaco *et al*., 2003).

Furthermore, the *weakly efficient solution* set can be defined as follows:

$$\mathbf{X}_{FE} = \{\mathbf{x} \in \mathbf{X}: \nexists \mathbf{x}' \in \mathbf{X}: \mathbf{z}(\mathbf{x}') > \mathbf{z}(\mathbf{x})\} \quad (4.5)$$

Moreover, the *weakly non-dominated solutions* set correspond to:

$$\mathbf{F}_{FE} = \{\mathbf{z} = \mathbf{z}(\mathbf{x}) \in \mathbf{F}: \mathbf{x} \in \mathbf{X}_{FE}\} \quad (4.6)$$

Thus, a solution $x^* \in X$ is *weakly efficient* (i.e., $\mathbf{x}^* \in \mathbf{X}_{FE}$) *if* and *only if* there is no other solution $\mathbf{x} \in \mathbf{X}$ such that $\mathbf{Cx} > \mathbf{Cx}^*$, i.e., *if* and *only if* there is no other solution $\mathbf{x} \in \mathbf{X}$ such that $\mathbf{z}(\mathbf{x}) > \mathbf{z}(\mathbf{x}^*)$ (i.e., *if* and *only if* there is no other solution **x** that strictly improves the value of all objective functions).

4.1.2 Processes for computing efficient solutions

Different processes can be used to determine an efficient solution to the MOLP model. Usually, these processes solve a substitute linear programming model incorporating parameters representing the decision maker's (DM) preferences, in which its optimal solution is *efficient* (or even, *weekly efficient*) to the MOLP model. These models use substitute functions, generally designated as *scalarizing* functions. I.e., scalarizing a MOLP model means formulating a single-objective LP model such that its optimal solution is an efficient solution to the MOLP model (Hwang & Masud, 1979). As referred to by Steuer (1986) and Climaco *et al*. (2003) there are essentially three types of *scalarization* techniques to compute efficient solutions to MOLP models: - optimizing a given objective function (in general, the most important according to the decision maker's point of view) while the remaining objective functions are set as constraints by specifying lower bounds; - optimizing a weighted sum of the objective functions; - minimizing a distance to a reference points. A brief review of these techniques will be presented in the next sections[3].

4.1.3 Optimizing one objective function considering the others as constraints

In this method, also called the ε-constraint method (Haimes *et al*., 1971), one of the objective functions from the original MOLP model is considered as a substitute scalar function while the other p-1 objective functions are treated as model constraints:

$$\text{Max } z_v = z_v(\mathbf{x}) = \sum_{j=1}^{n} c_{vj}\, x_j \tag{4.7}$$

$$\begin{aligned}
\text{S.t.:}\quad & z_k(\mathbf{x}) = \sum_{j=1}^{n} c_{kj}\, x_j, && k = 1,\ldots,p \quad \text{and} \quad k \neq v \\
& \sum_{j=1}^{n} a_{ij}\, x_j \begin{Bmatrix} \leq \\ = \\ \geq \end{Bmatrix} b_i, && i = 1,\ldots,m \\
& x_j \geq 0 && j = 1,\ldots,n
\end{aligned}$$

In order to guarantee that this scalar function achieves an *efficient solution* (and not just a *weak efficient solution*) a perturbation term (with ε_k as a small positive number) is added to the scalar objective function:

$$\text{Max}\quad z_v = z_v(\mathbf{x}) = \sum_{j=1}^{n} c_{vj}\, x_j + \sum_{k=1,\, k\neq v}^{p} \varepsilon_k \sum_{j=1}^{n} c_{kj}\, x_j \tag{4.8}$$

$$\begin{aligned}
\text{S.t.:}\quad & z_k(x) = \sum_{j=1}^{n} c_{kj}\, x_j, && k = 1,\ldots,p \quad \text{and} \quad k \neq v \\
& \sum_{j=1}^{n} a_{ij}\, x_j \begin{Bmatrix} \leq \\ = \\ \geq \end{Bmatrix} b_i, && i = 1,\ldots,m \\
& x_j \geq 0 && j = 1,\ldots,n
\end{aligned}$$

As referred to by Climaco *et al*. (2003) despite the simplicity of this scalarizing form, the selection of the objective function to be optimized can be a difficult task. Moreover, fixing an objective function to be optimized in the whole process makes the method less flexible and the results somewhat dependent on the objective function selected.

[3] See Clímaco *et al*. (2003) for a more detailed overview.

4.1.4 Minimization of a distance to a reference point

This method consists in the minimization of a distance between the feasible region and a given reference point in the objective space using a given metric, e.g. the Tchebycheff metric[4]. A metric is a distance function that assigns to each pair of vectors $\mathbf{w}^1$, $\mathbf{w}^2 \in \Re^n$ a scalar $\|\mathbf{w}^1 - \mathbf{w}^2\| \in \Re^n$. For the L_p metric the distance between two points in $\Re^n$ is given by:

$$\|\mathbf{w}^1 - \mathbf{w}^2\|_p = \sum_{i=1}^{n} \left| w_i - w_i^2 \right|^p \Big]^{/p} \qquad p \in \{1, 2, \ldots\} \tag{4.9}$$

Therefore, for the Tchebycheff metric L_∞ the distance between two points in $\Re^n$ is given by:

$$\|\mathbf{w}^1 - \mathbf{w}^2\|_\infty = \max_i \left| w_i - w_i^2 \right| \tag{4.10}$$

Generally, the reference point consists of the individual objective function values which the DM would like to attain for each objective function. The *ideal solution* **z*** is often used as the reference point, because it represents the best values that can be (individually) obtained by each objective function in the feasible region[5]. Thus, the scalar problem to compute the solution that minimizes the (weighted) Tchebycheff distance to a reference point can be formulated as:

$$\text{Min} \left\{ \underset{k=1,\ldots,p}{\text{Max}} \ \lambda_k [z_k^* - z_k(\mathbf{x})] \right\} \tag{4.11}$$

$$\text{S.t.:} \quad \sum_{j=1}^{n} a_{ij} x_j \begin{Bmatrix} \leq \\ = \\ \geq \end{Bmatrix} b_i \qquad i = 1,\ldots, m$$

$$x_j \geq 0 \qquad j = 1,\ldots, n$$

$$\boldsymbol{\lambda} \in \Lambda$$

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[4] Any metric can be used, but just the Tchebycheff metric is presented. For a MOLP just the L1 (city block) and the L∞ (Tchebycheff) metrics give origin to linear scalar functions (Clímaco *et al*., 2003).

[5] It is important to refer that generally **z*** does not belong to the feasible region, since no solution exists simultaneously optimizing all objective functions. It is also noteworthy that, while it is possible to define the ideal solution **z*** in the objective space, the respective image in the decision space may not exist. I.e., it is not assured that **x*** such that **z*** = **f** (**x***) always exists (Clímaco *et al*., 2003).

where Λ is the set of the weight vectors $\Lambda = \{\, \boldsymbol{\lambda}: \boldsymbol{\lambda} \in \Re^p,\ \sum_{k=1}^{p} \lambda_k = 1, \lambda_k > 0\}$.

In order to guarantee that this scalar function achieves a (strict) efficient solution a perturbation term $\varepsilon \sum_{k=1}^{k} [z_k^* - z_k(\mathbf{x})]$ is added to the objective function**,** with ε as a small number (Clímaco *et al*., 2003).

$$\text{Min} \left\{ \underset{k=1,\ldots,p}{\text{Max}}\ \lambda_k\, [z_k^* - z_k(\mathbf{x})] + \varepsilon \sum_{k=1}^{k} [z_k^* - z_k(\mathbf{x})] \right\} \tag{4.12}$$

$$\begin{aligned} \text{S.t.:}\quad & \sum_{j=1}^{n} a_{ij}\, x_j \begin{Bmatrix} \le \\ = \\ \ge \end{Bmatrix} b_i, && i = 1,\ldots, m \\ & x_j \ge 0 && j = 1,\ldots, n \\ & \boldsymbol{\lambda} \in \Lambda. \end{aligned}$$

As referred to by Clímaco *et al*. (2003) the model in (4.12) is equivalent to the following linear program model:

$$\text{Min } v + \varepsilon \sum_{k=1}^{k} [z_k^* - z_k(\mathbf{x})] \tag{4.13}$$

$$\begin{aligned} \text{S.t.:}\quad & \lambda_k [z_k^* - z_k(\mathbf{x})] \le v \\ & \sum_{j=1}^{n} a_{ij}\, x_j \begin{Bmatrix} \le \\ = \\ \ge \end{Bmatrix} b_i, && i = 1,\ldots, m \\ & x_j \ge 0 && j = 1,\ldots, n \\ & \boldsymbol{\lambda} \in \Lambda. \end{aligned}$$

This formulation will be useful to describe, in a further section, the interactive MOLP method that will be applied to the model developed in this thesis.

4.1.5 Optimizing a weighted-sum of the objective functions

Another method used to compute efficient solutions to the MOLP model consists in optimizing a weighted-sum of the objective functions. In this method, each objective function is associated with a weight coefficient λ_k to construct a scalar objective function corresponding to the weighted sum of the *p* objective functions:

$$\text{Max} \sum_{k=1}^{p} \lambda_k \ z_k(\mathbf{x}) \quad = \quad \text{Max} \sum_{k=1}^{p} \lambda_k \ \sum_{j=1}^{n} c_{kj}\, x_j \tag{4.14}$$

$$\text{S.t.:} \quad \sum_{j=1}^{n} a_{ij}\, x_j \begin{Bmatrix} \leq \\ = \\ \geq \end{Bmatrix} b_i, \qquad i = 1,\ldots, m$$

$$x_j \geq 0 \qquad j = 1,\ldots, n$$

Optimizing a weighted sum of a scalar function leads to an *efficient solution* in the MOLP model *if* the optimal solution to the scalar model is unique, even with some $\lambda_k = 0$. In addition, optimizing a weighted sum of a scalar function with any $\lambda_k = 0$ can lead to *weakly efficient solutions* to the MOLP model *if* the scalarizing model has *alternative optima*. In this case, the (strict) efficiency of the solution obtained is guaranteed *only if* all weights λ_k are strictly positive (Clímaco *et al*., 2003).

4.1.6 Classification of the main methods in MOLP

MOLP models, even of limited dimensions, can result in a large set of *efficient solutions*. This influences the level of interaction of the DM in the process of obtaining compromise solutions between the competing objective functions, requiring in some extent an exchange of information (dialogue) between the DM and the methodology. Some authors have classified the methods to compute efficient solutions to MOLP models according to different characteristics (the degree of DM's intervention, the type of DM's preferences modeling, number of DMs, uncertainty of the model parameters, etc.) as outlined in Table 4.1.

The interactive methods to deal with the model proposed in this thesis include the TRIMAP method, the STEP method and also a procedure based on the interval programming approach. Basically, the methods have an interactive nature in which a hypothetical DM, in a stepwise way, guides the search for new efficient solutions in order to obtain further information about the problem and his/her preference structure thus progressively shaping the knowledge that enables him/her to make a final decision. These methods have deterministic (TRIMAP and STEP methods) and non-deterministic (the method using interval programming) characteristics, which will be useful to assess the results considering or not uncertainty in the model.

<table>
<tr><th colspan="4">Table 4.1 – Classification of the main methods in multi-objective linear programming[6]</th></tr>
<tr><th>Classification</th><th colspan="2">Sub-category</th><th>Authors</th></tr>
<tr><td rowspan="3">Based on the degree of DM's intervention</td><td colspan="2">A priori definition of the DM's preferences</td><td rowspan="3">Cohon (1978), Hwang & Masud (1979), Goicochea et al. (1982) and Steuer (1986).</td></tr>
<tr><td colspan="2">Progressive (interactive) definition of DM's preferences</td></tr>
<tr><td colspan="2">A posteriori definition of the DM's preferences</td></tr>
<tr><td rowspan="5">Based on the type of DM's preferences modeling</td><td colspan="2">Considering a global utility function</td><td rowspan="5">Chankong & Haimes (1983).</td></tr>
<tr><td colspan="2">Establishing priorities between objective functions</td></tr>
<tr><td colspan="2">Fixing aspiration levels or goals for the objective functions</td></tr>
<tr><td colspan="2">Pairwise comparisons (both alternative and/or criteria pairs)</td></tr>
<tr><td colspan="2">Considering marginal rates of substitution</td></tr>
<tr><td rowspan="2">Based on the number of DMs</td><td colspan="2">Single DM</td><td rowspan="2">Cohon (1978), Goicochea et al. (1982) and Szidarovsky et al. (1986).</td></tr>
<tr><td colspan="2">A group of DMs</td></tr>
<tr><td rowspan="2">Based on the determination/ uncertainty of the parameters</td><td colspan="2">Deterministic formulation</td><td rowspan="2">Goicochea et al. (1982) and Chankong & Haimes (1983).</td></tr>
<tr><td colspan="2">Non-deterministic formulation – considering explicitly the uncertainty in the coefficients and parameters</td></tr>
<tr><td rowspan="7">Based on the inputs and outputs of the model</td><td rowspan="2">Inputs</td><td>Type and confidence of data</td><td rowspan="7">Chankong & Haimes (1983).</td></tr>
<tr><td>Participation of the DM in the modeling process</td></tr>
<tr><td rowspan="5">Outputs</td><td>Optimizing a utility function</td></tr>
<tr><td>Searching the most efficient compromise solution</td></tr>
<tr><td>Searching a satisfactory solution</td></tr>
<tr><td>Ranking alternatives</td></tr>
<tr><td>Classifying the alternatives in groups</td></tr>
</table>

4.1.7 Interactive methods in MOLP – a brief overview

Interactive methods applied to MOLP models have been developed in order to enable a progressive and selective search for non-dominated solutions, thus facilitating to focus the computational effort on the non-dominated regions where solutions more interesting for the DM are located. These methods apply a step-by-step calculation process using a progressive (and interactive) definition of the DM's preferences. In each step of the method a single solution or a set of efficient solutions is presented to the DM, who analyze the information and give his/her feedback thus providing guidelines for the subsequent calculation step in order to narrow the scope of search or even finishing the process. Two of those methods will

[6] This table has been constructed based on the classification provided in Clímaco *et al*. (2003).

be applied in this thesis: the *Step Method* (STEM) and the TRIMAP method, and therefore a brief overview of these methods will be presented in the next sections.

4.1.7.1 The Step Method

The Step method (STEM) developed by Benayoun *et al.* (1971) is an interactive method performing a progressive reduction of the feasible region. This method computes the solution that minimizes the worst deviation of all objectives with respect to the *ideal solution* (the *optimal* values for each objective function, which cannot be obtained simultaneously since the objective functions are in conflict) by progressively reducing the feasible region according to the DM's preferences. Non-dominated solutions are computed by using a weighted min–max (Tchebycheff) scalar function. The solution is presented to the DM, who should specify whether he/she considers this solution as a satisfactory balance between the competing objectives. If any of the objective functions does not yet attain a satisfactory value, the DM should specify the objectives for which he/she is willing to accept a degradation (relaxation), and the corresponding amount, in order to improve the not yet satisfactory objectives. This amount is used to impose further constraints on the objective function values and a corresponding reduction of the feasible region. Therefore, the solution search process is guided according to the DM's preferences to the regions where solutions that more closely correspond to these preferences are located, which also decreases the computational effort. The process continues until the DM identifies a solution as a good compromise one.

Objective Functions → / Objective Optimized ↓	f_1	f_2	⋯	f_{p-1}	f_p
x^1	$z = z^*$	z_2	⋯	z_{p-1}	z_p
x^2	z^2	$z_2^2 = z_2^*$	⋯	z_{p-1}^2	z_p^2
			⋱		
x^{p-1}	z^{p-1}	z_2^{p-1}	⋯	$z_{p-}^{p-} = z_{p-1}^*$	z_p^{p-1}
x^p	z^p	z_2^p	⋯	z_{p-1}^p	$z_p^p = z_p^*$

Figure 4.1 – Schematic representation of the pay-off table (based on Henriques, 2008).

The STEM algorithm can be summarily explained in the following steps:

a) Each objective function is optimized individually in order to construct a *pay-off table*. The *pay-off table* arrange the non-dominated solutions computed in each separate optimization (see Figure 4.1):

b) The *ideal solution* (in the diagonal of the *pay-off table*) is used to estimate the weights β_k to be applied in the calculation steps, in order to take into account the magnitude and range of the objective function values in the calculation of an efficient solution that minimizes a weighted (Tchebycheff) distance to the ideal solution. The weights can be calculated as:

$$\beta_k = \begin{cases} \frac{z_k^* - \delta_k}{z_k^*} \left[\sum_{j=1}^{n} c_{kj}^2\right]^{-\frac{1}{2}} & if \quad z_k^* \geq 0 \\ \frac{\delta_k - z_k^*}{\delta_k} \left[\sum_{j=1}^{n} c_{kj}^2\right]^{-\frac{1}{2}} & if \quad z_k^* \leq 0 \end{cases} \qquad k = 1,\ldots, p \tag{4.15}$$

where δ_k is the minimum value of column *k* in the pay-off table, i.e., δ_k is the minimum value of the objective function $z_k(\mathbf{x})$ in the pay-off table.

c) Furthermore, the set R with the indices of the 'relaxed' objective functions until that interaction (including that defined by the DM) is defined. In the first iteration $R = \emptyset$ and $X^{(1)} \equiv X$ (X represents the feasible region). Thus, the weights used in the weighted L_∞ metric in the current interaction (h) are:

$$\alpha_k^{(h)} = \begin{cases} 0 & if \quad k \in R \\ \frac{\beta_k}{\sum_{i=1}^{p} \beta_i} & if \quad k \notin R \end{cases} \tag{4.16}$$

It is important to mention that the weights $\alpha_k^{(h)} = 0$ for the objective functions the values of which were relaxed until interaction h. In addition, the weights $\alpha_k^{(h)}$ are normalized such that $\sum_{k=1}^{p} \alpha_k^{(h)} = 1$, that is:

$$\alpha_k^{(h)} \leftarrow \frac{\alpha_k^{(h)}}{\sum_{i=1}^{p} \alpha_i^{(h)}} \qquad k = 1,\ldots, p \tag{4.17}$$

d) In the calculation step the following linear problem minimizing a weighted (Tchebycheff) distance to the ideal solution is solved:

$$\text{Min } v \tag{4.18}$$

$$\text{S.t.:} \quad \alpha_k^{(h)}[z_k^* - z_k(\mathbf{x})] \le v \qquad 1 \le k \le p$$

$$\mathbf{x} \in X^{(h)}$$

$$v \ge 0$$

As part of the interactive process, the solution $\mathbf{z}^{(h)} = \mathbf{z}(\mathbf{x}^{(h)})$ of the problem in the interaction h is presented to DM. Here $\mathbf{x}^{(h)}$ is the point of the reduced feasible region $X^{(h)}$ corresponding to the point $\mathbf{z}^{(h)}$ closer to $\mathbf{z}^*$ according to the weighted Tchebycheff metric.

e) The process finishes if the DM considers the solution presented as a satisfactory one (and $\mathbf{x}^{(h)}$ as a final solution). Otherwise the DM indicates the objective function to be relaxed (or allowed to degrade), as well as the maximum amount to be relaxed, attempting to improve other objective functions values that still have not a satisfactory level.

f) With the information provided by the DM in the interaction phase, a new calculation step is prepared by constructing a new reduced feasible region through adding new constraints to the objective function values. Therefore the reduced feasible region for the iteration (h+1) will integrate the constraints (4.19) (corresponding to the objective function relaxed in the iteration h+1) and (4.20):

$$z_i(\mathbf{x}) \ge z_i(\mathbf{x}^{(h)}) - \Delta z_i \tag{4.19}$$

$$z_k(\mathbf{x}) \ge z_k(\mathbf{x}^{(h)}) \qquad k \ne i \tag{4.20}$$

g) The method returns to the step c) until the DM decides to stop the interactive process since a satisfactory compromise solution has been obtained[7] (Clímaco *et al*., 2003).

The interactive STEM method provides a flexible analysis, allowing the exploration of compromise solutions according to the preference information issued by the DM. This interactive solution search process provides comprehensive information about the solution

[7] Although in the original version each objective function should be relaxed only once and only one objective function can be relaxed in each interaction (in a maximum of *p* interactions), it is possible to eliminate those limitations providing a more flexible approach, thus allowing the relaxation of more than one objective function in each interaction and the relaxation of an objective function previously relaxed. This more flexible version of the STEM method can overcome the problem of irrevocable decisions, whereas imposing more complexity in a computational point of view (Clímaco *et al*., 2003).

structure and trade-offs that are at stake between the competing objectives in different regions of the search space, which is progressively reduced.

4.1.7.2 The TRIMAP method

The region encompassing the set of weights that leads to the same basic (that is, a vertex of the feasible region) efficient solution is called an *indifference region*. In this region, the DM may be indifferent to all combinations of weights, since they lead to the same efficient solution. The indifference region may be obtained from the *multi-objective simplex tableau* corresponding to a basic efficient solution. It is possible to represent graphically, in models with three objective functions, the decomposition of the parametric diagram in indifference regions as follows (Clímaco & Antunes, 1989):

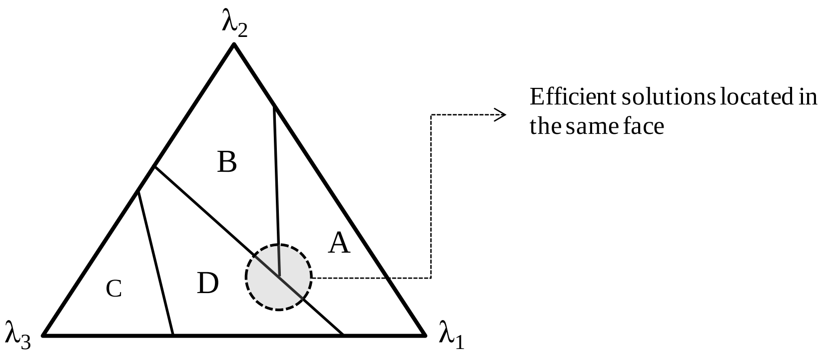

Figure 4.2 – Parametric diagram of a model with 3 objective functions (based on Henriques, 2008)

Figure 4.2 illustrates 4 indifference regions (A, B, C and D) corresponding to 4 vertex efficient solutions obtained from optimizing weighted sum scalar functions using combinations of the weights (λ_1, λ_2 and λ_3) for the three objective functions. In this graphic a border belonging to two indifference regions means that the respective basic (vertex) efficient solutions are connected by an efficient edge (e.g. regions C and D in Figure 4.2), corresponding to turn basic a non-basic efficient variable (i.e. a non-basic variable that leads to an adjacent vertex efficient solution through an edge consisting of efficient solutions). If a point $\lambda \in \Lambda$ belongs to several indifference regions (as the point marked with a circle in Figure 4.2), thus these regions correspond to vertex efficient solutions located on the same efficient face (regions A, B and D in Figure 4.2).

Therefore, it is possible taking advantage of the graphical representation of the decomposition of the parametric diagram in indifference regions in models with three objective functions to perform an interactive search for non-dominated solutions. This feature has been explored by the TRIMAP method, an interactive decision support tool designed for problems with three objective functions developed by Clímaco & Antunes (1987, 1989).

The TRIMAP method uses graphical tools for enabling a progressive and selective search for non-dominated solutions, thus facilitating to focus the computational effort on the non-dominated regions where solutions more interesting for the DM are located and also providing the DM insightful information about the trade-offs at stake in those regions. TRIMAP combines three main procedures: decomposition of the objective function parametric diagram (“weight space”), introduction of constraints directly in the weights, and introduction of constraints in the objective function space that are then translated into the parametric diagram (Clímaco & Antunes, 1987, 1989). The parametric diagram display is used for collecting and presenting to the DM the information obtained during the search process. The parametric diagram is filled with the indifference regions corresponding to the (basic) non-dominated solutions already computed, i.e. the regions defined by the objective function weights for which the optimization of a (scalar) weighted-sum function aggregating the multiple objective functions leads to the same vertex efficient solution. Another graph shows the non-dominated solutions already computed, also enabling to identify non-dominated edges and faces in the objective function space.

This interactive system offers the DM the possibility of progressively exploiting and learning the characteristics of the non-dominated region, and then narrowing down the search toward a solution (or set of solutions) according to his/her preferences. The TRIMAP search process generally starts with a broad strategic search to gather information about distinct solutions, in particular those that individually optimize each of the conflicting functions, and then gradually focus onto regions in which more interesting solutions are found taken into account the trade-offs unveiled throughout the interactive procedure. In this way irrelevant solutions, from the DM’s point of view, are avoided and a learning process of the characteristics of solutions and the trade-offs at stake between the competing objectives is privileged. Also a clarification of the own DM’s preferences and judgments is facilitated. The interactive process continues until the DM has gathered "sufficient knowledge" about the set of non-dominated solutions rather than pre-specifying a given number of iterations or any other stopping condition. This method is summarily presented in the block diagram in Figure 4.3. For a more detailed review of the TRIMAP see Clímaco & Antunes, (1987, 1989) and Clímaco *et al*. (2003).

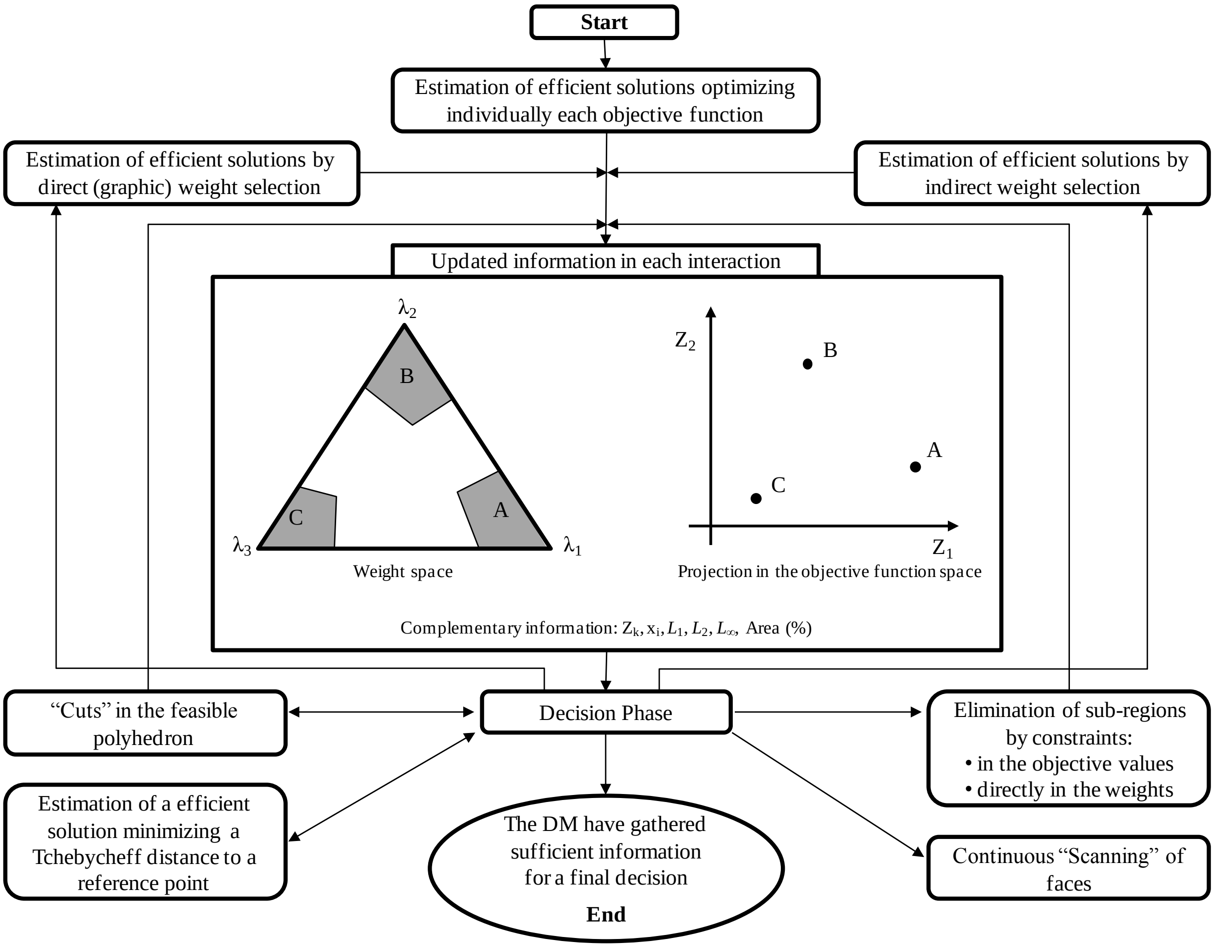

Figure 4.3 – Block diagram of the TRIMAP method (based on Clímaco *et al*., 2003).

4.2. UNCERTAINTY ANALYSIS WITH INTERVAL PROGRAMMING

As referred to above, a variety of approaches has been proposed to deal with uncertainty in mathematical programming, such as sensitivity analysis, robust programming, fuzzy programming, stochastic programming and interval programming. Furthermore, as discussed earlier, the modeling of uncertainty in input-output models can rely essentially on the stochastic, fuzzy and interval approaches. The relevant feature of the interval programming is assuming the range of possible variation of some (or all) of the model coefficients not requiring the specification of *probability* distributions (as in stochastic programming) or *possibility* distributions (as in fuzzy programming) of the model coefficients. Since in this study the interval programming will be used for uncertainty treatment, an overview of the theory regarding this approach will be briefly described in the next sections.

4.2.1 Theory of interval numbers – brief review

Before presenting the MOLP models with interval coefficients, some concepts and fundamental properties of the theory of interval numbers will be briefly outlined in this section. A more complete review about this theory can be found for instance in Moore (1966), Alefeld & Herzberger (1983), Bojadziev & Bojadziev (1995), Sengupta *et al*. (2001) and Henriques (2008).

4.2.1.1 Basic concepts, arithmetic operations and properties

Firstly, let us consider that a value a (a real number) is uncertain[8], knowing only that a lies between two real numbers a^L and a^U and $a^L < a^U$. Therefore both numbers forms a range, in which all numbers in this range have the same importance. Hence, an *interval number A* is defined as the set of real numbers a such that $a^L \leq a \leq a^U$, that is $a \in [a^L, a^U]$, a^L, $a^U \in \Re$ or:

$$A = [a^L, a^U] = \{a: a^L \leq a \leq a^U, a \in \Re\} \qquad (4.21)$$

Thus, the closed interval (4.21) represents an uncertain number $a \in [a^L, a^U]$, where a^L and a^U are the limits of the interval.

If $A = [a^L, a^U]$ and $a^L = a^U$, thus the *interval number A* is a *point interval number*.

Two *interval numbers* $A = [a^L, a^U]$ and $B = [b^L, b^U]$ are equal *if and only if* $a^L = b^L$ and $a^U = b^U$.

An *interval number* is *non-limited* when the upper and/or lower bounds are infinite.

The interval number $A^- = [a^L, a^U]^- = [-a^U, -a^L]$ is the *symmetric* of the *interval number* $A = [a^L, a^U]$.

The interval number $A^{-1} = [a^L, a^U]^{-1} = [\frac{}{^{U}}, \frac{}{a^{L}}]$, with $0 \notin [a^L, a^U]$ is the *inverse* of the *interval number* $A = [a^L, a^U]$.

The *midpoint* (or central value) of the *interval number* $A = [a^L, a^U]$ is given by $m[A] = \frac{(a^L + a^U)}{2}$.

The *width* of the *interval number* $A = [a^L, a^U]$ is given by $w[A] = a^U - a^L$.

[8] All lower case letters denote the real numbers and the upper case letters denote the interval numbers or the closed intervals on $\Re$. *I* denotes the set of interval numbers on $\Re$.

It is possible to expand an operator $* \in \{+ , - , . , \div\}$ in the set of real numbers to be used in the set of interval numbers. Hence, for the interval numbers $A = [a^L, a^U]$ and $B = [b^L, b^U]$ and $0 \notin B$ it is possible to define the operator $\circledast$ as follows:

$$A \circledast B = (a * b, a \in A; b \in B) \tag{4.22}$$

where $A \circledast$ B allows estimating the possible region of $a \circledast b$ values, such that $a \in A; b \in B$. The operator $\circledast$ is called the '*possible expanded operator* of $*$' (Inuiguchi & Kume, 1991).

The *possible expanded addition* (or *possible addition*) of the interval numbers *A* and *B* is given by:

$$A \oplus B = [a^L, a^U] \oplus [b^L, b^U] = [a^L + b^L, a^U + b^U] \tag{4.23}$$

The *possible expanded subtraction* (or *possible subtraction*) of the interval numbers *A* and *B* is given by:

$$A \ominus B = [a^L, a^U] \ominus [b^L, b^U] = [a^L - b^U, a^U - b^L] \tag{4.24}$$

The following equations also hold for $A \oplus B$ and $A \ominus B$:

$$m[A \oplus B] = m[A] + m[B] \tag{4.25}$$

$$m[A \ominus B] = m[A] - m[B] \tag{4.26}$$

$$w[A \oplus B] = w[A \ominus B] = w[A] + w[B] \tag{4.27}$$

The *possible expanded maximum* (or *possible maximum*) of interval numbers *A* and *B* is given by:

$$A ⓥ B = [a^L \vee b^L, a^U \vee b^U] \tag{4.28}$$

The *multiplication* of interval numbers *A* and *B* is given by:

$$A \odot B = [a^L, a^U] \odot [b^L, b^U] = [\text{minimum } (a^L b^L, a^L b^U, a^U b^L, a^U b^U), \text{maximum } (a^L b^L, a^L b^U, a^U b^L, a^U b^U)] \tag{4.29}$$

The *division* of interval numbers A and B is given by[9]:

$$A \oslash B = [a^L, a^U] \oslash [b^L, b^U] = [a^L, a^U] \odot [\frac{1}{b^U}, \frac{1}{b^L}] \qquad (4.30)$$

4.2.1.2 Order and preference relations in closed intervals

Basically, two transitive order relations over intervals can be defined[10]. The first one is an extension of '<' (less than) on the real numbers as:

$$A < B \quad \textit{if and only if} \quad a^U < b^L \qquad (4.31)$$

and the other as an extension of the concept of *set inclusion*, i.e.:

$$A \subseteq B \quad \textit{if and only if} \quad a^L \geq b^L \text{ and } a^U \leq b^U \qquad (4.32)$$

However, as referred to by Sengupta *et al*. (2001) these order relations cannot explain ranking between two overlapping intervals. In addition, the extension of the set inclusion cannot order A and B in terms of value. Thus, other approaches have been developed to compare two interval numbers.

Ishibuchi & Tanaka (1990) developed an approach for ranking two interval numbers in models maximizing or minimizing an objective function. For instance in the maximization problem, the maximum of A and B can be defined by an order relation $\leq_{LU}$ between A and B as follows:

$$A \leq_{LU} B \quad \textit{if and only if} \quad a^L \leq b^L \text{ and } a^U \leq b^U \qquad (4.33)$$

$$A <_{LU} B \quad \textit{if and only if} \quad A \leq_{LU} B \text{ and } A \neq B \qquad (4.34)$$

However, several pairs of intervals cannot be ranked by the relation $\leq_{LU}$. Thus, Ishibuchi & Tanaka (1990) suggested another order relation $\leq_{mw}$ based on the *midpoint* and *width* of the intervals where $\leq_{LU}$ cannot be applied, as follows:

$$A \leq_{mw} B \quad \textit{if and only if} \quad m[A] \leq m[B] \text{ and } w[A] \geq w[B] \qquad (4.35)$$

---

[9] If $0 \in B$, therefore $A \oslash B$ is not defined.
[10] Considering the interval numbers $A = [a^L, a^U]$ and $B = [b^L, b^U]$.

$A <_{mw} B$ *if* and *only if* $A \leq_{mw} B$ and $A \neq B$ (4.36)

Ishibuchi & Tanaka (1990) suggested another order relation $\leq_{Lm}$ which allows relating both $\leq_{LU}$ and $\leq_{mw}$ as follows[11]:

$A \leq_{Lm} B$ *if* and *only if* $a^L \leq b^L$ and $m[A] \leq m[B]$ (4.37)

$A <_{Lm} B$ *if* and *only if* $A \leq_{Lm} B$ and $A \neq B$ (4.38)

$A \leq_{Lm} B$ *if* and *only if* $A \leq_{LU} B$ or $A \leq_{mw} B$ (4.39)

$A <_{Lm} B$ *if* and *only if* $A <_{LU} B$ or $A <_{mw} B$ (4.40)

Other authors such as Chanas & Kuchta (1996) suggested a generalization of Ishibuchi & Tanaka (1990) preference relations introducing the notion of *cuts* in one interval. In addition, Sengupta & Pal (2000) suggested a method using an *acceptability index* for comparing any two interval numbers on the real line taking into account the DM's satisfaction. Both approaches have been discussed in detail by Chanas & Kuchta (1996), Sengupta *et al*. (2001) and Henriques (2008).

4.2.1.3 Linear inequalities and equalities with interval coefficients – main features

A linear inequality with interval coefficients can be represented by:

$[a_1, a_2]\, x_1 + [b_1, b_2]\, x_2\ (\leq, \geq)\ [c_1, c_2]$ (4.41)

An *extreme version* of a linear inequality with interval coefficients is obtained when the coefficients take values in one of the extreme limits of the intervals, for instance in the example as follows:

$a_1 x_1 + b_1 x_2\ (\leq, \geq)\ c_1$ (4.42)

---

[11] A discussion of the properties regarding those preference relations can be found in Ishibuchi & Tanaka (1990) and Henriques (2008).

An *intermediate version* of a linear inequality is obtained when one of the interval coefficients assumes a value at an intermediate point of the interval, as in the example as follows:

$$a_2 x_1 + \frac{1}{2}(b_1 + b_2)\, x_2 \ (\leq, \geq)\ c_1 \qquad (4.43)$$

The *dislocation* of a linear inequality is a parallel movement of such inequality from a position to another without changing its slope, while the *perturbation* of a linear inequality changes its slope. The former case is a result of changes in the independent terms, while the later correspond to changes in the values of the coefficients of the decision variables (technological coefficients). An *inversion* of a linear inequality is a special case of perturbation as a result of a simultaneous change in the signs of all right-hand side coefficients. In general, the dislocation, the perturbation and the inversion of a linear inequality lead to changes in the feasible region of a mathematical programming model (Henriques, 2008).

Consider Q as a set of inequalities with interval coefficients and Q_I and Q_{II} as two different sets of inequalities generated from Q through its extreme versions. Thus, the feasible regions S_I and S_{II} generated from Q_I and Q_{II}, respectively, can lead to the following possibilities:

a) $S_I \subseteq S_{II}$ or $S_{II} \subseteq S_I$, that is, the feasible regions are entirely included in each other, i.e. every element of S_I is also an element of S_{II};
b) $S_I \neq S_{II}$ and $S_I \cap S_{II} \neq \emptyset$, that is, the feasible regions are partially intersecting each other;
c) $S_I \cap S_{II} = \emptyset$, that is, the feasible regions are not intersecting each other (or they are *disjoint*).

As referred to by Shaocheng (1994) any linear inequality with interval coefficients has at least two different *extreme versions*, resulting in two distinct feasible regions corresponding to both more comprehensive and less comprehensive regions (*maximum and minimum value range inequality*) respectively. Consider, without loss of generality, the following set of inequalities:

$$\sum_{j=1}^{n} \left[a_{ij}^{L}, a_{ij}^{U}\right] x_j \geq \left[b_i^{L}, b_i^{U}\right] \qquad i = 1,\ldots, m \qquad (4.44)$$

where $x_j \geq 0$, $[a_{ij}^L, a_{ij}^U]$ and $[b_i^L, b_i^U] \in I(\Re)$ and $I(\Re)$ is the set of all interval numbers in $\Re$.

According to the interval arithmetic properties each inequality *i* of (4.44), with *n* interval coefficients and *m* interval independent terms, can generate 2^{n+1} distinct *extreme versions* with all the coefficients having all the combinations for the extreme values of their intervals. That is, for every interval inequality *i* in (4.44) the more comprehensive and less comprehensive inequalities correspond to $\sum_{j=1}^{n} a_j^U x_j \geq b^L$ and $\sum_{j=1}^{n} a_j^L x_j \geq b^U$ respectively (Shaocheng, 1994). Ramadan (1997) and Chinneck & Ramadan (2000) demonstrated that any equality with interval coefficients may also have both more comprehensive and less comprehensive versions.

4.2.2 MOLP model with interval coefficients

Interval programming has been used by Bitran (1980), Steuer (1981), Urli & Nadeau (1992), Inuiguchi *et al*. (1999), Antunes & Clímaco (2000), Wang & Wang (2001a), Oliveira & Antunes (2007), among others, as an alternative approach to deal with the difficulty in specifying the *probabilistic* distributions (as in stochastic programming) or the *possibilistic* distributions (as in fuzzy programming) of the model coefficients. In *interval programming* it is assumed that information about the range of variation of the uncertain coefficients is available. It is only necessary to consider in the model a variability range for the coefficients, i.e. they are unkwon but bounded. The uncertainty treatment may be carried out only in the objective function (e.g. Bitran (1980), Steuer (1981), Inuiguchi & Kume (1991), Inuiguchi *et al*. (1999), Antunes & Clímaco (2000), Ida (1999, 2005) and Wang & Wang (2001a)), in the objective functions and in the right hand side of the constraints (Wang & Wang, 2001b) or in all coefficients of the model (Urli & Nadeau, 1992; Henriques, 2008; Oliveira & Antunes, 2009). The basic MOLP with interval coefficients can be represented as follows:

$$\text{Max } z_k(\mathbf{x}) = \sum_{j=1}^{n} \left[c_{kj}^{L}, c_{kj}^{U}\right] x_j \qquad k = 1,\ldots,p \tag{4.45}$$

$$\text{S.t.} \quad \sum_{j=1}^{n} \left[a_{ij}^{L}, a_{ij}^{U}\right] x_j \le \left[b_i^{L}, b_i^{U}\right] \qquad i = 1,\ldots, m$$

$$x_j \ge 0 \qquad j = 1,\ldots, n$$

Inuiguchi & Kume (1994) and Inuiguchi & Sakawa (1995) consider two distinct approaches for dealing with MOLP models with interval objective functions: the *satisficing approach* and the *optimizing approach*. Before presenting a brief overview of those approaches, some basic concepts regarding the *ideal interval solution*, the *best optimum value*, the *worst optimum value* and some methods for solving linear programming models with interval coefficients (LPIC) will be presented in the next section.

4.2.3 The best optimum value, the worst optimum value, the ideal interval solution and methods for solving LPIC models

In general, reference points represent levels of aspiration of the objective functions for the DM. The *ideal solution* is often used as a reference point in MOLP models, since it represents the best value of each objective function in the feasible region. As previously stated a linear inequality with interval coefficients has at least two different extreme versions, resulting in the more and the less comprehensive feasible regions, respectively. An objective function with interval coefficients has at least two different extreme versions: an optimistic (giving the best optimal value of the objective function) and a pessimistic (giving the worst optimal value of the objective function) (Henriques, 2008).

In this context, the individual optima obtained with the extreme versions of the feasible regions and the extreme formulations of the objective function allow defining the *ideal interval solution* (Oliveira & Antunes, 2007). Thus, the *ideal interval solution* comprehends the optimal solution in the more comprehensive feasible region with the more favorable formulation of the objective function and the optimal solution in the less comprehensive feasible region with the less favorable formulation of the objective function, respectively. The optimal value obtained by the first scenario of coefficients is called the *best optimal value*, while the optimal value obtained from the second scenario of coefficients is called the *worst optimual value* (Ramadan, 1997; Chinneck & Ramadan, 2000).

Ramadan (1997) and Chinneck & Ramadan (2000) developed algorithms to solve the model (4.45), for any x_j, with or without sign constraints, associated or not with the interval coefficients of the model. For the application of the algorithms developed by Ramadan (1997) and Chinneck & Ramadan (2000) the decision variables are classified into three distinct groups:

a) x^0: variables with or without sign restriction associated with fixed coefficients;
b) x^{si}: variables with sign restriction associated with at least one interval coefficient;
c) x^{ui}: variables without sign restriction associated with at least one interval coefficient.

In general, when all the variables have sign restriction, the less comprehensive feasible region should allow to obtain the *worst optimal solution*, while the more comprehensive feasible regions should allow to obtain the *best optimal solution* (Henriques, 2008). Thus, the LP models with interval coefficients (LPIC) in the objective function and constraints are classified according to the decision variables into two types (Chinneck & Ramadan, 2000):

a) LPIC models Type I: all variables are of type x^0 or x^{si}.
b) LPIC models Type II: at least one variable is the type x^{ui} and the remaining are of type x^0 or x^{si}.

In this study only the LPIC models Type I will be used, and therefore only this type of models will be further discussed.

In order to briefly describe the algorithm proposed by Ramadan (1997) and Chinneck & Ramadan (2000) to solve LPIC models Type I, let us firstly consider the following LP model minimizing an interval objective function subject to constraints of type ≥ with interval coefficients and interval right hand side as follows[12]:

$$\text{Min } z(\mathbf{x}) = \sum_{j=1}^{n} \left[c_j^L, c_j^U\right] x_j \qquad (4.46)$$

$$\text{S.t.} \quad \sum_{j=1}^{n} \left[a_{ij}^L, a_{ij}^U\right] x_j \geq \left[b_i^L, b_i^U\right] \qquad i = 1,\dots,m$$

$$x_j \geq 0 \qquad j = 1,\dots, n$$

From the objective function $z(\mathbf{x}) = \sum_{j=1}^{n} \left[c_j^L, c_j^U\right] x_j$ it is possible to verify that $\sum_{j=1}^{n} c_j^U x_j \geq \sum_{j=1}^{n} c_j^L x_j$ for any vector $\mathbf{x} = (x_1, x_2,\dots, x_n)^T$. In addition, since $x_j \geq 0$, $j = 1,\dots, n$, $x_j \in x^0 \cup x^{si}$.

[12] For maximizing the objective function the reverse situation is considered, while for the non-positive variables the necessary replacements are required in order to consider only non-negative variables. For constraints of type ≤ it is necessary to perform the multiplication of both members of the inequality by (-1).

$\sum_{j=}^{n} c_j^L$ x_j corresponds to the *more favorable objective function* version (which allows to obtain the *best optimal solution* to the LPIC model), while $\sum_{j=1}^{n} c_j^U$ x_j corresponds to the *less favorable objective function* (which allows to obtain the *worst optimal solution* of the LPIC model) (Ramadan, 1997; Chinneck & Ramadan, 2000).

The algorithm proposed by these authors to estimate the *best optimal value* and the *worst optimal value* are represented as follows in two steps:

Step 1. Solving the linear programming model (4.47) (or type I) to obtain the *best optimum value*:

$$\text{Min} \quad Z^L(\mathbf{x}) = \sum_{j=1}^{n} c'_j\, x_j \qquad x_j \in \mathbf{x}^{si};\ c'_j = \begin{cases} c_j^L, \textit{ if } x_j \geq 0 \\ c_j^U, \textit{ if } x_j \leq 0 \end{cases} \tag{4.47}$$

$$\text{S.t.} \quad \sum_{j=1}^{n} a'_{ij}\, x_j \geq b_i^L$$

$$\text{where} \quad i = 1,\ldots, m; \qquad x_j \in \mathbf{x}^{si}; \qquad a'_j = \begin{cases} a_j^U, \textit{ if } x_j \geq 0 \\ a_j^L, \textit{ if } x_j \leq 0 \end{cases}$$

Step 2. Solving the linear programming model (4.48) (or type II) to obtain the *worst optimum value*:

$$\text{Min} \quad Z^U(\mathbf{x}) = \sum_{j=1}^{n} c''_j\, x_j \qquad x_j \in \mathbf{x}^{si};\ c''_j = \begin{cases} c_j^U, \textit{ if } x_j \geq 0 \\ c_j^L, \textit{ if } x_j \leq 0 \end{cases} \tag{4.48}$$

$$\text{S.t.} \quad \sum_{j=1}^{n} a''_{ij}\, x_j \geq b_i^U$$

$$\text{where} \quad i = 1,\ldots, m; \qquad x_j \in \mathbf{x}^{si}; \qquad a''_j = \begin{cases} a_j^L, \textit{ if } x_j \geq 0 \\ a_j^U, \textit{ if } x_j \leq 0 \end{cases}$$

Let us consider $\mathbf{x'} = (x'_1, x'_2,\ldots, x'_n)^T$ as the optimal solution to the LP model (4.47) and Z^L the respective optimal value, and $\mathbf{x''} = (x''_1, x''_2,\ldots, x''_n)^T$ as the optimal solution to the LP model (4.48) and Z^U the respective optimal value. Therefore the *best optimal solution* is $\mathbf{x'} = (x'_1, x'_2,\ldots, x'_n)^T$ with Z^L the respective optimal value and the coefficients c'_j, a'_{ij} and b_i^L, whereas the *worst optimal solution* is $\mathbf{x''} = (x''_1, x''_2,\ldots, x''_n)^T$ with Z^U the respective optimal value and the coefficients c''_j, a''_{ij} and b_i^U. Thus, the optimal value to the interval model is located between Z^L (best scenario) and Z^U (worst scenario), i.e. $Z = [Z^L, Z^U]$, according to the scenarios associated with the interval coefficients considered[13].

Ramadan (1997) and Chinneck & Ramadan (2000) also proposed a method to determine the *best optimum value* and the *worst optimum value* when the LPIC models have interval equalities. The method can be summarilly presented by considering a minimizing an LPIC model of type I with *m* interval inequalities and *k* interval equalities ($k \geq 1$), in which $\sum_{j=1}^{n}\left[a_{ij}^{L}, a_{ij}^{U}\right] x_j = \left[b_i^L, b_i^U\right]$ is an equality constraint of the model. Firstly, considering that k = 1 and $x_j \geq 0$ for every j = 1,…, n, that is $\sum_{j=1}^{n}\left[a_j^L, a_j^U\right] x_j = \left[b^L, b^U\right]$, it is possible to obtain an expression defining a convex feasible region called as the *possibility feasible region* (Henriques, 2008) as follows[14]:

$$\sum_{j=1}^{n} {}_{j}^{U}\, x_j \geq b^L \qquad \text{and} \qquad \sum_{j=1}^{n} {}_{j}^{L}\, x_j \leq b^U \tag{4.49}$$

Ramadan (1997) and Chinneck & Ramadan (2000) proposed to solve a LP model to obtain the coefficient scenario allowing achieving, for instance, the *best optimal value*. In this model the unknown coefficients of the LP model (4.47) described in the first step of the algorithm are considered as variables and the respective original variables are treated as constants. Therefore, considering *k* as the number of interval equalities of the LPIC model of type I and that the *best optimal solution* to this model is denoted as **x**, the LP model (4.50) is solved (where a_{ij} and b_i are variables and $x_j \in \mathbf{x}^*$ are fixed constants):

$$\text{Max} \quad {}_{i=1}^{k} \quad {}_{j=1}^{n} \quad {}_{ij} \quad {}_{j=1}^{k} b_i \tag{4.50}$$

$$\text{S.t.} \quad {}_{j=1}^{n} \; {}_{ij}\, x_j - b_i = 0 \qquad i = 1,\ldots,k$$

$$\left.\begin{array}{l} {}_{ij}^{L} \leq a_{ij} \leq a_{ij}^{U} \\ b_i^L \leq b_i \leq b_i^U \end{array}\right\} \qquad i = 1,\ldots,k \quad \text{and} \quad j = 1,\ldots, n$$

with a_{ij} and b_i without sign restriction.

Hence, the optimal solution to this model identify the coefficient scenarios leading to the *best optimal solution* of the LPIC model of type I, which can therefore be used to estimate

[13] Some conclusions and demonstrations of these formulations can be found in detail in Ramadan (1997).

[14] A more detailed description of this formulation can be found in Ramadan (1997), Chinneck & Ramadan (2000) and Henriques (2008).

the *worst optimal value* in model (4.48). For a more detailed overview of this formulation see e.g. Ramadan (1997), Chinneck & Ramadan (2000) and Henriques (2008).

4.2.4 The *satisficing approach* in interval mathematical programming models

The models classified in the *satisficing approach* are mainly related to the LP models with one interval objective function. In the *satisficing approach* each interval objective function is transformed into one or more objective functions (lower limit, upper limit and central value of the intervals are generally used) in order to obtain a compromise solution (e.g. Rommelfanger *et al*. (1989), Ishibuichi & Tanaka (1990), Inuiguchi & Kume (1991), Chanas & Kuchta (1996), Antunes & Clímaco (2000) and Sengupta *et al*. (2001))[15]. In this section the most representative methods of this approach (categorized according to Oliveira & Antunes, 2007) will be summarily presented.

Firstly, let's consider the linear programming model with an interval objective function as follows:

$$\begin{aligned} \text{Max} \quad & Z(\mathbf{x}) = \boldsymbol{c}\mathbf{x} \\ \text{S.t.:} \quad & A\mathbf{x} \le \mathbf{b} \\ & \mathbf{x} \ge 0 \end{aligned} \qquad (4.51)$$

where $\boldsymbol{c}$ is a interval vector in which each generic element $c_j \in \left[c_j^L, c_j^U\right]$ and j = 1,…, n, A is a ($m \times n$) matrix, **b** is a vector ($n \times 1$) and the index letters L an U represents lower and upper limits of the coefficients, respectively.

Thus, in the context of the satisficing approach, the following substitute model can be considered (see e.g. Sengupta *et al*., 2001):

$$\begin{aligned} \text{Max} \quad & Z^{\mathbf{c}}(\mathbf{x}) = \boldsymbol{c}^c\mathbf{x} \\ \text{S.t.:} \quad & A\mathbf{x} \le \mathbf{b} \\ & \mathbf{x} \ge 0 \end{aligned} \qquad (4.52)$$

[15] As referred to by Antunes & Clímaco (2000) although the compromise solution thus obtained can be always *possibly efficient*, it may not be the most appropriate or interesting from the DM standpoint. In fact, if the gradients of the selected objective functions are strongly correlated, the scope of search may be reduced and the cone of objective function gradients cone may even be reduced to a half-ray.

where $\boldsymbol{c}^{c}$ is the vector of the central values of the original interval vector $\boldsymbol{c}$.

Other authors such as Rommelfanger *et al*. (1989) and Ishibuichi & Tanaka (1990) suggested some variations of this method. In the model of Rommelfanger *et al*. (1989) only the extreme limits of the interval objective function are used, by which the model (4.51) can be solved by the following bi-objective model:

$$\text{Max} \quad Z^{L}(\mathbf{x}) = \sum_{j=1}^{n} c_j^{L}\, x_j \tag{4.53}$$

$$\text{Max} \quad Z^{U}(\mathbf{x}) = \sum_{j=1}^{n} c_j^{U}\, x_j$$

$$\text{S.t.:} \quad A\mathbf{x} \le \mathbf{b}$$

$$\mathbf{x} \ge 0$$

Ishibuichi & Tanaka (1990) applied a similar approach, although applying a pessimistic perspective. I.e., in objective functions to be maximized, the central values and the lower limits of the coefficients are used to define the objective functions, whereas in objective functions to be minimized, the central values and the upper limits of the coefficients are used to define the objective functions. Antunes & Clímaco (2000) applied an approach to convert a model with one interval objective function into a three-objective model according to the filtering method proposed by Steuer (1981). Chanas & Kuchta (1996) applied the concepts of 'cut' of an interval and parametric linear programming in order to obtain the following substitute model:

$$\text{Max} \quad Z(\mathbf{x}) = \lambda\left(\sum_{j=1}^{n}\left[c_j^{L} + \varphi_0\left(c_j^{U} - c_j^{L}\right)\right] x_j\right) + \left(1-\lambda\right)\left(\sum_{j=1}^{n}\left[c_j^{L} + \varphi\ \left(c_j^{U} - c_j^{L}\right)\right] x_j\right) \tag{4.54}$$

$$\text{S.t.:} \quad A\mathbf{x} \le \mathbf{b}$$

$$0 \le \lambda \le 1$$

$$0 \le \varphi_0 \le \varphi_1 \le 1 \qquad (\varphi_0 \text{ and } \varphi_1 \text{ are fixed})$$

$$\mathbf{x} \ge 0$$

Inuiguchi & Kume (1991) developed some models in the context of goal programming, obtaining four substitute formulations for the goal programming model with interval objectives and targets. The authors have considered the concepts of necessary subtraction and possible subtraction between intervals, minimizing either the lower (optimistic perspective) or the upper (pessimistic perspective) limit of *interval regret functions*. Urli & Nadeau (1992) proposed a generic methodology that allows transforming a non-deterministic MOLP model in a deterministic one, which is thus solved by an interactive approach derived from the STEM method. A complete review of the formulation of both models can be seen in Oliveira & Antunes (2007) and Henriques (2008).

4.2.5 The optimizing approach in interval linear programming

In the *optimizing approach* the concept of efficiency in MOLP is extended to the MOLP with interval coefficients in the objective function (e.g. Bitran (1980), Ida (1999, 2005), Inuiguchi & Sakagawa (1996), Steuer (1981) and Wang & Wang (2001a, 2001b)).

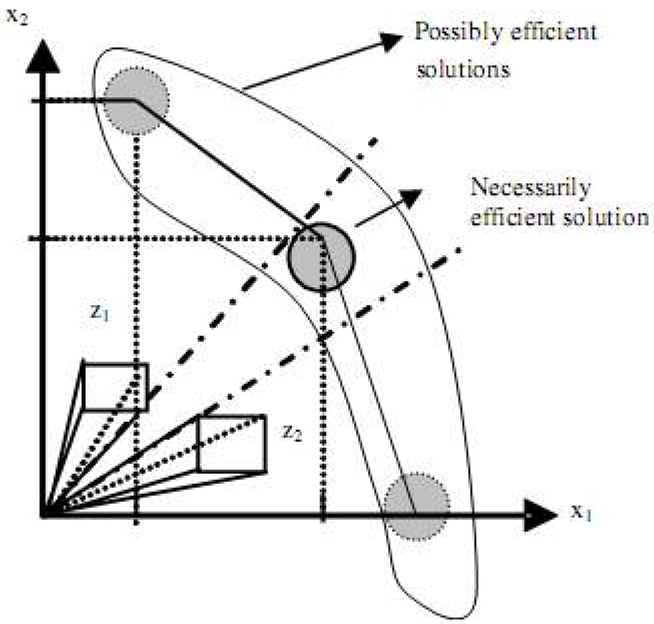

Figure 4.4 – Necessarily and possibly efficient solutions (Oliveira & Antunes, 2007).

Two types of efficient solutions in the context of MOLP models with interval coefficients can be identified: *necessarily efficient solutions* and *possibly efficient solutions* (see Figure 4.4). The solution is *necessarily efficient if* and *only if* it is efficient for any combination of vectors of the objective function coefficients within their feasible ranges of variation, while the solution is said to be *possibly efficient if* and *only if* it is efficient for at least one combination of vectors of the objective function coefficients within their feasible ranges of variation (Bitran, 1980). As referred by Ida (1999) the ‘necessarily efficient’ solutions are the most robust, while the ‘possibly efficient’ solutions are considered to be the optimistic ones.

Considering, without loss of generality, the problem (4.2) in which $C \in$ D (where D is a set of ($p \times n$) matrices, with each row of the form $\boldsymbol{c}_k$, in which each generic element $c_{kj} \in [c_{ij}^L, c_{ij}^U]$, k = 1,…, p and j = 1,…, n) as follows:

$$\text{Max} \quad \mathbf{z}(\mathbf{x}) = C\mathbf{x} \tag{4.55}$$

$$\text{S.t.:} \quad \mathbf{x} \in \mathbf{X} = \{\mathbf{x} \in \Re^n : \mathbf{x} \geq 0, A\mathbf{x} \leq \mathbf{b} \in \Re^n\}$$

$$C \in D$$

Thus a solution is *necessarily efficient* to problem (4.55) *if* and *only if* it is efficient for any $C \in$ D. The *necessarily efficient solution* set N_E is obtained by:

$$N_E = \bigcap_{C \in D} X_E(C) \tag{4.56}$$

where X_E (C) is the efficient set for each $C \in$ D.

On the other hand, a solution is *possibly efficient* to problem (4.55) *if* and *only if* it is efficient for at least one $C \in$ D. The *possibly efficient solution* set P_E is obtained by:

$$P_E = \bigcup_{C \in D} X_E(C) \tag{4.57}$$

Since $N_E \subseteq P_E$, therefore a necessarily efficient solution is also a possibly efficient solution (Oliveira & Antunes, 2007).

Some methods in the context of the *optimizing approach* have been used to compute the set of necessarily and/or possibly efficient solutions to the problem (4.55). The methods to compute necessarily efficient solutions are based on the implicit enumeration algorithm, the *branch and bound* algorithm and the extreme ray generation method (see e.g. Bitran (1980) and Ida (1999; 2005)). The methods to compute possibly efficient solutions include the studies of Inuiguchi & Sakawa (1996), which have proposed a possibly efficiency test for a given feasible solution, Steuer (1981, 1986) which who developed three algorithms (*F-cone, E-cone* and *all emanating edges*) for solving LP problems in which some or all the objective function coefficients are specified as intervals, and Wang & Wang (2001a, 2001b) who used Telgen’s method (Telgen, 1982) to obtain the *irreducible generator of the criterion cone*. A detailed review of those methods is provided in Oliveira & Antunes (2007) and Henriques (2008).

4.3. AN INTERACTIVE METHOD FOR INTERVAL MULTI-OBJECTIVE LINEAR PROGRAMMING

In the previous sections, we have reviewed some methods used for dealing with uncertainty in LP and MOLP models using the interval approach. In this section an interactive method for the treatment of uncertainty in MOLP models with interval coefficients in objective functions and constraints proposed by Henriques (2008) and Oliveira & Antunes (2009) will be summarily presented. Before presenting the interactive steps of this method, a brief review of the surrogate deterministic problems proposed by Henriques (2008) and Oliveira & Antunes (2009) in the context of this method will be outlined in the next section.

4.3.1 Obtaining the Surrogate Deterministic Problems

In order to present the model proposed by Henriques (2008) and Oliveira & Antunes (2009), let us consider the MOLP model with interval coefficients in (4.45), in which $\left[c_{\mathrm{kj}}^{\mathrm{L}}, c_{\mathrm{kj}}^{\mathrm{U}}\right]$, $\left[a_{ij}^{L}, a_{ij}^{U}\right]$ and $\left[b_{\mathrm{i}}^{\mathrm{L}}, b_{\mathrm{i}}^{\mathrm{U}}\right]$ are closed interval. Thus two surrogate models are initially obtained by considering that the DM wants to minimize the worst distance of each interval with respect to an interval target utilizing the concept of possible deviation (Henriques, 2008). I.e. the DM wants to minimize the worst possible deviation (Inuiguchi & Kume, 1991) of each interval objective function to an established interval goal, considering satisfaction thresholds for the constraints (Urli & Nadeu, 1992). The possible deviation $D_{\mathrm{k}}(\mathbf{x})=\left[d_{\mathrm{k}}^{\mathrm{L}}(\mathrm{x}),\ d_{\mathrm{k}}^{\mathrm{U}}(\mathbf{x})\right]$ of $Z_{\mathrm{k}}(\ )=\left[\sum_{\mathrm{j=1}}^{\mathrm{n}} c_{\mathrm{kj}}^{\mathrm{L}}\mathrm{x_j}=Z_{\mathrm{k}}^{\mathrm{L}}(\mathbf{x}),\quad {}_{\mathrm{j=1}}^{\mathrm{n}} c_{\mathrm{kj}}^{\mathrm{U}}\mathrm{x_j}=Z_{\mathrm{k}}^{\mathrm{U}}(\mathbf{x})\right]$ to an interval target $T_{\mathrm{k}}=\left[t_{\mathrm{k}}^{\mathrm{L}}, t_{\mathrm{k}}^{\mathrm{U}}\right]$ is:

$$D_{\mathrm{k}}(\mathbf{x})=\left|T_{\mathrm{k}}\ (-)\ Z_{\mathrm{k}}(\mathbf{x})\right|=\left|\left[t_{\mathrm{k}}^{\mathrm{L}}-\sum_{\mathrm{j=1}}^{\mathrm{n}} c_{\mathrm{kj}}^{\mathrm{U}}\mathrm{x_j}, t_{\mathrm{k}}^{\mathrm{U}}-\ {}_{\mathrm{j=1}}^{\mathrm{n}} c_{\mathrm{kj}}^{\mathrm{L}}\mathrm{x_j}\right]\right|=$$

$$=\begin{cases} a)\ \left[t_{\mathrm{k}}^{\mathrm{L}}-\sum_{\mathrm{j=1}}^{\mathrm{n}} c_{\mathrm{kj}}^{\mathrm{U}}\mathrm{x_j},\quad t_{\mathrm{k}}^{\mathrm{U}}-\ {}_{\mathrm{j=1}}^{\mathrm{n}} c_{\mathrm{kj}}^{\mathrm{L}}\mathrm{x_j}\right] & if\ t_{\mathrm{k}}^{\mathrm{L}}-\sum_{\mathrm{j=1}}^{\mathrm{n}} c_{\mathrm{kj}}^{\mathrm{U}}\mathrm{x_j}\geq 0, \\ b)\ \left[0, \left(\sum_{\mathrm{j=1}}^{\mathrm{n}} c_{\mathrm{kj}}^{\mathrm{U}}\mathrm{x_j}-t_{\mathrm{k}}^{\mathrm{L}}\right)\vee\left(t_{\mathrm{k}}^{\mathrm{U}}-\sum_{\mathrm{j=1}}^{\mathrm{n}} c_{\mathrm{kj}}^{\mathrm{L}}\mathrm{x_j}\right)\right] & if\ t_{\mathrm{k}}^{\mathrm{L}}-\sum_{\mathrm{j=1}}^{\mathrm{n}} c_{\mathrm{kj}}^{\mathrm{U}}\mathrm{x_j}<0<t_{\mathrm{k}}^{\mathrm{U}}-\ {}_{\mathrm{j=1}}^{\mathrm{n}} c_{\mathrm{kj}}^{\mathrm{L}}\mathrm{x_j} \\ c)\ \left[\sum_{\mathrm{j=1}}^{\mathrm{n}} c_{\mathrm{kj}}^{\mathrm{L}}\mathrm{x_j}-t_{\mathrm{k}}^{\mathrm{U}},\ \sum_{\mathrm{j=1}}^{\mathrm{n}} c_{\mathrm{kj}}^{\mathrm{U}}\mathrm{x_j}-t_{\mathrm{k}}^{\mathrm{L}}\right] & if\ t_{\mathrm{k}}^{\mathrm{U}}-\sum_{\mathrm{j=1}}^{\mathrm{n}} c_{\mathrm{kj}}^{\mathrm{L}}\mathrm{x_j}\leq 0 \end{cases} \tag{4.58}$$

In order to transform the interval constraints of the MOLP model in (4.45) into deterministic constraints, Henriques (2008) and Oliveira & Antunes (2009) have used the approach of Urli & Nadeau (1992), which is based on the DM's degree of satisfaction relatively to a non-deterministic constraint. Thus the degree of satisfaction, μ, of an interval constraint of (4.45) is given by:

$$\mu\left(\sum_{j=1}^{n} a_{ij}x_j \le b_i\right)=\begin{cases} 0, \textit{ if } \sum_{j=1}^{n} a_{ij}^{L}x_j \ge b_i^{U}, \\ 1, \textit{ if } \sum_{j=1}^{n} a_{ij}^{U}x_j \le b_i^{L}, \\ \dfrac{b_i^{U} - \sum_{j=1}^{n} a_{ij}^{L}x_j}{\left(b_i^{U} - b_i^{L}\right)+\sum_{j=1}^{n}\left(a_{ij}^{U} - a_{ij}^{L}\right)x_j}, \text{ otherwise,} \end{cases} \tag{4.59}$$

where $a_{ij} \in \left[a_{ij}^{L}, a_{ij}^{U}\right]$ and $b_i \in \left[b_i^{L}, b_i^{U}\right]$

The solutions to the model (4.45) should individually satisfy each non-deterministic constraint with some satisfaction threshold, called *individual satisfaction threshold on constraints* and denoted by α_i (i = 1,..., m). Therefore, each interval constraint has the following deterministic form, for a given $\alpha_i \in [0, 1]$ (i = 1,..., m):

$$\mu\left(\sum_{j=1}^{n} a_{ij}x_j \le b_i\right) \ \ge \ \alpha_i \qquad\qquad i = 1,..., m \tag{4.60}$$

Thus, from the relation (4.59) it is possible to transform the constraint (4.60) as follows:

$$\sum_{j=1}^{n} \left(a_{ij}^{L} + \alpha_i\left(a_{ij}^{U} - a_{ij}^{L}\right)\right) x_j \le b_i^{U} - \ \alpha_i\left(b_i^{U} - b_i^{L}\right) \tag{4.61}$$

In the next step, for each objective function $Z_k(\mathbf{x})$ the following LP models are solved, which allow obtaining the best and worst optima (Ramadan, 1997; Chinneck & Ramadan, 2000), respectively:

$$\begin{aligned} &\text{Max} \quad Z_k^U(\mathbf{x}) && k = 1,\dots, p && (4.62)\\ &\text{S.t.:} \quad \sum_{j=1}^{n} a_{ij}^{L} x_j \le b_i^{U} && i = 1,\dots, m \\ &\qquad x_j \ge 0 && j = 1,\dots, n \end{aligned}$$

and

$$\begin{aligned} &\text{Max} \quad Z_k^L(\mathbf{x}) && k = 1,\dots, p && (4.63)\\ &\text{S.t.:} \quad \sum_{j=1}^{n} a_{ij}^{U} x_j \le b_i^{L} && i = 1,\dots, m \\ &\qquad x_j \ge 0 && j = 1,\dots, n \end{aligned}$$

The problems (4.62) and (4.63) are denoted by β = 0 and β = 1, respectively, and the optimal solution to each problem is given by $\mathbf{x}_k^{\beta}$, β = 0, 1 and k = 1,..., p (Oliveira & Antunes, 2009). Thus, the interval goals are chosen by considering:

$$t_k^U = Z_k^U(\mathbf{x}_k^0) = Z_k^{U^*} \qquad k = 1,\dots, p \qquad (4.64)$$

$$t_k^L = Z_k^L(\mathbf{x}_k) = Z_k^{L^*} \qquad k = 1,\dots, p \qquad (4.65)$$

Henriques (2008) and Oliveira & Antunes (2009) define the possible deviation of each interval objective function to the corresponding interval ideal solution as follows:

$$D_k(\mathbf{x}) = \left\| \left[Z_k^{L^*} - Z_k^U(\mathbf{x}),\ \ Z_k^{U^*} - Z_k^L(\mathbf{x}) \right] \right\| =$$

$$= \begin{cases} a)\ \ Z_k^{L^*} - Z_k^U(\mathbf{x}),\ \ Z_k^{U^*} - Z_k^L(\mathbf{x}) \big] & \text{if } Z_k^{L^*} - Z_k^U(\mathbf{x}) \ge 0 \\ b)\ \ \left[0,\ \left(Z_k^U(\mathbf{x}) - Z_k^{L^*}\right) \vee \left(Z_k^{U^*} - Z_k^L(\mathbf{x})\right)\right] & \text{if } Z_k^{L^*} - Z_k^U(\mathbf{x}) < 0 < Z_k^{U^*} - Z_k^L(\mathbf{x}) \end{cases} \qquad (4.66)$$

As referred to by the authors in this case line (*c*) of expression (4.58) can never occur because $Z_k^{U^*} - Z_k^L(\mathbf{x}) \ge 0$, since $Z_k^{U^*}$ is the best possible optimum that the objective function *k* can attain.

Let $\varepsilon_k = Z_k^{L^*} - Z_k^U(\mathbf{x})$, such that $\varepsilon_k = \varepsilon_k^+ - \varepsilon_k^-$, $\varepsilon_k^+ \ge 0$, $\varepsilon_k^- \ge 0$, and $\varepsilon_k^+ \varepsilon_k^- = 0$, thus:

$$D_{\mathrm{k}}(\mathbf{x}) = \begin{cases} a) \left[\, \varepsilon_{\mathrm{k}}^{+} - \varepsilon_{\mathrm{k}}^{-},\ \ Z_{\mathrm{k}}^{\mathrm{U}^*} - Z_{\mathrm{k}}^{\mathrm{L}}(\mathbf{x}) \right] & if\ \ \varepsilon_{\mathrm{k}}^{+} - \varepsilon_{\mathrm{k}}^{-} \geq 0 \\ \ \ ) \left[0,\ \left(\varepsilon_{\mathrm{k}}^{-} - \varepsilon_{\mathrm{k}}^{+} \right) \vee \left(Z_{\mathrm{k}}^{\mathrm{U}^*} - Z_{\mathrm{k}}^{\mathrm{L}}(\mathbf{x}) \right) \right] & if\ \ \varepsilon_{\mathrm{k}}^{+} - \varepsilon_{\mathrm{k}}^{-} < 0 < Z_{\mathrm{k}}^{\mathrm{U}^*} - Z_{\mathrm{k}}^{\mathrm{L}}(\mathbf{x}) \end{cases} \quad (4.67)$$

Thus, the occurrence of the following situations is possible:

a) *If* $\varepsilon_{\mathrm{k}}^{+} = 0$, then $\varepsilon_{\mathrm{k}}^{-} \geq 0$ and $D_{\mathrm{k}}(\mathbf{x}) = \left[0,\ \varepsilon_{\mathrm{k}}^{-} \vee \left(Z_{\mathrm{k}}^{\mathrm{U}^*} - Z_{\mathrm{k}}^{\mathrm{L}}(\mathbf{x}) \right) \right.$;

b) *If* $\varepsilon_{\mathrm{k}}^{-} = 0$, then $\varepsilon_{\mathrm{k}}^{+} \geq 0$ and $D_{\mathrm{k}}(\mathbf{x}) = \left[\varepsilon_{\mathrm{k}}^{+},\ \left(Z_{\mathrm{k}}^{\mathrm{U}^*} - Z_{\mathrm{k}}^{\mathrm{L}}(\mathbf{x}) \right) \right]$.

Therefore $D_{\mathrm{k}}(\mathbf{x}) = \left[\varepsilon_{\mathrm{k}}^{+},\ \varepsilon_{\mathrm{k}}^{-} \vee \left(Z_{\mathrm{k}}^{\mathrm{U}^*} - Z_{\mathrm{k}}^{\mathrm{L}}(\mathbf{x}) \right) \right]$ for k = 1,..., p.

If the DM intends to minimize the worst possible deviation of each objective function to the corresponding interval target, the model (4.45) has the following substitute problem for a particular level of α_i (i = 1, ..., m):

$$\text{Min Max} \quad \lambda_{\mathrm{k}} D_{\mathrm{k}}(\mathbf{x}) \qquad \mathrm{k} = 1,\dots,\mathrm{p} \quad (4.68)$$

$$\text{S.t.:} \quad \sum_{\mathrm{j}=1}^{\mathrm{n}} \left(a_{\mathrm{ij}}^{\mathrm{L}} + \alpha \left(a_{\mathrm{ij}}^{\mathrm{U}} - a_{\mathrm{ij}}^{\mathrm{L}} \right) \right) \mathrm{x_j} \leq b^{\mathrm{U}} - \alpha \left(b^{\mathrm{U}} - {}^{\mathrm{L}} \right) \qquad \mathrm{i} = 1,\dots,\mathrm{m}$$

$$\varepsilon_{\mathrm{k}}^{+} - \varepsilon_{\mathrm{k}}^{-} = Z_{\mathrm{k}}^{\mathrm{L}^*} - Z_{\mathrm{k}}^{\mathrm{U}}(\mathbf{x}) \qquad \mathrm{k} = 1,\dots,\mathrm{p}$$

$$\varepsilon_{\mathrm{k}}^{+}\ \ \varepsilon_{\mathrm{k}}^{-} = 0 \qquad \mathrm{k} = 1,\dots,\mathrm{p}$$

$$\varepsilon_{\mathrm{k}}^{+} \geq 0 \qquad \mathrm{k} = 1,\dots,\mathrm{p}$$

$$\varepsilon_{\mathrm{k}}^{-} \geq 0 \qquad \mathrm{k} = 1,\dots,\mathrm{p}$$

$$\mathrm{x_j} \geq 0 \qquad \mathrm{j} = 1,\dots,\mathrm{n}$$

where λ_k is a scaling factor that allows to normalize the different orders of magnitude of the objective functions (Henriques, 2008).

Let $\omega_k \in \{0, 1\}$, k = 1,..., p, $\mathrm{s}_{\mathrm{k}}^{+} = \omega_{\mathrm{k}} \varepsilon_{\mathrm{k}}^{+}$, $\mathrm{s}_{\mathrm{k}}^{-} = \left(1 - \omega_{\mathrm{k}}\right) \varepsilon_{\mathrm{k}}^{-}$; then the model (4.68) can be written as:

$$\text{Min Max} \quad \lambda_{\mathrm{k}} D_{\mathrm{k}}(\mathbf{x}) = \lambda_{\mathrm{k}} \left[\mathrm{s}_{\mathrm{k}}^{+}, \mathrm{s}_{\mathrm{k}}^{-} \vee Z_{\mathrm{k}}^{\mathrm{U}^*} - Z_{\mathrm{k}}^{\mathrm{L}}(\mathbf{x}) \right] \qquad \mathrm{k} = 1,\dots,\mathrm{p} \quad (4.69)$$

$$\text{S.t.:} \quad \sum_{\mathrm{j}=1}^{\mathrm{n}} \left(a_{\mathrm{ij}}^{\mathrm{L}} + \alpha \left(a_{\mathrm{ij}}^{\mathrm{U}} - a_{\mathrm{ij}}^{\mathrm{L}} \right) \right) \mathrm{x_j} \leq b^{\mathrm{U}} - \alpha \left(b^{\mathrm{U}} - {}^{\mathrm{L}} \right) \qquad \mathrm{i} = 1,\dots,\mathrm{m}$$

$s_k^+ - s_k^- = Z_k^{L^*} - Z_k^U(\mathbf{x})$ k = 1,..., p

$s_k^+ - M\omega_k \le 0$ k = 1,..., p

$s_k^- + M\omega_k \le M$ k = 1,..., p

$s_k^+ \ge 0$ k = 1,..., p

$s_k^- \ge 0$ k = 1,..., p

$\omega_k \in \{0, 1\}$ k = 1,..., p

$x_j \ge 0$ j = 1,…, n

where M is an arbitrary large number.

If the DM intends to minimize the lower bound of the worst possible deviation, the model (4.45) is replaced by the following mixed integer LP (MILP) model:

Min $d^L(\mathbf{x}) = d^L + \gamma \sum_{k=1}^{p}(s_k^+)$ (4.70)

S.t.: $\lambda_k s_k^+ \le d^L$ k = 1,..., p

$\sum_{j=1}^{n}\left(a_{ij}^L + \alpha\left(a_{ij}^U - a_{ij}^L\right)\right)x_j \le b^U - \alpha\left(b^U - \quad ^L\right)$ i = 1,…, m

$s_k^+ - s_k^- = Z_k^{L^*} - Z_k^U(\mathbf{x})$ k = 1,..., p

$s_k^+ - M\omega_k \le 0$ k = 1,..., p

$s_k^- + M\omega_k \le M$ k = 1,..., p

$s_k^+ \ge 0$ k = 1,..., p

$s_k^- \ge 0$ k = 1,..., p

$\omega_k \in \{0, 1\}$ k = 1,..., p

$d^L \ge 0$

$x_j \ge 0$ j = 1,…, n

where γ is a very small number and M is an arbitrary large number.

However, *if* $Z_k^{L^*} - Z_k^U(\mathbf{x}) \le 0$, thus the variable d^L in model (4.70) becomes sign unrestricted.

If the DM intends to minimize the upper bound of the worst possible deviation, the model (4.45) is replaced by the following MILP model:

$$\text{Min} \quad d^U(\mathbf{x}) = d^U + \gamma \sum_{k=1}^{p} \left[s_k^- + Z_k^{U^*} - Z_k^L(\mathbf{x}) \right] \tag{4.71}$$

S.t.:

$$\lambda_k s_k^- \le d^U \qquad k = 1,..., p$$

$$\lambda_k \left(Z_k^{U^*} - Z_k^L(\mathbf{x}) \right) \le d^U \qquad k = 1,..., p$$

$$\sum_{j=1}^{n} \left(a_{ij}^L + \alpha \left(a_{ij}^U - {}_{ij}^L \right) \right) x_j \le b^U - \alpha \left(b^U - {}^L \right) \qquad i = 1,\ldots, m$$

$$s_k^+ - s_k^- = Z_k^{L^*} - Z_k^U(\mathbf{x}) \qquad k = 1,..., p$$

$$s_k^+ - M\omega_k \le 0 \qquad k = 1,..., p$$

$$s_k^- + M\omega_k \le M \qquad k = 1,..., p$$

$$s_k^+ \ge 0 \qquad k = 1,..., p$$

$$s_k^- \ge 0 \qquad k = 1,..., p$$

$$\omega_k \in \{0, 1\} \qquad k = 1,..., p$$

$$d^U \ge 0$$

$$x_j \ge 0 \qquad j = 1,\ldots, n$$

where γ is a very small number and M is an arbitrary large number.

4.3.2 The interactive phase of the method

The interactive method proposed by Henriques (2008) and Oliveira & Antunes (2009) can be summarily outlined by the block diagram of the Figure 4.5.

This method can be succinctly described by the following steps:

Step 1 – The algorithm starts by obtaining the surrogate deterministic formulations of the interval MOLP model (4.45) by considering the minimization of the worst possible deviation of the interval objective functions to their corresponding interval ideal solutions (as presented in the previous section).

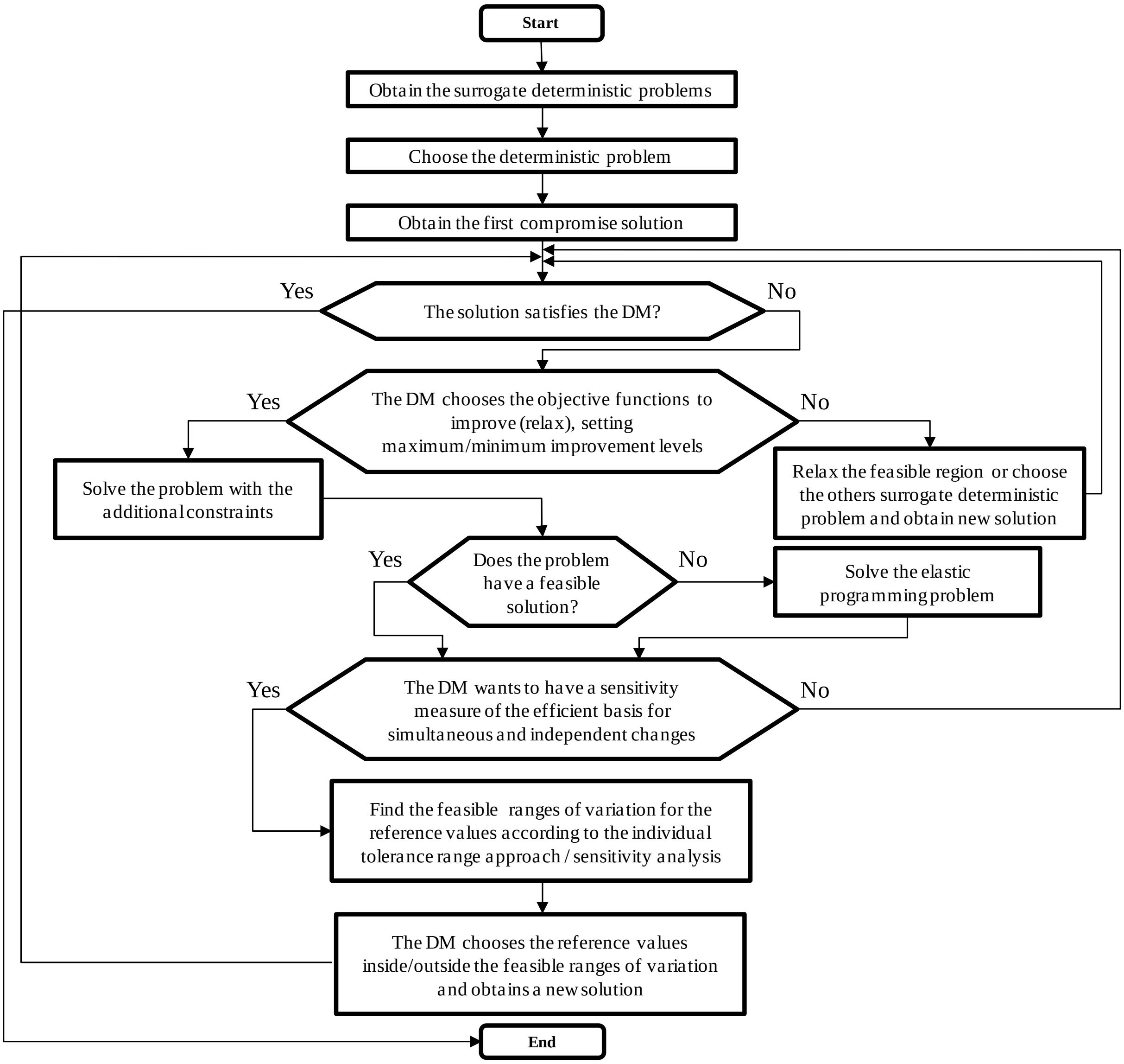

Figure 4.5 – Flowchart of the interactive algorithm for interval MOLP models (based on Oliveira & Antunes, 2009).

<u>Step 2</u> – One of the surrogate deterministic problems (4.70) and (4.71) is solved according to a more or less conservative stance of the DM with the narrowest version of the feasible region in order to obtain the first compromise solution ($x^{1U'}$ or $x^{1U''}$, respectively).

<u>Step 3</u> –The interactive phase of the method starts. The DM is asked to reveal his/her satisfaction regarding the solution being analyzed. The DM can accept this solution (and the

algorithm stops) or decides continuing the algorithm in order to compute other solutions $\mathbf{x}^{m} = \mathbf{x}^{mU'}$ and/or $\mathbf{x}^{mU''}$ (m = 2, 3, 4, …).

<u>Step 4</u> – The DM analyzes the solutions $\mathbf{x}^{m}$ as far as additional information is supplied, such as:

- the interval objective function values $Z_k(\mathbf{x}^m) = \left[Z_k^L(\mathbf{x}^m),\ Z_k^U(\mathbf{x}^m)\right]$ (k = 1,…,p and m = 2, 3, 4,…) obtained in each solution and the corresponding *midpoint* (4.72) and *width* (4.73) of the interval[16]:

$$m[Z_k(\mathbf{x}^m)] = \frac{Z_k^L(\mathbf{x}^m) + Z_k^U(\mathbf{x}^m)}{2} \tag{4.72}$$

$$w[Z_k(\mathbf{x}^m)] = Z_k^U(\mathbf{x}^m) - Z_k^L(\mathbf{x}^m) \tag{4.73}$$

- the distance of the interval objective function values obtained in each solution $Z_k(\mathbf{x}^m)$ to the corresponding interval ideal solutions $Z_k^* = \left[Z_k^{L*}, Z_k^{U*}\right]$:

$$d\left(Z_k^*,\ Z_k(\mathbf{x}^m)\right) = \mathrm{Max}\left(\left|Z_k^{L*} - Z_k^L(\mathbf{x}^m)\right|, \left|Z_k^{U*} - Z_k^U(\mathbf{x}^m)\right|\right) \tag{4.74}$$

- the comparison between the interval objective function values and the corresponding interval ideal solutions through the use of an acceptability index[17] ($\mathcal{A}$), i.e. the acceptability of $Z_k(\mathbf{x}^m)$ being inferior ($\prec$) to Z_k^*:

$$\mathcal{A}\left(Z_k(\mathbf{x}^m) \prec Z_k^*\right) = \frac{\left(m[Z_k^*] - m[Z_k(\mathbf{x}^m)]\right)}{\left(\frac{w[Z_k(\mathbf{x}^m)]}{2} + \frac{w[Z_k^*]}{2}\right)} \tag{4.75}$$

- the achievement rates of the bounds of the objective function values $\left[Z_k^L(\mathbf{x}^m),\ Z_k^U(\mathbf{x}^m)\right]$ in each solution with respect to the lower and upper bounds of the corresponding interval ideal solutions $\left[Z_k^{L*}, Z_k^{U*}\right]$, respectively in (4.76) and (4.77):

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[16] These values can be compared with the values obtained for the corresponding interval ideal solutions (Oliveira & Antunes, 2009).

[17] As referred to by Oliveira & Antunes (2009): '*since the main aim is to find the solutions that allow obtaining the interval objective function values that are closer to their corresponding interval ideal solutions when both the distance and the acceptability index are close to zero, the interval objective functions are close to the corresponding interval ideal solutions*'.

$$tc_{\mathrm{k}}^{\mathrm{L}} = 1 - \frac{\left(Z_{\mathrm{k}}^{\mathrm{L}*} - \ _{\mathrm{k}}^{\mathrm{L}}(\mathbf{x}^{\mathrm{m}})\right)}{\left(Z_{\mathrm{k}}^{\mathrm{L}*} - m_{\mathrm{k}}^{\mathrm{L}}\right)} \quad (4.76)$$

$$tc_{\mathrm{k}}^{\mathrm{U}} = 1 - \frac{\left(Z_{\mathrm{k}}^{\mathrm{U}*} - \ _{\mathrm{k}}^{\mathrm{U}}(\mathbf{x}^{\mathrm{m}})\right)}{\left(Z_{\mathrm{k}}^{\mathrm{U}*} - m_{\mathrm{k}}^{\mathrm{U}}\right)} \quad (4.77)$$

where $m_{\mathrm{k}}^{\mathrm{L}}$ and $m_{\mathrm{k}}^{\mathrm{U}}$ are the worst optimal values obtained from the expanded pay-off table[18]. The closer the values of $tc_{\mathrm{k}}^{\mathrm{L}}$ and $tc_{\mathrm{k}}^{\mathrm{U}}$ are to 1, the closer the DM is to meet his/her aspiration level $\ _{\mathrm{k}}^{*}$ (Oliveira & Antunes, 2009)[19].

- The impact of different values for α_i on the compromise solution if the DM wants to analyze other solutions with distinct coefficient sets.

<u>Step 5</u> – The DM is asked to reveal his/her satisfaction regarding the solution being analyzed. The DM can accept this solution (and the algorithm stops) or the algorithm proceeds. In this case the DM have 3 options:

- Choosing the objective function(s) he/she is willing to relax in order to improve the other objective function(s) and solve the problem with the additional constraints. In this step the DM is asked to set the minimum/maximum improvement levels $\Delta_{\mathrm{k}}^{\mathrm{L}*}$ or $\Delta_{\mathrm{k}}^{\mathrm{U}*}$ of the chosen objective function(s). If the DM is not able to specify those levels, they can be automatically set in the following way:

$$\Delta_{\mathrm{k}}^{\mathrm{L}*} = Z_{\mathrm{k}}^{\mathrm{L}*} - \ _{\mathrm{k}}^{\mathrm{L}}(\mathbf{x}^{\mathrm{m}}) \quad (4.78)$$

$$\Delta_{\mathrm{k}}^{\mathrm{U}*} = Z_{\mathrm{k}}^{\mathrm{U}*} - \ _{\mathrm{k}}^{\mathrm{U}}(\mathbf{x}^{\mathrm{m}}) \quad (4.79)$$

- Relaxing the model constraints to 'enlarge' the feasible region and returning to step 3;
- Choosing other surrogate deterministic model and returning to step 3 in order to obtain a new set of solutions.

<u>Step 6</u> – If the DM chooses to relax the objective function(s) and the problem obtained with the additional constraints has an empty feasible region, thus information about the amount he/she should relax the different objective reference values in order to restore feasibility is

[18] The extended pay-off table is the pay-off table with the optimum values of problems (4.62) and (4.63).
[19] As referred to by Oliveira & Antunes (2009), in general the value of $tc_{\mathrm{k}}^{\mathrm{U}}$ ranges between 0 and 1. However $tc_{\mathrm{k}}^{\mathrm{L}}$ can be greater than 1, when α_i is relaxed. A value greater than 1 corresponds to a deviation from the goal considered instead of an improvement of the achievement solution rate.

provided. For this purpose the 'elastic programming model' introduced by Brown & Graves (1975) is used to widen the feasible region and thus a LP problem is solved based on "the smallest variable cost model" (see e.g. Brown & Graves (1975), Chinneck & Dravnieks (1991) and Murty *et al*. (2000)) [20].

Step 7 – The DM is asked if he/she wants to have a sensitivity measure of the efficient basis obtained for simultaneous and independent changes of the reference values considered for the objective functions or to have a sensitivity measure of the efficient basis obtained when changes occur in only one reference value for one objective function. In the first case the ranges of variation of these reference values are computed according to the *individual tolerance range approach* (Wondolowski, 1991), while in the last case the range of variation of this reference value is computed according to *sensitivity analysis techniques* (Gal, 1979). For a more detailed review of both methods see Henriques (2008) and Oliveira & Antunes (2009).

Step 8 – The DM can choose new reference values within or outside the ranges of variation computed, knowing that in the last option the efficient basis will be changed.

The DM decides when to stop the solution search process, as far as he/she considers to have gathered enough information about the problem to make a final decision (Henriques, 2008; Oliveira & Antunes, 2009).

4.4. FINAL REMARKS

The STEM and TRIMAP intercative methods allow the exploration of compromise solutions according to the preference information issued by the DM. STEM allows an interactive solution search process providing information about the trade-offs that are at stake between the competing objectives in different regions of the search space, which is progressively reduced. The TRIMAP interactive method offers great flexibility in the analysis, allowing a progressive and selective exploration of compromise solutions in a user-friendly graphical environment based on the display of indifference regions associated with vertex eficiente solutions on the parametric diagram. Both methods are able to provide

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[20] The "elastic programming" consists n the addition of extra variables (the "elastic variables," e_k) which allow constraints to be relaxed thus enlarging the feasible region. In "the smallest variable cost model" the resistance to "stretch" implied by the elastic term is supplied by creating a new objective: minimizing the sum of the total variable cost of all changes (i.e., of the elastic variables) (Oliveira & Antunes, 2009). For a more detailed overview of both methods see Henriques (2008) and Oliveira & Antunes (2009).

relevant decision support information to the DM assisting him/her in identifying compromise solutions to MOLP models.

Interval programming for tackling uncertainty, which is intrinsic to the models in real-world problems, copes with the difficulty in specifying *probabilistic* distributions (as in stochastic programming) or *possibilistic* distributions (as in fuzzy programming) of the model coefficients. In this chapter an overview of different approaches to carry out the treatment of uncertainty in MOLP models using interval programming has been presented, in which satisfaction and optimization approaches were briefly reviewed.

In addition, an interactive approach to dealing with uncertainty in MOLP models with interval coefficients developed by Henriques (2008) and Oliveira & Antunes (2009) was summarily presented. This approach involves the formulation of surrogate deterministic models for the interval MOLP model (based on minimization of the worst possible deviation of the interval objective functions to their corresponding interval ideal solutions) and an interactive phase in which a synergy between the algorithm (providing information to the DM) and the DM (processing the information and providing guidelines for the computation process) allows a searching process based on the closeness of the values of the interval solution in relation to the ideal interval solution. This model allows: getting a simpler mathematical formulation of the interval model; a strong integration of the DM with the algorithm, with not very demanding information requirements; treating uncertainty in all model coefficients; reviewing the searching options for solutions considered relevant by the DM. Therefore, the applicability of this algorithm in MOLP models with interval coefficients with realistic dimensions as in Henriques (2008) and Oliveira & Antunes (2011) has vouched the option in applying this method for uncertainty treatment in the model presented in the next chapter of this thesis.

CHAPTER 5 AN IO-MOLP MODEL FOR ENERGY-ENVIRONMENT-ECONOMIC ANALYSIS IN BRAZIL

In previous chapters the role of IOA as an analytical tool for assessing the inter/intra-relationships between different economic activities, as well as to estimate energy/environmental impacts was highlighted. Furthermore, the relationship and intrinsic characteristics of IOA and LP was also underlined in Chapter 3. As referred to by Christ (1955) the generalization of the Leontief's model with LP enables investigating efficient combinations of inputs and outputs on the boundary of the production possibility frontier established in the IOA, therefore allowing obtaining a degree of information that would not be possible to achieve with a separated application of both methodologies (Henriques, 2008).

The complexity of real-world problems and the conflicting interactions between energy, economic, environmental and social concerns has led to the development of MOLP models coupled with the IO framework. These models allows capturing the diversity of evaluation aspects and a rational comparison of alternative compromising solutions, since there is no admissible solution that simultaneously optimizes all objective functions (Steuer, 1986; Roy, 1990; Clímaco *et al*., 2003). In these models multiple, conflicting and incommensurable axes of evaluation of different potential policies are explicitly considered (rather than aggregated in a single indicator), which enables to exploit the trade-offs between those competing objectives.

Nevertheless, a range of uncertainty sources in the IO models and the lack of information and uncertainty associated with the definition of the coefficients of the objective functions and constraints in mathematical programming models can be a drawback (Bullard *et al*., 1978; Lenzen, 2001; Rocco & Guarata, 2002), and therefore it is useful to include the uncertainty treatment in those models. As referred to in previous chapters, three different approaches have been used to incorporate uncertainty treatment in the scope of IO models: the probabilistic (or *stochastic*) approach (e.g. West (1986) and Raa & Steel (1994)), the fuzzy (or *possibilistic*) approach (e.g. Buckley (1989)), and the interval approach (e.g. Jerrel (1995, 1997) and Rocco & Guarata (2002)). As referred to by Jerrel (1995, 1997) and Henriques (2008) the interval programming is an appropriate tool to deal with uncertainty in this type of model due to its practical and simplifying characteristics, since in this approach is only necessary to have information about the possible ranges of variation of the uncertain coefficients rather than specifying *probability* or *possibility* distributions as in stochastic and fuzzy programming.

For this reason, in this study a hybrid IO-MOLP model for economic, energy and environmental planning applied to the Brazilian economic system is developed, in which a (real or hypothetical) decision maker (DM) can also eventually consider interval coefficients for the uncertainty treatment. This model allows a DM obtaining solutions according to different scenarios. The MOLP model based on IOA proposed by Oliveira & Antunes (2004, 2011) and Henriques & Antunes (2012) for Portugal is used as basis for the model developed in this study. This model was adapted for the Brazilian economic system, which has a very different structure leading to important changes in the mathematical model, especially in the environmental accounts. The model includes (internal) coherence constraints derived from the IOA, several economic and environmental constraints, as well as constraints concerning the employment level and energy consumption, which are described in detail in this chapter. It is noteworthy that for the sake of simplicity this chapter will be divided in five main parts (I to V) due to the number of subsections. Therefore the section (and subsection) numbering will be dissimilar in this chapter compared to other chapters. A detailed description of the variables and coefficients considered in the proposed model and its numerical specification are made in Appendices A and B. The model with deterministic coefficients is firstly presented. The constraints of this model are then modified to incorporate interval coefficients are presented in a section at the end of this chapter. Moreover, since interval coefficients are considered in a high number of model constraints, in obtaining the extreme versions of the defining constraints (e.g. private consumption, imports, GDP, etc.), the variables within those constraints (which may result from other defining constraints) must always assume the same extreme value in the same defining constraint. Furthermore, the use of equalities with interval coefficients was avoided by imposing upper/lower bounds in the defining constraints with interval coefficients as needed, according to the data available (see Appendix B).

I. COHERENCE CONSTRAINT

This constraint, which is derived from the basic IO formulation, establishes that the intermediate consumption and final demand of goods and services of each activity sector shall not exceed the total amount available from national production and competitive imports:

$$\mathbf{A\,x + exp + g + cnpish + cf + gfcf \pm sc \leq x + imp} \tag{5.1}$$

where **A** is the inter-sectoral (or technical) coefficient matrix, **x** the total national production (or total output), **exp** is the exports of goods and services, **g** is the final consumption expenditure of general government, **cnpish** is the final consumption expenditure of non-profit institutions serving households (NPISH), **cf** is the final consumption expenditure of households[1], **gfcf** is the gross fixed capital formation (GFCF), **sc** is the changes in inventories and $\mathbf{imp}^c$ is the competitive imports.

II. ECONOMIC CONSTRAINTS

The model includes several defining constraints for economic variables, which are determined essentially at constant prices (i.e. the values for the time period under analysis are expressed in terms of the prices of the base period, in this case, 2009 prices). Constant prices allow obtaining the performance (or changes) of those variables in quantity terms (i.e. the real changes) so that the effects of inflation are removed. Moreover, GDP, disposable income and

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[1] The final consumption expenditure of households does not include the final consumption of NPISH, which is separately accounted for.

fiscal variables are also determined in current prices, where the value for each item is expressed in terms of the prices in the prospective period (in this case, 2018 prices) allowing to obtain the changes in prices and quantities (i.e. the nominal changes). In order to limit the variations of those variables within a plausible range (i.e. closer to official projections), lower and upper values limits are exogenously defined, i.e. additional bound constraints are also included in the model. The main economic variables of the model are: the production of sectors, imports, exports, private consumption, GDP, gross value added, public administration's global balance and public debt, which will be described in detail in the next sections.

II.1. Final consumption expenditure of households on the territory (constant basic prices)

The final consumption expenditure of households on the territory (**cf**) is decomposed by products (corresponding to the sectors considered in the model), through the use of estimated coefficients ($\mathbf{a}_{cf}$) and the total final consumption expenditure of households on the territory (cf)[2]:

$$\mathbf{cf} = \mathbf{a}_{cf}\,(cf) \tag{5.2}$$

$cf \leq cf^U$.

II.2. Total final consumption expenditure of households on the territory (constant consumer prices)

The total final consumption expenditure of households on the territory corresponds to the total consumption of residents (cfr) and non-residents (cpe) households on the territory:

$$cf = cfr + cpe \tag{5.3}$$

$cpe^L \leq cpe$,

$cpe \leq cpe^U$

[2] Letters L and U in superscripts indicate lower and upper bounds exogenously defined for the corresponding variable.

II.3. Total final consumption expenditure of residents - households and NPISH (constant consumer prices)

The total final consumption expenditure of residents (households and NPISH) (cpr) is considered linearly dependent on the disposable income of households and NPISH (yd):

$$cpr = \beta_0 + \beta_1 (yd) \tag{5.4}$$

$cpr \leq cpr^U$,

$yd \leq yd^U$.

II.4. Final consumption expenditure of resident's households on the territory (constant consumer prices)

The final consumption expenditure of resident's households on the territory (cfr) is equal to the total consumption of residents less imports of tourism (cpm) and the final consumption expenditure of NPISH (cnpish):

$$cfr = cpr - cpm - cnpish \tag{5.5}$$

$cfr \leq cfr^U$,

$cpm \leq cpm^U$.

II.5. Imports of tourism (constant consumer prices)

Imports of tourism (or the final consumption expenditure - in tourism services - by resident's households abroad) are considered, for simplicity, as a fixed proportion (exogenously defined) of the total final consumption expenditure of residents:

$$cpm = (\alpha) (cpr) \tag{5.6}$$

II.6. Final consumption expenditure of NPISH (constant basic prices)

The consumption of goods or services by NPISH is decomposed by products analogous to (5.2) through the use of estimated coefficients ($\mathbf{a}_{npish}$):

$\mathbf{cnpish} = \mathbf{a}_{npish}$ (cnpish) (5.7)

$cnpish^L \leq cnpish$,

$cnpish \leq cnpish^U$.

II.7. Final consumption expenditure of general government (constant basic prices)

The consumption of goods or services by the general government is decomposed by products analogously to (5.2) through the use of estimated coefficients ($\mathbf{a}_g$):

$\mathbf{g} = \mathbf{a}_g$ (g) (5.8)

$g^L \leq g$,

$g \leq g^U$.

II.8. Gross fixed capital formation (constant basic prices)

GFCF is decomposed by products analogously to (5.2) through the use of estimated coefficients ($\mathbf{a}_{gfcf}$) and the total GFCF (gfcf):

$\mathbf{gfcf} = \mathbf{a}_{gfcf}$ (gfcf) (5.9)

$gfcf^L \leq gfcf$,

$gfcf \leq gfcf^U$.

II.9. Changes in inventories (constant basic prices)

Changes in inventories are decomposed by products analogously to (5.2) through the use of estimated coefficients ($\mathbf{a}_{sc}$) and the total changes in inventories (sc):

$\mathbf{sc} = \mathbf{a}_{sc}$ (sc) (5.10)

$sc^L \leq sc$,

$sc \leq sc^U$.

II.10. Exports (basic prices and energy units)

The exports are decomposed by products analogously to (5.2) through the use of estimated coefficients ($\mathbf{a}_{exp}$) applied to the applied to the total exports at consumer prices (excluding tourism expenditure) (expcpwt):

$$\mathbf{exp} = \mathbf{a}_{exp} \text{ (expcpwt)} \tag{5.11}$$

II.11. Exports – excluding tourism expenditure (consumer prices)

The exports (excluding tourism expenditure) at constant consumer prices of 2009 (**expcpwt**) are obtained by the sum of **exp** multiplied by a diagonal matrix $\hat{\mathbf{p}}_{exp}$ (with the prices for energy products and 1 for the rest of sectors) and taxes less subsidies and commercial and transportation margins on exports, which are estimated by the respective technical coefficients ($\mathbf{a}_{expts}$) and ($\mathbf{a}_{expctm}$) applied to the total exports at consumer prices (excluding tourism expenditure) (expcpwt):

$$\mathbf{expcpwt} = \mathbf{exp}\ \hat{\mathbf{p}}_{exp} + \mathbf{a}_{expts} \text{ (expcpwt)} + \mathbf{a}_{expctm} \text{ (expcpwt)} \tag{5.12}$$

II.12. Total exports – excluding tourism expenditure (consumer prices)

The total exports (excluding tourism expenditure) at constant consumer prices (expcpwt) are equal to the vector of exports (excluding tourism expenditure) at consumer prices (**expcpwt**) multiplied by a vector ($\mathbf{e}_1$):

$$\text{expcpwt} = \mathbf{e}_1^T(\mathbf{expcpwt}) \tag{5.13}$$

$$\text{expcpwt} \geq \text{expcpwt}^L.$$

II.13. Total exports - including tourism expenditure (consumer prices)

The exports at consumer prices including tourism expenditure (expcpt) are obtained adding to (expcpwt) the amount of the consumption from non-residents (cpe):

$$\text{expcpt} = \text{expcpwt} + \text{cpe} \quad (5.14)$$

$\text{expcpt} \leq \text{expcpt}^U$.

II.14. Total Imports - excluding tourism expenditure (constant CIF prices)

The total imports (excluding tourism expenditure) at constant CIF prices (impwtcif) are obtained by the sum of imports of non-energy goods and services for intermediate consumption ($\mathbf{A}_m \mathbf{x}$) and final demand items (cfm, cnpishm, gm, gfcfm and scm), with the competitive imports of energy products in monetary units. For this purpose a vector with the prices for imports of each energy product $\mathbf{p}_{imp}$ is also used:

$$\text{impwtcif} = (\mathbf{p}_{imp})^{\mathbf{T}}\, \mathbf{imp}^c + \mathbf{e}_2^T\, \mathbf{A}_m\, \mathbf{x} + \text{cfm} + \text{cnpishm} + \text{gm} + \text{gfcfm} + \text{scm} \quad (5.15)$$

$\text{impwtcif} \geq \text{impwtcif}^L$.

II.15. Consumption of non-energy goods or services from non-competitive imports – households

The consumption of non-energy goods or services from non-competitive imports by households (cfm) is decomposed by product through the use of import coefficients estimated for the national economy ($\mathbf{am}_{cf}$):

$$\text{cfm} = \mathbf{e}_3^T\, \mathbf{am}_{cf}\, (\text{cf}) \quad (5.16)$$

$\text{cfm} \geq \text{cfm}^L$.

II.16. Consumption of non-energy goods or services from non-competitive imports – NPISH

The consumption of non-energy goods or services from non-competitive imports by NPISH (cnpishm) is obtained analogously to (5.16) through the use of estimated coefficients ($\mathbf{am}_{cnpish}$) for the national economy:

$$\text{cnpishm} = \mathbf{e}_4^T\, \mathbf{am}_{cnpish}\, (\text{cnpish}) \quad 5.17)$$

II.17. Consumption of non-energy goods or services from non-competitive imports - general government

The consumption of non-energy goods or services from non-competitive imports by the general government (gm) is obtained analogously to (5.16) through the use of estimated coefficients ($\mathbf{am}_g$) for the national economy:

$$gm = \mathbf{e}_5^T \, \mathbf{am}_g \, (g) \tag{5.18}$$

II.18. Gross fixed capital formation from non-competitive imports of non-energy goods or services

GFCF from non-competitive imports of non-energy goods or services (gfcfm) is obtained analogously to (5.16) through the use of estimated coefficients ($\mathbf{am}_{gfcf}$) for the national economy:

$$gfcfm = \mathbf{e}_6^T \, \mathbf{am}_{gfcf} \, (gfcf) \tag{5.19}$$

II.19. Changes in inventories of non-energy goods or services from non-competitive imports

Changes in inventories of non-energy goods or services from non-competitive imports (scm) are obtained analogously to (5.16) through the use of estimated coefficients ($\mathbf{am}_{sc}$) for the national economy:

$$scm = \mathbf{e}_7^T \, \mathbf{am}_{sc} \, (sc) \tag{5.20}$$

II.20. Total imports - excluding tourism expenditure (constant FOB prices)

The total imports (excluding tourism expenditure) at constant FOB prices (impwtfob) are given by the imports at CIF prices (impwtcif) less a CIF/FOB adjustment component which is given by a CIF/FOB coefficient (a_{ciffob}):

$$impwtfob = impwtcif \, (1 - a_{ciffob}) \tag{5.21}$$

$$impwtfob \leq impwtfob^U.$$

II.21. Total imports - including tourism expenditure (constant FOB prices)

The total imports (including tourism expenditure) at constant FOB prices (impfob) are obtained from (5.6) and (5.21):

$$\text{impfob} = \text{impwtfob} + \text{cpm} \quad (5.22)$$

$\text{impfob} \leq \text{impfob}^U$.

II.22. Taxes less subsidies on goods or services (constant prices)

The taxes less subsidies on goods or services (ts) are calculated from the summation of taxes less subsidies applied to the intermediate consumption and final demand items:

$$\text{ts} = \mathbf{e}_8^T \mathbf{A}_{ts} \mathbf{x} + \text{cfts} + \text{cnpishts} + \text{gts} + \text{gfcfts} + \text{scts} \pm \text{expts} \quad (5.23)$$

$\text{ts} \geq \text{ts}^L$.

II.23. Taxes less subsidies on goods or services – households (constant prices)

The taxes less subsidies on goods or services consumed by households (cfts) are decomposed by product using estimated coefficients ($\mathbf{a}_{cfts}$) for the national economy and a correspondingly vector of 1 as follows:

$$\text{cfts} = \mathbf{e}_9^T \mathbf{a}_{cfts} (\text{cf}) \quad (5.24)$$

II.24. Taxes less subsidies on goods or services – NPISH (constant prices)

The taxes less subsidies on goods or services consumed by NPISH (cnpishts) are obtained analogously to (5.24) through the use of estimated coefficients ($\mathbf{a}_{cnpishts}$) for the national economy:

$$\text{cnpishts} = \mathbf{e}_{10}^T \mathbf{a}_{cnpishts} (\text{cnpish}) \quad (5.25)$$

II.25. Taxes less subsidies on goods or services – general government (constant prices)

The taxes less subsidies on goods or services consumed by the general government (gts) are obtained analogously to (5.24) through the use of estimated coefficients ($\mathbf{a}_{gts}$) for the national economy:

$$gts = \mathbf{e}_{11}^{T}\, \mathbf{a}_{gts}\, (g) \tag{5.26}$$

II.26. Taxes less subsidies on goods or services – GFCF (constant prices)

The taxes less subsidies on goods or services to GFCF (gfcfts) are obtained analogously to (5.24) through the use of estimated coefficients ($\mathbf{a}_{gfcfts}$) for the national economy:

$$gfcfts = \mathbf{e}_{12}^{T}\, \mathbf{a}_{gfcfts}\, (gfcf) \tag{5.27}$$

II.27. Taxes less subsidies on goods or services – changes in inventories (constant prices)

The taxes less subsidies on goods or services to changes in inventories (scts) are obtained analogously to (5.24) through the use of estimated coefficients ($\mathbf{a}_{scts}$) for the national economy:

$$scts = \mathbf{e}_{13}^{T}\, \mathbf{a}_{scts}\, (sc) \tag{5.28}$$

II.28. Taxes less subsidies on goods and services – exports (constant prices)

The taxes less subsidies on goods or services exports (expts) are obtained analogously to (5.24) through the use of estimated coefficients ($\mathbf{a}_{expts}$) for the national economy:

$$expts = \mathbf{e}_{14}^{T}\, \mathbf{a}_{expts}\, (expcpwt) \tag{5.29}$$

II.29. Gross value added (constant basic prices)

The gross value added (gva) is given by the sum of wages (wag), gross mixed income (gmi), gross operating surplus (gos), other taxes on the production (opt) and other subsides on the production (ops). For this calculation specific technical coefficients are used for each item:

$$gva = \mathbf{a}_{wag}^{\mathbf{T}}\,\mathbf{x} + \mathbf{a}_{gmi}^{\mathbf{T}}\,\mathbf{x} + \mathbf{a}_{gos}^{\mathbf{T}}\,\mathbf{x} + \mathbf{a}_{opt}^{\mathbf{T}}\,\mathbf{x} - \mathbf{a}_{ops}^{\mathbf{T}}\,\mathbf{x} \tag{5.30}$$

II.30. Gross Domestic Product (constant prices)

It is possible to estimate the GDP by three different approaches: expenditure, production and income. In the expenditure approach the GDP is estimated by the sum of exports (expcpt), general government consumption expenditures (g), consumption expenditure of NPISH (cnpish), consumption expenditure of households (cf), gross fixed capital formation (gfcf) and changes in inventories (sc), less imports (impfob):

$$gdp_{ex} = expcpt + g + cnpish + cf + gfcf \pm sc - impfob \tag{5.31}$$

$gdp^{L} \leq gdp_{ex}$,

$gdp_{ex} \leq gdp^{U}$.

In the production approach (also called the output approach) the GDP is estimated by the difference between value of output (or production) less the intermediary consumption (or the value of goods and services used in producing these outputs) of sectors plus the total of taxes less subsides on products which are not included in the production. In the income approach the GDP is estimated by the sum of (gav) and the total of taxes less subsides on products (ts) which are not included in the production (IBGE, 2008). Since the estimates of both approaches are made in a quite similar way, only the last one has been considered in this model:

$$gdp_{in} = gva + ts \tag{5.32}$$

$gdp^{L} \leq gdp_{in}$

$gdp_{in} \leq gdp^{U}$,

$gdp_{ex} = gdp_{in}$.

II.31. Gross Domestic Product (current prices)

The GDP at current prices (gdpcurr) is estimated by using the GDP at constant prices in the expenditure approach and specific deflators for: the total final consumption expenditure of residents – households and NPISH (pcpr), changes in inventories (psc), exports (pexpcpt) and imports (pimpfob). The consumption of goods and services by the general government at current prices (gcurr) and the GFCF at current prices (gfcfcurr) (which are exogenously defined) are also considered:

$$\text{gdpcurr} = (\text{cpr})(\text{pcpr}) + \text{gcurr} + \text{gfcfcurr} \pm (\text{sc})(\text{psc}) + (\text{expcpt})(\text{pexpcpt}) - \\ - (\text{impfob})(\text{pimpfob}) \quad (5.33)$$

$\text{gdpcurr} \leq \text{gdpcurr}^{U}$,

$\text{gcurr}^{L} \leq \text{gcurr}$,

$\text{gcurr} \leq \text{gcurr}^{U}$,

$\text{gfcfcurr}^{L} \leq \text{gfcfcurr}$,

$\text{gfcfcurr} \leq \text{gfcfcurr}^{U}$.

II.32. Wages (current prices)

The wages at current prices (wagcurr) are an indicator for income wealth and can be estimated in real terms by the total output of each sector, a technical coefficient vector ($\mathbf{a}_{\text{wag}}$) and an unit employee cost index (iucl) which is a deflator allowing to transform the wages from constant to current prices:

$$\text{wagcurr} = \mathbf{a}_{\text{wag}}^{\mathbf{T}}\, \mathbf{x}\, (\text{iucl}) \quad (5.34)$$

$\text{wagcurr} \leq \text{wagcurr}^{U}$.

II.33. Households and NPISH disposable income (current prices)

The households and NPISH disposable income at current prices (ydcurr) is estimated by deducting the general government and (non-financial and financial) corporation's disposable incomes from the National Disposable Income. For this calculation it is considered: the GDP at current prices (gdpcurr); the corporations savings (as a fixed proportion of GDP at current prices) (psgdpcurr); the balance of primary incomes ($\text{pi}^{+} - \text{pi}^{-}$); indirect taxes less subsides (itsub and itsubg); current transferences (ctr); direct taxes (dt and dtc); social security contributions (ssc); balance of property incomes ($pig^+ - pig^-$); and transferences from the general government to households (trgh).

$$ydcurr = gdpcurr\ (1 - psgdpcurr) + (pi^+ - pi^- + itsub - itsubg) + ctr - dt - dtc - ssc - \\ - itsub - (pig^+ - pig^-) + trgh \quad (5.35)$$

$ydcurr \leq ydcurr^U$,

$pi^L \leq (pi^+ - pi^-)$,

$(pi^+ - pi^-) \leq pi^U$,

$itsub \leq itsub^U$,

$itsubg \leq itsubg^U$,

$ctr^L \leq ctr$,

$ctr \leq ctr^U$,

$dt \leq dt^U$,

$dtc \leq dtc^U$,

$ssc \leq ssc^U$,

$pig^+ - pig^- \leq pig^U$,

$trgh^L \leq trgh$,

$trgh \leq trgh^U$.

II.34. Direct tax on households and NPISH disposable income (current prices)

The direct tax on households and NPISH (dt) is calculated by an average tax rate (dtydcurr) on the total disposable income (ydcurr) of households and NPISH:

$$dt = (dtydcurr)\ ydcurr \quad (5.36)$$

II.35. Direct tax on (financial and non-financial) corporation's disposable income (current prices)

The direct tax on corporation's income (dtc) is obtained from the GDP at current prices (gdpcurr) by using the coefficient (dtcgdpcurr):

$$\text{dtc} = (\text{dtcgdpcurr})\ \text{gdpcurr} \quad (5.37)$$

II.36. Total indirect taxes less subsides (current prices)

The total indirect taxes less subsides (itsub) includes the indirect taxes on products (net of subsides) and indirect taxes on production, which are multiplied by a private consumption deflator (pcpr) and an evolution index of the indirect tax rate (itrei):

$$\text{itsub} = (\mathbf{a}_{\text{opt}}\ \mathbf{x} - \mathbf{a}_{\text{ops}}\ \mathbf{x} + \text{ts})\ (\text{pcpr})\ (\text{itrei}) \quad (5.38)$$

II.37. Net indirect taxes less subsides (received – paid) for the general government (current prices)

The net indirect taxes less subsides (received – paid) for the general government (itsubg) is estimated exogenously by a proportional coefficient (titsubg) on the total indirect taxes less subsides (itsub)[3]:

$$\text{itsubg} = (\text{titsubg})\ \text{itsub} \quad (5.39)$$

II.38. Social security contributions paid to the general government (current prices)

The social security contributions (ssc) are estimated by a proportional coefficient (tssc) on the general wages level at current prices (wagcurr):

$$\text{ssc} = (\text{tssc})\ \text{wagcurr} \quad (5.40)$$

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[3] Due to the fact that the indirect taxes less subsides (paid/received) by the general government represents the largest part of the total indirect taxes less subsides, it will be considered a 100% equivalence between them.

II.39. Balance of property incomes of the general government (current prices)

The balance of property incomes of the general government ($pig^+ – pig^-$) is estimated by a proportional coefficient (repggdpcurr) on the GDP at current prices (gdpcurr):

$$pig^+ - pig^- = (repggdpcurr)\ gdpcurr \qquad (5.41)$$

II.40. General Government Gross Debt (current prices)

The general government gross debt (debt) is given by the summation of the previous public debt ($debt_{-1}$) with the symmetrical value of the general government's structural balance (gbg^+ - gbg^-) and an adjustment variable (dat):

$$debt = debt_{-1} - (gbg^+ - gbg^-) + dat \qquad (5.42)$$

$debt \leq debt^U$,

$debt_{-1}^L \leq debt_{-1}$,

$debt_{-1} \leq debt_{-1}^U$,

$(gbg^+ - gbg^-) \geq gbg^L$,

$dat \geq dat^L$.

II.41. Interest on the general government gross debt

The interest on the general government gross debt (jurg) is given by the average debt applied to an average interest rate on the general government gross debt (rg):

$$jurg = rg\ (debt_{-1} + debt)/2 \qquad (5.43)$$

$jurg \leq jurg^U$.

II.42. General government structural balance (current prices)

The general government structural balance ($gbg^+ – gbg^-$) is estimated by subtracting the expenditures from the revenues of the general government:

$$(gbg^{+} - gbg^{-}) = dt + dtc + ssc + itsubg + (pig^{+} - pig^{-}) - gcurr - trgh + ctrg - jurg + tk + trkg - gfcfg \quad (5.44)$$

$ctrg \leq ctrg^{U}$,

$tk \leq tk^{U}$,

$trkg \leq trkg^{U}$,

$gfcfg \geq gfcfg^{L}$.

where *ctrg* is the current transferences of the general government, *tk* is the capital tax, *trkg* is the capital transferences of the general government and *gfcf*g is the GFCF of the general government.

II.43. Capital tax (current prices)

The capital tax (tk) is estimated by a proportional coefficient (tkgdpcurr) on the GDP at current prices (gdpcurr):

$$tk = (tkgdpcurr)\ gdpcurr \quad (5.45)$$

III. EMPLOYMENT

The employment level (emp) is obtained by using labor gross productivity coefficients (**lp**) estimated for each sector:

$$emp = \mathbf{lp}^{\mathbf{T}}\ \mathbf{x} \quad (5.46)$$

IV. ENERGY CONSUMPTION

Constraints are included in the model to incorporate the analysis of the energy use in the country. These constraints make use of the hybrid IO framework (as referred to in Chapter 3) previously developed, in which the flows of each primary and secondary energy source[4]

[4] Primary energy refers to the energy products found in nature in an immediately available form, such as natural gas, coal, animal and vegetable residues, solar and wind energy, etc. Secondary energy refers to the energy products obtained from various transformation centers and channeled to the different consumption sectors or to other transformation centers (EPE, 2013).

are allocated to in the intermediary transaction matrix and final demand items according to their production/transformation, final consumption, exports and variation in inventories. This allocation is based on the information available in the Brazilian National Energy Report (MME, 2009), in which the following relations are taken into account[5]:

✷ **Primary energy sources**

production (+) imports = transformation (+) exports (+) final consumption (±) variation in inventories

✷ **Secondary energy sources**

transformation (+) imports = transformation (+) exports (+) final consumption (±) variation in inventories

where:

- production: accounts the primary energy obtained from mineral, plant and animal resources (biogas), hydraulic, geothermal reservoirs, sun, wind, seas, and tides in the country[6];
- imports: quantity of each primary or secondary energy coming into the country from overseas;
- transformation: in "primary energy sources" this item refers to the net amount of primary energy used in the transformation centers to generate secondary energy sources in the country[7]. In "secondary energy sources" this item refers to the amount of secondary energy produced in the transformation centers (left-hand side) or the amount of secondary energy used as input in transformation centers to produce other secondary energy source (right-hand side) in the country;
- exports: quantity of each primary and secondary energy sent overseas;
- final consumption: primary or secondary energy made available for utilization by all the country's final consumption sectors (including both the amount of energy contained in products utilized by different sectors for non-energy purposes and the final consumption for energy purposes);

[5] More details about this allocation can be consulted in the Appendix B.
[6] The secondary energy sources are accounted for in the transformation item.
[7] The transformation centers referrer to the places where primary and/or secondary energy is processed to obtain one or more secondary energy products, such as: oil refineries, natural gas plants, gasification plants, coking plants, nuclear fuel cycle, public utilities and self-production power plants, charcoal plants and distilleries (EPE, 2013).

- <u>variation in inventories</u>: annual difference between initial stocks and final stocks (entries in stock have a negative sign, while withdrawals have a positive sign) (EPE, 2013)[8].

Thus, technical coefficients for intermediary ($\mathbf{A}_E$), households ($\mathbf{a}_{cfE}$), NPISH ($\mathbf{a}_{cnpishE}$) and general government ($\mathbf{a}_{gE}$) (primary and secondary) energy consumption are estimated from the hybrid IO framework and then used to compute the total (national and imported) energy consumed in the country (**ce**) as follows[9]:

$$\mathbf{ce} = \mathbf{A}_E\,\mathbf{x} + \mathbf{a}_{cfE}\,(cf) + \mathbf{a}_{cnpishE}\,(cnpish) + \mathbf{a}_{gE}\,(g) \tag{5.47}$$

Nevertheless, some primary and secondary energy sources may be used for nonfuel purposes (or non-energy use of fuels) such as: *feedstock* – used as raw material in chemical conversion processes in order to produce organic and inorganic chemicals and their derivatives (e.g. naphta, natural gas, bioethanol). This item includes the energy products used as input (or raw material) in the transformation centers to generate other energy sources (e.g. oil, wood, coal); *reductant* – used as reducing agent for the production of various metals and inorganic products (e.g. coke); and *non-energy products* – byproducts of refineries and coking plants which are used directly (i.e., without chemical conversion) for their physical or diluent properties or which are sold to the chemical industry as chemical intermediates (e.g. lubricants, greases, paraffin waxes, bitumen, coal tar) (IPCC, 2006). Hence, in order to account for the amount of energy used for fuel purposes (or the energy use of fuels) in the country it is necessary to exclude the amount of energy consumed for non-energy purposes from the final consumption of energy products. For this reason, additional technical coefficients for intermediary ($\mathbf{N}_E$), household ($\mathbf{a}_{ncfE}$), NPISH ($\mathbf{a}_{ncnpishE}$) and general government ($\mathbf{a}_{ngE}$) consumption of (primary and secondary) energy products for non-fuel purposes are included in (5.47) to estimate the final consumption of energy for fuel purposes:

$$\mathbf{fe} = (\mathbf{A}_E - \mathbf{N}_E)\,\mathbf{x} + (\mathbf{a}_{cfE} - \mathbf{a}_{ncfE})\,(cf) + (\mathbf{a}_{cnpishE} - \mathbf{a}_{ncnpishE})\,(cnpish) + (\mathbf{a}_{gE} - \mathbf{a}_{ngE})\,(g) \tag{5.48}$$

[8] It is important to refer that the amount of natural gas reinjected (i.e. the natural gas reinjected into oil wells to obtain a better yield) and non-utilized (i.e. the quantity of natural gas that is not presently being used because of technical or economic constraints, the losses occurring during production, distribution and storage of energy (e.g. losses in gas and oil pipelines, electricity transmission lines and electrical and gas distribution networks, not including losses in transformation centers), and adjustments (deficits and surpluses resulting from statistical error, information and measurement errors) by simplification are accounted for jointly with the variation of inventories items. More details of this allocation process are described in the Appendix B.

[9] It is noteworthy that the amounts of variation in inventories and exported energy are not taken into account in this calculation, since they represent quantities of energy that have not been used in the country.

V. ENVIRONMENTAL CONSTRAINTS

The model considers a set of environmental constraints for carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O) emissions from different source's categories. In this step, based on the methodology proposed by the Intergovernmental Panel on Climate Change (IPCC) to compute National Greenhouse Gas Inventories (IPCC, 2006), emission factors are used in combination with specific technical coefficients from the hybrid IO framework and the level of activity of each specific sector and final demand components (which are variables of the model).

The IPCC guidelines usually provide three levels of methodological complexity (or *tiers*): *tier 1* is the basic (or default) method, *tier 2* is the intermediate one and *tier 3* is the most demanding method in terms of complexity and data requirements. The last two methods are sometimes referred to as *higher tier* methods and generally considered to be more accurate. *Lower tier* IPCC methods typically are based on 'top-down' approaches that rely on highly aggregated data at a summary category level, while *higher tier* IPCC methods typically are based on detailed 'bottom-up' approaches that rely on highly disaggregated data and a well-defined sub-categorization of sources and sinks (IPCC, 2006). It is noteworthy that different methods can be applied to each source category and greenhouse gas, as well as different tiers can be used for different source categories, depending on the importance of the source category within the national total and availability of resources (e.g. time, work force, model sophistication, budget and data) (IPCC, 2006). The model herein proposed applies the *tier 1* approach in the estimates of most categories due to the lack of required data for a *higher tier* (country specific emission factors and other data needed for *tier* 2 and 3 methods). However, in some categories specific data and emission factors regarding the Brazilian reality are used, which characterizes, in some extent, the *tier* 2 approach.

The CO_2, CH_4 and N_2O emissions calculated in this model include: emissions from fuel combustion activities (energy and manufacturing industries; construction, commercial, agriculture, residential, transport – civil aviation, road, railways and waterborne transportation – and public sectors); fugitive emissions from fuel production, distribution and storage; emissions from industrial processes and product use; emissions in the agriculture, forestry and other land use (e.g. enteric fermentation, manure management, biomass burning, managed soils and rice cultivation); solid waste disposal, biological treatment of solid waste, incineration and open burning of waste; and wastewater treatment and discharge. A detailed description of the constraints of each emission source will be set in the next sections of this chapter.

V.1. GHG emissions from energy combustion

The energy combustion process essentially generates CO_2 by oxidation of the carbon contained in the fuel, although CH_4 and N_2O emissions (and emissions of other GHGs) can also be produced due to the imperfect characteristics of the combustion and secondary effects (MCT, 2010). The *2006 IPCC Guidelines* (IPCC, 2006) provides three *tiers* for estimating emissions from fuel combustion based on a *sectoral* (or *bottom up*) *approach*, in which the emissions from stationary and mobile combustion are specified for a number of societal and economic activities defined within the IPCC sector "fuel combustion activities"[10] (IPCC, 2006). In the *tier* 1 method, the emissions from all sources of combustion can be estimated on the basis of the quantities of fuel combusted in the source category (usually obtained from national energy statistics) and default emission factors[11]. In the *tier* 2 method, the emissions from fuel combustion are estimated from similar fuel statistics as used in the *tier* 1 method, but country-specific emission factors (where possible derived from national fuel characteristics) are used instead of the *tier* 1 default emission factors. In the *tier* 3 method, fuel statistics and data on combustion technologies are jointly applied with technology-specific emission factors (i.e. using detailed emission models and facility level emission data) (IPCC, 2006)[12].

Besides to the three tiers applied in the *sectoral approach*, the *2006 IPCC Guidelines* also proposes a *reference approach* to estimate CO_2 emissions from fossil fuel combustion.

[10] These activities are classified as: energy industries; manufacturing industries and construction; other sectors (including commercial/institutional, residential, agriculture/forestry/fishing/fish farms); and non-specified activities (including mobile sources).

[11]As referred to by IPCC (2006) *CO_2 emission factors for all tiers reflect the full carbon content of the fuel less any non-oxidized fraction of carbon retained in the ash, particulates or soot*. The *tier* 1default emission factors assume a complete oxidation of the carbon contained in the fuel (carbon oxidation factor equal to 1). On the other hand, *emission factors for CH_4 and N_2O for different source categories differ due to differences in combustion technologies applied in the different source categories*. The default factors for *tier* 1 apply to technologies without emission controls and assume effective combustion in high temperature.

[12] As referred to by the IPCC (2006): "*The quality of these emission factors differs between gases. For CO_2, emission factors mainly depend upon the carbon content of the fuel. Combustion conditions (combustion efficiency, carbon retained in slag and ashes etc.) are relatively unimportant. Therefore, CO_2 emissions can be estimated fairly accurately based on the total amount of fuels combusted and the averaged carbon content of the fuels. However, emission factors for CH_4 and N_2O depend on the combustion technology and operating conditions and vary significantly, both between individual combustion installations and over time. Due to this variability, use of averaged emission factors for these gases that must account for a large variability in technological conditions, will introduce relatively large uncertainties*". Therefore, a detailed calculation for CH_4 and N_2O emissions is more appropriate.

The *reference approach* is a *top down* method that can be applied based on relatively easily available energy supply statistics and can be compared to the sum of sectoral-based estimates from a *tier* 1, 2, or 3 approach. I.e. the *reference approach* can be used to produce a second independent estimate of CO_2 emissions from fuel combustion with limited additional effort and data requirements and used as an independent check of the *sectoral approach*[13]. The *reference approach* basically calculates the emissions of CO_2 from fuel combustion using apparent fuel consumption data (without distinguishing between different source categories), whilst the carbon conservation assumption is considered (e.g. the carbon in crude oil is equal to the total carbon content of all the derived products). Hence, a supply balance of primary and secondary fuels is required (fuels produced, imported, exported, changes in inventories and used in international transport – bunker fuels) such that the carbon brought into the country from energy production and imports (adjusted for changes in inventories) and moved out of the country through exports and international bunkers are identified (IPCC, 2006). The calculation of CO_2 emissions from fuel combustion using the *reference approach* is made in 5 steps:

- estimate apparent fuel consumption in original units;
- convert to a common energy unit;
- multiply by carbon content to compute the total carbon;
- compute the excluded carbon;
- correct for carbon unoxidized and convert to CO_2 emissions.

The model herein proposed will use a *sectoral-based approach* to estimate both CO_2 and non-CO_2 emissions from energy combustion in the intermediary sectors (energy industries; trade and services; agriculture, forestry, fishing and livestock; manufacturing industries, construction and transports) and final demand (general government, households and NPISH). The model will use the *tier* 1 approach, since a lack of data makes difficult applying a higher *tier* for the Brazilian reality in this category[14]. Emission estimates are based on the data of production/transformation and consumption by energy source obtained from the

[13] Although the quality of the *reference approach* is typically lower than the *sectoral approach*, it is less sensitive to errors due to its simplicity and can be used as a top-down completeness check. Applying both *sectoral* and *reference* approaches to estimate a country's CO_2 emissions from fuel combustion in National Inventories allows comparing the results of these two independent estimates and recognize problems if significant differences are identified (IPCC, 2006).

[14] The authors have also computed the emission using the *reference approach* only for comparison and checking purposes, by which the constraints and results obtained using this approach will not be included in this thesis.

National Energy Balance (MME, 2009) and used in the hybrid IO framework previously referred to in the energy consumption section[15]. The detailed description of the constraints related to the GHG emissions from energy combustion will be given in the next sections.

V.1.1 Energy Industries

The category energy industries comprise emissions from fuels combusted by energy-extraction or energy-producing industries. This category includes emissions from electricity and combined heat and power generation, petroleum and gas extraction, petroleum refining, and bioethanol plants according to the IPCC (2006) methodology and Brazilian reality.

V.1.1.1 Electricity Generation and Combined Heat and Power Generation

This estimate comprise emissions from fuel combustion in electricity ($ecele_w$) and combined heat and power (or self producers) plants ($ecechp_w$), considering different technical coefficient sub-matrices ($\mathbf{A}_{Eele}$) and vectors ($\mathbf{a}_{Echp}$), emission factors ($\mathbf{fecele}_w$ and $\mathbf{fecchp}_w$) and a diagonal matrix with transformation factors from toe to TJ by fuel ($\hat{\mathbf{fctj}}_E$). The total output of the electricity generation sector ($\mathbf{x}_{ele}$) and the total output of cogeneration in combined heat and power plants (x_{chp}) are also used in the corresponding equation. The energy consumed for non-energy purpose is also excluded in these calculations in which technical coefficients ($\mathbf{N}_{Eele}$ and $\mathbf{n}_{Echp}$) are used in the corresponding equation:

$$ecele_w = (\mathbf{fecele}_w)^T \, (\hat{\mathbf{fctj}}_E \, ((\mathbf{A}_{Eele} \, \mathbf{x}_{ele}) - (\mathbf{N}_{Eele} \, \mathbf{x}_{ele})) \, (10^{-9}) \quad (5.49)$$

$$ecechp_w = (\mathbf{fecchp}_w)^T \, (\hat{\mathbf{fctj}}_E \, ((\mathbf{a}_{Echp} \, x_{hp}) - (\mathbf{n}_{Echp} \, x_{hp})) \, (10^{-9}) \quad (5.50)$$

V.1.1.2 Petroleum Refining

This calculation includes all emissions from combustion activities supporting the refining of petroleum products ($ecref_w$) including on-site combustion for the generation of electricity and heat for own use. Technical coefficient sub-matrices ($\mathbf{A}_{Eref}$) and ($\mathbf{N}_{Eref}$), an

[15] Only GHG emissions related to fossil fuels have to be computed in the national total, since emissions from the combustion of biomass as fuel are considered null by the IPCC (these emissions will be computed only for information purposes). However, whilst the CO_2 emissions from biogenic carbon are not included in national totals, the CH_4 and N_2O from the combustion of biofuels in mobile sources will be computed in the national total as recommended by the IPCC Guidelines.

emission factor ($\mathbf{fecref}_w$) and the total output of the refining of petroleum sector ($\mathbf{x}_{ref}$) (analogous to (5.49)) are considered in (5.51). In this estimate only the net energy amount used in the petroleum refining activity is considered (i.e. excluding the energy transformed from primary to secondary forms, as well as transport and distribution losses).

$$ecref_w = (\mathbf{fecref}_w)^T \{\hat{\mathbf{fctj}}_E\ [(\mathbf{A}_{Eref}\ \mathbf{x}_{ref}) - (\mathbf{N}_{Eref}\ \mathbf{x}_{ref})]\}\ (10^{-9}) \qquad (5.51)$$

V.1.1.3 Petroleum and gas extraction

The computation of GHG emissions from petroleum and gas extraction ($ecpge_w$) in (5.52) is similar to (5.49). Technical coefficient sub-matrices ($\mathbf{A}_{Epge}$) and ($\mathbf{N}_{Epge}$), an emission factor ($\mathbf{fecpge}_w$) and the total output of the petroleum and gas extraction sector ($\mathbf{x}_{pge}$) are used.

$$ecpge_w = (\mathbf{fecpge}_w)^T \{\hat{\mathbf{fctj}}_E\ [(\mathbf{A}_{Epge}\ \mathbf{x}_{pge}) - (\mathbf{N}_{Epge}\ \mathbf{x}_{pge})]\}\ (10^{-9}) \qquad (5.52)$$

V.1.1.4 Bioethanol Production

The estimate of GHG emissions from bioethanol production ($ecbio_w$) is computed in (5.53) analogously to (5.49). Technical coefficient sub-matrices ($\mathbf{A}_{Ebio}$) and ($\mathbf{N}_{Ebio}$), an emission factor ($\mathbf{fecbio}_w$) and the total output of the bioethanol production sector ($\mathbf{x}_{bio}$) are considered.

$$ecbio_w = (\mathbf{fecbio}_w)^T \{\hat{\mathbf{fctj}}_E\ [(\mathbf{A}_{Ebio}\ \mathbf{x}_{bio}) - (\mathbf{N}_{Ebio}\ \mathbf{x}_{bio})]\}\ (10^{-9}) \qquad (5.53)$$

V.1.2 Public Consumption

The calculation of emissions from the public sector (ecg_w) in (5.54) is obtained from the intermediary energy consumption in the public health, public education and public administration sectors, as well as the general government final demand. This calculation is similar to (5.49), in which technical coefficient sub-matrices ($\mathbf{A}_{Egi}$) and ($\mathbf{N}_{Egi}$) and vectors ($\mathbf{a}_{gE}$) and ($\mathbf{a}_{ngE}$), an emission factor ($\mathbf{fecg}_w$) and the total output of public sectors ($\mathbf{x}_{gi}$) are considered. It is noteworthy that the institutional emission factors from IPCC (2006) are used to define ($\mathbf{fecg}_w$).

$$ecg_w = (\mathbf{fecg}_w)^T\ (\hat{\mathbf{fctj}}_E\ \{[(\mathbf{A}_{Egi}\ \mathbf{x}_{gi}) - (\mathbf{N}_{Egi}\ \mathbf{x}_{gi})] + [(\mathbf{a}_{gE}\ (g) - \mathbf{a}_{ngE}\ (g)]\})\ (10^{-9}) \qquad (5.54)$$

V.1.3 Household's Consumption

The estimate of emissions from household's consumption ($eccf_w$) in (5.55) is similar to (5.49), in which technical coefficient vectors ($\mathbf{a}_{cfE}$) and ($\mathbf{a}_{ncfE}$) and an emission factor ($\mathbf{feccf}_w$) are considered. It is noteworthy that the residential emission factors from IPCC (2006) are used to define ($\mathbf{feccf}_w$).

$$eccf_w = (\mathbf{feccf}_w)^T \, (\hat{\mathbf{fctj}}_E \, [\mathbf{a}_{\,fE} \, (cf) - \mathbf{a}_{ncfE} \, (cf)] \, (10^{-9}) \qquad (5.55)$$

V.1.4 NPISH's Consumption

The computation of emissions from NPISH's consumption ($eccnpish_w$) in (5.56) is similar to (5.49), in which technical coefficient vectors ($\mathbf{a}_{cnpishE}$) and ($\mathbf{a}_{ncnpishE}$) and an emission factor ($\mathbf{fecnpish}_w$) are considered. It is noteworthy that the residential emission factors from IPCC (2006) are used to define ($\mathbf{fecnpish}_w$).

$$eccnpish_w = (\mathbf{fecnpish}_w)^T \, (\hat{\mathbf{fctj}}_E \, [\mathbf{a}_{\,npishE} \, (cnpish) - \mathbf{a}_{ncnpishE} \, (cnpish)] \, (10^{-9}) \qquad (5.56)$$

V.1.5 Trade and Service sectors

The calculation of emissions from trade and service sectors ($eccs_w$) in (5.57) are obtained from the energy consumption in the sectors: trade, information services, financial intermediation and insurance, real estate and rents, maintenance and repair, accommodation services and meals, business services, private education, private health and services for families. This calculation is similar to (5.49), in which technical coefficient sub-matrices ($\mathbf{A}_{Ecs}$) and ($\mathbf{N}_{Ecs}$), an emission factor ($\mathbf{feccs}_w$) and the total output of trade and service sectors ($\mathbf{x}_{cs}$) are considered. It is noteworthy that the commercial emission factors from IPCC (2006) are used to define ($\mathbf{feccs}_w$).

$$eccs_w = (\mathbf{feccs}_w)^T \, (\hat{\mathbf{fctj}}_E \, [(\mathbf{A}_{Ecs} \, \mathbf{x}_{cs}) - (\mathbf{N}_{Ecs} \, \mathbf{x}_{cs})] \, (10^{-9}) \qquad (5.57)$$

V.1.6 Agriculture, Forestry, Fishing and Livestock sectors

The estimate of emissions from agriculture & forestry and fishing & livestock sectors ($ecal_w$) in (5.58) are obtained from the energy consumption in these sectors. This calculation is similar to (5.49), in technical coefficient sub-matrices ($\mathbf{A}_{Eal}$) and ($\mathbf{N}_{Eal}$), an emission factor

($\mathbf{fecal}_w$) and the total output of trade and service sectors ($\mathbf{x}_{al}$) are considered. It is noteworthy that the agriculture/forestry/fishing/fish farms emission factors from IPCC (2006) are used to define ($\mathbf{fecal}_w$).

$$ecal_w = (\mathbf{fecal}_w)^T (\hat{\mathbf{fctj}}_E [(\mathbf{A}_{Eal}\, \mathbf{x}_{al}) - (\mathbf{N}_{Eal}\, \mathbf{x}_{al})] (10^{-9}) \quad (5.58)$$

V.1.7 Manufacturing Industries and Construction

This category includes the emissions from combustion of fuels in the manufacturing industries and construction sectors ($ecind_w$) and is calculated in (5.59) analogously to (5.49). Technical coefficient sub-matrices ($\mathbf{A}_{Eind}$) and ($\mathbf{N}_{Eind}$), an emission factor ($\mathbf{fecind}_w$) and the total output of manufacturing industries and construction sectors ($\mathbf{x}_{ind}$) are considered. It is noteworthy that the default emission factors for manufacturing industries and construction sectors from IPCC (2006) are used to define ($\mathbf{fecind}_w$).

$$ecind_w = (\mathbf{fecind}_w)^T \{\hat{\mathbf{fctj}}_E [(\mathbf{A}_{Eind}\, \mathbf{x}_{ind}) - (\mathbf{N}_{Eind}\, \mathbf{x}_{ind})]\} (10^{-9}) \quad (5.59)$$

where *ind* corresponds to all non-energy sectors from N04 to N37 (i.e. sectors in this range identified by the letter N in the Table B.2 in the Appendix B) and sector N39[16].

V.1.8 Transportation

The GHG emissions in the transportation sector ($\mathbf{ectr}_{\mathbf{tw}}$) are estimated in (5.60) by multiplying the consumption of each fuel by each transportation mode (calculated by technical coefficient sub-matrices ($\mathbf{A}_{Et}$) and ($\mathbf{N}_{Et}$) and the total output of the transportation sector ($\mathbf{x}_t$)) by a corresponding emission factor ($\mathbf{fectr}_{tw}$) related to the fuel used in the respective transportation mode. In this estimate the emission factors for the fuel combustion in mobile sources from the IPCC (2006) are used to define ($\mathbf{fectr}_{tw}$).

$$ectr_{tw} = (\mathbf{fectr}_{tw})^T \{\hat{\mathbf{fctj}}_E [(\mathbf{A}_{Et}\, \mathbf{x}_t) - (\mathbf{N}_{Et}\, \mathbf{x}_t)]\} (10^{-9}) \quad (5.60)$$

where t is equal to the artificial transport sectors (water transport; air transport; railway transport; road transport) in the intermediary matrix.

[16] Sectors: N04, N05, N06, N07, N08, N09, N10, N11, N12, N13, N14, N15, N16, N17, N18, N19, N20, N21, N22, N23, N24, N25, N26, N27, N28, N29, N30, N31, N32, N33, N34, N35, N36, N37 and N39.

V.1.9 Total GHG emissions from fuel combustion

The total GHG emission from fuel combustion (ec_w) is computed by the summation of the emissions from: energy industries; public sector; household consumption; NPISH consumption; trade and services sectors; agriculture, forestry, fishing and livestock sectors; manufacturing industries; construction; and transportation sector:

$$ec_w = ecele_w + ecechp_w + ecref_w + ecoge_w + ecbio_w + ecg_w + eccf_w + eccnpish_w + \\ + eccs_w + ecal_w + ecind_w + \sum_t ectr_{tw} \quad (5.61)$$

V.2. Fugitive emissions

Fugitive emissions occurring during the extraction, processing, storage and delivery of fossil fuels to the point of final use are sources of direct and indirect GHG emissions (IPCC, 2006). The fugitive emissions of different sources in Brazil (coal production, gas production, gas transmission, gas storage, gas distribution, transport of Liquefied Petroleum Gas, oil production and oil transport) are computed in the model herein proposed by using the IPCC (2006) methodology for developing countries in combination with specific data of the Brazilian conditions provided in the Brazilian National GHG Inventory (MCT, 2010), resulting in technical coefficients which are applied to the activity level of the specific sectors. These estimates will be further described in the next sections[17].

V.2.1 Coal Production

Fugitive emissions in the coal production (or *mining emissions*) result from the liberation of stored gas during the breakage of coal, and the surrounding strata, during mining operations (IPCC, 2006). In order to estimate the fugitive emissions from coal production in Brazil is necessary taken into account the amount of coal produced in each mining system (i.e. underground and surface mining), as well as the different emission factors for each one. The computation of fugitive emissions from coal production in both mining systems (underground/surface) ($fecpms_w$) considers: a row vector with technical coefficients for coal production ($\mathbf{a_{cp}}$); a sub-vector of the vector ($\mathbf{x}$) with the total output of coal products ($\mathbf{x}_{cp}$); a conversion factor from energy units to mass units (ton/toe) for each coal product ($\mathbf{\hat{c}ftoet}$); the

[17] The fugitive emissions that occur at industrial facilities other than, coal, oil and gas facilities are accounted for in section V.2.10. Furthermore, the fugitive emissions from waste disposal activities are accounted for in section V.4.

ratio (%) of underground (ur) or surface (sr) mining in the total coal production; a conversion factor from ton to m^3 for coal products (cftm3); and a emission factor for coal underground ($efcpmu_w$) or surface mining ($efcpms_w$).

$$fecpms_w = [\mathbf{a}_{cp}\ \hat{\mathbf{c}}\mathbf{ftoet}\ \mathbf{x}_{cp}]\ (ur)\ (efcpmu_w) + [\mathbf{a}_{cp}\ \hat{\mathbf{c}}\mathbf{ftoet}\ \mathbf{x}_{cp}]\ (sr)\ (efcpms_w) \quad (5.62)$$

V.2.2 Post-mining

The IPCC (2006) methodology also recommends estimating other emissions occurring after the mining activity due to subsequent handling, processing and transportation of coal, which are termed post-mining emissions ($fepmms_w$). The computation of these emissions is similar to (5.62), in which the differences between the underground and surface mining and a specific emission factor for post-mining activities ($efpmmu_w$ and $efpmms_w$) are also considered:

$$fepmms_w = [\mathbf{a}_{cp}\ \hat{\mathbf{c}}\mathbf{ftoet}\ \mathbf{x}_{cp}]\ (ur)\ (efpmmu_w) + [\mathbf{a}_{cp}\ \hat{\mathbf{c}}\mathbf{ftoet}\ \mathbf{x}_{cp}]\ (sr)\ (efpmms_w) \quad (5.63)$$

V.2.3 Gas Production

This category comprises emissions from venting, flaring and all other fugitive sources associated with the exploration, production, processing, transmission, storage and distribution of natural gas (including both associated and non-associated gas) (IPCC, 2006).

V.2.3.1 Flaring

According to the IPCC (2006) flaring means broadly all burning of waste natural gas and hydrocarbon liquids by flares or incinerators as a disposal option rather than for the production of useful heat or energy. In order to estimate the emissions related to gas flaring ($fegpfl_w$), a coefficient vector for natural gas (wet and dry) production ($\mathbf{a}_{gp}$) applied to the natural gas output sub-vector ($\mathbf{x}_{gp}$) and transformed from toe to cubic meters by the diagonalized matrix of the vector **cftoem3** is considered. Furthermore, a specific emission factor for gas flaring ($efgpfl_w$) is utilized to get the total emissions from this activity:

$$fegpfl_w = [\mathbf{a}_{gp}\ \hat{\mathbf{c}}\mathbf{ftoem3}\ \mathbf{x}_{gp}]\ (efgpfl_w) \quad (5.64)$$

V.2.3.2 Venting

The emissions in this category comprise venting of natural gas and waste gas/vapor streams at gas facilities (IPCC, 2006). The computation of these emissions ($fegpv_w$) is analogous to (5.64) in which a specific emission factor for gas venting ($efgpv_w$) is used:

$$fegpv_w = [\mathbf{a}_{gp}\ \hat{\mathbf{c}}\mathbf{ftoem3}\ \mathbf{x}_{gp}]\ (efgpv_w) \tag{5.65}$$

V.2.3.3 Other Fugitive emissions

In this category other fugitive emissions at natural gas facilities not specifically accounted for as venting or flaring ($fegpf_w$) are computed. The calculation of these emissions is similar to (5.64) in which a specific emission factor ($efgpf_w$) is used:

$$fegpf_w = [\mathbf{a}_{gp}\ \hat{\mathbf{c}}\mathbf{ftoem3}\ \mathbf{x}_{gp}]\ (efgpf_w) \tag{5.66}$$

V.2.4 Gas transmission

In this category the fugitive emissions from systems used to transport processed natural gas to industrial consumers and natural gas distribution systems are estimated (IPCC, 2006). For the calculation of these emissions ($fegtf_w$) technical coefficients for intermediary and final consumption of natural gas ($\mathbf{A}_{ng}$, $\mathbf{a}_{cfng}$, $\mathbf{a}_{cnpishng}$, $\mathbf{a}_{gng}$) are used (instead of coefficients for natural gas produced in the country), given that the natural gas not produced in the country which is transported inside the country has to be also accounted for. A specific emission factor ($efgtf_w$) is also used:

$$fegtf_w = \{\mathbf{cftoem3}\ [\mathbf{A}_{ng}\ \mathbf{x} + \mathbf{a}_{cfng}\ (cf) + \mathbf{a}_{cnpishng}\ (cnpish) + \mathbf{a}_{gng}\ (g)]\}\ (efgtf_w) \tag{5.67}$$

V.2.5 Gas Storage

This category includes fugitive emissions from natural gas storage ($fegs_w$). These emissions are estimated analogously to (5.67) in which a specific emission factor ($efgs_w$) is used:

$$fegs_w = \{\mathbf{cftoem3}\ [\mathbf{A}_{ng}\,\mathbf{x} + \mathbf{a}_{cfng}\,(cf) + \mathbf{a}_{cnpishng}\,(cnpish) + \mathbf{a}_{gng}\,(g)]\}\ (efgs_w) \tag{5.68}$$

V.2.6 Gas Distribution

Fugitive emissions from the distribution of natural gas to end-users ($fegd_w$) are computed similarly to (5.67) using a specific emission factor ($efgd_w$):

$$fegd_w = \{\mathbf{cftoem3}\ [\mathbf{A}_{ng}\,\mathbf{x} + \mathbf{a}_{cfng}\,(cf) + \mathbf{a}_{cnpishng}\,(cnpish) + \mathbf{a}_{gng}\,(g)]\}\ (efgd_w) \tag{5.69}$$

V.2.7 Liquefied Petroleum Gas Distribution

Fugitive emissions related to the distribution of Liquefied Petroleum Gas (LPG) ($felpgd_w$) are also accounted for similarly to (5.67) in which a specific emission factor ($eflpgd_w$) is used:

$$felpgd_w = \{\mathbf{cftoem3}\ [\mathbf{A}_{lpg}\,\mathbf{x} + \mathbf{a}_{cflpg}\,(cf) + \mathbf{a}_{cnpishlpg}\,(cnpish) + \mathbf{a}_{glpg}\,(g)]\}\ (eflpgd_w) \tag{5.70}$$

V.2.8 Oil Production

The fugitive emissions on oil systems are estimated using the *tier 1* approach and default emission factors for developing countries provided in the *2006 IPCC Guidelines*. This category comprises the emissions from venting, flaring, transport and other fugitive releases (not accounted for in any previous category, which involve equipment leaks, evaporation and flashing losses) related to the crude oil system. For this purpose specific technical coefficients are estimated and combined with the level of oil production and specific emission factors for each source. It is noteworthy that emissions from well drilling, well testing and well servicing are not accounted for due to the lack of data for establishing those coefficients in the model. Furthermore, emissions from oil upgrading, oil refining and refined product distribution are not accounted, since the emission factor for those activities are not applicable or not determined in the IPCC methodology for developing countries and for the Brazilian conditions.

V.2.8.1 Venting

This category includes emissions from venting of associated gas and waste gas/vapor streams at oil facilities ($feopv_w$). In order to estimate these emissions a coefficient vector for oil production ($\mathbf{a}_{op}$) applied to the sub-vector of vector ($\mathbf{x}$) regarding the total oil output ($\mathbf{x}_{op}$) and transformed from toe to cubic meters by ($\hat{\mathbf{c}}\mathbf{ftoem3}$) is considered. Moreover, a specific emission factor for venting at oil facilities ($efopv_w$) is used to get the total emissions from this activity:

$$feopv_w \quad [\mathbf{a}_{op}\ \hat{\mathbf{c}}\mathbf{ftoem3}\ \mathbf{x}_{op}]\ (efopv_w) \tag{5.71}$$

V.2.8.2 Flaring

The emissions from flaring of natural gas and waste gas/vapor streams at oil facilities ($feopfl_w$) are calculated similarly to (5.71) in which a specific emission factor ($efopfl_w$) is used:

$$feopfl_w \quad [\mathbf{a}_{op}\ \hat{\mathbf{c}}\mathbf{ftoem3}\ \mathbf{x}_{op}]\ (efopfl_w) \tag{5.72}$$

V.2.8.3 Other fugitive emissions (Offshore)

This category includes all other fugitive emissions at oil facilities not specifically accounted for as venting or flaring ($feopf_w$). The computation of these emissions is similar to (5.71) in which a specific emission factor (for offshore production) ($efopf_w$) is used:

$$feopf_w \quad [\mathbf{a}_{op}\ \hat{\mathbf{c}}\mathbf{ftoem3}\ \mathbf{x}_{op}]\ (efopf_w) \tag{5.73}$$

V.2.9 Oil Transport

This category includes fugitive emissions (excluding venting and flaring) related to the transport of marketable crude oil to refineries ($feotp_w$), in which evaporation losses from storage, filling and unloading activities and fugitive equipment leaks are the primary sources (IPCC, 2006). In Brazil, most of the crude oil is produced in offshore platforms and transported to the docks by tanker ships. Subsequently the crude oil is carried to the refineries by pipelines. However, in this study we have considered that the Brazilian oil production is transported to the refineries only by pipelines, since the emission factors related to the loading of off-shore production on tanker ships are not specified in the IPCC guidelines for developing countries. It is also considered that the oil transported to the refineries is equal to the total crude oil consumed by the refinery sector. The calculation of these emissions is analogous to (5.71) in which a specific emission factor ($efotp_w$) is used:

$$feotp_w \quad [\mathbf{a}_{op}\ \mathbf{\hat{c}ftoem3}\ \mathbf{x}_{op}]\ (efotp_w) \tag{5.74}$$

V.2.10 Industrial process and product use

In spite of the GHG emissions from fossil fuel combustion some industries generate GHG as a byproduct of their production processes (especially in industrial processes that chemically or physically transform materials) (IPCC, 2006). The main industrial processes that generate fugitive emissions of CO_2 in Brazil are: the chemical industry (production of ammonia, carbide, petrochemicals and carbon black), the mineral industry (production of cement or clinker, lime and carbonates) and the metal industry (production of aluminum, pig iron and steel). Furthermore, the production of some chemicals generate N_2O (production of nitric acid, adipic acid and caprolactam) and CH_4 emissions (petrochemical and carbon black production)[18] which are also accounted in this category (MCT, 2010)[19]. Hence, in order to estimate the fugitive emissions from industrial process not accounted for as a result of fuel combustion, the output of specific sectors (x_z) are used in combination with corresponding emissions factors ($effeip_{zw}$). These emission factors are obtained by dividing the total national emissions related to each industrial process (allocated in the corresponding sector) provided in the Brazilian National Inventory by the corresponding sector's output in the base year of the study. Thus, the fugitive emissions in the industrial processes ($feip_{zw}$) are computed as follows:

$$feip_{zw} \quad (effeip_{zw})\ (x_z) \tag{5.75}$$

where *z* represents the sectors: chemicals, cement, other products of nonmetallic minerals, manufacture of steel and steel products and metallurgy of nonferrous metals.

Furthermore, the use of some non-energy products (such as lubricants and paraffin wax) can also be sources of CO_2, N_2O and CH_4 emissions in this category. However, only fugitive emissions of CO_2 from lubricants use ($felu_w$) will be computed in the model herein proposed, since only the data of the level of lubricants consumption in the country are available in the Brazilian Energy Report allowing including this product in the hybrid IO framework. In this estimate a *tier* 1 approach is used, in which the amount of lubricants used

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[18]Although the carbide production also generates CH_4 emissions they are not accounted for in the Brazilian National Inventory by which they are not included in the estimates of the model herein proposed.

[19] Although emissions of other GHG are also originated in this category they are not accounted for in this model, which are limited to compute only CO_2, CH_4 and N_2O sources.

in the country (x_{lub}) (which is a scalar of the vector **x**) – net of the amount of lubricants exported, which is obtained by a coefficient a_{elub} applied to the total of lubricants used in the country – is multiplied by the carbon content of lubricants (cc_{lub}) and an *oxidised during us*e factor (odu_{lub}) (both default values) as follows[20]:

$$felu_w = [x_{lub} - (a_{elub}\ x_{lub})]\ (cc_{lub})\ (odu_{lub})\ (^{44}/_{12}) \qquad (5.76)$$

V.2.11 Total fugitive emissions

The total fugitive emissions (tfe_w) are given by the summation of (5.62) to (5.76):

$$tfe_w = fecpms_w + fepmms_w + fegpfl_w + fegpv_w + fegpf_w + fegtf_w + fegs_w + fegd_w + \\ + felpgd_w + feopv_w + feopfl_w + feopf_w + feotp_w + \sum_z feip_{zw} + felu_w \qquad (5.77)$$

V.3. GHG emissions from Agriculture, Forestry, Livestock and Fishing Sectors

Agriculture and livestock are activities of great importance in Brazil, which is a country with vast availability of arable and pasture land, occupying a prominent place in the worldwide production of these sectors. These activities are also responsible for GHG emissions from several processes. The IPCC (2006) methodology recommends the computation of emissions related to *Agriculture, Forestry and Other Land Use* (AFOLU)[21] sector, by which these emissions will also be included in the total emissions calculated in this study. For this purpose, a direct correspondence between the AFOLU emission sources and the agriculture, forestry and logging, livestock and fishing (AFLF) sectors in the hybrid IO framework is established. The model computes the following emissions in the AFOLU sector: CH_4 (and N_2O) emissions from manure management systems; CH_4 emissions from enteric fermentation; N_2O emissions from managed soils; CH_4 and N_2O emissions from fire on managed land; and CH_4 emissions from rice cultivation. Emissions from other sources (such as CO_2, CH_4 and N_2O emissions from land use change and N_2O emissions from organic soils)

[20] The carbon content of lubricants, usually given in ton C/TJ in the IPCC guidelines, is converted to Gg C/ toe. In this estimate is also necessary multiply the results by 44/12 (the mass ratio of CO_2/C) in order to convert C emissions to CO_2 emissions.

[21] Although the word "livestock" has not been explicitly referred to in the name of this sector, the methodology for computation of emissions of this source is included in the volume regarding the AFOLU sector in the IPPC guidelines.

are considered as having the same values estimated for 2005 in the Brazilian GHG emissions Inventory Report (MCT, 2010).

V.3.1 N_2O and CH_4 emissions from manure management

N_2O and CH_4 emissions can be produced, directly and indirectly, during the storage and treatment of manure[22] before it is applied to land as fertilizers. Additionally, the manure used as fertilizers and the manure deposited directly by grazing animals on pasture can also generate N_2O emissions directly and indirectly from the soil. In this section only N_2O and CH_4 of manure management systems will be computed, whereas N_2O emissions from managed soils will be computed in a different section as recommended by the IPCC (2006).

V.3.1.1 N_2O emissions

The IPCC (2006) methodology to estimate both direct and indirect N_2O emissions from manure management systems implies taking into account the amount of manure produced (or nitrogen excretion) by each type of animal species/category, the participation of the different manure management systems used for each type of animal species/category (and climate region) and (default and/or specific country's) emission factors[23]. Thus, applying a *tier* 1 method, the total direct N_2O emissions from manure management (emm_w) are computed in (5.78) by using: a coefficient of number of heads of each livestock species/category (cattle, buffaloes, pigs, chickens, turkeys, ducks, lamb, sheep, horses, mules and asses) by millions of output of the livestock and fishing sector (**aep**); the output of the livestock and fishing sector (x_{lf}); a diagonal matrix with the coefficients of nitrogen (N) excretion by each livestock species/category ($\hat{\mathbf{amp}}$); a matrix with the fraction of total annual nitrogen excretion for each livestock species/category *i* that is managed in manure management system *j* (anaerobic lagoon, solid storage, anaerobic digester and dry lot) in the country ($\mathbf{A}_{ma}$); and the emission factors for direct N_2O emissions from each manure management system ($\mathbf{efdmm}_w$)[24]:

$$\text{edmm}_w = \{[\mathbf{aep}\ (x_{lf})]^{\mathbf{T}}\ \hat{\mathbf{amp}}\ \mathbf{A}_{ma}\}\ \mathbf{efdmm}_w\ ({}^{44}/_{28}) \qquad (5.78)$$

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[22]As referred to by IPCC (2006) the term manure or dung is used collectively for solid and liquid waste produced by livestock.

[23] It is noteworthy that pasture is the main system used for cattle in Brazil (except for chickens and pigs), whereas the anaerobic lagoon, anaerobic digester, solid storage and dry lot (especially for chickens) are the main manure management systems used in the country.

[24] In the estimate regarding N_2O emissions from manure management it is also necessary multiplying the results by 44/28 in order to convert N_2O-N emissions to N_2O emissions.

Furthermore, indirect N_2O emissions due to volatilization of N from manure management ($eimm_w$) can also be computed by including in (5.78) the transposed of the matrix ($\mathbf{A}_{fv}$) with the percentage of managed manure nitrogen for livestock category *i* that volatilizes as NH_3 and NO_x in the manure management system *j*, a proper vector of 1 ($\mathbf{e}_{15}$) and a specific emission factor for N_2O emissions from atmospheric deposition of nitrogen on soils and water surfaces ($efadv_w$) as follows[25]:

$$eimm_w = \{[\mathbf{aep}\ (x_{lf})]^{\mathbf{T}}\ \mathbf{\hat{a}mp}\ [\mathbf{A}_{ma}\ \mathbf{A}_{fv}^{\mathrm{T}}]\}\ \mathbf{e}_{15}\ efadv_w\ (^{44}/_{28}) \tag{5.79}$$

V.3.1.2 CH_4 emissions

The *tier* 1 approach from *IPCC Guidelines* is applied to estimate CH_4 emissions from manure management (emm_{rw}), in which a simplified method that only requires livestock population data by animal species/category – calculated by the total output of the livestock and fishing sector (x_{lf}) and a coefficient of number of heads of each livestock species/category by millions of output (aep_r) – and an emission factor for the defined livestock population ($efmm_{rw}$) is applied:

$$emm_{rw} = (efmm_{rw})\ (aep_r\ x_{lf}) \tag{5.80}$$

where r represents: cattle, buffaloes, pigs, chickens, turkeys, ducks, lamb, sheep, horses, mules and asses.

V.3.2 CH_4 emissions from enteric fermentation

CH_4 is produced in herbivores as a by-product of enteric fermentation (IPCC, 2006). The emission intensity depends on the type of animal, the type and amount of food, its degree of digestibility and intensity of physical activity of the animal, according to the different husbandry practices (MCT, 2010). The IPCC (2006) *tier* 1 methodology is used to compute CH_4 emissions from enteric fermentation ($eentf_{rw}$) similarly to (5.80), in which a specific emission factor for this source category ($efentf_{rw}$) is considered:

[25] Indirect N_2O emissions due to leaching and runoff from manure management will not be computed, since the fraction of manure N that leaches from manure management systems is highly uncertain and country-specific data are not available in the Brazilian National Inventory for applying a *tier* 2 method. However, indirect N_2O emissions due to leaching and runoff from manure applied to soil will be computed in a corresponding forthcoming section.

$$eentf_{rw} = (efentf_{rw})\ (aep_r\ x_{lf}) \tag{5.81}$$

V.3.3 N_2O emissions from managed soils

Nitrogen additions to soils can enhance *nitrification* and *denitrification* rates which then can increase the production of N_2O (IPCC, 2006). Direct N_2O emissions from managed soils generated by the synthetic and organic fertilizers applied to soils, crop residues returned to soils and from manure of grazing animals deposited on pasture are estimated in this section. Indirect N_2O emissions due to atmospheric deposition of N volatilized and leaching/runoff from managed soils are also calculated and outlined in the respective forthcoming sub-sections.

V.3.3.1 Grazing animals

The manure deposited directly in soil by grazing animals are the most important source of N_2O emissions from agricultural soils in Brazil due to the large herd and predominance of extensive cattle farming in the country (MCT, 2010). Total direct N_2O emissions from N additions to the soils by manure deposited directly in soil by grazing animals (egm_w) will be computed in this section, in which the IPCC (2006) *tier* 1 methodology is applied. The methodology is similar to (5.78), but a specific emission factor for N_2O emissions from urine and dung N deposited on pasture by grazing animals of each livestock species/category ($\mathbf{egm}_w$) is used. In addition, a diagonal matrix ($\hat{\mathbf{a}}_{ga}$) with the fraction of total annual N excretion that is deposited directly in soil by grazing animals of each livestock species/category is also considered as follows:

$$egm_w = \{[\mathbf{aep}\ (x_{lf})]^{\mathbf{T}}\ \hat{\mathbf{a}}\mathbf{mp}\ \hat{\mathbf{a}}_{ga}\}\ \mathbf{egm}_w\ (^{44}/_{28}) \tag{5.82}$$

V.3.3.2 Manure used as organic fertilizer

The amount of animal manure from the different management systems applied to soils as organic fertilizer is also a source of direct and indirect N_2O emissions from agricultural soils. It is noteworthy that only the emissions of the remaining amount of animal manure nitrogen applied to soils have to be estimated, since significant direct and indirect losses of the total nitrogen excreted by animals in managed systems prior to final application to managed soils occur (IPCC, 2006) [26]. Hence, the total direct N_2O emissions from the net N additions to the soils from managed manure applied as fertilizer (or organic fertilizers) (eof_w) will be computed in this section using the IPCC (2006) *tier* 1 methodology similarly to (78). A matrix $\mathbf{E}_1$ with all *i* x *j* elements equal to 1 (where *i* = 1,…, r and *j* = 1,…, s) and the matrix ($\mathbf{A}_{fv}$) with the percentage of managed manure nitrogen for livestock category *i* that volatilizes as NH_3 and NO_x in the manure management system *j* are included in (5.78) in order to discount the amount of N volatilized in each manure management system[27]. Moreover, a proper vector of 1 ($\mathbf{e}_{16}$) and an emission factor for N_2O emissions from N inputs to soils ($eofmm_w$) are also considered as follows:

$$eof_w = \{[\mathbf{aep}\,(x_{lf})]^{\mathbf{T}}\ \mathbf{\hat{a}mp}\ [\mathbf{A}_{ma}\ (\mathbf{E}_1 - \mathbf{A}_{fv})^{T}]\}\ \mathbf{e}_{16}\ eofmm_w\,({}^{44}/_{28}) \qquad (5.83)$$

V.3.3.3 Crop residues

The nitrogen contained in crop residues that are incorporated in the soil is also a source of N_2O emissions. The amount of N_2O in crop residues (above and below ground) (ecr_{qw}) is estimated in (5.84) for the main Brazilian cultures (rice, sugarcane, corn, soy, bean and cassava) using as basis the *tier* 1 methodology of IPCC (2006). For this purpose the model considers: a coefficient of productivity of each crop *q* ($aprod_q$); a coefficient of area cultivated per unit economic production of each crop *q* ($aprodut_q$); a ratio of each crop *q* in the total output of the agriculture and forestry sector ($apats_q$); a scalar representing the production of the agriculture and forestry sector (x_{af}); a ratio of the burnt area of crop *q* in the total area (considered only for sugarcane) ($aburn_q$); the ratio of dry matter (d.m.) produced by each crop output ($admqp_q$); a ratio of above ground dry matter in the total dry matter produced by each crop *q* ($admag_q$); the N content of above-ground residues (d.m) for each crop *q* (nag_q); a ratio

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[26] The revised version of the *2006 IPCC Guidelines* (IPCC, 2006) provided some changes from the methodology described in the *1996 IPCC Guidelines* (IPCC, 1996) (which were applied in the Brazilian National Inventory) such that *"for the tier 1 approach, the amounts of applied mineral nitrogen fertilizers and of applied organic nitrogen fertilizers are no longer adjusted for the amounts of NH_3 and NO_x volatilization after application to soil"*. This is justified because *"the N_2O emission factors for applied N were not adjusted for volatilization when they were estimated"*, by which *"adjusting the amount of N input for volatilization before multiplying it with the emission factor would in fact underestimate total N_2O emissions"* (IPCC, 2006). Therefore, only the N volatilized in the manure management systems is excluded from the computation of total N applied to soil as fertilizers.

[27] Since indirect N_2O emissions due to leaching and runoff from manure management have not been computed, only the fraction of manure N that volatizes in the manure management systems will be discounted from the total N from manure management systems. Therefore, in this study it will be considered that the net amount of manure applied to soils is equal to the total amount of manure managed in each system minus the losses due to volatilization.

of below ground dry matter in the total dry matter produced by each crop *q* ($admbg_q$); the N content of below-ground residues (d.m.) for each crop *q* (nbg_q); and an emission factor for N_2O emissions from N additions to the soils from crop residues ($efcr_w$)[28]:

$$ecr_{qw} = (aprod_q)\,(aprodut_q)\,(apats_q)\,(x_{af})\,(1 - aburn_q)\,(admqp_q)\,[(admag_q)\,(nag_q) + \\ + (admbg_q)\,(nbg_q)]\,(efcr_w)\,(^{44}/_{28}) \qquad (5.84)$$

where *q* is equal to rice, sugarcane, corn, soy, bean and cassava.

V.3.3.4 Synthetic fertilizer

The use of nitrogen fertilizers has been considered as the major cause for the overall increase in N_2O emissions from agricultural soils, whilst the main source of these N_2O emissions in Brazil is the manure from grazing animals (MCT, 2010). The direct N_2O emissions from synthetic fertilizers (esf_w) are related to the fertilized area (and fertilization pattern)[29] by which a coefficient of utilization of synthetic fertilizers N in the agriculture sector (afert), the total output of the agriculture and forestry sector (x_{af}) and the emission factor for N_2O emissions from N inputs to soils ($eofmm_w$) are considered for this calculation[30]:

$$esf_w = (afert)\,(x_{af})\,(eofmm_w)\,(^{44}/_{28}) \qquad (5.85)$$

V.3.3.5 Total direct N_20 emissions from managed soils

The total direct N_2O emissions from managed soils ($edms_w$) are computed by summing the direct N_2O emissions from grazing animals, organic fertilizers, crop residues,

[28]In this expression the IPCC default value (equal to 1) for the fraction of total area under crop *q* that is renewed annually is used, while the removal fraction is assumed to be null due to data shortage. Additionally, as in the MCT (2010) estimates, the total residues from sugarcane cultivation in the São Paulo State are assumed being returned to the field due to the mechanization process.

[29] In this estimate a general coefficient for synthetic fertilization (without considering the different conditions of application) in the country is used. This coefficient is estimated considering the amount of the main nitrogen fertilizers used in Brazil (urea, ammonia, anhydrous ammonia nitrate and ammonium sulfate) in the base year of study, which are divided by the total output of the agricultural and forestry sector.

[30]Some of the nitrogen fertilizers applied to the soil is incorporated into plants and soil, but other part volatilizes as NH_3 and NO_x and is emitted as N_2O. As referred to previously, due to methodology changes in the *2006 IPCC Guidelines* the computation of direct N_2O emissions from synthetic fertilization have no longer to provide any adjustment for the amount of N volatilized. The indirect N_2O emissions from N volatilization are accounted for in a forthcoming section.

synthetic fertilizers and the annual direct N_2O emissions from managed organic soils (eos_w), which is a given exogenous variable:

$$edms_w = \left[egm_w + eof_w + \sum_q ecr_{qw} + esf_w + eos_w\right] \quad (5.86)$$

V.3.3.6 Indirect N_20 emissions from managed soils

In addition to the direct emissions of N_2O from the soils to which N is applied, indirect emissions of N_2O also occur due to atmospheric deposition of N volatilized from managed soils and from N leaching/runoff from managed soils in regions where leaching/runoff occurs (IPCC, 2006). The N_2O emissions from atmospheric deposition of N volatilized from managed soil ($eimsv_w$) are estimated in (5.87) using the *tier* 1 approach considering: the amount of N additions to soils from organic fertilizers (of_N); the amount of N additions to soils from manure deposited by grazing animals (gm_N); a fraction of applied organic N fertilizers and manure N deposited by grazing animals that volatilizes as NH_3 and NO_x (aofgav); the amount of synthetic fertilizer N applied to soils which is estimated by the coefficient utilization of synthetic fertilizers N in the agriculture sector (afert) and the total output of the agriculture and forestry sector (x_{af}); a fraction of synthetic fertilizer N that volatilizes as NH_3 and NO_x (asfv); and the emission factor for N_2O emissions from atmospheric deposition of N on soils and water surfaces ($efadv_w$):

$$eimsv_w = \{[(of_N + gm_N)(aofgav)] + [(afert)\ (x_{af})\ (asfv)]\}\ (efadv_w)\ ({}^{44}/_{28}) \quad (5.87)$$

where

$$of_N = \left\{[\mathbf{aep}\ (x_{lf})]^{\mathbf{T}}\ \mathbf{\hat{a}mp}\ [\mathbf{A}_{ma}\ (\mathbf{E}_1 - \mathbf{A}_{fv})^{T}]\right\}\ \mathbf{e}_{17} \quad (5.88)$$

$$gm_N = \{[\mathbf{aep}\ (x_{lf})]^{\mathbf{T}}\ \mathbf{\hat{a}mp}\ \mathbf{\hat{a}}_{ga}\}\ \mathbf{e}_{18} \quad (5.89)$$

The N_2O emissions produced from leaching and runoff of N additions to managed soils ($eilr_w$) is computed in (5.90) considering: the amount of N additions to soils from organic fertilizers (of_N), manure deposited by grazing animals (gm_N), crop residues (cr_N) and from synthetic fertilizers [(afert) (x_{af})][31]; a fraction of all N added to managed soils in regions where leaching/runoff occurs that is lost through leaching and runoff (aflr); and a emission factor for N_2O emissions from N leaching and runoff ($eflr_w$) as follows:

$$eilr_w = \{of_N + gm_N + cr_N + [(afert)\,(x_{af})]\}\,(aflr)\,(eflr_w)\,({}^{44}/_{28}) \qquad (5.90)$$

where

$$cr_N = \sum_q \{(aprod_q)\,(aprodut_q)\,(apats_q)\,(x_{af})\,(1 - aburn_q)\,(admqp_q)\,[(admag_q)\,(nag_q) + \\ + (admbg_q)\,(nbg_q)]\} \qquad (5.91)$$

V.3.4 CH_4 and N_2O emissions from crop residues burning

In Brazil, only the residues of sugarcane are still burned in the field[32], although the progressive increase of mechanized harvesting in recent years has diminished this practice to some small regions. Although crop residues burning produce CO_2 emissions, only non-CO_2 emissions (such as CH_4 and N_2O emissions) have to be accounted for. This is justified because the carbon released during the combustion process is assumed to be reabsorbed through photosynthesis during plant growth (IPCC, 2006). Therefore, CH_4 and N_2O emissions from crop (specifically, sugarcane) residues burning ($ecrb_{qw}$) (*q* = sugarcane) will be computed in (5.92) by considering the amount of dry matter available in the burnt area of crop *q* (calculated by the items inside the square brackets), the ratio of residues (dry matter) burnt in the total dry matter produced ($admbdm_q$) and a specific emission factor for dry matter burnt for each GHG ($efburn_{qw}$) as follows:

$$ecrb_{qw} = [(aprod_q)\,(aprodut_q)\,(apats_q)\,(x_{af})\,(aburn_q)\,(admqp_q)](admbdm_q)\,(efburn_{qw}) \qquad (5.92)$$

where q is equal to sugarcane.

[31] The amount of N mineralized in mineral soils associated with loss of soil C from soil organic matter as a result of changes to land use or management in regions where leaching/runoff occurs are considered as null, since this amount are not computed in the Brazilian National Inventory (MCT, 2010).

[32] The practice of burning in the cultivation of cotton is no longer common since early 1990s (MCT, 2010).

V.3.5 CH_4 emissions from rice cultivation

Anaerobic decomposition of organic material in irrigated or flooded rice fields is an important source of CH_4 (MCT, 2010). In order to assess the CH_4 emissions from this culture it is recommended to account for the variability of natural conditions and agricultural management of rice production by disaggregating the national harvested area (of rice) into sub-units (e.g. harvested areas under different water regimes) (Sass, 2002). Thus, for the computation of the CH_4 emissions from rice cultivation, different water regimes of rice production according to the ecosystems and flooding patterns will be considered in this study. The amount of CH_4 emissions in each water regime ($erice_{Tw}$) is estimated by considering: the weight of the output of rice in the total output of the agriculture and forestry sector ($apats_q$) (where q = rice); the total output of the agriculture and forestry sector (x_{af}); a coefficient of annual harvested area of rice according to each water regime ($arice_T$) and an annual emission factor for each water regime ($efrice_{Tw}$):

$$erice_{Tw} = (apats_q)\,(x_{af})\,(arice_T)\,(efrice_{Tw}) \qquad (5.93)$$

where T represents different water regimes of rice production according to the ecosystems and flooding patterns, such as continuously flooded, intermittently flooded and regular rainfed[33].

V.3.6 Total emissions in the AFLF sectors

The total emissions from the AFLF sector ($eaflf_w$) are computed by the summation of the respective direct and indirect GHG emissions from: manure management, enteric fermentation, managed soils, crop residues burning and rice cultivation. Furthermore, although this category is usually accounted for in a detached section in the national inventories, CO_2, CH_4 and N_2O emissions from land use change ($eluc_w$) (including the CO_2 emissions from liming) are considered as exogenous variables obtained from the Brazilian National Inventory for the year 2005 and included in this calculation:

$$eaflf_w = edmm_w + eimm_w + \sum_r emm_{rw} + \sum_r eentf_{rw} + edms_w + eimsv_w + eilr_w +$$

[33] Although the IPCC methodology (IPCC, 2006) recommends considering the type and amount of organic amendments in the estimates, as well as other conditions under which CH_4 emissions from rice may vary (such as soil type, rice cultivar, sulphate containing amendments, etc.), we have followed in this study the approach utilized by MCT (2010), which has not addressed those factors due to shortage of experimental data for establishing specific emission factors under different regional and climate conditions in Brazil.

$$+ \sum_q ecrb_{qw} + \sum_T erice_{Tw} + eluc_w \quad (5.94)$$

V.4. Solid Waste Disposal (SWD)

The treatment and disposal of municipal, industrial and other wastes produces significant amounts of CH_4 (IPCC, 2006)[34]. Furthermore, the waste incineration is also responsible for emissions of CO_2, CH_4 and N_2O according to the composition of the waste, although this activity is greatly reduced in Brazil (MCT, 2010). Hence, CH_4 emissions related to solid waste disposal, as well as CO_2, CH_4 and N_2O emissions from waste incineration are estimated in this section, in which different sub-sections for Municipal Solid Waste (MSW), Industrial Solid Waste (ISW) and Clinical Waste (CW) are considered.

V.4.1 Municipal Solid Waste

The amount of MSW generated in Brazil is estimated similarly to the methodology used by MCT (2010), which is calculated from a per capita disposal basis. Therefore, the MSW in the year of analysis is computed by using a coefficient of MSW disposal per capita (amsw), a fraction of urban population on the total human population in the country (a_{up}) applied to the total population in the country in the year of study (p):

$$msw = (amsw)\,(a_{up})\,(p) \quad (5.95)$$

V.4.1.1 Allocation of MSW to Solid Waste Disposal Sites (SWDS)

The MSW which is carried to SWDS ($mswswd_u$) is allocated by category or type/material. For this estimate the amount of MSW generated (msw), a fraction of MSW disposed to SWDS (fmswswd) and a coefficient of MSW by type ($amsw_u$) are used:

$$mswswd_u = (msw)\,(fmswswd)\,(amsw_u) \quad (5.96)$$

where u is equivalent to: (1) food waste, (2) garden (yard) and park waste, (3) paper and cardboard, (4) wood, (5) textiles, (6) nappies (disposable diapers), (7) rubber and leather, (8)

[34] Decomposition of organic material derived from biomass sources (e.g., crops, wood) is the primary source of CO_2 released from waste. These CO_2 emissions are not included in national totals, because the carbon is of biogenic origin and net emissions are accounted for under the AFOLU Sector. No methodology is provided for N_2O emissions from SWDS because they are not significant (IPCC, 2006).

plastics, (9) metal, (10) glass (and pottery and china), (11) other (e.g., ash, dirt, dust, soil, electronic waste).

V.4.1.2 CH_4 emissions from MSW in SWDS

CH_4 emissions from MSW in SWDS ($emswswd_{uw}$) are computed using the IPCC methodology, which is based on the First Order Decay (FOD) method (*tier* 2). This method assumes that the degradable organic component (degradable organic carbon, DOC) in waste decays slowly throughout a few decades, during which CH_4 (and CO_2) are formed (IPCC, 2006). I.e. this method considers that CH_4 emissions persist over a number of years after the waste disposal (MCT, 2010)[35]. In order to estimate these emissions a fraction of degradable organic carbon in the year of deposition ($docmsw_u$), a fraction of DOC that can be decomposed ($docfmsw_u$), a CH_4 correction factor for aerobic decomposition in the year of deposition ($mcfmsw_u$), and a fraction of CH_4 in generated landfill gas ($fch4glg_w$) are considered:

$$emswswd_{uw} = \sum_n \Big[(1 - e^{-k})(mswswd_{un})(mcfmsw_u)(docmsw_u)(docfmsw_u)(fch4glg_w) \left({}^{16}/_{12}\right)(1 - e^{k_u\,(2018-n)}) \Big] \tag{5.97}$$

where k is the reaction constant ($k = \ln(2)/t_{1/2}$)[36] and n represents the period considered (1998 to 2018).

V.4.1.3 Biological treatment of MSW

The biological treatment of MSW includes composting and anaerobic digestion processes[37]. Composting is an aerobic process and a large fraction of DOC in the waste material is converted into CO_2, whilst CH_4 is formed in anaerobic sections of the compost. Anaerobic digestion of organic waste expedites the natural decomposition of organic material

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[35] Part of the CH_4 generated is oxidized in the cover of the SWDS, or can be recovered for energy or flaring (IPCC, 2006). In this study these values are considered null due to a lack of data, following the Brazilian National GHG Inventory (MCT, 2010).

[36] The recommended default CH_4 generation rate (k) values under tier 1, tropical (mat > 20°c), moist and wet (map ≥ 1000 mm) were used.

[37] The mechanical-biological treatment of waste is also characterized as a biological treatment process. In this process, *the waste material undergoes a series of mechanical and biological operations that aim to reduce the volume of the waste as well as stabilize it to reduce emissions from final disposal* (IPCC, 2006). However, this process is more common in Europe, and no data for this process is available in Brazil, by which it has not been considered in this study.

and the generated CH_4 is generally used to produce heat and/or electricity. Although these processes are associated mostly with CH_4 and CO_2 emissions[38], some N_2O emissions can also be identified (IPCC, 2006). For the computation of the amount of MSW carried to composting and anaerobic digestion processes (mswbt) an exogenous fraction of MSW (fmswbt) is considered which is applied to the total MSW generated:

$$mswbt = (msw)\ (fmswbt) \qquad (5.98)$$

V.4.1.4 N_2O and CH_4 from biological treatment of MSW

The emissions from biological treatment ($emswbt_w$) are estimated in (5.99) using a specific emission factor for biological treatment of MSW ($efmswbt_w$) and a recovery factor ($rfmsw_w$)[39]:

$$emswbt_w = (mswbt)\ (efmswbt_w)\ (1 - rfmsw_w) \qquad (5.99)$$

V.4.2 Industrial Solid Waste (ISW)

This category includes solid waste production and treatment from industrial sectors, including refinery activities.

V.4.2.1 ISW production by industrial sector

The amount of ISW generated[40] by each industrial sector (isw_{ind}) is calculated by a coefficient of ISW production by monetary unity of output (a_{isw}), multiplied by each element (x_{ind}) of the vector ($\mathbf{x}_{ind}$) with the total output of each industrial sector:

$$isw_{ind} = (a_{isw}\ x_{ind}) \qquad (5.100)$$

[38] Since CO_2 emissions are of biogenic origin, they will not be accounted or even reported as information in the energy sector in this study (as recommends the IPCC Guidelines).
[39] The IPCC methodology recommends considering a recovery factor in the calculation of CH_4 emissions. For N_2O emissions this value is equal to 0.
[40] For simplicity all hazardous waste (HW) are herein considered as produced in the industrial sector. Therefore, this amount includes both hazardous and non-hazardous ISW generated by the industrial sector. Furthermore, it is noteworthy that due to a lack of data the same approach used in Brazilian National Inventory is herein utilized, which considers as HW only the amount of ISW which is incinerated outside the industrial process by outsource incinerators, since data for hazardous ISW incinerated into the industrial process are not available.

V.4.2.2 Organic ISW for SWDS

The amount of organic ISW carried to SWDS (isworgswd) is calculated by the fraction of ISW to solid waste disposal (fiswswd), the fraction of organic waste in the industrial waste (fisworgswd) applied to the total ISW generated. A coefficient of non-hazardous waste in the industrial waste (fnhwisw) is also considered in order to identify the net non-hazardous waste from the ISW generated:

$$\text{isworgswd} = \sum_{ind} \text{isw}_{ind} \text{ (fnhwisw) (fiswswd) (fiworgswd)} \qquad (5.101)$$

V.4.2.3 CH_4 emissions from organic ISW in SWDS

The emissions from organic ISW in SWDS (eisworgswd_w) are estimated in (5.102) multiplying the total organic ISW to SWDS by a default emission factor for organic ISW disposed (efiworgswd_w)[41]:

$$\text{eisworgswd}_w = (\text{efiworgswd}_w) \text{ (isworgswd)} \qquad (5.102)$$

V.4.2.4 Incineration of ISW without energy recovery

The amount of ISW incinerated without energy recovery (iswincin) is estimated by multiplying the total ISW by a coefficient with the fraction of ISW incinerated (without energy recovery) in the total ISW (fiswincin)[42]:

$$\text{iswincin} = \sum_{ind} \text{isw}_{ind} \text{ (fiswincin)} \qquad (5.103)$$

V.4.2.5 CH_4 and N_2O emissions from incineration of ISW without energy recovery

CH_4 and N_2O emissions of ISW incinerated (without energy recovery) (eiswincin_w) are computed by multiplying the total ISW without energy value (or non-recovered) by an emission factor for ISW incineration (efiswincin_w). In this estimate only the ISW without energy value is considered, since the ISW with energy recovery is considered into the energy

[41] A default emission factor is used in this calculation because data on waste production by industry type and waste composition are not available.

[42] Due to a lack of data the same approach applied in the Brazilian National Inventory is herein used, in which all incineration of ISW is considered as without energy recovery.

combustion calculation. Furthermore, due to a lack of data about the waste production by industry type and waste composition, a default emission factor is used:

$$eiswincin_w = (iswincin)\ (efiswincin_w) \tag{5.104}$$

V.4.3 Clinical Waste (CW)

CW is usually incinerated or may be disposed in SWDS. In this study, it is considered that the CW produced by the public and private health sectors is carried to incineration and the amount of CW generated is associated with the output of these sectors. The computation of these emissions is based on the IPCC (2006) *tier* 2 approach, in which specific emission factors for Brazil from MCT (2010) are considered. The formulation is presented in the next sections.

V.4.3.1 Incineration of CW without energy recovery

The amount of CW incinerated without energy recovery (cwincin) is computed in (5.105) using a coefficient of CW incinerated per unit of output of the private and public health sectors (acwincin) applied to the total output of these sectors ($\mathbf{x}_{hs}$):

$$cwincin = (acwincin)\ [\mathbf{e}_{19}^{T}\ \ \mathbf{x}_{hs}] \tag{5.105}$$

where *hs* represents sectors N48 and N51 (see Table B.2 in the Appendix B).

V.4.3.2 CH_4 and N_2O emissions from CW incineration without energy recovery

CH_4 and N_2O emissions from CW incineration ($ecwincin_w$) are estimated by multiplying the amount of CW incinerated by a default emission factor for clinical waste incinerated ($efcwincin_w$):

$$ecwincin_w = (cwincin)\ (efcwincin_w) \tag{5.106}$$

V.4.4 CO_2 emissions from solid waste incineration

The IPCC methodology to estimate CO_2 emissions from solid waste incineration differs from the methodology used to compute CH_4 and N_2O emissions by which it will be outlined in this special section. For the computation of CO_2 emissions from MSW, ISW and

CW[43] incinerated ($eswincin_w$) the following elements will be considered: the amount of MSW, the fraction of MSW incinerated (fmswincin), the carbon content in MSW (ccmsw), the fraction of fossil carbon in MSW (ffcmsw), the amount of ISW incinerated (iswincin), the carbon content in ISW (ccisw), the fraction of fossil carbon in ISW (ffcisw), the amount of CW incinerated (cwincin), the carbon content in CW (cccw), the fraction of fossil carbon in CW (ffccw) and the combustion efficiency of incinerators (ceinc)[44]:

$$eswincin_w = [(msw)(fmswincin)(ccmsw)(ffcmsw) + (iswincin)(ccisw)(ffcisw) + (cwincin)(cccw)(ffccw)]\,({}^{44}/_{12})\,(ceinc) \quad (5.107)$$

V.4.5 Total emissions of SWD

The total emissions of SWD are given by the estimates from (5.97) to (5.107) of each respective GHG:

$$eswd_w = \sum_u emswswd_{uw} + emswbt_w + eisworgswd_w + eiswincin_w + ecwincin_w + eswincin_w \quad (5.108)$$

V.5. Wastewater and sludge emissions

Different systems are used for wastewater treatment in Brazil, although a significant amount of wastewater is directly discharged into rivers and ocean without any treatment. Wastewater can be a source of CH_4 and N_2O emissions due to the degree of organic and nitrogen contents (MCT, 2010). CO_2 emissions from wastewater are not considered in the *IPCC Guidelines* because of its biogenic origin and therefore should not be included in the national total emissions. Different sections to estimate the emissions from wastewater and sludge are considered in this study due to different sources (domestic, commercial and industrial) and treatment methods (on site, sewered to a centralized plant or disposed untreated nearby or via an outfall).

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[43] Due to the reduced practice of sewage sludge (SS) incineration in Brazil, these emissions are assumed to be negligible in the Brazilian National Inventory (MCT, 2010) by which they are also not included in this calculation. Furthermore, as previously referred to, the ISW emissions refer essentially to hazardous waste incinerated in outsourcing incinerators, since the data for hazardous and non-hazardous ISW incinerated into the industrial process are not available.

[44] Although the IPCC (2006) recommends using data of wastes on a dry matter basis, the same approach applied in the Brazilian National inventory is applied in this study, in which wet basis data is used.

V.5.1 CH_4 emissions from domestic wastewater

Domestic wastewater is essentially a result of household water use. CH_4 emissions from wastewater (echdww) is estimated in (5.109) considering the degree of utilization of treatment/discharge pathway or system ($adwwt_j$), the total organics in wastewater in the analyzed year (tow), a coefficient of CH_4 recovered in the inventory year (adwwrec) and an emission factor for each domestic wastewater treatment and discharge pathway and system ($efdww_j$)[45]:

$$\text{echdww} = \left[\sum_j \left(\left(\text{adwwt}_j\right)\left(\text{efdww}_j\right)\right)\right](\text{tow})\left(1 - \text{adwwrec}\right)\left(10^{-6}\right) \tag{5.109}$$

where *j* represents each treatment/discharge pathway or system: septic system; anaerobic lagoon; sea, river and lake discharge; anaerobic reactor; stagnant sewer; flowing sewer (open or closed); centralized, aerobic treatment plant; and anaerobic digester for sludge.

The total amount of organically degradable material in the wastewater (tow) is a function of human population in the country (p) and biochemical oxygen demand per person (bod):

$$\text{tow} = (\text{p})\,(\text{bod}) \tag{5.110}$$

The ($efdww_j$) is estimated by the maximum CH_4 producing potential (b_o) and the methane correction factor (mcf_j) for each wastewater treatment and discharge system:

$$\text{efdww}_j = (\text{b}_o)\,(\text{mcf}_j) \tag{5.111}$$

V.5.2 CH_4 emissions from industrial wastewater

This section summarizes the methodology applied to estimate CH_4 emissions from on-site industrial wastewater treatment ($echiww_{yw}$). These emissions are computed in (5.112) considering: a matrix ($\mathbf{Asp}_{yp}$) with the fraction of each selected product *p* in the total output of the respective sector *y* (and 0 otherwise); a diagonal matrix with the coefficients of physical production of each product per unit of output of the respective sector ($\mathbf{\hat{a}prod}_p$); the

[45] The degree of utilization of treatment/discharge pathway or system is considered in an overall basis and the fraction of population in the different income groups was not taken into account as recommended by the *IPCC methodology*. Furthermore, the organic component removed as sludge was not considered due to a lack of specific data according to the Brazilian reality.

biochemical oxygen demand in the wastewater from each product ($\hat{\mathbf{bod}}_p$)[46]; the diagonalized matrix of the vector $\mathbf{efiww}_p$ with the emission factor of CH_4 by BOD produced for each product; and a coefficient of net amount of CH_4 from wastewater discounting the amount of CH_4 recovery from wastewater ($\mathbf{achnr}_p$)[47]:

$$echiww_w = (\mathbf{x}_y)^T\,(\mathbf{Asp}_{yp})\,(\hat{\mathbf{aprod}}_p)\,(\hat{\mathbf{bod}}_p)\,(\hat{\mathbf{efiww}}_p)\,(\mathbf{achnr}_p)^T\,(10^{-6}) \qquad (5.112)$$

where *y* represents the sectors[48] (bioethanol; food and beverages; agriculture and forestry; pulp and cellulosic; and livestock and fishing)[49] and *p* represents the products (bioethanol, sugar, beer, milk, cotton, paper, swine, cattle and poultry).

The $\mathbf{efiww}_p$ is estimated similarly to (5.111) by the maximum CH_4 producing potential (b_{oind})[50] and the methane correction factor for industrial wastewater by product ($\mathbf{mcf}_p$):

$$\mathbf{efiww}_p = (b_{oind})\,(\mathbf{m\ \ f}_p) \qquad (5.113)$$

V.5.3 N_2O emissions from wastewater

N_2O emissions from wastewater effluent (en2oww) are calculated in (5.114) based on the IPCC (2006) methodology in which the annual per capita protein consumption (pcprot), the fraction of nitrogen in protein (fnprot), a factor for non-consumed protein added to the wastewater (fncprot), a factor for industrial and commercial co-discharged protein into the sewer system (findcom), a coefficient for nitrogen removed with sludge (asludge) and an emission factor for N_2O emissions from nitrogen discharged to wastewater (efn2oww)[51] are considered:

$$en2oww = (p)\,(pcprot)\,(fnprot)\,(fncprot)\,(findcom)\,(1 - asludge)\,(efn2oww)\,(10^{-6}) \qquad (5.114)$$

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[46] The methodology applied in the II Brazilian Inventory of GHG emissions is used in this calculation, in which the biochemical oxygen demand (BOD) are applied instead of the chemical organic demand (COD) as the IPCC (2006) methodology recommends.

[47] The organic component removed as sludge in the inventory year is not considered in this estimate due to a lack of specific data for Brazilian conditions.

[48] The CH_4 emissions of the wastewater from sugar and bioethanol production are considered as zero, since the wastewater from these activities is completely utilized as an organic fertilizer in the field. In addition, as different wastewater treatment systems with different emission factors are used in beer production, a weighted emission factor is applied for this product.

[49] The 10 major industrial sectors (and respective products) producers of wastewater with high CH_4 gas production potential are considered in this study as recommended by the II Brazilian Inventory of GHG emissions methodology.

[50] The Good Practice Guidance (IPCC, 2000) default value (0.6 kg CH /kg BOD) is used.

[51] This emission factor is multiplied by 44/28 in order to convert N_2O-N emissions to N_2O emissions.

V.6. Total emissions

Total emissions of CO_2 (teco), CH_4 (tech) e N_2O (teno) are calculated by the sum of respective CO_2, CH_4, and N_2O emissions from: energy combustion; fugitive emissions; agriculture, livestock and forestry sector; solid waste disposal; wastewater and sludge:

V.6.1 CO_2 emissions

$$teco = ec_w + tfe_w + eaflf_w + eswd_w \tag{5.115}$$

V.6.2 CH_4 emissions

$$tech = ec_w + tfe_w + eaflf_w + eswd_w + echdww + \sum_y echiww_{yw} \tag{5.116}$$

V.6.3 N_2O emissions

$$teno = ec_w + tfe_w + eaflf_w + eswd_w + en2oww \tag{5.117}$$

V.6.4 Total GHG emissions

In order to estimate the total GHG emissions (ghg) the total emissions of CO_2, CH_4 and NO_2 are transformed into CO_2 equivalent, utilizing the corresponding equivalence factor (25 for CH_4 and 298 for N_2O) as follows:

$$ghg = teco + 25\,(tech) + 298\,(teno) \tag{5.118}$$

VI. OBJECTIVE FUNCTIONS

The economic development in Brazil impels the policy making process to taking into account the performance of the country in different spheres. According to the objectives of this study, which is contributing to provide decision support in the planning process of (short-medium term) future scenarios analysis throughout the assessment of interactions between economic growth, energy use, GHG emissions and employment level in 2018, the model herein proposed explicitly considers four competing objective functions.

VI.1. Maximization of GDP

The GDP is an indicator of global economic performance, which is able to capture variations in production, income and consumption levels in a country. In this sense, the maximization of this item (at constant prices) in volume (or real) terms (defined in equation 5.31) is considered:

$$\text{Max } z_1 = gdp_{exp} \quad (5.119)$$

VI.2. Minimization of energy consumption

Even though the energy consumed in Brazil is mostly produced in the country and new oil reserves have been discovered while the production using renewable fuels has increased, the energy supply/demand relation can limit the economic growth. Additionally, the oil scarcity spots the necessity of improving its efficient utilization. In this sense, the minimization of the energy consumption (defined in equation 5.48) is considered, in order to unveil its impacts on economic growth and GHG emissions as well as on the energy mix[52]:

$$\text{Min } z_2 = cfe \quad (5.120)$$

VI.3. Minimization of total GHG

The correlation between the economic activity (and energy use) and GHG emissions as well as the international agreement on the necessity to reduce GHG emissions motivate the assessment of the trade-offs associated with the minimization of GHG emissions (defined in equation 5.118) on the economic growth and energy consumption, which is another objective analyzed in this study:

$$\text{Min } z_3 = ghg \quad (5.121)$$

VI.4. Maximization of employment level

In order to include the social dimension in this analysis, the employment level (defined in equation 5.46), which can be considered as a social welfare indicator, is maximized:

[52] The scalar cfe is obtained by the sum of all elements of the vector **cfe**.

Max z_4 = emp (5.122)

VII. INTERVAL MODEL

With the aim of incorporating the uncertainty treatment in the (deterministic) model previously described, interval coefficients and bounds are included in some of the economic constraints. The constraints in the deterministic model are substituted by the corresponding modified constraints that include interval coefficients and bounds. For the sake of simplicity and avoiding repetitiveness only these modified constraints will be highlighted in the next sections. Moreover, the enumeration of the formulas in the deterministic model is maintained in this section plus an additional letter (i) aiming facilitating the identification and visualization of the corresponding interval formula. In addition, the signal (*) is used to highlight the modified items.

VII.1. Final consumption expenditure of households on the territory (constant basic prices)

The final consumption expenditure of households on the territory includes an upper interval limit for the final consumption expenditure of households on the territory (cf*):

$\mathbf{cf} = \mathbf{a}_{cf}\,(cf)$ (5.2i)

$cf \leq cf^*$.

VII.2. Total final consumption expenditure of households on the territory (constant consumer prices)

In this constraint the total consumption of non-residents households on the territory (cpe) is bounded by an upper interval limit (cpe*):

$cf = cfr + cpe$ (5.3i)

$cpe \leq cpe^*$.

VII.3. Total final consumption expenditure of residents - households and NPISH (constant consumer prices)

The total final consumption expenditure of residents (cpr) and the disposable income of households and NPISH (yd) are bounded by the corresponding upper interval limits cpr* and yd*:

$cpr = \beta_0 + \beta_1 (yd)$
(5.4123i)

$cpr \leq cpr^*$,

$yd \leq yd^*$.

VII.4. Final consumption expenditure of resident's households on the territory (constant consumer prices)

In this constraint upper interval limits for the final consumption expenditure of resident's households on the territory (cfr*) and for the imports of tourism (cpm*) are considered:

$cfr = cpr – cpm – cnpish$ (5.5i)

$cfr \leq cfr^*$,

$cpm \leq cpm^*$.

VII.5. Total imports - excluding tourism expenditure (constant FOB prices)

The total imports (excluding tourism expenditure) at constant FOB prices (impwtfob) is bounded by an upper interval limit (impwtfob*):

$impwtfob = impwtcif\,(1 - a_{ciffob})$ (5.21i)

$impwtfob \leq impwtfob^*$.

VII.6. Total imports - including tourism expenditure (constant FOB prices)

The total imports (including tourism expenditure) at constant FOB prices (impfob) is bounded by an upper interval limit (impfob*):

$$impfob = impwtfob + cpm \tag{5.22i}$$

$$impfob \leq impfob^*.$$

VII.7. Gross Domestic Product (constant prices)

An upper interval limit (gdp*) is considered for both GDP in the expenditure and income approaches:

$$gdp_{ex} = expcpt + g + cnpish + cf + gfcf \pm sc - impfob \tag{5.31i}$$

$$gdp^L \leq gdp_{ex} \leq gdp^*.$$

$$gdp_{in} = gva + ts \tag{5.32i}$$

$$gdp^L \leq gdp_{in} \leq gdp^*,$$

$$gdp_{ex} = gdp_{in}.$$

VII.8. Gross Domestic Product (current prices)

An upper limit for the GDP at current prices (gdpcurr*) is included in this constraint, while the specific deflators for the total final consumption expenditure of residents (pcpr*), changes in inventories (psc*), exports (pexpcpt*) and imports (pimpfob*) are considered as interval coefficients:

$$gdpcurr = (cpr)(pcpr^*) + gcorr + gfcfcurr \pm (sc)(psc^*) + (expcpt)(pexpcpt^*) -$$
$$- (impfob)(pimpfob^*)$$
(5.12433i)

$$gdpcurr \leq gdpcurr^*,$$

$$gcurr^L \leq gcorr \leq gcurr^U,$$

$gfcfcurr^L \leq gfcfcurr \leq gfcfcurr^U$.

VII.9. Wages (current prices)

In this constraint an upper interval limit for wages at current prices (wagcurr*) is considered:

$$wagcurr = \mathbf{a}_{wag}{}^{\mathbf{T}}\, \mathbf{x}\ (iucl^*) \qquad (5.34i)$$

$wagcurr \leq wagcurr^*$.

VII.10. Households and NPISH disposable income (current prices)

In this constraint the proportion of corporation savings on the GDP at current prices is considered as an interval coefficient (psgdpcurr*). Furthermore, upper interval limits are set for: the households and NPISH disposable income at current prices (ydcurr*); the balance of primary incomes (pi*); indirect taxes less subsides (itsub* and itsubg*); current transferences (ctr*); direct taxes (dt* and dtc*); social security contributions (ssc*); balance of property incomes (pig*); and transferences from the general government to households (trgh*):

$$\begin{aligned} ydcurr = {} & gdpcurr\,(1 - psgdpcurr^*) + (pi^+ - pi^- + itsub - itsubg) + ctr - dt - dtc - ssc - \\ & - itsub - (pig^+ - pig^-) + trgh \end{aligned} \qquad (5.35i)$$

$ydcurr \leq ydcurr^*$,

$pi^+ - pi^- \leq pi^*$,

$itsub \leq itsub^*$,

$itsubg \leq itsubg^*$,

$ctr \leq ctr^*$,

$dt \leq dt^*$,

$dtc \leq dtc^*$,

$sss \leq ssc^*$,

$pig^{+} - pig^{-} \leq pig^{*}$,

$trgh \leq trgh^{*}$.

VII.11. General Government Gross Debt (current prices)

An upper interval limit is set for the general government gross debt (debt*), whereas lower interval limits are considered for the public debt in the previous period ($debt_{-1}^{*}$), the general government's structural balance (gbg^{*}) and the adjustment variable (dat*):

$$debt = debt_{-1} - (gbg^{+} - gbg^{-}) + dat \quad (5.42i)$$

$debt \leq debt^{*}$,

$debt_{-1} \geq debt_{-1}^{*}$,

$(gbg^{+} - gbg^{-}) \geq gbg^{*}$,

$dat \geq dat^{*}$.

VII.12. Interest rate of the general government gross debt

In this formula the debt interest rate is considered as an interval coefficient (rg*) and the interest rate on the general government gross debt is bounded by an upper interval limit (jurg*):

$$jurg = rg^{*} (debt_{-1} + debt)/2 \quad (5.43i)$$

$jurg \leq jurg^{*}$.

VII.13. General government structural balance (current prices)

In this constraint upper interval limits for capital tax (tk*), current (ctrg*) and capital (trkg*) transferences of the general government are set. Moreover, the gross fixed capital formation of the general government is bounded by a lower interval limit (gfcfg*):

$$(gbg^+ - gbg^-) = dt + dtc + ssc + itsubg + (pig^+ - pig^-) - gcurr - trgh + ctrg - jurg + \\ + tk + trkg - gfcfg \qquad (5.44i)$$

$ctrg \leq ctrg^*$,

$tk \leq tk^*$,

$trkg \leq trkg^*$,

$gfcfg \geq gfcfg^*$.

CHAPTER 6 RESULTS AND DISCUSSION

In this chapter, both deterministic and interval formulations of the MOLP model presented in Chapter 5 are applied to the Brazilian economic system. The interactive STEP method and the TRIMAP method are used to compute a set of solutions using the deterministic formulation. In addition the deterministic formulation is used for an analysis of prospective bioethanol production in Brazil, in which different 2G bioethanol production processes are considered. Finally, the method present in section 4.3 of Chapter 4 is used to compute a set of solutions considering the MOLP model with interval coefficients.

For the application of both deterministic and interval MOLP models presented in Chapter 5 to the Brazilian economic system, an Extended Hybrid IO framework is firstly built up by rearranging the IO system to include the energy flows in physical units. The sectors that are not explicitly available in the Brazilian IO table are constructed or disaggregated from the sector in which they appear based on the methodology proposed in Cunha & Scaramucci

(2006)[1]. In this step, the data of production and consumption of the different energy commodities available in the Brazilian National Energy Balance (MME, 2009) are incorporated into the 2009 Brazilian IO system (Guilhoto & Sesso Filho, 2010) by considering ‘artificial sectors’ (identified with a letter A in the first column of the Table B.2 in Appendix B) (see also Oliveira & Antunes, 2004, 2011). The rows and columns associated with the ‘artificial sectors’ for representing the different energy commodities are included in the transactions matrix to allocate the energy flows (in physical units) between energy and non-energy sectors (identified with letters E and N in the first column of the Table B.2 in Appendix B, respectively). Furthermore, new rows associated with those ‘artificial sectors’ representing the different energy commodities are also included in the final demand and total output vectors. The rows in the transaction table, the final demand and the total output vectors representing the energy sectors, originally computed in monetary units, are substituted by flows in physical units to allocate the energy produced in the corresponding sector. I.e., the cells representing the commodities produced in that sector (e.g. anhydrous bioethanol produced in the bioethanol sector) display the values of production of that commodity in the respective sector, while the other cells have null values. This procedure generates new transaction matrices and vectors for final demand and total output with hybrid units, where energy flows are considered in physical quantities of energy (tons of oil equivalent - toe) and all non-energy sector flows are measured in monetary units (Brazilian Real - R$). These new matrices and vectors are used to generate new technical coefficients matrices and vectors, in which the entries are measured in hybrid units (monetary/physical, monetary/monetary, physical/physical or physical/monetary) according to the corresponding activity sectors (and commodities).

The adjustments performed in the IO framework provide: a square matrix with 110 activity sectors split into 53 economic sectors, 6 energy producing sectors, 5 artificial sectors used for distributing the energy consumed by each means of transportation and 46 artificial energy-product sectors; 6 column vectors with the components of final demand (exports, final consumption expenditure of the general government, consumption of residents, gross fixed capital formation - GFCF, and changes in inventories); 1 column vector for competitive imports (considered for energy products only); and 6 row vectors for the primary inputs (wages, gross mixed income, gross operating surplus, other production taxes and other production subsides).

[1] Further details are given in Appendix C.

Finally, based on the IPCC (2006) methodology, the Hybrid IO framework is externally expanded to compute GHG emissions from energy combustion, industrial processes, agriculture activities, waste management, wastewater treatment and discharge, and fugitive emissions. In this step, (lower, upper and default) emission factors for carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O) emissions are used in combination with the level of activity of specific sectors and final demand components assuming a proportional relation and the corresponding Global Warming Potential (100-year horizon: 25 for CH_4 and 298 for NO_2) relatively to CO_2 (IPCC, 2007). The Extended Hybrid IO framework has been compiled using a workbook structure of multiple linked spreadsheets (using Microsoft Excel). Further details of all procedures to build up the Extended Hybrid IO framework to the Brazilian economic system are outlined in Appendix B.

Thus, the Extended Hybrid IO framework is used as the basis to define the variables, constraints and objective functions of the MOLP model proposed in Chapter 5. A set of real-world data gathered from several sources (IBGE, 2008; MME, 2009; MCT, 2010; Guilhoto & Sesso Filho, 2010; IMF, 2014) are also used to instantiate the MOLP model (see more details in Appendix B). The results obtained by different methods applied for both deterministic an interval formulations are outlined in following sections.

6.1 SOLUTIONS USING THE INTERACTIVE STEP METHOD

The deterministic MOLP model has 443 variables including: the total output and exports (at basic and consumer prices) of each sector (a total of 336 variables); competitive imports of energy commodities (49 variables); several economic variables (58 variables). The deterministic model also includes a set of 490 (defining and bound) constraints. The multi-objective optimization was performed using Open Solver (OS; http://opensolver.org), which is fully adapted to run within Microsoft Excel framework, thus avoiding data exporting processes to other optimization solvers. The non-dominated solutions obtained using the STEP method are described as follows.

Firstly, each objective function was optimized individually, resulting in 4 distinct non-dominated solutions (see Table 6.1). These solutions provide an overview of the range of variation of the objective values within the non-dominated region.

Table 6.1– Optimal solutions to each objective function.						
Notation	**Objective functions**	**Units**	**Sol. 1**	**Sol. 2**	**Sol. 3**	**Sol. 4**
gdp	Gross Domestic Product	R\$ × 10^3 (2009 constant prices)	**4,351,337**	4,133,118	4,126,511	4,351,337
cfe	Total Energy Consumption	toe × 10^3	273,740	**256,800**	257,254	273,526
ghg	GHG emissions	Gg CO_2eq	2,738,023	2,660,362	**2,659,322**	2,752,640
emp	Employment	Employees × 10^3	55,200	52,883	52,766	**55,319**

Table 6.2 displays the values of some of the main economic variables for these non-dominated solutions, which individually optimize each objective function (Table 6.1).

Table 6.2– Values of some economic variables for the individual optima to each function.					
Main Indicators	**Units**	**Sol. 1**	**Sol. 2**	**Sol. 3**	**Sol. 4**
Final consumption expenditure of residents	R\$ × 10^3 (2009 constant prices)	2,668,603	2,475,401	2,494,412	2,574,038
Consumption expenditure - general government	R\$ × 10^3 (2009 constant prices)	922,816	922,816	922,816	922,816
Changes in inventories	R\$ × 10^3 (2009 constant prices)	-10,082	-9,527	-9,405	-10,221
Gross fixed capital formation	R\$ × 10^3 (2009 constant prices)	861,608	816,599	786,297	861,608
Imports including tourism	R\$ × 10^3 (2009 constant prices)	436,793	411,438	408,272	436,188
Exports including the tourism	R\$ × 10^3 (2009 constant prices)	345,186	339,267	340,663	439,284
Gross value added	R\$ × 10^3 (2009 constant prices)	3,757,340	3,574,262	3,568,728	3,758,636
Total indirect taxes less subsides	R\$ × 10^3 (2009 constant prices)	593,996	558,856	557,783	592,700
GDP current	R\$ × 10^3 (2018 current prices)	6,735,909	6,447,358	6,486,833	6,776,766
Households disposable income	R\$ × 10^3 (2018 current prices)	4,726,263	4,384,091	4,417,761	4,558,783
General government structural balance	R\$ × 10^3 (2018 current prices)	-130,120	-245,756	-245,774	-139,629
General government gross debt	R\$ × 10^3 (2018 current prices)	4,558,698	4,674,334	4,702,954	4,568,207

Solution 1: The optimal level for GDP reaches the upper limit established in our projections. This solution results in positive effects on national production confirmed by higher values for the gross value added (similar to solution 4). Furthermore, the highest direct and indirect taxes level is obtained in this solution, contributing to the lowest values (in absolute terms) of general government structural balance and general government gross debt (corresponding to 1.93% and 67.68% of current GDP, respectively). In contrast, this solution has higher values for energy consumption (6.60% higher than the optimal value in solution 2) and GHG emissions (2.96% higher than the optimal value in solution 3), but with slightly lower values than in solution 4, which optimizes employment. The sectors that have the highest output improvements are linked to the oil and natural gas extraction, oil refining and coke, electricity generation, construction and services for families.

Solution 2: The optimal energy consumption (approximately 256.8 toe × 10^6) leads to an overall contraction of the economic activity, since lower levels for GDP and gross value added are achieved in this solution. The lower values of indirect taxes achieved in this solution leads to negative pressures on the general government gross debt (72.5% of current GDP) and the most negative value of general government structural balance (3.81 % of current GDP). Additionally, the lowest level for the residents' disposable income also leads to the lowest consumption of residents (the main item contributing to the GDP in the expenditure approach), while the employment level also decreases 4.40% in comparison to its optimal solution. Moreover, the optimal energy consumption does not lead to the lowest fossil energy consumption (see Table 6.5) (slightly higher than in solution 3). This can be explained by the fossil fuel intensiveness of the Brazilian economy, which although it has improved the use of renewable energy it is still very dependent on non-renewable sources. This means that an overall reduction in the total energy consumed in the country will affect both renewable and non-renewable energy, unless the substitution process between these sources is intensified in the future. It is noteworthy that the deterministic characteristic of the technical coefficients, which are constant and reflecting the economic structure in the base year, in which more fossil fuels are consumed, does not allow capturing internal variations in the pattern of utilization of energy in each sector (e.g. substitution of non-renewable by renewable energy in the transportation sector) that can occur in the prospective scenario. For this purpose the uncertainty treatment and an analysis of the variation in the coefficients is intended to be considered in future versions of the model.

Solution 3: The results obtained for the solution minimizing GHG emissions are quite correlated with the results in solution 2 (since the fossil fuel combustion is one of the main GHG emission sources in the country; see Table 6.6). The overall contraction of the economic activity is also confirmed by the lowest levels for GDP, gross value added and GFCF achieved in this solution. The employment level also achieves the lowest values between all solutions (4.61% lower than its optimal value in solution 4). Furthermore, the lowest level of direct and indirect taxes is attained in this solution, contributing for negative impacts on the general government structural balance (3.79% of current GDP) and the highest level of general government gross debt in absolute terms (corresponding to 72.5% of current GDP). Besides the energy producing sectors, the main sectors' outputs that are negatively affected in solutions 2 and 3 are the energy intensive sectors, such as: chemicals, pulp and paper products, manufacture of steel and steel products, metallurgy of nonferrous metals, iron ore and other extractive industries.

Solution 4: The results obtained optimizing the employment level are similar to the ones obtained optimizing GDP (solution 1). Both solutions reached the upper limit estimated for GDP, characterizing an alternative optimum to GDP. This solution leads to the highest level of gross value added, exports and GFCF (similar to the values in the solution optimizing

GDP). This indicates that investments have an important role in the job creation process, coupled with the exports increase. Moreover, this solution presents lower values of general government gross debt in relation to the GDP (67.41% of current GDP) of these four solutions (although slightly higher than solution 1 in absolute terms), which is supported by lower values of general government structural balance levels (2.06% of current GDP) and higher levels of indirect taxes, following the results in solution 1. However, solution 4 leads to higher values for imports (slightly lower than solution 1) and energy consumption (6.51% higher than the optimal value in solution 2), whereas GHG emissions (3.51% higher than the optimal value in solution 3) achieved the highest level when compared to the other solutions herein analyzed. In this solution, the main sectors that have improvements in their output levels are: other products of nonmetallic minerals, metal products except machinery and equipment, machinery and equipment, including maintenance and repairs, office machines and computer equipment, trucks and buses, and cement.

In these four solutions, it is possible to recognize a strong correlation between economic growth and social welfare (measured through GDP and employment levels) for the Brazilian economic system. In fact, the recent Brazilian GDP growth, which led to an almost full employment condition in the country (the unemployment rate has reached almost 4.8% in January 2014 (IBGE, 2012), validates this statement. Additionally, a correlation between energy consumption and GHG emissions can also be stated, since energy combustion has been one of the main GHG emission sources (see MCT, 2010). Although the upward demand for energy has been mainly supplied by new oil and hydropower facilities, the renewable energy mix is expected to be enlarged by biomass, wind and solar power, which is a key factor in reducing GHG emissions. An antagonism between solutions 1 and 4 and solutions 2 and 3 can also be identified, since the optimal values in solutions 1 and 4 result in higher values of energy consumption and GHG emissions; also the optimal values in solutions 2 and 3 result in lower GDP and employment levels.

Other more balanced solutions have also been computed using the Step method (STEM) (Benayoun et al., 1971). This method computes the solution that minimizes the worst deviation of all objectives with respect to the “ideal” solution (comprising the optimal values to each objective function, which in general cannot be obtained simultaneously since the objective functions are in conflict) by progressively reducing the feasible region according to the preferences of the DM. Non-dominated solutions are computed by using a min–max (Tchebycheff) surrogate scalar function. The solution is presented to the DM, who should specify whether he/she considers this solution as a satisfactory balance between the competing objectives. If any of the objective functions does not yet attain a satisfactory value, the DM should specify the objectives he/she is willing to accept degrading (relaxing) in order to improve the not yet satisfactory objectives. This leads to imposing further constraints on the objective function values and a corresponding reduction of the feasible region. Therefore, the solution search process is guided according to the DM's preferences to the regions where solutions that more closely correspond to these preferences are located, which also decreases the computational effort. The process continues until the DM identifies a good compromise solution.

Table 6.3 – Results of STEM – 1st round.

Objective functions	**Units**	**Sol. 5**	**Sol. 6**	**Sol. 7**	**Sol. 8**
GDP	R$ × 10^3 (2009 constant prices)	4,294,478	4,273,006	4,344,811	4,279,639
GHG	Gg CO_2eq	2,716,181	2,708,414	2,735,498	2,710,813
Main Indicators	**Units**				
Total Energy Consumption	toe × 10^3	269,074	267,365	273,203	267,893
Employment	Employees × 10^3	54,611	54,393	55,132	54,460
Consumption of residents	R$ × 10^3 (2009 constant prices)	2,615,111	2,591,341	2,662,598	2,598,684
Consumption expenditure - general government	R$ × 10^3 (2009 constant prices)	922,816	922,816	922,816	922,816
Changes in inventories	R$ × 10^3 (2009 constant prices)	-9,970	-9,933	-10,069	-9,945
Gross fixed capital formation	R$ × 10^3 (2009 constant prices)	861,608	861,608	861,608	861,608
Imports including tourism	R$ × 10^3 (2009 constant prices)	431,280	429,194	436,160	429,838
Exports including the tourism	R$ × 10^3 (2009 constant prices)	336,194	336,368	344,019	336,315
Gross value added	R$ × 10^3 (2009 constant prices)	3,709,550	3,691,554	3,751,854	3,697,113
Total indirect taxes less subsides	R$ × 10^3 (2009 constant prices)	584,929	581,453	592,958	582,526
GDP current	R$ × 10^3 (2018 current prices)	6,641,188	6,605,418	6,725,038	6,616,467
Households disposable income	R$ × 10^3 (2018 current prices)	4,631,526	4,589,428	4,715,629	4,602,433
General government structural balance	R$ × 10^3 (2018 current prices)	-188,015	-176,412	-133,632	-179,996
General government gross debt	R$ × 10^3 (2018 current prices)	4,616,594	4,788,928	4,562,211	4,796,939

The non-dominated solutions computed using the interactive STEM method are displayed in Table 6.3. In this first application of the STEM method (1st round) only two objective functions (maximization of GDP and minimization of GHG emissions; see the corresponding individual optimal solutions in Table 6.1) have been considered. Solution 5 (the initial solution computed by STEM) minimizes a weighted Tchebycheff (min-max) distance to the ideal solution (the values in bold in Table 6.1). For the second STEM iteration a relaxation of 0.5% of the GDP value obtained in solution 5 was specified. This information involves reducing the feasible region in such a way that a new solution (6) is computed trying to improve the total GHG emissions at the expense of letting GDP worsening at most 0.5% with respect to solution 5. Let us suppose that after analyzing solution 6, the DM decides to relax the value of GHG emissions. For this purpose a constraint allowing an increase of 1% in the GHG emissions obtained in solution 6 is included in the model in order to improve the GDP values, leading to solution 7. Finally, the DM decides to assess the effects of a further reduction of 1.5% in the GDP values obtained in solution 7 in order to further improve the GHG emission level, thus obtaining solution 8. The main characteristics of these solutions are described in Table 6.3.

Table 6.4 – Results of STEM – 2nd Round.

Objective functions	Units	Optimal Values	Sol. 9	Sol. 10	Sol. 11
GDP	R$ × 10^3 (2009 constant prices)	**4,351,337**	4,236,658	4,239,417	4,264,057
Energy Consumption	Toe × 10^3	**257,244**	264,410	264,173	266,653
GHG	Gg CO_2eq	**2,697,318**	2,695,334	2,705,177	2,705,177
Employment	Employees × 10^3	**55,324**	54,024	54,116	54,302
Main Indicators	**Units**				
Consumption of residents	R$ × 10^3 (2009 constant prices)	-	2,551,100	2,497,578	2,581,435
Consumption expenditure - general government	R$ × 10^3 (2009 constant prices)	-	922,816	922,816	922,816
Changes in inventories	R$ × 10^3 (2009 constant prices)	-	-9,870	-9,958	-9,918
Gross fixed capital formation	R$ × 10^3 (2009 constant prices)	-	861,608	861,608	861,608
Imports including tourism	R$ × 10^3 (2009 constant prices)	-	425,656	425,580	428,324
Exports including the tourism	R$ × 10^3 (2009 constant prices)	-	336,660	392,953	336,441
Gross value added	R$ × 10^3 (2009 constant prices)	-	3,661,086	3,664,141	3,684,053
Total indirect taxes less subsides	R$ × 10^3 (2009 constant prices)	-	575,572	575,276	580,004
GDP current	R$ × 10^3 (2018 current prices)	-	6,544,865	6,549,462	6,590,510
Households disposable income	R$ × 10^3 (2018 current prices)	-	4,518,159	4,423,368	4,571,883
General government structural balance	R$ × 10^3 (2018 current prices)	-	-193,215	-197,990	-177,890
General government gross debt	R$ × 10^3 (2018 current prices)	-	4,621,794	4,626,569	4,606,469

Since the main feature of multi-objective models is allowing the explicit consideration of the various axes of evaluation to enable the exploration of trade-offs, we have complemented the analysis by computing non-dominated solutions using the interactive STEM method applied to the four objectives previously specified (2nd round), which are displayed in Table 6.4. Solution 9 (the initial solution computed by STEM) minimizes a weighted Tchebycheff distance to the ideal solution (“optimal values” column in Table 6.4). For the second STEM iteration a relaxation of 1.5% of the GHG emissions value obtained in solution 9 was specified. This information involves reducing the feasible region in such a way that a new solution (10) is computed trying to improve the objective functions that are not yet considered as having a satisfactory value, at the expense of letting the GHG emissions worsen at most 1.5% with respect to solution 9. Since the values for solution 10 were not yet satisfactory a relaxation value of 1.5% of increase in the energy consumption was specified, leading to solution 11.

The main characteristics of these solutions are:

Solution 9: In this solution all objective functions achieved intermediate values in the range of variation between the best and worst values in Table 6.1. The GDP decreased about 2.64% and the employment level 2.34% compared to their optimal values, while the energy consumption and the GHG emissions increased 2.96% and 1.35%, respectively.

Solution 10: The relaxation of GHG emissions by 1.5% gives room for slight improvements in the other objectives. The GDP and the employment level increased about 0.07% and 0.17% in relation to solution 9, while the energy consumption decreased 0.09% in relation to solution 9. It is important to refer that even allowing to increase the value for GHG emissions in 1.5% with respect to solution 9, the GHG emissions does not reach the maximum acceptable value defined for the relaxation (approximately 2,736 Tg CO_2eq) increasing only 0.37%.

Solution 11: The relaxation of the energy consumption level by 1.5% is also not fully used - this objective only increased 0.94%. In addition, this relaxation provided only slight improvements in the other objectives, in which the GDP and employment level increased 0.58% and 0.34% with respect to solution 10, respectively, and the GHG emissions did not change. Further relaxations, for instance, in the GDP, would not result in the variation of any of the objective function values. The reduced feasible region after the previous STEM iterations becomes too rigid in such a way that a relaxation of GDP is not able to improve the values in any of the other objectives. Thus, solution 11 can be considered a well-balanced solution according to the preferences revealed by the DM, or the interactive procedure may be restarted in order to assess the tradeoffs unveiled by different relaxations.

The values of the objective functions in all solutions are displayed in Figure 6.1. In this figure each quadrant represents a graph with the values of the objective function (in columns) for each non-dominated solution obtained in the individual optimization of each objective and using the STEM method (in rows). It is possible to recognize the trade-offs between the competing objectives as relaxation values are specified with the aim to improve the objectives whose values are not yet considered satisfactory. The employment level displays a higher sensitivity to the preference information supplied by the DM (in the form of relaxations of some objective functions), which provides hints on how the trade-offs between the objective functions may be exploited in policy design.

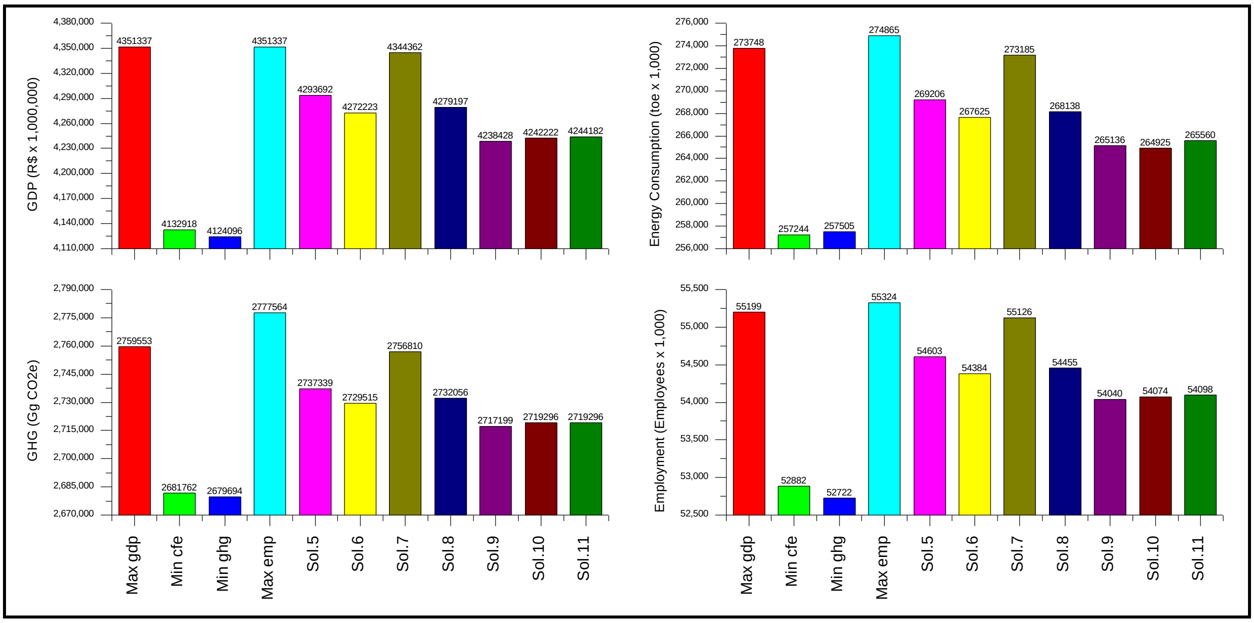

Figure 6.1 – Objective function values for the individual optimal solutions and the solutions computed using STEM (2nd round).

Table 6.5 – Estimated Brazilian energy mix in 2018 (toe × 10^3).

	EPE-2012	EPE-2018	Sol.1	Sol.2	Sol.3	Sol.4	Sol.9	Sol.10	Sol.11
Total Fossil Fuels	**128,500**	**161,794**	**137,782**	**129,553**	**129,383**	**139,318**	**133,278**	**134,352**	**134,314**
Diesel	46,280	57,919	48,766	45,822	45,853	49,120	47,104	47,357	47,492
Fuel Oil	4,170	5,655	7,749	7,334	7,304	8,034	7,528	7,708	7,573
Gasoline	24,512	28,066	19,733	18,272	18,415	19,019	18,846	18,441	19,075
GLP	8,023	9,360	9,850	9,179	9,227	9,565	9,456	9,295	9,557
Kerosene	3,769	4,981	3,780	3,550	3,551	3,790	3,652	3,661	3,682
Natural Gas	17,349	25,512	20,543	19,401	19,335	21,130	19,921	20,308	20,054
Coal and Coke	11,588	15,543	10,533	10,040	9,908	11,228	10,338	10,758	10,368
Other fossil fuels	12,809	14,759	16,827	15,955	15,791	17,431	16,434	16,824	16,513
Total Renewable	**108,243**	**152,737**	**135,958**	**127,247**	**127,871**	**134,208**	**131,132**	**129,821**	**132,339**
Wood	16,428	16,619	21,985	20,556	20,577	21,798	21,192	21,099	21,386
Charcoal	4,646	6,974	5,108	4,845	4,797	5,349	4,992	5,139	5,014
Sugarcane Bagasse	28,391	38,814	36,593	33,851	34,450	36,723	35,111	34,791	35,462
Electricity	42,862	56,296	49,969	47,204	47,131	48,336	48,455	47,567	48,868
Bioethanol	9,916	20,599	15,808	14,637	14,752	15,234	15,097	14,771	15,280
Other renewables	6,000	13,436	6,494	6,154	6,165	6,767	6,286	6,454	6,329
TOTAL	**236,744**	**314,531**	**273,740**	**256,800**	**257,254**	**273,526**	**264,410**	**264,173**	**266,653**

The energy consumption by energy source obtained in the solutions that individually optimize each objective (solutions 1 to 4) and in the 2nd round of STEM (solutions 9 to 11) is displayed in Table 6.5. The consolidated values calculated by the Brazilian Energy Research Center (*Empresa de Pesquisa Energética* - EPE) for 2012 (EPE – 2012) and the prospective values for 2018 (EPE – 2018) (EPE, 2011; 2013) are displayed in the first and second columns as references. The values attained in almost all energy sources are higher than the values obtained in 2012 (confirming the assumption that energy consumption follows the economic growth trend) and lower than the values estimated by (EPE, 2011), although some variations between all solutions are verified. The highest deviation occurs in the gasoline and bioethanol consumption. This fact is explained because (EPE, 2011) considered that a substitution between the consumption of both fuels may occur in the next years in the transportation sector. This fact suggests a weakness of this kind of modeling formulation, which is unable to capture these effects. However, the values obtained in all simulations are closer to the consolidated values in 2012, which can afford that the fuel consumption in the transportation sector cannot attain the substitution effect estimated in EPE (2011) unless an abrupt structural change occurs in the next years, such as an increase of lignocellulosic-based bioethanol production (supply side) or policies providing comparative advantages for bioethanol consumption in relation to gasoline or liquefied petroleum gas (demand side).

Table 6.6 – Total GHG emissions by emission source in each solution (Gg CO_2eq).

	2005	2020	Sol. 1	Sol. 2	Sol. 3	Sol. 4	Sol. 9	Sol.10	Sol.11
Fugitive Emissions (a)	**18,679**	**868,000** (a+b)	**13,880**	**13,183**	**13,177**	**14,925**	**13,418**	**14,007**	**13,504**
Energy Combustion (b)	**312,092**		**473,624**	**445,646**	**444,799**	**478,268**	**458,558**	**461,816**	**462,045**
Energy Industry	52,726	-	75,776	71,581	71,479	76,478	73,352	73,954	73,914
Other Industries	78,910	-	134,783	128,108	126,557	141,132	132,101	135,949	132,589
Transportation	134,575	-	209,699	196,057	196,586	207,684	201,849	200,842	203,772
Others Sources	45,881	-	53,366	49,900	50,178	52,974	51,256	51,071	51,770
Industrial Processes (c)	**72,553**	**234,031** (c+d)	**95,866**	**91,169**	**89,739**	**99,995**	**94,184**	**96,769**	**94,482**
SWD and Wastewater (d)	**47,857**		**116,924**	**116,255**	**116,303**	**117,026**	**116,513**	**116,583**	**116,609**
Agriculture	**461,048**	**729,752**	**697,536**	**653,916**	**655,111**	**702,232**	**672,468**	**675,808**	**678,344**
LUC	**1,340,979**	**1,403,521**	**1,340,193**	**1,340,193**	**1,340,193**	**1,340,193**	**1,340,193**	**1,340,193**	**1,340,193**
TOTAL	**2,253,208**	**3,235,305**	**2,738,023**	**2,660,362**	**2,659,322**	**2,752,640**	**2,695,334**	**2,705,177**	**2,705,177**

In Table 6.6 the GHG emissions of different emission sources obtained in each solution (1 to 4 and 9 to 11) are displayed. The GHG emissions for 2005 estimated in the Brazilian National GHG Inventory (MCT, 2010) and the prospective values for 2020 from (Brasil, 2010) are displayed in the first and second columns as references. It is possible to verify that the emissions from energy combustion in other industries and solid waste and wastewater are the items presenting highest increases (at least 60% and 143%, respectively) compared to the official results in the Brazilian National GHG Inventory (MCT, 2010), whereas the other items present lower improvements varying between 23.69% (for industrial processes) and 42.52% (for energy combustion). A negative variation is also verified in the fugitive emissions, probably due to a lower number of emission sources computed in this study. It is noteworthy that, in addition to the energy combustion, the major source of reductions of GHG emissions in solutions 2 and 3 is derived from agriculture activities. Thus, it is important Brazil continues promoting the substitution of fossil fuels for renewable energy, as well as investing in energy efficiency measures. Moreover, a reduction of the energy intensiveness in the agriculture sector and adoption of procedures to decrease the emissions specially from enteric fermentation will provide remarkable benefits in reducing the total GHG emissions in Brazil, since the country is one of the world's largest agricultural and livestock producers.

From the results herein presented it can be concluded that it will be a difficult challenge for Brazil (according to 2009 technological coefficients) achieving the prospective economic growth (about 2.5-3.5% (IMF, 2014)), guaranteeing improvements in social welfare, while decreasing the energy consumption and accomplishing GHG emission reduction targets. Brazil aims at voluntarily decreasing the prospective GHG emissions in 2020 (approximately 3,236 Tg CO2eq; see Table 6.6) to a total ranging from 1,977 to 2,068 Tg CO2eq (Brasil, 2010) and the results herein obtained are quite far from these targets even in a best case scenario. However, it should be mentioned that the LUC and forestry emissions are considered in this study as a constant value of 2000 according to data obtained from the Brazilian National GHG Inventory (MCT, 2010). Since LUC and forestry emissions are responsible for almost 50% of the total GHG emissions in the country, the results obtained may be somewhat biased. Policies aiming a significant reduction in this emission source can allow the country obtaining considerable improvements toward this reduction target. Therefore, if better results of this item in future updates of National GHG Inventories are considered in the model, a downward variation of the total GHG emissions estimates is possible regarding the ones presented in this study. Making endogenous the estimates of the emissions from these sources in this type of analysis in future upgrades of this model can also contribute to diminish this bias problem.

6.2 SOLUTIONS USING THE INTERACTIVE TRIMAP METHOD

The TRIMAP interactive method, which is briefly described in section 4.1.7.2 of Chapter 4, has also been used to make a progressive and selective search for non-dominated solutions using the Extended Hybrid IO MOLP model and the information provided by the DM. Two features of TRIMAP have been applied: the decomposition of the parametric diagram (“weight space”) into indifference regions and the introduction of constraints in the objective function values that are then translated into constraints for limiting the search in the parametric diagram. The graphical tools of TRIMAP, in particular the parametric diagram, allows the DM obtaining insightful information about the trade-offs at stake by progressively learning and exploiting the characteristics of the non-dominated region and then narrowing down the scope of the search toward a solution (or set of solutions) according to his/her preferences.

The objective functions considered are the maximization of GDP and the minimization of the total energy consumption and GHG emissions. Firstly, each objective function was optimized individually, resulting in 3 distinct non-dominated solutions (see Figure 6.1-A and Table 6.1). These solutions provide a first overview of the range of variation of the objective values within the non-dominated region. The characterization of these solutions (objective function and decision variable values, and indifference regions in the parametric diagram) is presented to the DM. Next, the DM indicates a set of weights not yet belonging to an indifference region in the parametric diagram to compute a new non-dominated solution. The weight specification should be understood not as a precise "importance coefficient" but rather as an indication of the objective functions to be (temporarily) privileged in the subsequent search. Note that the area of the indifference region in the parametric space also gives an indication of the solution "robustness" regarding weight changes. Information about some solutions may lead the DM to conclude that it is not worthwhile to proceed with the search using weights in-between the corresponding indifference regions because the solutions then obtained would not be so different and therefore would not be relevant for decision support purposes. This enables a progressive and selective search of the non-dominated solution set using the parametric diagram as a valuable visual feedback tool enabling to identify sub-sets of solutions sharing similar characteristics, namely trade-offs between the competing objectives, until a satisfactory compromise solution is identified.

In this case, the parametric diagram was interactively and gradually filled with indifference regions corresponding to 14 non-dominated (basic) solutions that have been considered providing sufficient information about different policies – see Figures 6.2-B-C-D, in which ($\lambda 1$, $\lambda 2$, $\lambda 3$) denote the weights assigned to each objective function (F1, F2, F3) to build a scalar weighted-sum function to be optimized leading to the identification of the corresponding indifference region using the multi-objective simplex tableau.

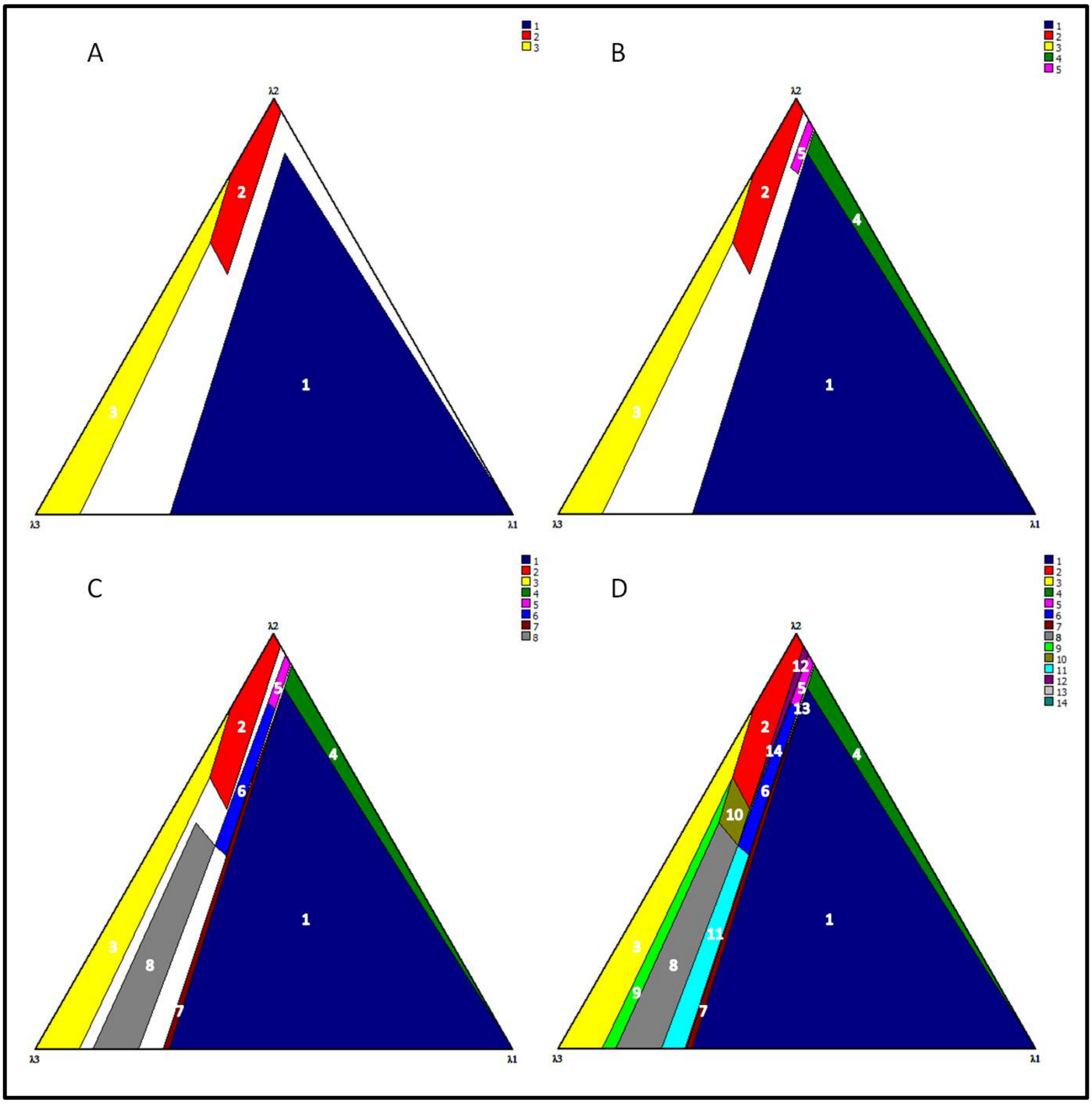

Figure 6.2 – Decomposition of the parametric diagram into indifference regions (corresponding to basic non-dominated solution).

Analyzing the objective function values, for example, of solutions 2, 5 and 6 in Figure 6.2-C it is possible that the DM has enough information to conclude that it is not worthwhile searching for new solutions in the parametric diagram region located between the indifference regions corresponding to those solutions (which would correspond to solutions 12 and 14 in Figure 6.2-D). The visual information displayed in the parametric diagram thus contributes to minimize the computational effort and the number of uninteresting solutions generated during the exploitation of the problem (and thus the information processing effort required from the DM).

Figure 6.3 – Additional bounds on the objective functions and regions in the parametric diagram satisfying them – 1st Round.

Another useful procedure offered by the TRIMAP interactive method was then applied. Additional bounds are imposed on the objective function values in order to narrow the scope of the search to regions of interest of the non-dominated solution set. This information stated in the objective function space (which is the most familiar space for the DM) is translated via an auxiliary problem into the parametric space, in which the regions of weights leading to solutions satisfying those bounds can be computed. In order to illustrate this feature of TRIMAP, in a preliminary analysis the DM established three bounds on the values of F1 ≥ R\$ 4,135,000 × 10^3, F2 ≤ 268,600 toe × 10^3 and F3 ≤ 2,700,000 Gg CO_2eq which are individually displayed in Figures 6.3-E-F-G. These bounds represent the expression of reservation levels, i.e. the DM stating that he/she is not interested in solutions providing worst values than those stated in those additional constraints. This restricts the search process to regions in the intersection area displayed in Figure 6.3-H. An exhaustive search in that area leads to the computation of solutions 2, 5, 6, 8, 10, 11, 12 and 14.

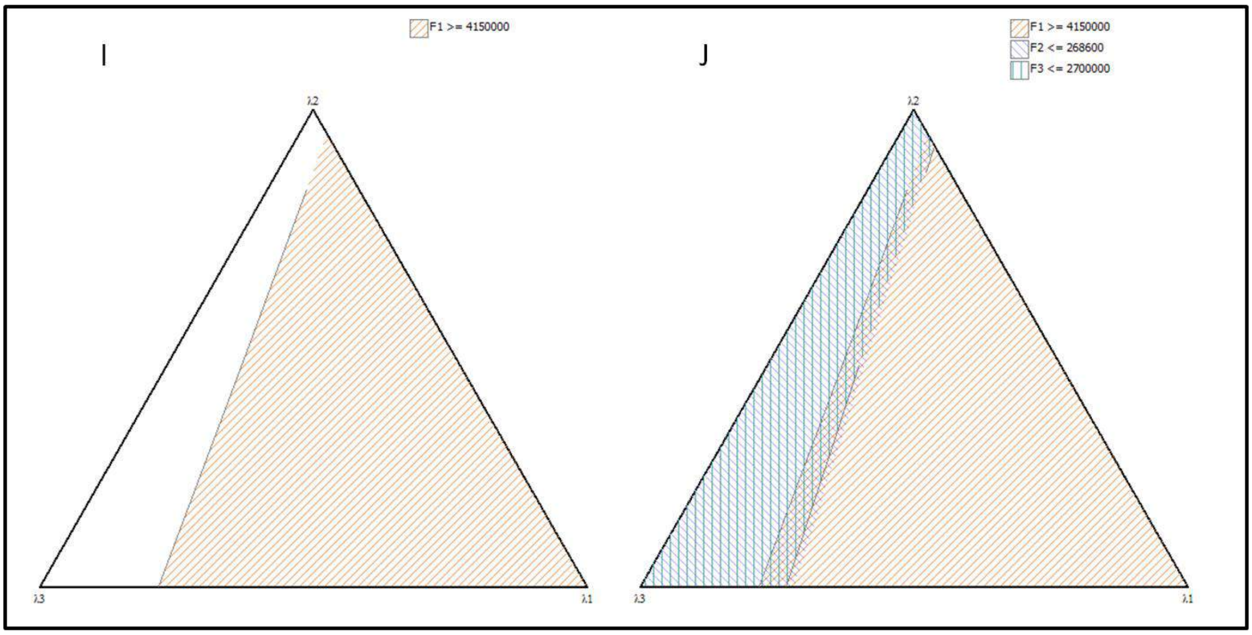

Figure 6.4 – Additional bounds on the objective functions and regions in the parametric diagram satisfying them – 2nd Round.

After these first experiments let us suppose that the DM decides to introduce an additional bound on the GDP level (i.e., F1 ≥ R$ 4,150,000 × 10^3, see Figure 6.4-I) in order to constrain the region of weights leading to solutions satisfying those bounds. This additional constraint reduces the search process to regions that include solutions 5, 6, and 11 (see Figure 6.4-J). This feature of TRIMAP is particularly valuable to reduce the scope of the search aligned with the DM's preferences (see Clímaco & Antunes, 1987, 1989, for technical details).

The weights chosen and objective function values of the 14 non-dominated solutions computed using the TRIMAP interactive method are presented in Table 6.7. The values in bold are the components of the ideal solution with the optimal values for F1, F2 and F3 (GDP, energy consumption and GHG emissions, respectively).

Table 6.7 – Objective function values for some non-dominated solutions.						
Solution	**λ1**	**λ2**	**λ3**	**F1 (10^3 R$)**	**F2 (10^3 toe)**	**F3 (Gg $CO_{2\ eq}$)**
1	1.00	0.00	0.00	**4,351,337**	272,708	2,762,011
2	0.00	1.00	0.00	4,135,630	**256,343**	2,682,583
3	0.00	0.00	1.00	4,132,885	256,488	**2,681,924**
4	0.20	0.79	0.01	4,351,337	272,601	2,764,176
5	0.06	0.91	0.02	4,158,886	257,403	2,689,481
6	0.10	0.76	0.15	4,158,933	257,431	2,689,263
7	0.26	0.09	0.66	4,247,369	264,327	2,721,053
8	0.14	0.07	0.79	4,135,508	256,540	2,682,287
9	0.06	0.49	0.44	4,132,885	256,488	2,681,924
10	0.09	0.56	0.34	4,135,630	256,343	2,682,583
11	0.18	0.35	0.47	4,158,857	257,783	2,688,781
12	0.04	0.94	0.02	4,142,049	256,532	2,684,566
13	0.09	0.86	0.06	4,203,850	260,733	2,705,664
14	0.09	0.69	0.21	4,142,049	256,532	2,684,566

A more detailed analysis of the characteristics of the solutions can be made using the results of the model decision variables in addition to the objective function values. The results herein described will be focused on their most relevant aspects and characteristics of the main variables.

It is possible to verify a conflicting relation between GDP and energy consumption (and GHG emissions). In solution 1, which maximizes GDP (R$ 4,351,337 × 10^3), the energy consumption achieved its highest values (272,708 toe × 10^3), whereas the GHG emissions are very close to their worst value known in the non-dominated region (2,762,011 Gg of CO_2 eq). On the other hand, for solution 2, which minimizes energy consumption, GDP achieves a value (R$ 4,135,630 × 10^3) not far from its worst one (see Table 6.7) and GHG emissions are very close to their optimum (2,682,583 Gg of CO_2eq). In addition, for solution 3, which minimizes GHG emissions (2,681,924 Gg of CO_2 equivalent), GDP achieves the worst level (R$ 4,132,885 × 10^3) while energy consumption is only 0.01 % higher than the optimal value.

Three main regions can be distinguished in the parametric diagram corresponding to solutions with different characteristics. Firstly, it is possible to see that solution 4 is an alternative optimum of solution 1 with respect to F1 (note that the set of weights λ1=1, λ2=λ3=0 belongs to both indifference regions). An important characteristic of these solutions is the highest values obtained for almost all economic variables and employment level, which achieves its highest value in solution 4 (55,216 employees × 10^3) (see Table 6.8). The sectors that have the highest output improvement are linked to the energy, construction and manufacturing industries.

It is also possible to recognize through the visual inspection of the parametric diagram that a well defined “cut” exists marked by the “left” boundaries of the indifference regions associated with those solutions (1 and 4). Until that boundary the value for GDP is the same (the optimal one) with small (trade-off) variations in F2 and F3 values. The GDP value decreases smoothly for solutions beyond that boundary as the weight assigned to F1 approaches zero (that is, λ1 = 0 and λ2 + λ3 = 1). Different combinations of λ2 and λ3 with λ1 = 0 enable to obtain solutions 2 and 3.

Table 6.8 – Values of some economic variables for the corresponding solutions (R$ constant 2009 prices)*.

	Sol. 1	Sol. 2	Sol. 3	Sol. 4	Sol. 5	Sol. 6
Consumption of residents	2,654,992	2,474,379	2,482,196	2,643,754	2,463,990	2,463,936
Consumption expenditure - general government	922,816	922,816	922,816	922,816	922,816	922,816
Changes in inventories	-10,099	-9,542	-9,492	-10,116	-9,735	-9,735
Gross fixed capital formation	861,608	819,800	807,318	861,608	861,608	861,608
Imports (including tourism)	435,536	410,926	409,632	435,333	416,861	416,765
Exports (including tourism)	357,556	339,104	339,679	368,608	337,068	337,072
Gross value added	3,757,564	3,576,423	3,574,127	3,757,701	3,595,932	3,595,938
Total indirect taxes less subsides	593,773	559,207	558,759	593,635	562,954	562,995
Employment*	55,210	52,913	52,866	55,216	53,224	53,223
*(thousands of employees)						

Table 6.8 – continuation

Sol. 7	Sol. 8	Sol. 9	Sol. 10	Sol. 11	Sol. 12	Sol. 13	Sol. 14
2,562,003	2,474,408	2,482,196	2,474,379	2,463,925	2,471,517	2,513,705	2,471,517
922,816	922,816	922,816	922,816	922,816	922,816	922,816	922,816
-9,888	-9,541	-9,492	-9,542	-9,735	-9,595	-9,813	-9,595
861,608	819,659	807,318	819,800	861,608	831,274	861,608	831,274
425,526	410,948	409,632	410,926	416,838	412,506	421,169	412,506
336,356	339,115	339,679	339,104	337,081	338,543	336,704	338,543
3,670,110	3,576,317	3,574,127	3,576,423	3,595,867	3,581,801	3,633,615	3,581,801
577,259	559,192	558,759	559,207	562,990	560,248	570,235	560,248
54,128	52,914	52,866	52,913	53,226	52,997	53,680	52,997

A second region involves solutions 2, 3, 8, 9, 10, 12 and 14, where the values for all objectives are very similar varying approximately 0.2% for GDP and 0.1% for energy consumption and GHG emissions between them. This region is characterized by lower values for GDP and values close to their optima for energy consumption and GHG emissions. An important drawback of these solutions is the negative impact on the employment level, which achieves its lowest values, especially in solutions 3 and 9 (52,866 employees × 10^3). An overall contraction of the economic activity is also identified, since lowest levels of GDP and gross value added are achieved in those solutions. Furthermore, the industrial sectors with negative impacts on their outputs, for example in solutions 2 and 3, are the energy intensive sectors, such as the extractive industry, petroleum refining and coke, chemicals and cement.

Note that solutions 9 and 10 are very similar to solutions 3 and 2, respectively. The difference in objective functions is only noticeable in decimals and slight changes occur is some decision variables.

Finally, the region containing solutions 5, 6, 7, 11 and 13 is characterized by intermediary values for all objective functions, with a variation of approximately 2.1% for GDP, 2.7% for energy consumption and 1.2% for GHG emissions between them. Solution 13 is representative of the main characteristics of the solutions within this region, with well-balanced values also for employment (53,680 employees × 10^3).

6.3 ANALYSIS OF THE BIOETHANOL SYSTEM

In this section the deterministic formulation of the Extended Hybrid IO MOLP model is used for an analysis of prospective 2G bioethanol production options. Firstly, the sugarcane sector, which is not explicitly available in the Brazilian IO table, is constructed (or disaggregated from the sector in which it appears) based on the methodology proposed in Cunha and Scaramucci (2006). For this purpose, estimates of the average utilization and costs of the main inputs in the life cycle of this sector (such as diesel oil, lubricants, agriculture inputs, salary, etc) were jointly used with the total output of this sector in 2009 available in the Brazilian Institute of Geography and Statistics (IBGE) database. The same procedure is also used to estimate a prospective sugarcane production scenario, in which optimized conditions of cultivation, harvesting and transportation are considered. Further details of this procedure are available in Appendix C.

Furthermore, the estimates of Macrelli *et al.* (2012) for eight different configurations of combined 1G+2G bioethanol production plants (2G-A to 2G-H) were used to calculate the cost of the main inputs utilized in each combined 1G+2G process to produce a monetary unit of bioethanol[2]. Those estimates were used to compute eight different sets of technical coefficients for the Brazilian bioethanol sector weighted by the total bioethanol produced in the 1G+2G plants for each scenario. Further details of this procedure are available in Appendix D.

These sets of technological coefficients of bioethanol production were used to substitute the technical coefficient of the bioethanol sector into the 2009 Brazilian technical

[2] The scenarios 2G-A to 2G-H represent the values for combined 1G+2G plants without mixing the material streams. The 1G process (autonomous distillery) comprises the traditional Melle-Boinot steps, while the 2G bioethanol production from sugarcane bagasse and leaves uses separate hydrolysis and fermentation (Macrelli *et al.*, 2012).

coefficient matrix in each optimization. Moreover, as referred to previously, two sugarcane production scenarios (current and prospective optimized conditions) will be considered and also inserted into the technical coefficient matrix according to the scenarios to be optimized. Therefore each bioethanol plant uses different sugarcane type as input: for the current scenario (1G) the sugarcane cultivated using average agricultural technology of Brazil in 2009 is considered, whereas for 1G-optimized and 1G+2G (2G-A to 2G-H) scenarios the sugarcane cultivated in optimized agricultural conditions – with mechanical harvesting, straw removal and delivery to the biorefinery – is considered.

Firstly, utilizing the Open Solver (OS; http://opensolver.org), each objective function (maximization of GDP at 2009 basic prices, maximization of the employment level, minimization of the total energy consumption, and minimization of the total GHG emissions) was optimized individually for the 1G scenario obtaining four distinct non-dominated solutions. These solutions provided an overview of the range of variation of the objective values within the non-dominated region.

Next, for the 1G scenario, the solution that minimizes the Tchebycheff distance to the ideal solution is computed, which allows obtaining a "balanced" compromise non-dominated solution to the MOLP model. The same procedure is then applied for the 1G-optimized and prospective technologies (1G+2G) scenarios, by substituting the 2009-average coefficient vector of the sugarcane sector by the optimized one – for all scenarios – and the coefficient vector of the bioethanol sector by the corresponding 1G+2G vector in each scenario. In this step, two additional constraints were included in the model in order to establish the values of GDP (at 2009 basic prices) and the total (anhydrous + hydrous) bioethanol production at the same levels obtained in the 1G scenario. This procedure enables to compare the impacts of the technologies on the other objectives (and decision variables) assuring the same economic performance and bioethanol production level.

Table 6.9 – Values of the objective functions in the non-dominated solutions individually optimizing each objective function.

Notation	Description	Units	2009*	Sol. 1	Sol. 2	Sol. 3	Sol. 4
				Max gdp	Max emp	Min cfe	Min ghg
gdp	Gross Domestic Product	R$ × 10^6 (constant 2009 prices)	3,239,404	**4,351,337**	4,351,337	4,133,118	4,126,511
emp	Employees	Emp. × 10^3	41,208	55,200	**55,319**	52,883	52,766
cfe	Energy consumption – total	toe × 10^3	205,679	273,740	273,526	**256,800**	257,254
ghg	GHG emissions – total	Gg CO_2eq	2,406,175	2,738,023	2,752,640	2,660,362	**2,659,322**

Table 6.10 – Values of the main variables in the non-dominated solutions presented in Table 6.9.

Notation	Description	Units	2009*	Sol. 1	Sol. 2	Sol. 3	Sol. 4
				Max gdp	Max emp	Min cfe	Min ghg
sug	Sugarcane	R$ × 10^6 (constant 2009 prices)	21,098	26,612	26,703	24,569	25,050
ba	Bioethanol Anhydrous	Litres × 10^6	7,014	8,836	8,922	7,014	8,325
bh	Bioethanol Hydrous	Litres × 10^6	19,089	24,929	24,633	22,521	23,357
cpr	Consumption of residents	R$ × 10^6 (constant 2009 prices)	1,979,751	2,668,603	2,574,038	2,475,401	2,494,412
g	Consumption expenditure - general government	R$ × 10^6 (constant 2009 prices)	687,001	922,816	922,816	922,816	922,816
sc	Changes in inventories	R$ × 10^6 (constant 2009 prices)	-7,471	-10,082	-10,221	-9,527	-9,405
gfcf	Gross fixed capital formation	R$ × 10^6 (constant 2009 prices)	585,317	861,608	861,608	816,599	786,297
impfob	Imports	R$ × 10^6 (constant 2009 prices)	360,847	436,793	436,188	411,438	408,272
expcpt	Exports	R$ × 10^6 (constant 2009 prices)	355,653	345,186	439,284	339,267	340,663
ts	Taxes	R$ × 10^6 (constant 2009 prices)	445,025	593,996	592,700	558,856	557,783
gva	Gross value added	R$ × 10^6 (constant 2009 prices)	2,794,379	3,757,340	3,758,636	3,574,262	3,568,728
gdpcurr	GDP current	R$ × 10^6 (current 2018 prices)	3,239,404	6,735,909	6,776,766	6,447,358	6,486,833
ydcurr	Residents' disposable income	R$ × 10^6 (current 2018 prices)	2,091,051	4,726,263	4,558,783	4,384,091	4,417,761
gbg^+-gbg^-	General Government Structural Balance	R$ × 10^6 (current 2018 prices)	-149,309	-130,120	-139,629	-245,756	-245,774
debt	General government gross debt	R$ × 10^6 (current 2018 prices)	2,167,856	4,558,698	4,568,207	4,674,334	4,702,954

*The values for *gdpcurr*, *ydcurr*, *ggb* and *debt* in the column 2009 are in current 2009 prices.

Table 6.11 – Values of the objective functions in the non-dominated solutions computed in each optimization considering the bioethanol scenarios.

Notation	Sol. 5	Sol. 6	Sol. 7	Sol. 8	Sol. 9	Sol. 10	Sol. 11	Sol. 12	Sol. 13	Sol. 14
	1G	1G Opt.	2G - A	2G - B	2G - C	2G - D	2G - E	2G - F	2G - G	2G - H
gdp	4,236,658	4,236,658	4,236,658	4,236,658	4,236,658	4,236,658	4,236,658	4,236,658	4,236,658	4,236,658
emp	54,024	54,024	54,029	54,024	54,024	54,016	54,013	53,998	54,005	54,000
cfe	264,410	264,410	264,379	264,409	264,405	264,453	264,474	264,588	264,519	264,581
ghg	2,695,334	2,695,337	2,695,190	2,695,333	2,695,314	2,695,541	2,695,641	2,696,177	2,695,853	2,696,145

Table 6.12 – Values of the main variables in the non-dominated solutions computed in each optimization considering the bioethanol scenarios.

Notation	Sol. 5	Sol. 6	Sol. 7	Sol. 8	Sol. 9	Sol. 10	Sol. 11	Sol. 12	Sol. 13	Sol. 14
	1G	1G Opt.	2G - A	2G - B	2G - C	2G - D	2G - E	2G - F	2G - G	2G - H
sug	25,536	25,536	25,021	24,423	24,473	23,455	23,152	21,565	22,238	21,739
ba	8,439	8,439	8,445	8,444	8,444	8,443	8,485	8,502	8,461	8,516
bh	23,867	23,867	23,862	23,862	23,862	23,863	23,822	23,805	23,846	23,791
cpr	2,551,100	2,551,101	2,549,135	2,549,557	2,549,827	2,551,814	2,552,048	2,551,951	2,551,637	2,552,113
g	922,816	922,816	922,816	922,816	922,816	922,816	922,816	922,816	922,816	922,816
sc	-9,870	-9,870	-9,875	-9,874	-9,874	-9,869	-9,479	-9,238	-9,700	-9,108
gfcf	861,608	861,608	861,608	861,608	861,608	861,608	861,608	861,608	861,608	861,608
impfob	425,656	425,656	426,333	426,260	426,309	426,363	426,093	425,689	425,965	425,681
expcpt	336,660	336,660	339,306	338,811	338,589	336,653	335,758	335,209	336,262	334,911
ts	575,572	575,574	575,636	575,661	575,664	575,732	575,729	575,776	575,754	575,768
gva	3,661,086	3,661,083	3,661,022	3,660,997	3,660,994	3,660,926	3,660,929	3,660,882	3,660,904	3,660,890
gdpcurr	6,544,865	6,544,865	6,544,865	6,544,865	6,544,865	6,544,865	6,544,865	6,544,865	6,544,865	6,544,865
ydcurr	4,518,159	4,518,160	4,514,679	4,515,426	4,515,904	4,519,422	4,519,838	4,519,666	4,519,110	4,519,952
gbg^+-gbg^-	-193,215	-193,239	-193,232	-193,190	-193,152	-192,900	-192,912	-192,962	-192,980	-192,946
debt	4,621,794	4,621,818	4,621,811	4,621,769	4,621,731	4,621,478	4,621,490	4,621,540	4,621,559	4,621,525

Tables 6.9, 6.10, 6.11 and 6.12 outlines the results for the objective functions and main variables of 14 non-dominated solutions corresponding to: 4 solutions regarding the individual optimization of each objective function (GDP, employment level, total energy consumption and total GHG emissions) considering the 1G scenario (Tables 6.9 and 6.10); 10 solutions for the minimization of the Tchebycheff distance to the ideal solution for the 1G, 1G-optimized and prospective 1G+2G scenarios (solutions 5 to 14 in Tables 6.11 and 6.12). The 2009 values (the base year) of each objective function and variables are included in Tables 6.9 and 6.10 for comparison purposes.

The solutions that minimize the Tchebycheff distance to the ideal solution present objective function values which are well balanced in comparison with the solutions that individually optimize each objective (which are more "extreme"). In a first overall analysis solutions considering different bioethanol scenarios (1G, 1G-optimized and 1G+2G) display a reduction between 1.17 to 1.32 million of employees compared to the solutions individually optimizing GDP and employment objectives, as well as an increase of approximately 1.11 to 1.26 million of employees compared to the solutions individually optimizing energy consumption and GHG emissions. In addition, the energy consumption and GHG emissions in the solutions pertaining to the bioethanol scenarios present a reduction between 8.94 to 9.36 million toe and 41,846 to 57,450 Gg CO_2eq, respectively, compared to the solutions individually optimizing GDP and employment objectives, as well as an increase of 7.13 to 7.79 million toe and 34,828 to 36,854 Gg CO_2eq, respectively, compared to the solutions individually optimizing those objectives.

Solution 6 (that minimizes the Tchebycheff distance to the ideal solution for the 1G-optimized scenario) presents marginal impacts in terms of energy consumption and GHG emissions, as well as unexpressive variations in the employment level in relation to solution 5 (that minimizes the Tchebycheff distance to the ideal solution for the 1G – 2009 average – scenario). In solution 6 the total energy consumption and GHG emissions are raised by 0.57 toe $\times 10^3$ and 2.75 Gg CO_2eq, respectively, compared to the 1G scenario. Although the more efficient and higher load capacity trucks for sugarcane transportation demand relatively less diesel oil and lubricants, the requirements of these products are higher as much as the mechanical harvesting process are applied, therefore counterbalancing the impacts. It is noteworthy that due to a lack of a reliable methodology and data shortage the model has not considered the substitution effects on the direct employment requirements from the harvesting and transportation activities in the 1G-optimized scenario in comparison to the 1G scenario.

Thus, the marginal variation observed in the total number of employees is mainly due to indirect effects on the total output of other sectors.

The total GHG emissions and energy consumption are dissimilar between the 1G+2G scenarios. While solutions 7 to 9 displays lower or similar values compared to the 1G and 1G-optimized scenarios, solutions 10 to 14 present relatively higher values. In addition, the same dissimilarities are observed in the general employment level. Whereas the employment level increases or have similar values in solutions 7 to 9 (achieving the highest values in scenario 2G-A representing a raise of approximately 5.19×10^3 employees compared to the 1G scenario), the employment level decreases in solutions 10 to 14 (achieving the lowest values in scenario 2G-F representing a reduction of almost 25.80×10^3 employees compared to the 1G scenario). These dissimilarities regarding the energy consumption, GHG emissions and employment level can be explained by the higher use of chemicals, especially enzymes (see Table D.2 in Appendix D), in the scenarios 10 to 14 in relation to scenarios 7 to 9. This fact raises the output of the chemical sector leading to direct and indirect effects on the energy consumption (and consequently on the GHG emissions), as well as on the overall employment level. Another important characteristic is that all 1G+2G scenarios display a reduction in the total sugarcane outputs, achieving the lowest value in the scenario 2G-F (R$ $21,565 \times 10^6$), validating the assumption that less sugarcane is demanded in combined 1G+2G plants in relation to 1G plants to produce the same bioethanol amount.

It is also possible to verify in Table 6.12 that even fixing the GDP and the total bioethanol values for computing those solutions, the economic structure is remarkably dissimilar in each solution (the same occurs for the amount of hydrous and anhydrous bioethanol produced). The main characteristics of those solutions include: an overall increase of exports, imports and taxes in the 1G+2G scenarios compared to the 1G scenario, while the values of general government structural balance (in absolute terms), general government gross debt and gross value added have a marginal overall decrease.

In order to compare the potential of these new technologies in increasing the total bioethanol production, as well as the impacts on the economic, environmental, energy and employment levels, the maximization of the total output of anhydrous and hydrous bioethanol commodities in each of the 10 different bioethanol production scenarios are considered. The results of the main variables in the solutions (15 to 24) computed in the optimization of each scenario are presented in Tables 6.13 and 6.14.

Table 6.13 – Values of the objective function in the non-dominated solutions computed in each optimization considering the maximization of the bioethanol production in each scenario.

Notation	Sol. 15	Sol. 16	Sol. 17	Sol. 18	Sol. 19	Sol. 20	Sol. 21	Sol. 22	Sol. 23	Sol. 24
	1G	1G Opt.	2G - A	2G - B	2G - C	2G - D	2G - E	2G - F	2G - G	2G - H
ba + bh	35,885	35,885	35,894	35,895	35,895	35,898	35,899	35,900	35,897	35,901

Table 6.14 – Values of the main variables in the non-dominated solutions computed in each optimization considering the maximization of the bioethanol production in each scenario.

Notation	Sol. 15	Sol. 16	Sol. 17	Sol. 18	Sol. 19	Sol. 20	Sol. 21	Sol. 22	Sol. 23	Sol. 24
	1G	1G Opt.	2G - A	2G - B	2G - C	2G - D	2G - E	2G - F	2G - G	2G - H
gdp	4,276,212	4,276,211	4,276,609	4,276,671	4,276,693	4,276,899	4,276,986	4,277,124	4,276,972	4,277,155
emp	52,252	52,252	52,256	52,251	52,253	52,248	52,247	52,234	52,238	52,237
cfe	284,614	284,614	284,500	284,572	284,550	284,617	284,620	284,833	284,793	284,782
ghg	2,803,884	2,803,884	2,803,701	2,803,946	2,803,985	2,804,657	2,804,900	2,805,540	2,804,993	2,805,578
sug	28,143	28,143	27,554	26,902	26,955	25,840	25,519	23,790	24,518	23,983
ba	9,703	9,703	9,777	9,777	9,781	9,799	9,809	9,805	9,787	9,814
bh	26,182	26,182	26,117	26,118	26,114	26,098	26,090	26,095	26,110	26,087
cpr	2,741,955	2,741,955	2,741,955	2,741,955	2,741,955	2,741,955	2,741,955	2,741,955	2,741,955	2,741,955
g	687,001	687,001	687,001	687,001	687,001	687,001	687,001	687,001	687,001	687,001
sc	-9,031	-9,032	-8,392	-8,397	-8,356	-8,202	-8,121	-8,157	-8,309	-8,081
gfcf	861,608	861,608	861,608	861,608	861,608	861,608	861,608	861,608	861,608	861,608
impfob	444,605	444,606	444,848	444,781	444,800	444,746	444,741	444,568	444,568	444,612
expcpt	439,284	439,284	439,284	439,284	439,284	439,284	439,284	439,284	439,284	439,284
ts	607,924	607,925	608,061	608,089	608,091	608,160	608,182	608,264	608,203	608,262
gva	3,668,287	3,668,286	3,668,548	3,668,582	3,668,602	3,668,740	3,668,804	3,668,860	3,668,769	3,668,893
gdpcurr	7,145,234	7,145,224	7,145,641	7,145,657	7,145,676	7,145,793	7,145,844	7,145,885	7,145,768	7,145,918
ydcurr	4,856,175	4,856,175	4,856,175	4,856,175	4,856,175	4,856,175	4,856,175	4,856,175	4,856,175	4,856,175
gbg^+-gbg^-	-264,535	-264,535	-263,934	-263,833	-263,799	-263,472	-263,336	-263,112	-263,348	-263,064
debt	4,834,887	4,834,887	4,834,887	4,834,887	4,834,887	4,834,887	4,834,887	4,834,887	4,834,887	4,834,887

It is possible to verify that all solutions (15 to 24) achieved the upper limit established for the consumption of residents (2.75% higher than the values obtained in the optimization of GDP), total exports and GFCF. However, all bioethanol scenarios have negative impacts in terms of employment level. The minimum value is obtained in solution 22 that is 5.58% lower than the solution optimizing the employment level. This fact can be explained by the negative influence on the outputs of the public services (the sectors presenting the major decreases) due to the lowest level of final consumption expenditure of the general government in those solutions. The major drawbacks of those solutions are the negative impacts on the total energy consumption and the GHG emissions, which achieved in the best case (solution 17) 284,500 toe × 10^3 and 2,803,701 Gg of CO_2eq, respectively. This can be explained by the influence of the higher production of bioethanol on the overall production of all sectors (verified by the higher levels obtained in the gross value added) and exports, as well as direct and indirect effects from the higher consumption of chemical products in the 1G+2G scenarios.

Additionally, the values of imports and taxes in all scenarios increase between 1.78% to 1.84% and 2.34% to 2.40%, respectively, compared to the solution optimizing the GDP. Furthermore, an important characteristic of these solutions is that even obtaining highest values (in absolute terms) of general government gross debt, the relation between general government gross debt and GDP are lower than the solutions optimizing the energy consumption and GHG emissions. The average values in solutions 15 to 24 represent 67.7% of the GDP, while in the solutions optimizing the energy consumption and GHG emissions this relation achieves the upper limit of 72.5%. Finally, as expected, all 1G+2G scenarios provided improvements in terms of total bioethanol production achieving the highest level in solution 24 with a surplus of 15.47 million liters of bioethanol compared to the 1G scenario (solution 15). In addition, even with a higher bioethanol production the total sugarcane requirements are reduced in all 1G+2G scenarios, achieving the lowest value in solution 22 (R$ 23,790 × 10^6).

6.4 SOLUTIONS OF THE INTERVAL PROGRAMMING MODEL

In this section, the solutions to the MOLP model with interval coefficients presented in Chapter 5 are analyzed. Updated data from several sources were used for the numerical specification of the interval MOLP model[3] including 518 constraints and 473 variables. Firstly, the surrogate LP models (4.70) and (4.71) are solved for each objective function $Z_k(x)$ ($k = 1,\dots, p$) considering the best and worst case coefficients scenarios, which allow obtaining 8 different solutions representing the best and worst individual optima, respectively (see Chapter 4). The optimal solutions obtained are designated as x_k^β ($k = 1, 2,..., 4$ and $\beta = 0, 1$) such that $\beta = 0$ for solutions obtained with the broadest feasible region (therefore leading to the best individual optimal values of each objective function) and $\beta = 1$ for solutions obtained with the narrowest feasible region (therefore leading to the worst individual optimal values of each objective function). The values of these solutions are outlined in Table 6.15. It should be noticed that all objective functions are considered to be maximized so the values of GHG emissions and total energy consumption appear with negative signs.

[3] More details about the numerical specification of the model are presented in Appendix B.

Table 6.15 – Values of Z_k^L (x_k^β) and Z_k (x_k^β).								
	x_1^0	x_1^1	x_2^0	x_2^1	x_3^0	x_3^1	x_4^0	x_4^1
Z_1	**4,351,337**	4,308,051	4,351,337	4,308,051	4,132,345	4,138,455	4,131,816	4,137,884
Z_1^L	4,351,326	**4,308,040**	4,351,326	4,308,040	4,132,335	4,138,445	4,131,805	4,137,874
Z_2	55,538,859	54,995,429	**55,582,497**	55,027,037	53,149,633	53,158,226	53,147,211	53,155,866
Z_2^L	54,986,233	54,448,211	55,029,437	**54,479,504**	52,620,781	52,629,288	52,618,383	52,626,952
Z_3	-274,515	-271,897	-273,535	-270,819	**-256,742**	-257,401	-257,386	-258,236
Z_3^L	-274,517	-271,900	-273,538	-270,821	-256,744	**-257,403**	-257,388	-258,239
Z_4	-2,709,949	-2,698,481	-2,715,274	-2,702,395	-2,629,851	-2,634,835	**-2,628,821**	-2,633,864
Z_4^L	-2,816,182	-2,803,706	-2,822,041	-2,808,083	-2,729,359	-2,734,756	-2,728,341	**-2,733,779**

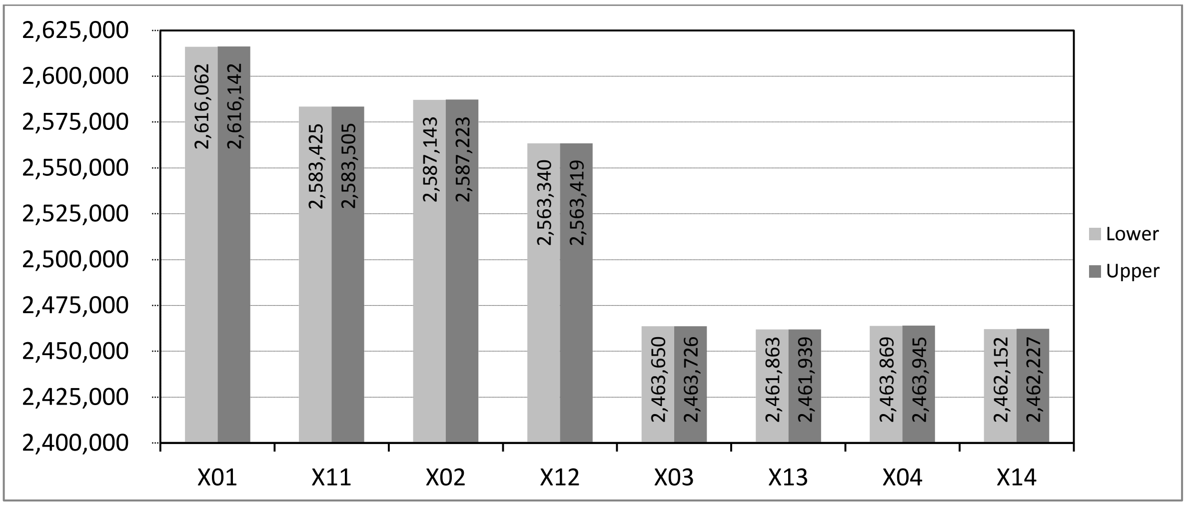

Figure 6.5 – Values for the consumption of residents in all 8 solutions of the surrogate LP models (R\$ × 10^6).

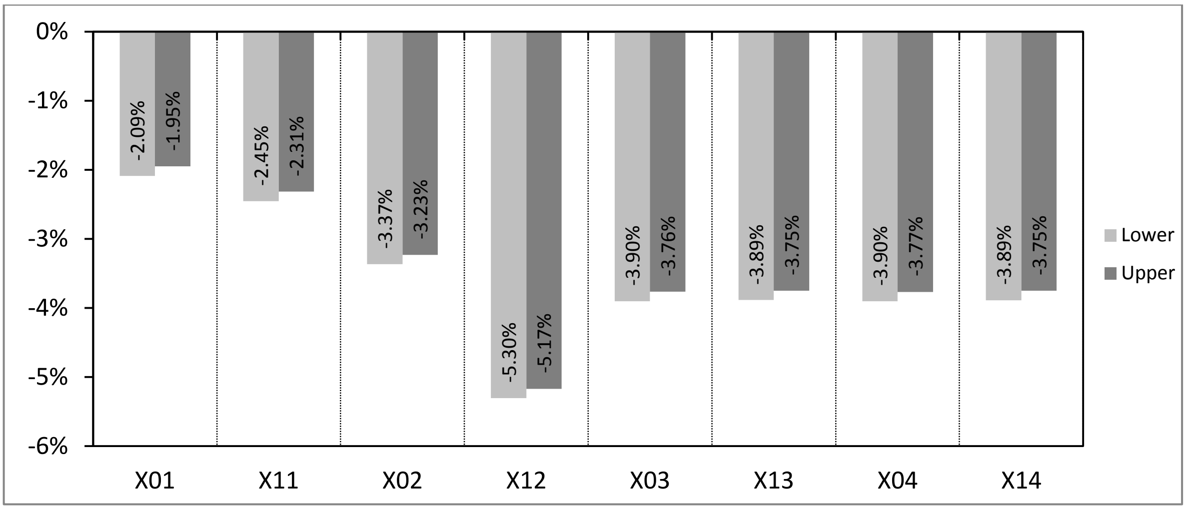

Figure 6.6 – Values for the general government structural balance in all 8 solutions of the surrogate LP models (% of GDP at current prices).

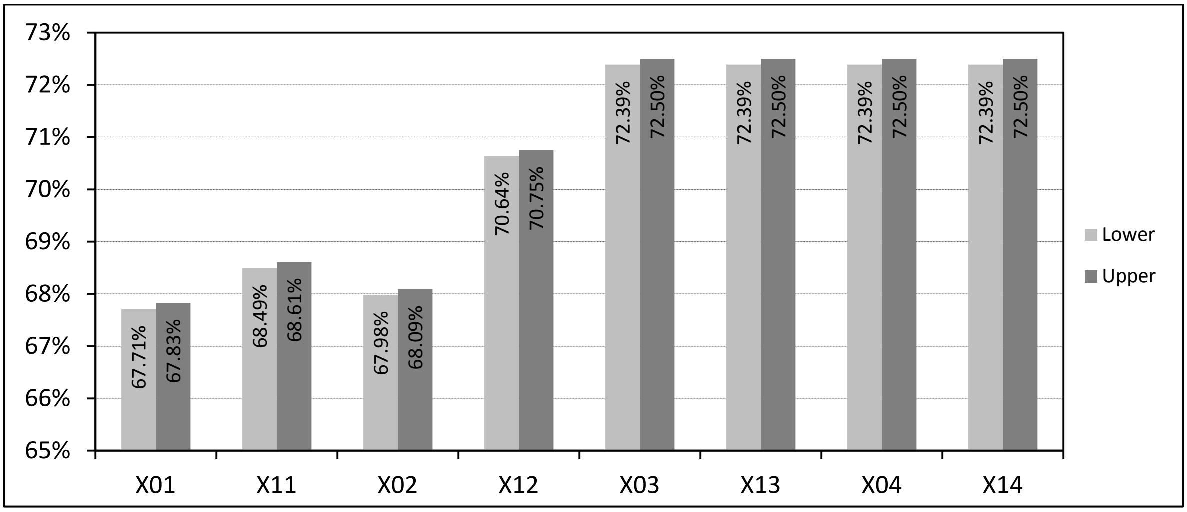

Figure 6.7 – Values for the general government gross debt in all 8 solutions of the surrogate LP models (% of GDP at current prices).

In solution x_1^0 (leading to the best optimal value of GDP) the average annual growth rate (AAGR) of real GDP achieved, as expected, the highest values of 3.81% (in both best and worst cases) with respect to the base year of the study. The AAGR of the nominal GDP has achieved between 11.99% (in the worst case) and 12.00% (in the best case). Moreover, the consumption of residents has the highest real AAGR compared to the 8 solutions initially obtained achieving approximately 3.57% in both scenarios (see Figure 6.5). The lowest level of general government structural balance as a percentage of GDP at current prices is reached in this solution ranging between -1.95% (in the best case scenario of coefficients) and -2.09% (in the worst case scenario of coefficients) (see Figure 6.6). The general government gross debt is also the lowest between all 8 solutions with values of 67.71% (in the worst scenario of coefficients) and 67.83% (in the best scenario of coefficients) (see Figure 6.7). The employment level also rose, with an AAGR between 3.72% (in the worst scenario of coefficients) and 3.86% (in the best scenario of coefficients) in relation to the base year of the study. These values follow the AAGR achieved for the real GDP, indicating a correlation between these indicators.

The composition of the energy mix of all solutions obtained with the broadest feasible region is presented in Table 6.16. The solution x_1^0 corresponding to the best optimal value of GDP at constants prices leads to the highest energy consumption (with values between 274,515 and 274,517 toe$\times 10^3$) of all solutions. However, it is worth noting that even with the highest level of total energy consumption the use of fossil fuels in solution x_1^0 is lower than in the solution optimizing the employment level (solution x_2^0). This fact is a result of higher use of renewable energy in solution x_1^0, mainly electricity generation, which achieved a value of approximately 50,299 toe$\times 10^3$. The total final energy consumption obtained in this solution is approximately 12.7% lower than the values estimated for 2018 based on the projections of EPE (2013) (see Table 6.5)[4].

Table 6.16 – Composition of the energy mix in solutions x_1^0 to x (toe × 10^3).

	x_1^0		x_2^0		x_3^0		x_4^0	
	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper
Total Fossil Fuels	**138,268.28**	**138,269.71**	**139,148.10**	**139,149.52**	**129,823.38**	**129,824.72**	**129,591.42**	**129,592.76**
Diesel	48,922.69	48,922.69	49,081.32	49,081.32	45,897.25	45,897.25	45,867.27	45,867.27
Fuel Oil	7,870.84	7,870.84	8,002.49	8,002.49	7,383.41	7,383.41	7,355.77	7,355.77
Gasoline	19,340.80	19,341.72	19,097.44	19,098.35	18,162.79	18,163.65	18,189.92	18,190.78
GLP	9,692.93	9,693.31	9,596.62	9,597.00	9,134.33	9,134.69	9,144.53	9,144.89
Kerosene	3,782.45	3,782.45	3,789.07	3,789.07	3,552.22	3,552.22	3,550.33	3,550.33
Natural Gas	20,717.80	20,717.93	21,065.42	21,065.55	19,502.08	19,502.21	19,409.21	19,409.34
Coal and Coke	10,913.13	10,913.13	11,151.33	11,151.33	10,149.41	10,149.41	10,120.35	10,120.35
Other fossil fuels	17,027.64	17,027.64	17,364.40	17,364.40	16,041.89	16,041.89	15,954.04	15,954.04
Total Renewable	**136,246.24**	**136,247.49**	**134,386.79**	**134,388.03**	**126,918.32**	**126,919.49**	**127,794.40**	**127,795.57**
Wood	21,882.39	21,882.86	21,818.80	21,819.27	20,526.09	20,526.54	20,532.25	20,532.69
Charcoal	5,239.85	5,239.89	5,322.48	5,322.52	4,882.81	4,882.85	4,872.49	4,872.52
Sugarcane Bagasse	36,687.85	36,687.85	36,708.72	36,708.72	33,729.91	33,729.91	34,302.64	34,302.64
Electricity	50,298.84	50,298.84	48,502.90	48,502.90	47,022.39	47,022.39	47,317.65	47,317.65
Bioethanol	15,492.91	15,493.65	15,297.25	15,297.98	14,549.26	14,549.95	14,571.08	14,571.78
Other renewables	6,644.40	6,644.40	6,736.64	6,736.64	6,207.86	6,207.86	6,198.30	6,198.30
TOTAL	**274,514.52**	**274,517.20**	**273,534.89**	**273,537.55**	**256,741.69**	**256,744.21**	**257,385.82**	**257,388.34**

Table 6.17 – GHG emissions by source category in solution x_1^0 (Gg).

	x_1^0 (Lower)				x_1^0 (Upper)			
	CO_2	CH_4	N_2O	Total (CO_2eq)	CO_2	CH_4	N_2O	Total (CO_2eq)
Energy Combustion	**437,118**	**118**	**10**	**443,107**	**483,146**	**1,182**	**106**	**544,238**
Energy Industry	68,405	9	1	69,078	80,682	92	16	87,670
Other Industries	123,465	28	3	124,969	145,444	259	30	160,839
Transportation	198,346	23	5	200,407	207,842	298	51	230,505
Others Sources	46,902	59	1	48,653	49,179	533	9	65,223
Fugitive Emissions	**7,652**	**158**	**0**	**11,604**	**10,465**	**250**	**0**	**16,707**
Industrial Processes	**88,796**	**12**	**30**	**97,895**	**88,796**	**12**	**30**	**97,895**
Agriculture	**-**	**18,597**	**789**	**700,169**	**-**	**18,597**	**789**	**700,169**
Enteric Fermentation	-	17,591	-	439,766	-	17,591	-	439,766
Animal manure	-	423	42	23,099	-	423	42	23,099
Soil	-	-	738	219,964	-	-	738	219,964
Rice cultivation	-	396	-	9,895	-	396	-	9,895
Residues burnt in the field	-	188	9	7,444	-	188	9	7,444
Solid Waste and Wastewater	**1,933**	**4,427**	**15**	**116,980**	**1,933**	**4,427**	**15**	**116,980**
LUC	**1,258,345**	**3,026**	**21**	**1,340,193**	**1,258,345**	**3,026**	**21**	**1,340,193**
TOTAL	**1,793,843**	**26,338**	**865**	**2,709,949**	**1,842,684**	**27,494**	**960**	**2,816,182**

[4] Only the final energy consumption of fuel oil, LPG and wood has presented higher values than EPE (2013).

The composition of the GHG emissions by source category in solution x_1^0 is presented in Table 6.17. Although a higher level of total GHG emissions in solution x_1^0 is observed (with values between 2,709,949 and 2,816,182 Gg CO_2eq), the values are lower than in the solution leading to the best optimal value of the employment level (solution x_2^0). Despite the LUC emissions are considered constant, therefore keeping LUC as the major GHG emission source in Brazil, the role of the agriculture sector is remarkable, representing 24.86% to 25.84% of the total emissions estimated. It is important to emphasize that the difference between the lower and upper values presented in Table 6.17 are due to the lower and upper values of consumption of residents, as well as the use of lower and upper emission factors provided by the IPCC (see Appendix B) to compute the emissions from energy combustion in each scenario.

In the solution x_2^0 (corresponding to the best optimum value of the employment level) an AAGR between 3.73% (in the worst scenario of coefficients) and 3.88% (in the best scenario of coefficients) with respect to the base year of the study is obtained for the employment level. The GDP at constant prices also achieved the upper bounds defined in this study with an AAGR of 3.81%, while the AAGR for the nominal GDP ranges between 12.35% (in the worst case) and 12.36% (in the best case). The general government structural balance as a percentage of GDP at current prices achieved values ranging between -3.23% (in the best scenario of coefficients) and -3.37% (in the worst scenario of coefficients). The values regarding the general government gross debt as a percentage of GDP at current prices are slightly higher than solution x_1^0, ranging between 67.98% (in the worst scenario of coefficients) and 68.09% (in the best scenario of coefficients).

Solution x_2^0 leads to higher levels of energy consumption (with values between 273,535 and 273,538 toe$\times 10^3$ approximately), but slightly lower than in solution x_1^0. As referred to previously, even with lower values of total energy consumption the use of fossil fuels in solution x_2^0 is higher (while the use of renewable energy is lower) than in solution optimizing GDP level (solution x_1^0), mainly due to marginal increases in the consumption of fuel oil, natural gas, coal and coke. This fact suggests that an additional increase of employees depends on the raise of the output of fossil fuel intensive sectors, which is confirmed by the highest increases in the outputs of the sectors construction, cement, other non-metallic products, bus and trucks in this solution.

The solution x_2^0 presents the highest levels of total GHG emissions of all 8 solutions with values between 2,715,274 and 2,822,041Gg CO_2eq. Despite a reduction in the emissions from energy combustion in the transportation activities is obtained in solution x_2^0, an overall increase in all emission sources in relation to solution x_1^0 is verified (see Table 6.18). The total GHG emissions level deteriorates between 0.20% and 0.21% in solution x_2^0 compared to solution x_1^0. Therefore, the additional increase of employees which influences the output of fossil fuel intensive sectors also results in more GHG emissions.

Table 6.18 – GHG emissions by source category in solution x_2^0 (Gg).

	x_2^0 (Lower)				x_2^0 (Upper)			
	CO_2	CH_4	N_2O	Total (CO_2eq)	CO_2	CH_4	N_2O	Total (CO_2eq)
Energy Combustion	**438,705**	**118**	**10**	**444,678**	**485,167**	**1,177**	**106**	**546,056**
Energy Industry	68,611	9	1	69,281	81,039	92	16	87,987
Other Industries	125,447	28	3	126,968	147,775	262	30	163,330
Transportation	197,831	22	5	199,879	207,274	294	51	229,760
Others Sources	46,815	59	1	48,550	49,079	528	9	64,980
Fugitive Emissions	**7,975**	**166**	**0**	**12,133**	**10,907**	**265**	**0**	**17,521**
Industrial Processes	**90,299**	**12**	**30**	**99,538**	**90,299**	**12**	**30**	**99,538**
Agriculture	-	**18,631**	**792**	**701,717**	-	**18,631**	**792**	**701,717**
Enteric Fermentation	-	17,617	-	440,434	-	17,617	-	440,434
Animal manure	-	423	42	23,134	-	423	42	23,134
Soil	-	-	740	220,599	-	-	740	220,599
Rice cultivation	-	401	-	10,015	-	401	-	10,015
Residues burnt in the field	-	190	9	7,534	-	190	9	7,534
Solid Waste and Wastewater	**1,933**	**4,429**	**15**	**117,014**	**1,933**	**4,429**	**15**	**117,014**
LUC	**1,258,345**	**3,026**	**21**	**1,340,193**	**1,258,345**	**3,026**	**21**	**1,340,193**
TOTAL	**1,797,258**	**26,382**	**867**	**2,715,274**	**1,846,651**	**27,539**	**963**	**2,822,041**

In solution x_3^0 (leading to the best optimal value of total final energy consumption) a reduction of approximately 18.4% in the total final energy consumption in relation to the values estimated for 2018 based on the projections of EPE (2013) is achieved (see Tables 6.5 and 6.16). However, it is worth noting that even with the lowest level of total energy consumption the use of fossil fuels in solution x_3^0 is higher than in the solution optimizing GHG emissions (solution x_4^0). Moreover, solution x_3^0 present slightly higher levels of total GHG emissions than solution x_4^0 (with values between 2,629,851 and 2,729,359 Gg CO_2eq in worst and best coefficient scenarios, respectively) in which a deterioration of approximately 0.04% in relation to solution x_4^0 is verified (see Table 6.19). Therefore, this fact indicates a strong effect of energy use on the environmental sphere.

An AAGR between 3.08% (in the worst scenario of coefficients) and 3.22% (in the best scenario of coefficients) with respect to the base year of the study is obtained for the employment level in solution x_3^0. The GDP at constant prices presents an AAGR of 3.06%, while the AAGR for the nominal GDP ranges between 11.02% (in the worst case) and 11.03% (in the best case). The general government structural balance as a percentage of GDP at current prices achieved values ranging between -3.76% (in the best case scenario of coefficients) and -3.90% (in the worst case scenario of coefficients). The values of general government gross debt as a percentage of GDP at current prices ranges between 72.39% (in the worst scenario of coefficients) and 72.50% (in the best scenario of coefficients), thus achieving the upper bound established in this study.

Table 6.19 – GHG emissions by source category in solution x_3^0 (Gg).

	x_3^0 (Lower)				x_3^0 (Upper)			
	CO_2	CH_4	N_2O	Total (CO_2eq)	CO_2	CH_4	N_2O	Total (CO_2eq)
Energy Combustion	**410,070**	**111**	**9**	**415,667**	**453,274**	**1,105**	**99**	**510,364**
Energy Industry	64,531	8	1	65,144	76,144	84	14	82,518
Other Industries	115,256	26	3	116,661	135,789	242	28	150,167
Transportation	186,273	21	5	188,208	195,190	280	48	216,474
Others Sources	44,010	56	1	45,654	46,151	500	9	61,205
Fugitive Emissions	**7,227**	**149**	**0**	**10,955**	**9,883**	**235**	**0**	**15,766**
Industrial Processes	**83,219**	**11**	**28**	**91,707**	**83,219**	**11**	**28**	**91,707**
Agriculture	**-**	**17,395**	**739**	**655,045**	**-**	**17,395**	**739**	**655,045**
Enteric Fermentation	-	16,457	-	411,429	-	16,457	-	411,429
Animal manure	-	396	39	21,610	-	396	39	21,610
Soil	-	-	691	205,878	-	-	691	205,878
Rice cultivation	-	368	-	9,204	-	368	-	9,204
Residues burnt in the field	-	174	9	6,924	-	174	9	6,924
Solid Waste and Wastewater	**1,926**	**4,400**	**15**	**116,283**	**1,926**	**4,400**	**15**	**116,283**
LUC	**1,258,345**	**3,026**	**21**	**1,340,193**	**1,258,345**	**3,026**	**21**	**1,340,193**
TOTAL	**1,760,787**	**25,092**	**811**	**2,629,851**	**1,806,647**	**26,173**	**901**	**2,729,359**

Solution x_4^0 leading to the best optimal value of total GHG emissions presents similar values of solution x_3^0 (the best optimal value of the total final energy consumption), thus suggesting a strong correlation between GHG and energy consumption. The total GHG emissions in solution x_4^0 ranges between 2,628,821 and 2,728,341 Gg CO_2eq in worst and best scenarios of coefficients, respectively (see Table 6.20). A reduction of approximately 18.2% in the total final energy consumption in relation to the values estimated for 2018 based on the projections of EPE (2013) is achieved in this solution (see Tables 6.5 and 6.16). As previously referred to although higher marginal aggregated values of total energy consumption is obtained in solution x_4^0 compared to solution x_3^0, a reduction of the fossil fuel use and an increase in the renewable sources are verified. It is noteworthy that the overall reduction of GHG emissions in this solution is not exclusively obtained by the reduction of fossil energy combustion, but mainly by the overall contraction of the economic activity affecting other emissions sources. Moreover, as referred to previously although a reduction in the fossil fuel consumption is achieved in solution x_4^0, more energy is consumed in the economy compared to solution x_3^0. Hence, the fossil fuel intensity of the economy makes difficult a complete substitution of fossil fuels by renewable sources, thus constraining further reductions of GHG emissions.

Similarly to solution x_3^0, an AAGR between 3.08% (in the worst scenario of coefficients) and 3.22% (in the best scenario of coefficients) with respect to the base year of the study is obtained for the employment level in solution x_4^0. The GDP at constant prices presents an AAGR of 3.06%, while the AAGR for the nominal GDP achieved approximately 11.02% (in both best and worst cases). The worst nominal values of general government structural balance are achieved in this solution (values between -251,968 to -243,034 to R$$\times 10^3$) representing -3.77% (in the best scenario of coefficients) and -3.90% (in the worst scenario of coefficients) of GDP at current prices. Moreover the highest values of general government gross debt is also obtained in this solution (with values between 4,671,613 and 4,680,547 R$$\times 10^3$) representing 72.39% (in the worst scenario of coefficients) and 72.50% (in the best scenario of coefficients) of GDP at current prices, therefore also achieving the upper bound established in this study. Hence, one of the main drawbacks associated with policies envisaging environmental improvements is the negative influence on the economic indicators reflected in negative impacts on the public accounts.

Table 6.20 – GHG emissions by source category in solution $_4$ (Gg).

	x_4^0 (Lower)				x_4^0 (Upper)			
	CO_2	CH_4	N_2O	Total (CO_2eq)	CO_2	CH_4	N_2O	Total (CO_2eq)
Energy Combustion	**409,620**	**111**	**10**	**415,234**	**452,711**	**1,108**	**99**	**509,988**
Energy Industry	64,296	9	1	64,926	75,837	86	15	82,382
Other Industries	115,011	26	3	116,414	135,497	241	28	149,857
Transportation	186,288	21	5	188,224	195,210	280	48	216,511
Others Sources	44,025	56	1	45,670	46,167	501	9	61,238
Fugitive Emissions	**7,138**	**148**	**0**	**10,829**	**9,763**	**233**	**0**	**15,596**
Industrial Processes	**82,850**	**11**	**28**	**91,327**	**82,850**	**11**	**28**	**91,327**
Agriculture	**-**	**17,393**	**739**	**654,956**	**-**	**17,393**	**739**	**654,956**
Enteric Fermentation	-	16,456	-	411,402	-	16,456	-	411,402
Animal manure	-	395	39	21,609	-	395	39	21,609
Soil	-	-	691	205,836	-	-	691	205,836
Rice cultivation	-	368	-	9,193	-	368	-	9,193
Residues burnt in the field	-	174	9	6,916	-	174	9	6,916
Solid Waste and Wastewater	**1,926**	**4,400**	**15**	**116,280**	**1,926**	**4,400**	**15**	**116,280**
LUC	**1,258,345**	**3,026**	**21**	**1,340,193**	**1,258,345**	**3,026**	**21**	**1,340,193**
TOTAL	**1,759,879**	**25,089**	**811**	**2,628,821**	**1,805,595**	**26,172**	**901**	**2,728,341**

In solution x_1^1 (leading to the worst value for GDP at constant prices) the AAGR of real GDP achieved 3.67% (in both best and worst cases) with respect to the base year of the study, while the nominal GDP achieved an AAGR between 11.84% (in the worst case) and 11.85% (in the best case). Both values are similar to solution x_2^1 and lower than in solutions x_1^0 and x_2^0. The real AAGR for the private consumption achieved approximately 3.39% in both scenarios (a reduction of 0.18% compared to solution x_1^0). The general government structural balance in this solution ranges between -2.31% (in the best scenario of coefficients) and -2.45% (in the worst scenario of coefficients) of GDP at current prices, while the general government gross debt achieved values between 68.49% (in the worst scenario of coefficients) and 68.61% (in the best scenario of coefficients). The employment level also improved in solution x_1^1 with an AAGR between 3.57% (in the worst scenario of coefficients) and 3.72% (in the best scenario of coefficients). It should be noticed the higher closeness of the AAGR values of employment level between solutions x_1^1 and x_2^1 than between solutions x_1^0 and x_2^0. Hence in a scenario of coefficients in which a slight contraction of the economic activity is considered the trade-offs between the levels of employment and wealth creation in the country are also reduced.

Table 6.21 – Composition of the energy mix in solutions $^{1}_{1}$ to $^{1}_{4}$ (toe × 10^3).

	x_1^1		x_2^1		x_3^1		x_4^1	
	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper
Total Fossil Fuels	**136,964.49**	**136,965.90**	**137,731.32**	**137,732.72**	**130,388.87**	**130,390.22**	**130,095.79**	**130,097.14**
Diesel	48,458.91	48,458.91	48,585.61	48,585.61	46,045.81	46,045.81	46,011.37	46,011.37
Fuel Oil	7,810.36	7,810.36	7,916.84	7,916.84	7,429.27	7,429.27	7,397.12	7,397.12
Gasoline	19,091.35	19,092.25	18,922.62	18,923.52	18,154.71	18,155.57	18,174.28	18,175.15
GLP	9,573.64	9,574.02	9,507.20	9,507.58	9,134.82	9,135.18	9,141.80	9,142.16
Kerosene	3,745.16	3,745.16	3,751.17	3,751.17	3,563.45	3,563.45	3,560.97	3,560.98
Natural Gas	20,537.37	20,537.50	20,843.40	20,843.53	19,614.22	19,614.35	19,496.08	19,496.20
Coal and Coke	10,859.87	10,859.87	11,025.64	11,025.64	10,263.50	10,263.50	10,241.03	10,241.03
Other fossil fuels	16,887.82	16,887.82	17,178.83	17,178.83	16,183.10	16,183.10	16,073.14	16,073.14
Total Renewable	**134,932.96**	**134,934.19**	**133,087.33**	**133,088.55**	**127,011.84**	**127,013.02**	**128,140.26**	**128,141.43**
Wood	21,649.77	21,650.24	21,605.71	21,606.17	20,586.53	20,586.97	20,590.38	20,590.82
Charcoal	5,206.89	5,206.93	5,264.42	5,264.46	4,928.55	4,928.58	4,920.47	4,920.50
Sugarcane Bagasse	36,336.63	36,336.63	36,340.79	36,340.79	33,766.82	33,766.82	34,345.81	34,345.81
Electricity	49,846.46	49,846.46	48,055.33	48,055.33	46,958.04	46,958.04	47,502.48	47,502.48
Bioethanol	15,292.93	15,293.66	15,157.26	15,157.98	14,542.62	14,543.31	14,558.38	14,559.08
Other renewables	6,600.27	6,600.27	6,663.82	6,663.82	6,229.29	6,229.29	6,222.75	6,222.75
TOTAL	**271,897.45**	**271,900.09**	**270,818.65**	**270,821.28**	**257,400.72**	**257,403.24**	**258,236.05**	**258,238.57**

Solution x_1^1 also presents higher levels of energy consumption with values between 271,897 and 271,900 toe$\times 10^3$ (see Table 6.21). However, a higher level of total energy consumption in solution x_1^1 have not implied higher use of fossil fuels when compared to solutions optimizing the employment level (solution x_2^1), such that the consumption of renewable energy is higher in solution x_1^1 than in solution x_2^1. The total final energy consumption obtained in this solution is approximately 13.67% lower than the values estimated for 2018 based on the projections of EPE (2013) (see Table 6.5). Therefore, either in more favorable or less favorable economic scenarios, the energy consumption of the majority of the fuels (except for fuel oil, LPG and wood) is lower than the estimated values obtained from EPE (2013). Thus, policies envisaging the supply increase or the substitution of fuel oil, LPG and wood by alternative products would be required.

Table 6.22 – GHG emissions by source category in solution x_1^1(Gg).

	x_1^1 (Lower)				x_1^1 (Upper)			
	CO_2	CH_4	N_2O	Total (CO_2eq)	CO_2	CH_4	N_2O	Total (CO_2eq)
Energy Combustion	**433,087**	**117**	**10**	**439,013**	**478,726**	**1,169**	**105**	**539,173**
Energy Industry	67,774	9	1	68,440	79,935	91	16	86,857
Other Industries	122,689	27	3	124,183	144,529	257	30	159,809
Transportation	196,208	22	5	198,245	205,595	294	50	227,989
Others Sources	46,416	58	1	48,146	48,667	527	9	64,518
Fugitive Emissions	**7,598**	**157**	**0**	**11,523**	**10,392**	**248**	**0**	**16,588**
Industrial Processes	**88,206**	**12**	**29**	**97,246**	**88,206**	**12**	**29**	**97,246**
Agriculture	**-**	**18,420**	**782**	**693,624**	**-**	**18,420**	**782**	**693,624**
Enteric Fermentation	-	17,422	-	435,559	-	17,422	-	435,559
Animal manure	-	419	42	22,878	-	419	42	22,878
Soil	-	-	731	217,970	-	-	731	217,970
Rice cultivation	-	393	-	9,826	-	393	-	9,826
Residues burnt in the field	-	186	9	7,392	-	186	9	7,392
Solid Waste and Wastewater	**1,932**	**4,423**	**15**	**116,882**	**1,932**	**4,423**	**15**	**116,882**
LUC	**1,258,345**	**3,026**	**21**	**1,340,193**	**1,258,345**	**3,026**	**21**	**1,340,193**
TOTAL	**1,789,168**	**26,156**	**857**	**2,698,481**	**1,837,601**	**27,298**	**952**	**2,803,706**

Although a higher level of total GHG emissions in solution x_1^1 is verified (with values between 2,698,481 and 2,803,706Gg CO_2eq), the values are lower than in the solution leading to the best optimal value of the employment level (solution x_2^1). The composition of the GHG emissions by source category in solution x_1^1 (presented in Table 6.22) follows the values of solution x_1^0 in which the LUC is responsible for 47.80% to 49.66%, the agriculture sector 24.74% to 25.70%, and the energy combustion for 16.27% to 19.23% of the total emissions estimated.

In the solution x_2^1 (leading to the worst optimal value of the employment level) an AAGR between 3.58% (in the worst scenario of coefficients) and 3.73% (in the best scenario of coefficients) with respect to the base year of the study is obtained for the employment level. The GDP at constant prices also achieved the upper bounds with an AAGR of 3.67%, while the AAGR for the nominal GDP ranges between 12.09% (in the worst case) and 12.10% (in the best case). The general government structural balance presents the most negative values of all 8 solutions (ranging between -5.17% to -5.30% of GDP at current prices in the best and worst case scenarios of coefficients, respectively) due to higher values of the GFCF of the public sector. This fact also leads to the highest nominal values of general government gross debt ranging between 4,778,517 to 4,787,795 R$$\times 10^3$. However, in relative terms, the general government gross debt is lower than in all solutions optimizing the energy consumption and GHG emissions due to higher nominal GDP levels (values ranging from 70.64% to 70.75% of nominal GDP in the worst and best scenarios of coefficients, respectively). Therefore, this solution shed light on the role of government investments on the job creation process in a scenario of constrained economic activity.

Table 6.23 – GHG emissions by source category in solution x_2^1(Gg).

	x_2^1 (Lower)				x_2^1 (Upper)			
	CO_2	CH_4	N_2O	Total (CO_2eq)	CO_2	CH_4	N_2O	Total (CO_2eq)
Energy Combustion	**434,251**	**117**	**10**	**440,165**	**480,230**	**1,165**	**105**	**540,524**
Energy Industry	67,916	9	1	68,579	80,216	91	15	87,095
Other Industries	124,078	28	3	125,582	146,162	260	30	161,552
Transportation	195,903	22	5	197,931	205,255	292	50	227,529
Others Sources	46,354	58	1	48,074	48,597	523	9	64,348
Fugitive Emissions	**7,884**	**164**	**0**	**11,997**	**10,783**	**262**	**0**	**17,326**
Industrial Processes	**89,322**	**12**	**30**	**98,460**	**89,322**	**12**	**30**	**98,460**
Agriculture	**-**	**18,444**	**784**	**694,674**	**-**	**18,444**	**784**	**694,674**
Enteric Fermentation	-	17,440	-	436,009	-	17,440	-	436,009
Animal manure	-	419	42	22,902	-	419	42	22,902
Soil	-	-	733	218,402	-	-	733	218,402
Rice cultivation	-	396	-	9,908	-	396	-	9,908
Residues burnt in the field	-	188	9	7,454	-	188	9	7,454
Solid Waste and Wastewater	**1,932**	**4,424**	**15**	**116,905**	**1,932**	**4,424**	**15**	**116,905**
LUC	**1,258,345**	**3,026**	**21**	**1,340,193**	**1,258,345**	**3,026**	**21**	**1,340,193**
TOTAL	**1,791,735**	**26,187**	**859**	**2,702,395**	**1,840,611**	**27,333**	**954**	**2,808,083**

Solution x_2^1 leads to higher levels of energy consumption (with values between 270,819 and 270,821 toe$\times 10^3$ approximately), but slightly lower than in solution x_1^1. As in solution x_2^0, even with lower values of total energy consumption the use of fossil fuels in solution x_2^1 is higher (while the use of renewable energy is lower) than in the solution optimizing GDP (solution x_1^1). An overall increase in all emission sources (except in the transportation activities) also leads to higher level of total GHG emissions in solution x_2^1 with values between 2,702,395 and 2,808,083 Gg CO_2eq (see Table 6.23). As in solution x_2^0, the additional employment raise in solution x_2^1 influenced the output of fossil fuel intensive sectors thus resulting in more GHG emissions.

Similar results regarding economic indicators are obtained in solutions x_3^1 and x_4^1 (leading to the worst optimal values of total final energy consumption and GHG emissions, respectively). The GDP at constant prices presents an AAGR of 3.08%, while the AAGR for the nominal GDP ranges between 11.02% (in the worst case) and 11.03% (in the best case). The general government structural balance as a percentage of GDP at current prices achieved values ranging between -3.75% (in the best scenario of coefficients) and -3.89% (in the worst scenario of coefficients) in both solutions. Furthermore, the values regarding the general government gross debt as a percentage of GDP at current prices ranges between 72.39% (in the worst scenario of coefficients) and 72.50% (in the best scenario of coefficients) in both solutions, thus achieving the upper bound established in this study. An AAGR between 3.08% (in the worst scenario of coefficients) and 3.22% (in the best scenario of coefficients) with respect to the base year of the study is obtained for the employment level in both solutions (values also similar to solutions x_3^0 and x_4^0).

Table 6.24 – GHG emissions by source category in solution x_3^1(Gg).

	x_3^1 (Lower)				x_3^1 (Upper)			
	CO_2	CH_4	N_2O	Total (CO_2eq)	CO_2	CH_4	N_2O	Total (CO_2eq)
Energy Combustion	**411,821**	**111**	**10**	**417,429**	**455,311**	**1,107**	**99**	**512,515**
Energy Industry	64,706	8	1	65,320	76,359	84	14	82,744
Other Industries	116,410	26	3	117,823	137,177	244	28	151,635
Transportation	186,658	21	5	188,595	195,587	280	48	216,887
Others Sources	44,047	56	1	45,691	46,187	500	9	61,249
Fugitive Emissions	**7,270**	**150**	**0**	**11,018**	**9,943**	**236**	**0**	**15,853**
Industrial Processes	**84,216**	**11**	**28**	**92,747**	**84,216**	**11**	**28**	**92,747**
Agriculture	**-**	**17,451**	**741**	**657,145**	**-**	**17,451**	**741**	**657,145**
Enteric Fermentation	-	16,510	-	412,759	-	16,510	-	412,759
Animal manure	-	397	39	21,680	-	397	39	21,680
Soil	-	-	693	206,528	-	-	693	206,528
Rice cultivation	-	369	-	9,232	-	369	-	9,232
Residues burnt in the field	-	175	9	6,945	-	175	9	6,945
Solid Waste and Wastewater	**1,926**	**4,400**	**15**	**116,302**	**1,926**	**4,400**	**15**	**116,302**
LUC	**1,258,345**	**3,026**	**21**	**1,340,193**	**1,258,345**	**3,026**	**21**	**1,340,193**
TOTAL	**1,763,578**	**25,150**	**814**	**2,634,835**	**1,809,741**	**26,233**	**903**	**2,734,756**

The total GHG emissions are similar in solutions x_3^1 and x_4^1 with a variation of approximately 0.04% between them (see Tables 6.24 and 6.25). In solution x_3^1 the values range between 2,634,835 and 2,734,756 Gg CO_2eq (in the worst and best scenarios of coefficients, respectively), whereas in solution x_4^1 the values range between 2,633,864 and

2,733,779 Gg CO_2eq (in worst and best scenarios of coefficients, respectively). Moreover, a reduction of approximately 18.2% in the total final energy consumption in relation to the values estimated for 2018 based on the projections of EPE (2013) is achieved in solution x_3^1 (see Table 6.5), while a reduction of 17.9% is obtained in solution x_4^1. As in solution x_3^0 and x_4^0, in solutions x_3^1 and x_4^1 the relationship between the overall contraction of the economic activity and the reduction of GHG emissions is remarkable, as well as the strong effect of energy use on the environmental sphere.

Table 6.25 – GHG emissions by source category in solution x_4^1(Gg).

	x_4^1 (Lower)				x_4^1 (Upper)			
	CO_2	CH_4	N_2O	Total (CO_2eq)	CO_2	CH_4	N_2O	Total (CO_2eq)
Energy Combustion	**411,380**	**111**	**10**	**417,007**	**454,749**	**1,110**	**99**	**512,141**
Energy Industry	64,479	9	1	65,110	76,046	86	15	82,610
Other Industries	116,214	26	3	117,626	136,943	243	28	151,388
Transportation	186,628	21	5	188,566	195,559	280	48	216,869
Others Sources	44,059	56	1	45,704	46,201	501	9	61,275
Fugitive Emissions	**7,157**	**148**	**0**	**10,859**	**9,789**	**234**	**0**	**15,640**
Industrial Processes	**83,874**	**11**	**28**	**92,397**	**83,874**	**11**	**28**	**92,397**
Agriculture	**-**	**17,451**	**741**	**657,107**	**-**	**17,451**	**741**	**657,107**
Enteric Fermentation	-	16,510	-	412,754	-	16,510	-	412,754
Animal manure	-	397	39	21,680	-	397	39	21,680
Soil	-	-	693	206,507	-	-	693	206,507
Rice cultivation	-	369	-	9,226	-	369	-	9,226
Residues burnt in the field	-	175	9	6,941	-	175	9	6,941
Solid Waste and Wastewater	**1,926**	**4,400**	**15**	**116,301**	**1,926**	**4,400**	**15**	**116,301**
LUC	**1,258,345**	**3,026**	**21**	**1,340,193**	**1,258,345**	**3,026**	**21**	**1,340,193**
TOTAL	**1,762,683**	**25,148**	**814**	**2,633,864**	**1,808,684**	**26,233**	**904**	**2,733,779**

Table 6.26 – Values for the individual targets.

Z_K^*	t_k^L	t_k^U	m [Z_K^*]	w [Z_K^*]
Z_1^*	4,308,040	4,351,337	4,329,688	43,296.90
Z_2^*	54,480	55,582	55,031	1,102.99
Z_3^*	-257,403	-256,742	-257,072	661.55
Z_4^*	-2,733,779	-2,628,821	-2,681,300	104,958.71

In the next step, the surrogate model of the original interval model is set by considering the minimization of the worst possible deviation of each interval objective function to the corresponding interval ideal solution (see Chapter 4). A hypothetical DM expressing his/her preferences regarding the information obtained in the solution search process is henceforth considered. Firstly, it has been considered the DM assumes a conservative approach, thus solutions are computed with the model that minimizes the upper bound of the worst possible deviation. The information regarding the targets t_k^L and t_k^U, the midpoint (m $[Z_K^*]$) and width (w $[Z_K^*]$) values are presented in Table 6.26.

In order to obtain a broader overview of the model with this formulation, four scenarios of coefficients are analyzed: a scenario with the narrowest feasible region; a scenario with a slightly constrained feasible region with individual constraint satisfaction thresholds of 0.75; an intermediate scenario with individual constraint satisfaction thresholds of 0.5; and a scenario with the broadest feasible region. The solutions obtained are nextly briefly characterized.

Table 6.27 – Information regarding solution $x^{1U''}$.

	Z_K^L	Z_K	m $[Z_k(x^{1U''})]$	w $[Z_k(x^{1U''})]$	$\mathcal{A}$ $[Z_k(x^{1U''}) \prec Z_K^*]$	D $(Z_K^*, Z_k(x^{1U''}))$	tc_K^L	tc_K
Z_1	4,241,727	4,241,738	4,241,733	10.60	4.06	109,599	0.62	0.50
Z_2	53,763	54,304	54,034	540.34	1.21	1,279	0.62	0.47
Z_3	-265,147	-265,144	-265,145	2.58	24.31	8,402	0.55	0.53
Z_4	-2,778,124	-2,674,910	-2,726,517	103,213.47	0.43	46,090	0.50	0.47

In solution $x^{1U''}$, obtained with the narrowest feasible region, the achievement rates of GDP and employment level are higher than the values for energy consumption and GHG emissions (see Table 6.27). Furthermore, the values of tc_K^L are higher than the values of tc_K^U for all objectives.

In solution $x^{2U''}$, obtained with a slightly constrained feasible region, all achievement rates are improved. The major relative impacts are linked to the upper bound of the employment level (see Table 6.28). Moreover, the distance and the acceptability index are reduced in all objectives; therefore the interval objectives and the corresponding ideal interval solution are closer than in solution $x^{1U''}$.

Table 6.28 – Information regarding solution $x^{2U''}$.

	Z_K^L	Z_K	m $[Z_k(x^{2U''})]$	w $[Z_k(x^{2U''})]$	$\mathcal{A}$ $[Z_k(x^{2U''}) \prec Z_K^*]$	D $(Z_K^*, Z_k(x^{2U''}))$	tc_K^L	tc_K
Z_1	4,242,511	4,242,521	4,242,516	10.60	4.03	108,816	0.63	0.50
Z_2	53,794	54,335	54,064	540.64	1.18	1,248	0.63	0.49
Z_3	-265,006	-265,003	-265,004	2.58	23.89	8,261	0.56	0.54
Z_4	-2,777,113	-2,673,967	-2,725,540	103,145.65	0.43	45,146	0.51	0.48

Solution $x^{3U''}$ obtained with the intermediate scenario provides marginal improvements in all achievement rates in comparison to the previous solutions. The major relative impacts are linked to the lower bound of the employment level (see Table 6.29). Moreover, the distance and the acceptability index are reduced in all objectives in relation to solution $x^{2U''}$, therefore providing further closeness of the interval objectives to their corresponding ideal interval solution.

Table 6.29 – Information regarding solution $x^{3U''}$.

	Z_K^L	Z_K	$m[Z_k(x^{3U''})]$	$w[Z_k(x^{3U''})]$	$\mathcal{A}[Z_k(x^{3U''}) \prec Z_K^*]$	$D(Z_K^*, Z_k(x^{3U''}))$	tc_K^L	tc_K
Z_1	4,243,294	4,243,304	4,243,299	10.60	3.99	108,032	0.63	0.51
Z_2	53,825	54,365	54,095	540.95	1.14	1,217	0.65	0.50
Z_3	-264,865	-264,862	-264,863	2.58	23.46	8,120	0.56	0.54
Z_4	-2,776,101	-2,673,024	-2,724,563	103,077.83	0.42	44,203	0.52	0.49

Table 6.30 – Information regarding solution $x^{4U''}$.

	Z_K^L	Z_K	$m[Z_k(x^{4U''})]$	$w[Z_k(x^{4U''})]$	$\mathcal{A}[Z_k(x^{4U''}) \prec Z_K^*]$	$D(Z_K^*, Z_k(x^{4U''}))$	tc_K^L	tc_K
Z_1	4,244,860	4,244,871	4,244,866	10.60	3.92	106,466	0.64	0.52
Z_2	53,886	54,427	54,156	541.56	1.06	1,155	0.68	0.53
Z_3	-264,582	-264,580	-264,581	2.58	22.61	7,838	0.58	0.56
Z_4	-2,774,079	-2,671,137	-2,722,608	102,942.19	0.40	42,316	0.54	0.51

Finally, solution $x^{4U''}$ obtained with the broadest feasible region provided the highest improvements in all achievement rates in comparison to the previous solutions. The lower and upper bounds of the employment level also presented major marginal impacts in comparison to solution $x^{3U''}$ with values increasing approximately 0.03 (see Table 6.30). The highest achievement rate among the lower bounds is obtained in the employment level (0.68), while the energy consumption presents the highest levels between upper bounds (0.56). In addition, the distance and the acceptability index are further reduced in all objectives in relation to solution $x^{3U''}$, such that the lowest values between solutions $x^{1U''}$ to $x^{4U''}$ are achieved for all interval objectives.

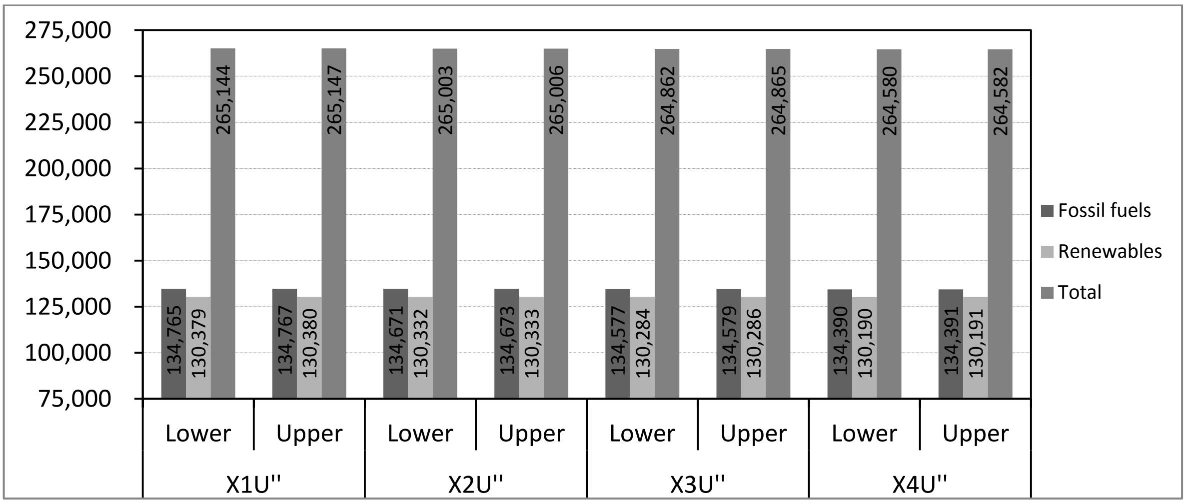

Figure 6.8 – Values for energy consumption in solutions $x^{1U''}$ to $x^{4U''}$ (toe × 10^3).

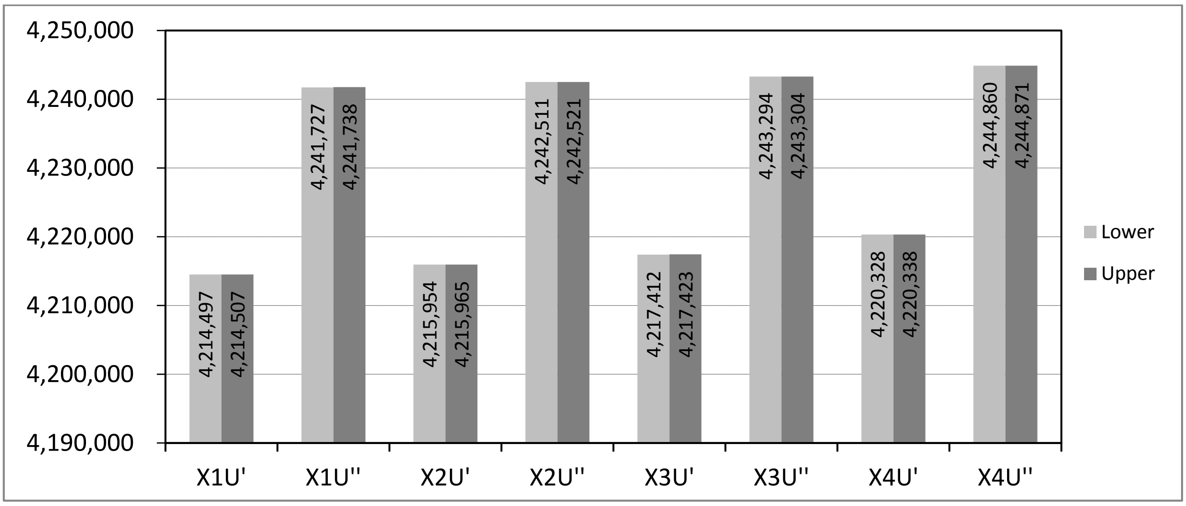

Figure 6.9 – Values for GDP at constant prices in solutions $x^{1U'}$ to $x^{4U'}$ and $x^{1U''}$ to $x^{4U''}$ (R\$ × 10^6).

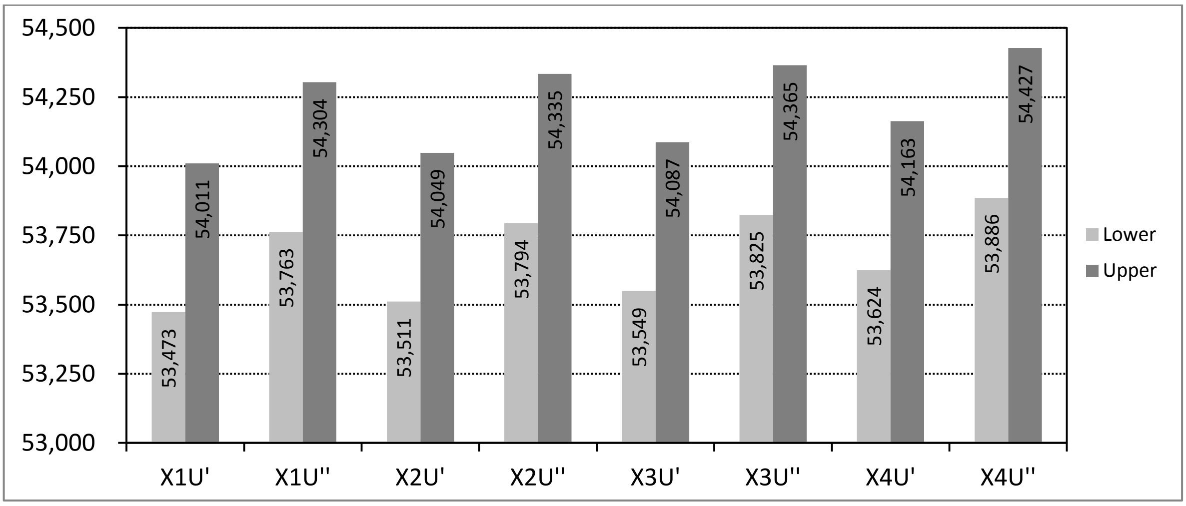

Figure 6.10 – Values for the employment level in solutions $x^{1U'}$ to $x^{4U'}$ and $x^{1U''}$ to $x^{4U''}$ (employees × 10^3).

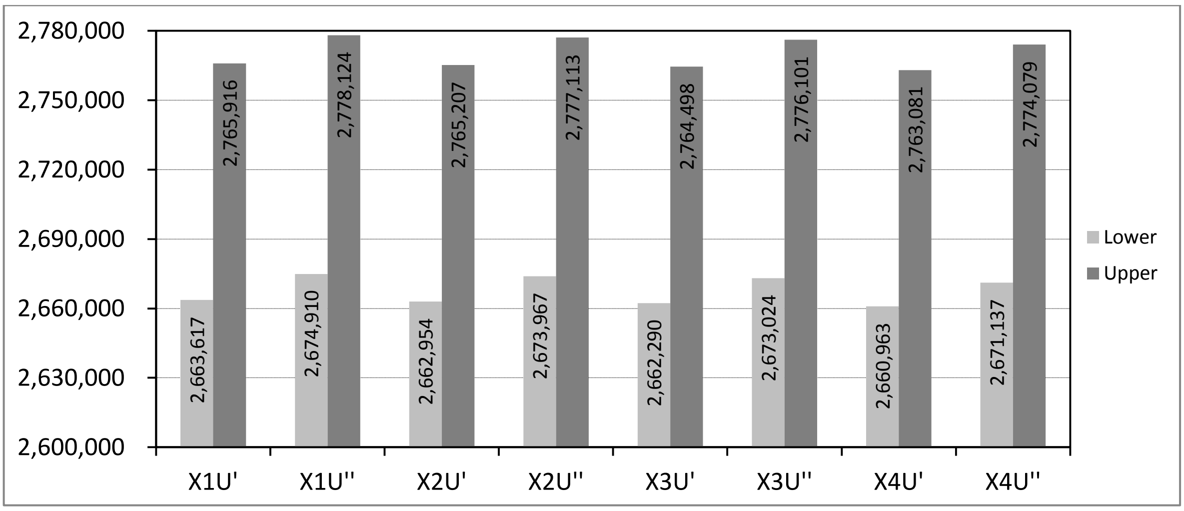

Figure 6.11 – Values for consumption of residents in solutions $x^{1U'}$ to $x^{4U'}$ and $x^{1U''}$ to $x^{4U''}$ (R\$ × 10^6).

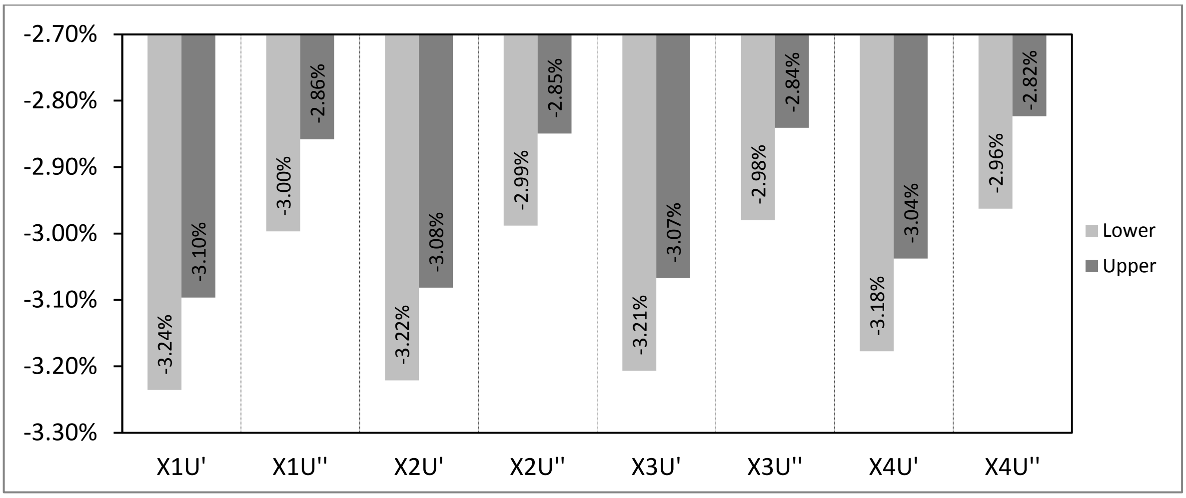

Figure 6.12 – General government structural balance in percentage of GDP at current prices in solutions $x^{1U'}$ to $x^{4U'}$ and $x^{1U''}$ to $x^{4U''}$ (%).

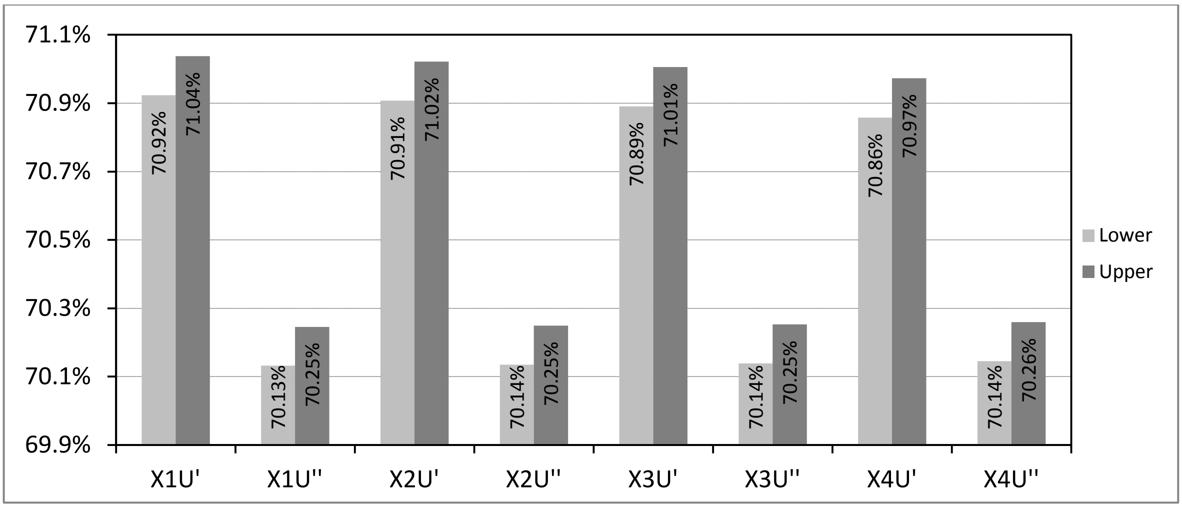

Figure 6.13 – General government gross debt in percentage of GDP at current prices in solutions $x^{1U'}$ to $x^{4U'}$ and $x^{1U''}$ to $x^{4U''}$ (%).

From the analysis of Figures 6.8 to 6.13 and the previous characterization of solutions $x^{1U''}$ to $x^{4U''}$ it is possible to conclude that:

- Gradual marginal improvements in GHG emissions, energy consumption, employment and GDP levels are provided by the transition from the narrowest to the broadest scenarios of coefficients;
- Solution $x^{4U''}$ (with the broadest feasible region) leads to best results for GHG emissions, energy consumption, employment and GDP levels, while solution $x^{1U''}$ (with the narrowest feasible region) leads to worst results of these indicators;
- The general government gross debt rises as much as the feasible region is enlarged due to the reduction of the individual constraint satisfaction thresholds (i.e., the general

government gross debt gradually increases from solution $x^{1U''}$ to solution $x^{4U''}$), while the general government structural balance presents the inverse characteristic (i.e., the general government structural balance gradually reduces from solution $x^{1U''}$ to solution $x^{4U''}$);

- Values for fossil and renewable energy consumption are higher than the consolidated values in 2012 and lower than the values estimated by EPE (2013) (although some variations between all solutions are verified);
- The values of total GHG emissions are higher than the voluntary targets established for the Brazilian government for 2020 even in the scenario with lower emission factors.

After this preliminary analysis, it is assumed that the DM has not considered any of the solutions previously obtained as a satisfactory compromise thus opting for applying a complementary analysis with an optimistic perspective. For this purpose the formulation of the model that minimizes the lower bound of the worst possible deviation is then considered. The same four scenarios of coefficients are also considered: the narrowest feasible region, a slightly constrained feasible region (individual constraint satisfaction thresholds of 0.75), an intermediate scenario (individual constraint satisfaction thresholds of 0.5) and the broadest feasible region. The characterization of the solutions obtained in this step is provided in Tables 6.31 to 6.34.

Solution $x^{1U'}$ obtained with the narrowest feasible region allows achieving improvements in terms of final energy consumption and GHG emissions with respect to solutions $x^{1U''}$ to $x^{4U''}$. However, the GDP and employment levels are lower in solution $x^{1U'}$ than in solutions $x^{1U''}$ to $x^{4U''}$. These facts are also expressed in the achievement rate of all objectives. The achievement rates of GDP and employment level are lower in solution $x^{1U'}$ than those obtained in solution $x^{1U''}$ (for example), while the energy consumption and GHG emissions present higher values (see Table 6.31). Furthermore, the values of tc_K^L are higher than the values of tc_K^U for all objectives.

Table 6.31 – Information regarding solution $x^{1U'}$.

	Z_K^L	Z_K	$m[Z_k(x^{1U''})]$	$w[Z_k(x^{1U''})]$	$\mathcal{A}[Z_k(x^{1U''}) \prec Z_K^*]$	$D(Z_K^*, Z_k(x^{1U''}))$	tc_K^L	tc_K
Z_1	4,214,497	4,214,507	4,214,502	10.50	5.32	136,830	0.47	0.38
Z_2	53,473	54,011	53,742	537.42	1.57	1,572	0.46	0.35
Z_3	-262,922	-262,919	-262,921	2.57	17.61	6,178	0.68	0.65
Z_4	-2,765,916	-2,663,617	-2,714,767	102,298.36	0.32	34,797	0.64	0.60

Table 6.32 – Information regarding solution $x^{2U'}$.

	Z_K^L	Z_K	m $[Z_k(x^{1U''})]$	w $[Z_k(x^{1U''})]$	$\mathcal{A}\,[Z_k(x^{1U''}) \prec Z_K^*]$	D $(Z_K^*, Z_k(x^{1U''}))$	tc_K^L	tc_K
Z_1	4,215,954	4,215,965	4,215,960	10.50	5.25	135,372	0.48	0.38
Z_2	53,511	54,049	53,780	537.80	1.52	1,534	0.48	0.37
Z_3	-262,836	-262,833	-262,835	2.57	17.35	6,092	0.68	0.66
Z_4	-2,765,207	-2,662,954	-2,714,080	102,253.20	0.32	34,133	0.64	0.61

Solution $x^{2U'}$ obtained with the slightly narrow feasible region allows achieving improvements in all objectives in comparison to solution $x^{1U'}$, remarkably in the employment level (with an improvement of 0.02 in both lower and upper achievement rates). Moreover, the final energy consumption and GHG emissions are also improved in solution $x^{2U'}$ with respect to solutions $x^{1\ ''}$ to $x^{4U''}$. However, even with improvements in relation to solution $x^{1U'}$ the GDP and employment levels are lower in solution $x^{2U'}$ than in solutions $x^{1U''}$ to $x^{4U''}$. Hence, the achievement rates of GDP and employment level present lower values in solution $x^{2U'}$ than those obtained in solution $x^{2U''}$, while higher values for the energy consumption and GHG emissions are observed (see Table 6.32).

Table 6.33 – Information regarding solution $x^{3U'}$.

	Z_K^L	Z_K	m $[Z_k(x^{1U''})]$	w $[Z_k(x^{1U''})]$	$\mathcal{A}\,[Z_k(x^{1U''}) \prec Z_K^*]$	D $(Z_K^*, Z_k(x^{1U''}))$	tc_K^L	tc_K
Z_1	4,217,412	4,217,423	4,217,417	10.60	5.18	133,914	0.49	0.39
Z_2	53,549	54,087	53,818	538.18	1.48	1,495	0.50	0.39
Z_3	-262,750	-262,747	-262,749	2.57	17.09	6,006	0.69	0.66
Z_4	-2,764,498	-2,662,290	-2,713,394	102,208.05	0.31	33,470	0.65	0.61

Solution $x^{3U'}$ obtained with the intermediary scenario allows achieving improvements in all objectives in comparison to solution $x^{2U'}$, in which the employment level also presented the highest improvements regarding the achievement rates (0.02 in both lower and upper achievement rates). The final energy consumption and GHG emissions are also improved in solution $x^{3U'}$ with respect to solutions $x^{1U''}$ to $x^{4U''}$, whereas the GDP and employment levels decrease. Thus the achievement rates of GDP and employment level present lower values in solution $x^{3U'}$ than those obtained in solutions $x^{1U''}$ to $x^{4U''}$, while higher values for the energy consumption and GHG emissions are verified (see Table 6.33).

Finally, solution $x^{4U'}$ obtained with the broadest feasible region allows obtaining improvements in all objectives in comparison to solution $x^{3U'}$, in which an increase of approximately 0.03% in the achievement rate of the employment level and 0.02% in the achievement rate of GHG emissions (in both lower and upper achievement rates) are verified. Solution $x^{4U'}$ presented lower achievement rates of GDP and employment level than those obtained in solutions $x^{1U''}$ to $x^{4U''}$. The highest achievement rates for the energy consumption and GHG emissions among all previous solutions are obtained in solution $x^{4U'}$ (see Table 6.34). Moreover, lowest values of the acceptability index and distance of the interval solutions to the ideal interval solutions for the final energy consumption and GHG emissions are obtained in solution $x^{4U'}$.

Table 6.34 – Information regarding solution $x^{4U'}$.

	Z_K^L	Z_K	m $[Z_k(x^{1U''})]$	w $[Z_k(x^{1U''})]$	$\mathcal{A}\,[Z_k(x^{1U''}) \prec Z_K^*]$	D $(Z_K^*, Z_k(x^{1U''}))$	tc_K^L	tc_K
Z_1	4,220,328	4,220,338	4,220,333	10.50	5.05	130,999	0.50	0.40
Z_2	53,624	54,163	53,894	538.94	1.39	1,419	0.54	0.42
Z_3	-262,578	-262,575	-262,577	2.57	16.58	5,834	0.70	0.67
Z_4	-2,763,081	-2,660,963	-2,712,022	102,117.74	0.30	32,142	0.67	0.63

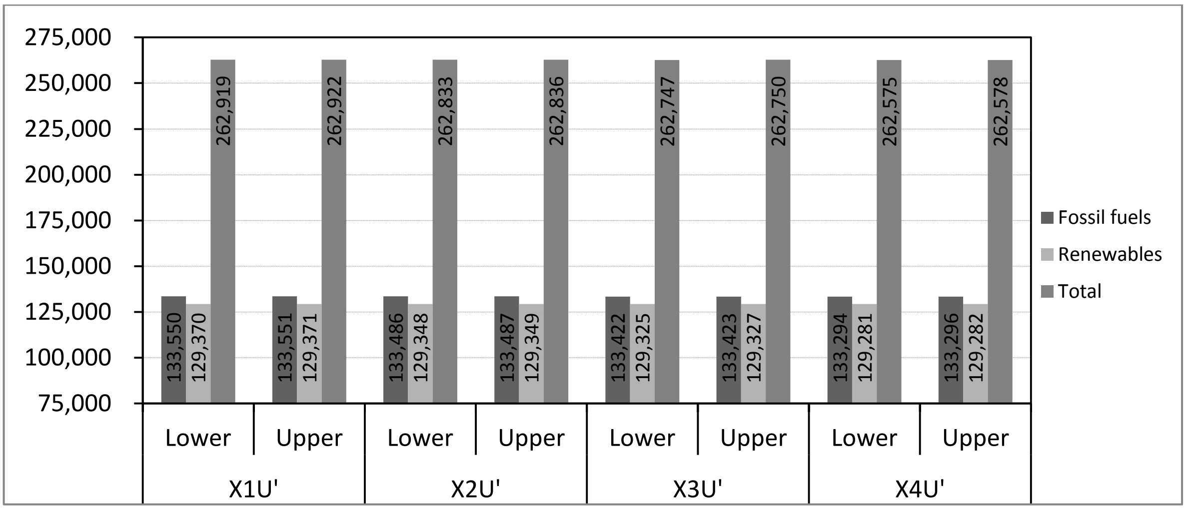

Figure 6.14 – Values for energy consumption in solutions $x^{1U'}$ to $x^{4U'}$ (toe × 10^3).

From the analysis of Figures 6.9 to 6.14 and the previous characterization of solutions $x^{1U'}$ to $x^{4U'}$ it is possible to conclude that:

- Gradual marginal improvements in GHG emissions, energy consumption, employment and GDP levels are provided by the transition from the narrowest to the broadest scenarios of coefficients;
- Solution $x^{4U'}$ (with the broadest feasible region) leads to best results for GHG emissions, energy consumption, employment and GDP levels in solutions $x^{1U'}$ to $x^{4U'}$;
- Solution $x^{1U'}$ (with the narrowest feasible region) leads to worst results for GHG emissions, energy consumption, employment and GDP levels in solutions $x^{1U'}$ to $x^{4U'}$;
- Contrarily to solutions $x^{1U''}$ to $x^{4U''}$ the level of general government gross debt decreases in solutions $x^{1U'}$ to $x^{4U'}$ as much as the feasible region is enlarged due to the

reduction of the individual constraint satisfaction thresholds (i.e. general government gross debt gradually reduces from solution $x^{1U'}$ to solution $x^{4U'}$);

- The general government structural balance in solutions $x^{1U'}$ to $x^{4U'}$ presents the same characteristic of solutions $x^{1U''}$ to solution $x^{4U''}$, i.e. the general government structural balance is gradually reduced from solution $x^{1U'}$ to solution $x^{4U'}$;
- The GDP, general government gross debt, general government structural balance and employment levels in solutions $x^{1U'}$ to $x^{4U'}$ are worse than the corresponding values in solutions $x^{1U''}$ to $x^{4U''}$;
- The acceptability index and achievement rates of GDP and employment are worse in solutions $x^{1U'}$ to $x^{4U'}$ than in solutions $x^{1U''}$ to $x^{4U''}$;
- Solution $x^{1U'}$ presents the highest distance of the interval values of GDP and employment level to the corresponding ideal interval solutions;
- The acceptability index and achievement rates of energy consumption and GHG emissions are better in solutions $x^{1U'}$ to $x^{4U'}$ than in solutions $x^{1U''}$ to $x^{4U''}$;
- The closest distance of the interval values of energy consumption and GHG emissions to the corresponding ideal interval solutions is obtained in solution $x^{4U'}$;
- The consumption of fossil energy is higher than the consumption of renewable energy in all 8 solutions;
- Values for fossil and renewable energy consumption are higher than the consolidated values in 2012 and lower than the values estimated by EPE (2013);
- The total GHG emissions are higher than the voluntary targets established by the Brazilian government for 2020 even in the scenario with lower emission factors.

6.5 CONCLUDING REMARKS

In this chapter deterministic and interval formulations of the MOLP model presented in Chapter 5 are applied to the Brazilian economic system. Relevant economic, social, environment and energy indicators are evaluated as a result of changes in the economic activity in line with the policy objectives considered. Firstly, the interactive STEP and TRIMAP methods are applied to the deterministic MOLP model to compute a set of non-dominated/efficient solutions. A specific analysis of prospective bioethanol production is also made considering a set of technical coefficients for 2G technologies and different (current and optimized) sugarcane cultivation conditions. Finally an interactive method is applied to the interval formulation of the MOLP model to include the uncertainty treatment of some variables and coefficients of the model.

The numerical specification of the MOLP model described in this chapter was carried out taken into account the values for the base year of the study (2009) from several data sources (IPCC, 2006; IBGE, 2008; MME, 2009; MCT, 2010; Guilhoto & Sesso Filho, 2010; Macrelli *et al.*, 2012), as well as official national projections for the main economic variables (IMF, 2014), energy production/consumption (EPE, 2013) and GHG emissions (Brasil, 2010) for the time horizon 2018. Auxiliary calculations are used to obtain the values for other economic variables for which no prospective data are available (see Appendix B). Four objective functions concerning to economic growth (maximization of GDP at constant prices), social welfare (maximization of employment level), energy use (minimization of final energy consumption) and environmental preservation (minimization of GHG emissions) were assessed. The model comprises 443 and 473 variables in the deterministic and interval formulations, respectively. A set of defining and bounding constraints (490 and 518 in the deterministic and interval formulations, respectively) is considered, in which technical coefficients matrices of an economy divided into 110 sectors are also used.

The STEM interactive method is not computationally demanding and offered a very flexible analysis, allowing the exploration of compromise solutions according to the preference information issued by the DM. This interactive solution search process has provided comprehensive information about the solution structure and trade-offs that are at stake between the competing objectives in different regions of the search space, which is progressively reduced.

The TRIMAP interactive method also revealed very flexible, allowing a progressive and selective exploration of compromise solutions in a user-friendly graphical environment. The non-dominated solutions computed allowed to unveil some patterns and the main characteristics of three main regions in the parametric diagram corresponding to sub-sets of solutions sharing the same features. The introduction of constraints on the objectives has allowed focusing the computation and analysis of non-dominated solutions as close as possible to the DM's preference information. Hence, both methods have provided remarkable decision support information to the DM such that they can be considered as complementary tools for identifying compromise solutions to the deterministic formulation of the MOLP model.

The uncertainty treatment performed by considering interval coefficients in a set of constraints has imposed some changes in relation to the deterministic model. As in the reference study of Oliveira (2008) upper/lower bounds are considered for all defining constraints of the model with interval coefficients thus avoiding the use of equalities with interval coefficients (and the associated exponential increase in the size of problems to be analyzed). The solution search process has also taken into account a hypothetical DM expressing their preferences according to the information presented to him/her. Optimistic and pessimistic perspectives have been considered in order to search for solutions using different decision alternatives.

The results obtained with both deterministic and interval formulations of the MOLP model have provided valuable insights about the trade-offs involved and allowed identifying the performance and trends of the main variables. The results suggest positive correlations between the GDP growth and the employment level, as well as for energy consumption and GHG emissions. Conflicting interactions between objective functions are also identified, namely the optimal solutions for GDP and employment levels lead to more energy consumption and GHG emissions, while the minimization of GHG emissions and energy consumption results in negative impacts on GDP and the employment level. Furthermore, an overall analysis of the solutions obtained with the interval formulation of the model allows identifying that solutions obtained with the more conservative position of the DM give higher relevance to the environmental and energy objectives in detriment of the economic and social ones, while in the more optimistic position the relevance of economic and social objectives is increased. In this sense, the policies to undertake should take these conflicting interactions into account, for instance engaging in strong energy efficiency programs to cope with potential increases in energy consumption and GHG emissions if a steady growth of GDP is envisaged, for instance by promoting public investment in infrastructures. Moreover, this type of programs may induce beneficial effects on several economic sectors and employment.

Despite the high rate of renewable energy, the share of fossil fuels in the total energy consumption is higher in all solutions even in the interval formulation thus pointing the need to reduce the fossil energy intensity of the Brazilian economy. Therefore, policies envisaging the reduction of the coefficients of energy consumption, and consequently the GHG emissions associated, will have a remarkable positive impact in achieving better performances in these objectives. Possible options include, for example, the substitution of fossil energy by other cleaner sources (e.g. increasing the national production of wind and solar energy, substituting the thermal power generation, increasing the share of biodiesel, bioethanol or even electricity in the transportation sector), encouraging energy efficiency and conservation actions (e.g. improving the public transport system, in order to reduce the use of individual transportation and increase the rate of people transported by unit of energy, raising the use of pipelines, railway and waterborne transport systems envisaging increase the weight transported by unit of energy consumed).

Finally, the impacts of different 1G and 1G+2G bioethanol production process on the Brazilian economic system and the bioethanol supply in a prospective scenario were also analyzed. Eight technical coefficients for different configurations of combined 1G+2G bioethanol production plants (2G-A to 2G-H) and sugarcane cultivation conditions were set. A total of 24 non-dominated solutions regarding different scenarios were obtained. Illustrative results have allowed identify that higher diesel oil and lubricants consumption in the mechanical harvesting process in 1G-optimized scenario has counterbalanced the positive effects of more efficient and higher load capacity trucks for sugarcane transportation leading to negative marginal impacts in terms of total energy consumption and GHG emissions when compared to the 1G scenario. Different patterns of chemical utilization (especially enzymes) between the 1G+2G processes have influenced the total GHG emissions, energy consumption and employment level. A reduction in the total sugarcane outputs is obtained in all 1G+2G scenarios validating the assumption that less sugarcane is demanded to produce the same amount of bioethanol in relation to the 1G plant. The amount of hydrous and anhydrous bioethanol produced and the economic structure is very dissimilar in solutions 5 to 14 even fixing the GDP and the total bioethanol values. All solutions maximizing the total (anhydrous + hydrous) bioethanol production (solutions 15 to 24) achieved the upper bound defined for consumption of residents, total exports and GFCF. A lower overall employment level is obtained in the 1G+2G scenarios (solutions 17 to 24) compared to the 1G and 1G-optimized scenarios (solutions 15 and 16) due to relatively less industrial employment requirements in the 1G+2G plants. An important negative effect in all scenarios (solutions 15 to 24) maximizing the total bioethanol production is the increase of the total energy consumption and the GHG emissions as a result of higher production of bioethanol on the overall production of all sectors and exports, as well as direct and indirect effects from higher consumption of chemicals in the 2G processes. Nevertheless, the cost of chemicals is expected to decrease in the medium to long term as far as new technological improvements and economies of scale are attained. Therefore, the negative influence of chemicals on the overall cost and consumption pattern of the 2G processes can be reduced, as well as the corresponding direct and indirect effects. Hence, it is worth noting that policies and technological choices for prospective bioethanol production have to take into account the direct and indirect effects on the whole economic system, since positive direct effects of 1G+2G plants can be counterbalanced by impacts on the output of other sectors, mainly from chemical use in the process. Thus, the integrated- or country-basis analysis as presented in this study can complement the plant- or process-basis analysis of the 2G bioethanol, such that the 2G bioethanol can be developed as a useful product to improve the (renewable) energy supply, reduce the overall GHG emissions, and afford the employment level sustainability.

CHAPTER 7 CONCLUSION

Economic growth is usually a policy objective pursued by most countries owing to the potential benefits on the overall social welfare and infrastructure levels. However, economic growth usually leads to an increase of energy consumption. As much as the energy consumption pattern relies on fossil fuels, which are finite resources and important sources of GHG emissions, the associated environmental impacts are also increased. Contrariwise, energy and environmental policies may have a negative (constraining) impact on economic growth and social welfare, therefore requiring the careful assessment of the impacts of different policies and the trade-offs at stake between different policy objectives.

The recent economic growth in Brazil has significantly improved social welfare and infrastructure levels, as well as increased energy consumption. Although Brazil has been improving the energy supply and the share of renewable sources in the energy mix, the fossil fuel production has also risen due to the exploitation of new oil extraction areas in order to satisfy this economic growth. Moreover, the energy sector has been the second major emission source in Brazil mainly due to the consumption of fossil fuels in the road transportation and industrial sectors. As one of the largest world economies, the assessment of the effects of different policies and the trade-offs associated with the economic growth, energy demand/supply, as well as environmental and social objectives in Brazil is key to provide reliable information and tools for planners and decision makers.

Input-Output Analysis has been traditionally used to study the inter/intra-relationships among different sectors in the economic system, describing the relationship between the inputs used and the outputs produced. The main concepts and assumptions underlying input-output models were summarily presented in Chapter 2 in order to outline their most important characteristics, as well as a critical analysis of its suitability for policy analysis. The usefulness of input-output analysis regards the analytical and modeling framework to explore direct and indirect structural interactions in the economy in a detailed level, such as sectors or commodities. This methodology is a flexible tool for the theoretical or empirical investigation of a wide range of applications encompassing the analysis of more aggregated or disaggregated systems, depending on the objectives of the study. In fact, despite some limitations, the most important feature of the input-output methodology regards to its practicality and usefulness as an analytical tool for empirical research supporting policy making in a wide variety of problems.

A succinct overview of extended versions of the traditional input-output model to deal with both environmental and energy issues, as well as the relationships between the input-output model with other methods such as Life Cycle Analysis and mathematical programming has also been presented in Chapter 3. Interactive methods, such as STEM and TRIMAP, enabling a progressive and selective search of efficient solutions in MOLP models were displayed in Chapter 4. In addition, an interactive approach to the treatment of uncertainty in MOLP models with interval coefficients developed by Henriques (2008) and Oliveira & Antunes (2009) was also summarily presented in Chapter 4.

The deterministic and interval formulations of an MOLP model based on a hybrid Input-Output framework was presented in Chapter 5, which aimed at assessing the trade-offs between economic, energy, environmental and social objectives in the Brazilian economic system for the time horizon 2018. The numerical specification of the model was developed by reorganizing the System of National Accounts (SNA) to include the National Energy Balance, creating a hybrid IO framework, with the technical coefficients matrices divided into 110 sectors. This framework was afterwards extended to assess GHG emissions. The model comprises 443 and 473 variables in the deterministic and interval formulations, respectively. A set of defining and bound constraints (490 and 518 in the deterministic and interval formulations, respectively) was considered. The bound constraints were defined in the model by using official data for the main economic variables and auxiliary calculations for other economic variables for which no prospective data are available. The bound constraints have set minimum and maximum levels of some economic variables such that the results obtained are as close as possible to the values estimated by statistics and planning entities. The interactive methods presented in Chapter 4 were used for a progressive and selective search of efficient solutions in the deterministic and interval formulations of the MOLP model. Four objective functions concerning to economic growth (maximization of GDP at constant prices), social welfare (maximization of employment level), energy use (minimization of final energy consumption) and environmental preservation (minimization of GHG emissions) were assessed. An additional analysis regarding the bioethanol sector was also made considering the deterministic formulation of the MOLP model. The results were presented and discussed in Chapter 6.

Indeed, extending the traditional input-output model by combining energy and environmental data in physical units with input-output data in monetary units has provided a consistent tool for the analysis of the energy-economy-environment interactions at national and sectoral levels. The model has proved being adequate for the evaluation of: the energy use and environmental impacts in prospective economic scenarios; the effects of an overall reduction of GHG emissions and energy consumption through all sectors of the economy; repercussions of setting a level for the output of the bioethanol sector on the outputs of the other sectors; the effects of the maximization of total bioethanol production by prospective technologies and a comparison with the current patterns. The combination of the extended input-output model as the basis structure for a multi-objective mathematical programming model has allowed obtaining an integrated framework encompassing technical, energy, environmental, economic and policy decision variables, objective functions and constraints, enabling to identify efficient combinations of inputs and outputs on the boundary of the production possibility frontier. Such combination of different modeling approaches has provided a complementary tool for the analysis, enabling to gather additional information that could not be possible to obtain by the isolated use of them.

The deterministic formulation of the model was dealt with using two different interactive methods: STEM and TRIMAP. The STEM method revealed to be very simple in the computation of non-dominated solutions and information required from the DM, allowing the exploration of compromise solutions according to the DM's preference indications. This interactive solution search process has provided comprehensive information about the solution structure and trade-offs that are at stake between the competing objectives in different regions of the search space, which was progressively reduced. The TRIMAP interactive method offered a very flexible analysis, allowing a progressive and selective exploration of compromise solutions in a user-friendly graphical environment. The non-dominated solutions computed have allowed unveiling some patterns and the main characteristics of regions in the parametric diagram, whereas the introduction of constraints on the objective functions has allowed focusing the computation and analysis of non-dominated solutions on regions as close as possible to the DM's preferences. Hence, both methods have provided significant decision support information such that they could be used as complementary tools for identifying compromise solutions to the deterministic formulation of the MOLP model in order to assist the DM.

The uncertainty treatment performed by considering interval coefficients in a set of constraints has imposed some changes in relation to the deterministic formulation of the MOLP model. As in the study of Henriques (2008) upper/lower bounds are considered for all defining constraints of the model with interval coefficients thus avoiding the use of equalities with interval coefficients (and the associated increase of the number and size of problems to be analyzed). This approach involves the formulation of surrogate deterministic models for the interval MOLP model (based on minimization of the worst possible deviation of the interval objective functions to their corresponding interval ideal solutions) and an interactive phase in which a synergy between the algorithm (providing information to the DM) and the DM (obtaining the information and choosing the subsequent search directions) allows a searching process guided by the closeness of the values of the interval solution in relation to the ideal interval solution. Hence, optimistic and pessimistic perspectives have been considered in order to search for solutions using different decision alternatives. This model has allowed: getting a simpler mathematical formulation of the interval model; a strong integration of the DM with the algorithm, with not very demanding information requirements; tackling the uncertainty in the main coefficients of the model; evaluating the search options for solutions well considered by the DM. Therefore, the option to apply this method to the model presented in Chapter 5 has vouched the applicability of this algorithm in MOLP models with interval coefficients with realistic dimensions. Finally, using interval programming for the treatment of uncertainty intrinsic to the coefficients of MOLP models applied to real problems has proved being a valuable approach to overcome the difficulty in specifying the *probabilistic* or the *possibilistic* distributions as required in stochastic and fuzzy programming, respectively.

As referred to previously, the impacts of different 1G and 1G+2G bioethanol production process on the Brazilian economic system and the bioethanol supply in a prospective scenario were also analyzed. The role of the bioethanol from sugarcane in the Brazilian transportation sector, mainly in light vehicles, is remarkable, such that a broader analysis of the bioethanol systems including social, energy and environmental performances rather than just an economic analysis is key for the energy policy in Brazil. Eight technical coefficients for different configurations of combined 1G+2G bioethanol production plants (2G-A to 2G-H) and sugarcane cultivation conditions were set. A total of 24 non-dominated solutions regarding different scenarios were obtained. Illustrative results have allowed identifying: counterbalancing effects from the use of diesel oil and lubricants in the mechanical harvesting process and higher load capacity trucks for sugarcane transportation; negative direct and indirect effects on GHG emissions, energy consumption and employment level due to different patterns of chemical utilization (especially enzymes) in the 2G processes. However, the cost of chemicals is expected to decrease in the medium to long term as far as new technological improvements and economies of scale are attained, such that the negative influence of chemicals use on the overall cost and consumption pattern of the 2G processes can be reduced. Hence, it is worth noting that policies and technological choices for prospective bioethanol production have to take into account the direct and indirect effects on the whole economic system, since positive direct effects of 1G+2G plants can be counterbalanced by impacts on the output of other sectors, mainly from the use of chemicals in the process.

The integrated- or country-basis analysis, as presented in this study, have allowed incorporating different process into the model and expanding the analysis boundaries and can complement the plant- or process-basis analysis of the 2G bioethanol, such that the 2G bioethanol can be developed as a useful product to improve the (renewable) energy supply, reduce the overall GHG emissions and afford the employment level sustainability. Therefore, the model applied in this study has provided a tool for prospective analysis of the Brazilian economic system and the bioethanol sector in Brazil taking advantage of the strengths of applying extended and hybrid input-output frameworks with mathematical programming models in modeling complex interrelationships between economic and physical systems. Such encompassing modeling and analysis has not been applied previously to Brazil, and especially to the Brazilian bioethanol system. Hence, the originality of this research lies on both modeling and analysis, which are claimed as the main value added of this thesis.

The application to a different country with the characteristics of Brazil has led to significant modifications in the mathematical model compared to the previous studies applied to Portugal (see Oliveira & Antunes (2000, 2002, 2004, 2005, 2011), Antunes et al. (2002)). Apart the GHG emissions from energy combustion, industrial processes, agricultural activities, wastewater, waste treatment and fugitive emissions computed in previous versions of the model, the GHG emissions from rice cultivation, fugitive emissions from coal and natural gas production and LUC and forestry emissions are considered in this thesis. The model also contains other important changes compared to previous versions, which are not exclusively related to the necessary adaptations due to an application to a different country. The GHG emissions from energy combustion have been estimated by using a bottom-up approach for all GHG (CO_2, CH_4 and N_2O), whereas in the previous studies a top-down approach for CO_2 and a bottom-up approach for CH_4 and N_2O were considered. In addition, lower and upper emission factors for GHG emissions from energy combustion and fugitive emissions from IPCC (2006) are also considered in the interval model instead of default values (as in the deterministic model), such that the range of possible variations of total emissions from those sources (and the uncertainty associated) can be better captured. Moreover, a different methodology regarding previous studies has been used to compute direct and indirect N_2O emissions from manure management and managed soils. The methodology applied in this study follows the IPCC guidelines such that the direct N_2O emissions from manure management and managed soils are accounted for considering the emissions from grazing animals, manure used as organic fertilizer, crop residues and synthetic fertilizers, whereas the corresponding indirect N_2O emissions from leaching and volatization of N are also accounted separately. Furthermore, the computation of emissions from solid waste disposable is based on the IPPC approach and depends on the exogenous variable total population, instead of associated with the consumption of households and NPISH and commercial sectors as in the previous studies. Finally, the computation of CH_4 emissions from industrial wastewater is based on the methodology used in the II Brazilian Inventory of GHG emissions, in which the biochemical oxygen demand (BOD) was applied instead of the chemical organic demand (COD) as suggested by the IPCC (2006) methodology. This methodology is also different from the methodology used in the previous studies in which emission factors provided by the Portuguese Inventory of GHG emissions were considered.

Some limitations inherent to this type of models can be identified. Firstly, the assumptions and simplifications of input-output models, such as fixity of coefficients, constant returns to scale, and homogeneity of production, impose criticisms about the exclusion of joint production, the uniqueness of technological process to each sector and the capacity of economic agents in responding to exogenous shocks. However, as discussed in Chapter 2, these assumptions only become limitations when they compromise the integrity of the conclusions that are being drawn from the research, by which some adjustments can be made (Bickneel et al., 1998; Cruz, 2002). Moreover, the homogeneity assumption possibly has some impacts for an application of the input-output model to a particular firm or product, but may not impose a strict limitation at a macro-level (Bickneel et al., 1998). Furthermore, although establishing no substitution between factors and the time invariability of the technology (assuming the input-output coefficients as the same in medium-long term) can be considered a strong assumption, the model could be suitable for such medium-to-long term analysis if such limitations are overcome by some updating mechanisms that are able to introduce or forecast the changes in the technological coefficients (Zhang & Folmer, 1998; Proops et al., 1993). This option was applied for both prospective bioethanol and sugarcane sectors in which new technical coefficients were estimated and endogenously introduced in the IO framework.

The amount of detailed and comprehensive data required to numerically instantiate this model can also be a limitation, since data are always subject to error and may be inaccurate in some extent. In addition, the time lag associated with the publication of input-output tables can limit the potential of the model. Due to the lack of recent official statistical information, the 2009 IO system was utilized. Significant changes in the economic system may occur and the inter-relationships between sectors can also be different in the Brazilian economic system in 2018, thus leading to a bias in the estimates. Furthermore, since input-output data aggregates diverse individual firms in a sector (considering 'average' prices and commodities) and sectors may be too heterogeneous, the results may not correctly reflect the real conditions in each sector. Moreover, due to a lack of official projections for future periods the time-horizon 2018 was considered. This is a drawback because some technologies (specially, for 2G bioethanol production) may not generate large impacts within that time span. Furthermore, official projections for 2018 are available only for the main economic variables. Thus minimum and maximum historical values are used as a basis for establishing bounds for those variables, leading to another uncertainty source in the model. Hence, the heterogeneity of sectors, the inter-relationships between sectors and the uncertainty associated with prospective Brazilian economic system are limitations inherent to this type of model that may lead to biased results, which may be mitigated by more accurate official projections data for some exogenous variables available in the future.

Finally, the IO-MOLP model and corresponding analysis are subjects for future improvements. The LUC and other emission sources are considered constant and having the same values as in 2000. Since LUC is the main GHG emission source in Brazil, it is planned to be the object of further improvements of this model expectedly as a component of an interactive modeling framework. The deterministic characteristics of the IO coefficients, the uncertainty inherent to the calculation of environmental impacts and issues due to the static nature of the model coefficients will be the theme for some adjustments in the production structure through the modification of specific coefficients or considering interval coefficients in future versions of this model. Since only the main inputs in the sugarcane and 2G bioethanol life cycle are considered, further improvements can include other less expressive inputs and outputs of those processes within a more detailed framework. Future developments will also include an analysis of the impacts associated with the achievement of national targets regarding the production of renewable energy sources, as well as variations in the energy consumption structure of the IO system. Other possible future improvements are in line with those proposed in previous studies, such as: the inclusion of carbon sequestration technologies and the corresponding impacts on reducing GHG emissions; development of a nationwide investment matrix to assess alternative patterns of energy consumption, according to different technologies; the explicit consideration of the stocks of capital goods depreciated for reuse or recycling of materials and the corresponding impacts on the environment.

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APPENDIX A – Description of variables, parameters and coefficients of the model presented in Chapter 5.

Table A.1 – Model Variables Description

Notation	Variables Description – Deterministic	Unities	Expressions[1]
x	Vector of total (output) national production by each sector.	Million R$ (constant basic prices) or toe according to non-energy or energy sector	1, 15, 23, 30, 34, 38, 46, 47, 48, 67, 68, 69, 70, 34i
exp	Vector of exports of goods and services.	Million R$ (constant basic prices) or toe according to non-energy or energy sector	1, 11, 12
g	Vector of final consumption expenditure of the general government.	Million R$ (constant basic prices) or toe according to non-energy or energy sector	1, 8
cnpish	Vector of final consumption expenditure of non-profit institutions serving households (NPISH).	Million R$ (constant basic prices) or toe according to non-energy or energy sector	1, 7
cf	Vector of final consumption expenditure of households on the territory.	Million R$ (constant basic prices) or toe according to non-energy or energy sector	1, 2, 2i
gfcf	Vector of gross fixed capital formation.	Million R$ (constant basic prices) or toe according to non-energy or energy sector	1, 9
sc	Vector of changes in inventories (can assume positive or negative values).	Million R$ (constant basic prices) or toe according to non-energy or energy sector	1, 10
$\mathbf{imp}^{c}$	Vector of competitive imports.	toe	1, 15
cf	Total final consumption expenditure of households on the territory.	Million R$ (constant consumer prices)	2, 3, 16, 24, 31, 47, 48, 55, 67, 68, 69, 70, 2i, 3i, 31i
cfr	Final consumption expenditure of resident's households on the territory.	Million R$ (constant consumer prices)	3, 5, 3i, 5i
cpe	Final consumption expenditure of non-resident's households on the territory (or exports of tourism services).	Million R$ (constant prices)	3, 14, 3i
cpr	Total final consumption expenditure of residents (households and NPISH).	Million R$ (constant consumer prices)	4, 5, 6, 33, 4i, 5i, 33i
yd	Households and NPISH disposable income.	Million R$ (constant prices)	4, 4i
cpm	The imports of tourism (or the final consumption expenditure - in tourism services - of resident households abroad).	Million R$ (constant prices)	5, 6, 22, 5i, 22i
cnpish	Total final consumption expenditure of NPISH.	Million R$ (constant consumer prices)	5, 7, 17, 25, 31, 47, 48, 56, 67, 68, 69, 70, 5i, 31i
g	Total final consumption expenditure of the general government.	Million R$ (constant consumer prices)	8, 18, 26, 31, 47, 48, 54, 67, 68, 69, 70, 31i
gfcf	Total gross fixed capital formation.	Million R$ (constant consumer prices)	9, 19, 27, 31, 31i

[1] For the sake of simplicity, the number of the chapter has been omitted from the nomenclature of the equations in Tables A.1 and A.2, since all the expressions are from Chapter 5.

sc	Total changes in inventories (can assume positive or negative values).	Million R$ (constant consumer prices)	10, 20, 28, 31, 33, 31i, 33i
expcpwt	Total exports (excluding tourism) at constant consumer prices	Million R$ (constant consumer prices)	11, 12, 13, 14, 29
expcpwt	Vector of exports (excluding tourism) at consumer prices	Million R$ (constant prices)	12, 13
expcpt	Total exports (including tourism) at consumer prices.	Million R$ (constant consumer prices)	14, 31, 33, 31i, 33i
impwtcif	Total imports (excluding tourism) at constant CIF prices.	Million R$ (constant CIF consumer prices)	15, 21, 21i
cfm	Consumption of non-energy goods or services from non-competitive imports by households	Million R$ (constant CIF prices)	15, 16
cnpishm	Consumption of non-energy goods or services from non-competitive imports by NPISH.	Million R$ (constant CIF prices)	15, 17
gm	Consumption of non-energy goods or services from non-competitive imports by the general government.	Million R$ (constant CIF prices)	15, 18
gfcfm	Gross fixed capital formation from non-competitive imports of non-energy goods or services.	Million R$ (constant CIF prices)	15, 19
scm	Changes in inventories of non-energy goods or services from non-competitive imports.	Million R$ (constant CIF prices)	15, 20
impwtfob	Total imports (excluding tourism) at constant FOB prices.	Million R$ (constant FOB prices)	21, 22, 21i, 22i
impfob	Total imports (including tourism) at constant FOB prices.	Million R$ (constant FOB prices)	22, 31, 33, 22i, 31i, 33i
ts	Taxes less subsidies on goods or services.	Million R$ (constant prices)	23, 32, 38, 32i
cfts	Taxes less subsidies on goods or services consumed by households.	Million R$ (constant prices)	23, 24
cnpishts	Taxes less subsidies on goods or services consumed by NPISH.	Million R$ (constant prices)	23, 25
gts	Taxes less subsidies on goods or services consumed by the general government.	Million R$ (constant prices)	23, 26
gfcfts	Taxes less subsidies on goods or services to GFCF.	Million R$ (constant prices)	23, 27
scts	Taxes less subsidies on goods or services to changes in inventories (can assume positive or negative values).	Million R$ (constant prices)	23, 28
expts	Taxes less subsidies on goods or services exports.	Million R$ (constant prices)	23, 29
gva	Gross value added.	Million R$ (constant prices)	30, 32, 32i
gdp_{exp}	GDP in the expense approach.	Million R$ (constant prices)	31, 119, 31i
gdp_{inc}	GDP in the income approach.	Million R$ (constant prices)	32, 32i
gdpcurr	GDP current.	Million R$ (current prices)	33, 35, 37, 41, 45, 33i, 35i
pcpr	Private consumption deflator (exogenous variable).	No dimension (to transform constant to current prices)	33, 38
gcurr	Consumption of goods or services by the general government at current prices.	Million R$ (current prices)	33, 44, 33i, 44i
gfcfcurr	Gross fixed capital formation at current prices.	Million R$ (current prices)	33, 33i
psc	Stock variations deflator (exogenous variable).	No dimension (to transform constant to current prices)	33
pexpcpt	Exports deflator (exogenous variable).	No dimension (to transform constant to current prices)	33
pimpfob	Imports deflator (exogenous variable).	No dimension (to transform constant to current prices)	33
wagcurr	Wages at current prices.	Million R$ (current prices)	34, 40, 34i

iucl	Unitary employees cost index (exogenous variable).	No dimension (allows transforming constant to current prices)	34
ydcurr	Household and NPISH disposable income at current prices.	Million R$ (current prices)	35, 36, 35i
$(pi^{+} – pi^{-})$	Balance of primary incomes.	Million R$ (current prices)	35, 35i
itsub	Total indirect taxes less subsides.	Million R$ (current prices)	35, 38, 39, 35i
itsubg	Net indirect taxes less subsides (total received – total paid) for the general government.	Million R$ (current prices)	35, 39, 44, 35i, 44i
ctr	Current transferences (can assume positive or negative values).	Million R$ (current prices)	35, 35i
dt	Direct tax on households and NPISH disposable income.	Million R$ (current prices)	35, 36, 44, 35i, 44i
dtc	Direct tax on (financial and non-financial) corporation's disposable income.	Million R$ (current prices)	35, 37, 44, 35i, 44i
ssc	Social security contributions paid to the general government.	Million R$ (current prices)	35, 40, 44, 35i, 44i
$(pig^{+} – pig^{-})$	Balance of property incomes (can assume positive or negative values).	Million R$ (current prices)	35, 41, 44, 35i, 44i
trgh	Transferences from the general government to households.	Million R$ (current prices)	35, 44, 35i, 44i
itrei	Evolution index of the indirect tax rate (exogenous variable).	%	38
debt	General government gross debt.	Million R$ (current prices)	42, 43, 42i, 43i
$debt_{-1}$	General government gross debt in the previous period.	Million R$ (current prices)	42, 43, 42i, 43i
gbg^{+} - gbg^{-}	General government structural balance (can assume positive or negative values).	Million R$ (current prices)	42, 44, 42i, 44i
dat	Adjustment variable for the general government gross debt.	Million R$ (current prices)	42, 42i
jurg	Interest on the general government gross debt.	Million R$ (current prices)	43, 44, 43i, 44i
rg	Interest rate on the general government gross debt (exogenous variable).	%	43
ctrg	Current transferences of the general government.	Million R$ (current prices)	44, 44i
tk	Capital tax.	Million R$ (current prices)	44, 45, 44i
trkg	Capital transferences of the general government (can assume positive or negative values).	Million R$ (current prices)	44, 44i
gfcfg	Gross fixed capital formation of the general government.	Million R$ (current prices)	44, 44i
emp	Employment level.	Number of employees.	46, 122
ce	Total final consumption of energy.	toe	47
cfe	Total final consumption of energy for fuel purposes.	toe	48, 120
$ecelet_{w}$	Emissions from fuel combustion in electricity power plants.	Gg	49, 61
$\mathbf{x}_{ele}$	Total output of the electricity generation sector and respective products.	toe	49
$ecechp_{w}$	Emissions from fuel combustion in combined heat and power plants (cogeneration).	Gg	50, 61
x_{chp}	Total output of cogeneration in combined heat and power plants.	toe	50
$ecref_{w}$	Emissions from combustion activities supporting the refining of petroleum products.	Gg	51, 61
$\mathbf{x}_{ref}$	Total output of the refining of petroleum sector and respective products.	toe	51

$ecpge_w$	Emissions from combustion of fuels in petroleum and natural gas extraction.	Gg	52, 61
$\mathbf{x}_{pge}$	Total output of the petroleum and natural gas extraction sector and respective products.	toe	52
$ecbio_w$	Emissions from combustion of fuels in the bioethanol production.	Gg	53, 61
$\mathbf{x}_{bio}$	Total output of the bioethanol sector and respective products.	toe	53
ecg_w	Emissions from combustion of fuels in the public sector.	Gg	54, 61
$\mathbf{x}_{gi}$	Total output of the public sectors.	Million R$ (constant basic prices)	54
$eccf_w$	Emissions from combustion of fuels by households.	Gg	55, 61
$eccnpish_w$	Emissions from combustion of fuels by NPISHs.	Gg	56, 61
$eccs_w$	Emissions from combustion of fuels in trade and service sectors.	Gg	57, 61
$\mathbf{x}_{cs}$	Total output of the trade and service sectors.	Million R$ (constant basic prices)	57
$ecal_w$	Emissions from combustion of fuels in the agriculture & forestry and fishing & livestock sectors.	Gg	58, 61
$\mathbf{x}_{al}$	Total output of the agriculture & forestry and fishing & livestock sectors.	Million R$ (constant basic prices)	58
$ecind_w$	Emissions from combustion of fuels in the manufacturing industries and construction sectors.	Gg	59, 61
$\mathbf{x}_{ind}$	Total output of the manufacturing industries and construction sectors.	Million R$ (constant basic prices)	59, 100
$ectr_{tw}$	GHG emissions from the transportation sector.	Gg	60, 61
$\mathbf{x}_{t}$	Total output of transportation sector and respective means of transport.	Million R$ (constant basic prices)	60
ec_w	Total GHG emissions from fuel combustion.	Gg	61, 115, 116, 117
$fecpms_w$	Fugitive emissions of coal production in underground and surface mining systems.	Gg	62, 75
$\mathbf{x}_{cp}$	Sub-vector of the total coal products outputs.	toe	62, 63
usr	Ratio of underground or surface mining in the total coal production.	%	62, 63
$fepmms_w$	Post-mining emissions of coal production in underground and surface mining systems.	Gg	63, 77
$fegpfl_w$	Emissions from natural gas flaring	Gg	64, 77
$\mathbf{x}_{gp}$	Sub-vector of the natural gas (wet and dry) output.	toe	64, 65, 66, 67, 68, 69, 70
$fegpv_w$	Emissions from natural gas venting.	Gg	65, 77
$fegpf_w$	Other fugitive emissions at natural gas facilities.	Gg	66, 77
$fegtf_w$	Fugitive emissions from gas transmission	Gg	67, 77
$fegs_w$	Emissions from natural gas storage.	Gg	68, 77
$fegd_w$	Fugitive emissions from the distribution of natural gas to end user.	Gg	69, 77
$felpgd_w$	Emissions of Liquified Petroleum Gas (LPG) distribution.	Gg	70, 77
$feopv_w$	Emissions from venting of associated gas and waste gas/vapour streams at oil facilities.	Gg	71, 77
$\mathbf{x}_{op}$	Sub-vector with the total oil output.	toe	71, 72, 73, 74

$feopfl_w$	Emissions from flaring of natural gas and waste gas/vapour streams at oil facilities.	Gg	72, 77
$feopf_w$	Other fugitive emissions at oil facilities not specifically accounted for as venting or flaring.	Gg	73, 77
$feotp_w$	Fugitive emissions (excluding venting and flaring) related to the transport of marketable crude oil to upgraders and refineries.	Gg	74, 77
x_z	Scalar of vector **x** with the output of the specific sector z: chemicals, cement, other products of nonmetallic minerals, manufacture of steel and steel products and metallurgy of nonferrous metals.	Million R$ (constant basic prices)	75
$effeip_{jw}$	Fugitive emissions from industrial process	Gg	75, 77
x_{lub}	Scalar of vector **x** with the amount of lubricants used in the country.	toe	76
$felu_w$	Fugitive emissions of CO_2 from lubricants use.	Gg	76, 77
tfe_w	Total fugitive emissions.	Gg	77, 115, 116, 117
$edmm_w$	Total direct N_2O emissions from manure management.	Gg	78, 94
x_{lf}	Scalar with the output of the livestock and fishing sector.	Million R$ (constant basic prices)	78, 79, 80, 81, 82, 83, 88, 89
$eimm_w$	Total indirect N_2O emissions from manure management.	Gg	79, 94
emm_{rw}	CH_4 emissions from manure management.	Gg	80, 94
$eentf_{rw}$	CH4 emissions from enteric fermentation.	Gg	81, 94
egm_w	Total direct N_2O emissions from the N additions to the soils from manure deposited directly in soil by grazing animals.	Gg	82, 86
eof_w	Total direct N_2O emissions from the net N additions to the soils from managed manure applied as fertilizer (or organic fertilizers).	Gg	83, 86
ecr_{qw}	Total direct N_2O emissions from the net N in crop residues (above and below ground).	Gg	84, 86
x_{af}	scalar with the production of the agriculture and forestry sector	Million R$ (constant basic prices)	84, 85, 87, 90, 91, 92, 93
esf_w	Total direct N_2O emissions from the net N additions to the soils from synthetic fertilizers.	Gg	85, 86
$edms_w$	Total direct N_2O emissions from managed soils.	Gg	86, 94
eos_w	Annual direct N_2O emissions from managed organic soils (exogenous variable).	Gg	86
$eimsv_w$	The N_2O emissions from atmospheric deposition of N volatilized from managed soil.	Gg	87, 94
of_N	Amount of N additions to soils from organic fertilizers.	Gg	87, 88, 90
gm_N	Amount of N additions to soils from manure deposited by grazing animals.	Gg	87, 89, 90
$eilr_w$	N_2O emissions produced from leaching and runoff of N additions to managed soils.	Gg	90, 94
cr_N	Amount of N additions to soils from crop residues.	Gg	90, 91
$ecrb_{qw}$	CH_4 and N_2O emissions from crop residues burning.	Gg	92, 94
$erice_{Tw}$	CH_4 emissions from rice cultivation.	Gg	93, 94
$eaflf_w$	Total emissions from the AFLF sector.	Gg	94, 115, 116, 117
$eluc_w$	CO_2, CH_4 and N_2O emissions from land use change (exogenous variable - includes CO_2 emissions from liming).	Gg	94
msw	Municipal solid waste.	Gg	95, 96, 98, 107

p	Human population in the country (exogenous variable).	Habitants	95, 110, 114
$mswswd_u$	MSW which is carried to SWDS.	Gg	96, 97
$emswswd_{uw}$	CH_4 emissions from SWDS.	Gg	97, 108
mswbt	MSW carried to composting and anaerobic digestion processes	Gg	98, 99
$emswbt_w$	Emissions from biological treatment.	Gg	99, 108
isw_{ind}	ISW generated by industrial sectors.	Gg	100, 101, 103
isworgswd	Amount of organic ISW carried to SWDS.	Gg	101, 102
$eisworgswd_w$	Emissions from organic ISW in SWDS.	Gg	102, 108
iswincin	Amount of ISW incinerated without energy recovery.	Gg	103, 104, 107
$eiswincin_w$	Emissions of ISW incinerated without energy recovery.	Gg	104, 108
cwincin	Amount of CW incinerated.	Gg	105, 106, 107
$\mathbf{x}_{hs}$	Output of the private and public health sectors.	Million R$ (constant basic prices)	105
$ecwincin_w$	Emissions from CW incineration.	Gg	106, 108
$eswincin_w$	CO_2 emissions from solid waste incineration.	Gg	107, 108
$eswd_w$	Total emission of SWD.	Gg	108, 115, 116, 117
echdww	CH_4 emissions from domestic wastewater.	Gg	109, 116
tow	Total organics (or organically degradable carbon) in wastewater in inventory year.	kg BOD/yr	109, 110
$echiww_{yw}$	CH_4 emissions from on-site industrial wastewater treatment.	Gg	112, 116
$\mathbf{x}_y$	Total output of the industrial sectors selected.	Million R$ (constant basic prices)	112
en2oww	N_2O emissions from wastewater effluent.	Gg	114, 116
teco	Total emissions of $CO_{2.}$	Gg	115, 118
tech	Total emissions of $CH_{4.}$	Gg	116, 118
teno	Total emissions of $N_2O_.$	Gg	117, 118
ghg	Total GHG emissions.	Gg of CO_2 equivalent	118, 121
Notation	**Variables Description - Interval**	**Unities**	**Expressions**
pcpr*	Private consumption deflator (exogenous interval variable).	No dimension (to transform constant to current prices)	33i
psc*	Stock variations deflator (exogenous interval variable).	No dimension (to transform constant to current prices)	33i
pexpcpt*	Exports deflator (exogenous interval variable).	No dimension (to transform constant to current prices)	33i
pimpfob*	Imports deflator (exogenous interval variable).	No dimension (to transform constant to current prices)	33i
iucl*	Unitary employees cost index (exogenous interval variable).	No dimension (allows transforming constant to current prices)	34i
itrei*	Evolution index of the indirect tax rate (exogenous interval variable).	%	38i
rg*	Interest rate on the general government gross debt (exogenous interval variable).	%	43i

Table A2 – Model Coefficients Description			
Notation	**Coefficients Description - Deterministic**	**Unities**	**Expressions**
A	Technical coefficient matrix. This matrix includes non-energy sectors, energy sectors and energy products (fuels). Each element a_{ij} represents the quantity of good or service *i* used to produce one unity of good or service *j*.	Million R$ (constant basic prices)/ Million R$ (constant basic prices), for flows between non-energy sectors; Million R$ (constant basic prices)/toe, for flows between non-energy and energy sectors; toe/ Million R$ (constant basic prices), for flows between energy and non-energy sectors; toe/toe, for flows between energy sectors.	1
$\mathbf{a}_{cf}$	Vector with the weights of household consumption, by sector or product, in the total private consumption of households in the territory.	Million R$ (constant basic prices) or toe according to non-energy or energy sector/ Million R$ (constant consumer prices)	2, 2i
cf^U	Upper limit for the final consumption expenditure of households on the territory.	Million R$ (constant consumer prices)	2
cpe^L	Lower limit for the total consumption of non-residents households on the territory.	Million R$ (constant prices)	3
cpe^U	Upper limit for the total consumption of non-residents households on the territory.	Million R$ (constant prices)	3
β_0	Autonomous private consumption.	Million R$ (constant consumer prices)	4, 4i
β_1	Marginal propensity to consume.	Million R$ (constant consumer prices)/ Million R$ (constant prices)	4, 4i
cpr^U	Upper limit for the total final consumption expenditure of residents (households and NPISH).	Million R$ (constant consumer prices)	4
yd^U	Upper limit for the households and NPISH disposable income.	Million R$ (constant prices)	4
cfr^U	Upper limit for the final consumption expenditure of resident's households on the territory.	Million R$ (constant consumer prices)	5
cpm^U	Upper limit for the imports of tourism (or the final consumption expenditure - in tourism services - of resident households abroad).	Million R$ (constant prices)	5
α	Scalar with the weight of imports of tourism on the total private consumption of residents.	%	6
$\mathbf{a}_{npish}$	Vector with the weight of NPISH's consumption, by sector or product, on the total NPISH's consumption.	Million R$ (constant basic prices) or toe for non-energy or energy sectors (respectively)/ Million R$ (constant consumer prices)	7
$cnpish^L$	Lower limit for the total final consumption expenditure of NPISH.	Million R$ (constant consumer prices)	7
$cnpish^U$	Upper limit for the total final consumption expenditure of NPISH.	Million R$ (constant consumer prices)	7
$\mathbf{a}_g$	Vector with the weight of public administration consumption, by sector or product, on the total public administration consumption.	Million R$ (constant basic prices) or toe for non-energy or energy sectors (respectively)/ Million R$ (constant consumer prices)	8
g^L	Lower limit for the consumption of goods or services by the general government.	Million R$ (constant consumer prices)	8
g^U	Upper limit for the consumption of goods or services by the general government.	Million R$ (constant consumer prices)	8
$\mathbf{a}_{gfcf}$	Vector with the weights of investment on GFCF, by sector or product, on the total GFCF.	Million R$ (constant basic prices) or toe for non-energy or energy sectors (respectively)/	9

		Million R$ (constant consumer prices)	
$gfcf^{L}$	Lower limit for the total gross fixed capital formation.	Million R$ (constant consumer prices)	9
$gfcf^{U}$	Upper limit for the total gross fixed capital formation.	Million R$ (constant consumer prices)	9
$\mathbf{a}_{sc}$	Vector with the weight of stock variation, by sector or product, on the total stock variation.	Million R$ (constant basic prices) or toe for non-energy or energy sectors (respectively)/ Million R$ (constant consumer prices)	10
sc^{L}	Lower limit for the total changes in inventories.	Million R$ (constant consumer prices)	10
sc^{U}	Upper limit for the total changes in inventories.	Million R$ (constant consumer prices)	10
$\mathbf{a}_{exp}$	Vector with the weight of exports, by sector or product, on the total exports (at CIF prices)	Million R$ (constant basic prices) or toe for non-energy or energy sectors (respectively)/ Million R$ (constant CIF consumer prices)	11
$_{exp}$	Diagonal matrix with the prices of energy products which is used to convert exports from toe to monetary units.	Average prices in Million R$ (basic constant prices)/ toe for energy products and 1 for other sectors.	12
$\mathbf{a}_{expts}$	Vector with the weights of net taxes (less subsidies) on exports (excluding tourism expenditure), by sector or product, on the total exports (excluding tourism expenditure).	Million R$ (constant prices)/ Million R$ (constant CIF consumer prices).	12
$\mathbf{a}_{expctm}$	Vector with the weights of commercial and transportation margins on exports (excluding tourism expenditure), by sector or product, on the total exports (excluding tourism expenditure).	Million R$ (constant prices)/ Million R$ (constant CIF consumer prices).	12
$\mathbf{e}_{1}$	Proper vector of 1.	No dimension	13
$expcpwt^{L}$	Lower limit for the total exports (excluding tourism) at constant consumer prices	Million R$ (constant consumer prices)	13
$expcpt^{U}$	Upper limit for total exports (including tourism) at consumer prices.	Million R$ (constant consumer prices)	14
$\mathbf{p}_{imp}$	Vector with the prices of energy products which is used to convert imports from toe to monetary units.	Average prices for energy products in Million R$ (basic constant prices)/ toe.	15
$\mathbf{e}_{2}$	Proper vector of 1.	No dimension	15
$\mathbf{A}_{m}$	Technical coefficient matrix with the non-competitive imports of goods and services by non-energy sectors.	Million R$ (constant CIF basic prices)/ Million R$ (constant basic prices)	15
$impwtcif^{L}$	Lower limit for total imports (excluding tourism) at constant CIF prices.	Million R$ (constant CIF consumer prices)	15
$\mathbf{e}_{3}$	Proper vector of 1.	No dimension	16
$\mathbf{am}_{cf}$	Vector with the weights of non-competitive imports of non-energy goods or services to the consumption of households in the territory on the total consumption of households in the territory.	Million R$ (constant CIF basic prices)/ Million R$ (constant consumer prices).	16
cfm^{L}	Lower limit for the consumption of non-energy goods or services from non-competitive imports by households.	Million R$ (constant CIF prices)	16
$\mathbf{e}_{4}$	Proper vector of 1.	No dimension	17
$\mathbf{am}_{cnpish}$	Vector with the weights of non-competitive imports of non-energy goods or services to the consumption of NPISH on the total consumption of NPISH.	Million R$ (constant CIF basic prices)/ Million R$ (constant consumer prices).	17
$\mathbf{e}_{5}$	Proper vector of 1.	No dimension	18

$\mathbf{am}_{g}$	Vector with the weights of non-competitive imports of non-energy goods or services to the public consumption on the total public consumption.	Million R$ (constant CIF basic prices)/ Million R$ (constant consumer prices).	18
$\mathbf{e}_{6}$	Proper vector of 1.	No dimension	19
$\mathbf{am}_{gfcf}$	Vector with the weights of non-competitive imports of non-energy goods or services to GFCF on the total GFCF.	Million R$ (constant CIF basic prices)/ Million R$ (constant consumer prices).	19
$\mathbf{e}_{7}$	Proper vector of 1.	No dimension	20
$\mathbf{am}_{sc}$	Vector with the weights of stock variations of non-competitive imports of non-energy goods or services on the total stock variation.	Million R$ (constant CIF basic prices)/ Million R$ (constant consumer prices).	20
a_{ciffob}	CIF/FOB adjustment coefficient.	Million R$/ Million R$	21, 21i
$impwtfob^{U}$	Upper limit for the total imports (excluding tourism) at constant FOB prices.	Million R$ (constant FOB prices)	21
$impfob^{U}$	Upper limit for the total imports (including tourism) at constant FOB prices.	Million R$ (constant FOB prices)	22
$\mathbf{e}_{8}$	Proper vector of 1.	No dimension	23
$\mathbf{A}_{ts}$	Matrix with the weights of taxes less subsidies (on goods or service) on the total sectors output.	Million R$ (constant prices)/ Million R$ (constant basic prices)	23
ts^{L}	Lower limit for taxes less subsidies on goods or services.	Million R$ (constant prices)	23
$\mathbf{e}_{9}$	Proper vector of 1.	No dimension	24
$\mathbf{a}_{cfts}$	Vector with the weights of taxes less subsidies on goods or services consumed by households on the total consumption of households.	Million R$ (constant prices)/ Million R$ (constant consumer prices)	24
$\mathbf{e}_{10}$	Proper vector of 1.	No dimension	25
$\mathbf{a}_{cnpishts}$	Vector with the weights of of taxes less subsidies on goods or services consumed by NPISHs on the total NPISHs.	Million R$ (constant prices)/ Million R$ (constant consumer prices)	25
$\mathbf{e}_{11}$	Proper vector of 1.	No dimension	26
$\mathbf{a}_{gts}$	Vector with the weights of taxes less subsidies on goods or services consumed by public administration on the total public administration consumption.	Million R$ (constant prices)/ Million R$ (constant consumer prices)	26
$\mathbf{e}_{12}$	Proper vector of 1.	No dimension	27
$\mathbf{a}_{gfcfts}$	Vector with the weights of taxes less subsidies on goods or services to GFCF on the total GFCF.	Million R$ (constant prices)/ Million R$ (constant consumer prices)	27
$\mathbf{e}_{13}$	Proper vector of 1.	No dimension	28
$\mathbf{a}_{scts}$	Vector with the weights of taxes less subsides on goods or services to stock variation on the total stock variation.	Million R$ (constant prices)/ Million R$ (constant consumer prices)	28
$\mathbf{e}_{14}$	Proper vector of 1	No dimension	29
$\mathbf{a}_{expts}$	Vector with the weights of taxes less subsides on goods or services exports on the total exports.	Million R$ (constant prices)/ Million R$ (constant consumer prices CIF)	29
$\mathbf{a}_{wag}$	Vector with the weights of wages on the production of each sector.	Million R$ (constant prices)/ Million R$ (constant basic prices)	30, 34, 34i
$\mathbf{a}_{gmi}$	Vector with the weights of gross mixed income on the production of each sector.	Million R$ (constant prices)/ Million R$ (constant basic prices)	30

$\mathbf{a}_{gos}$	Vector with the weights of gross operating surplus on the production of each sector.	Million R$ (constant prices)/ Million R$ (constant basic prices)	30
$\mathbf{a}_{opt}$	Vector with the weights of other production taxes on the production of each sector.	Million R$ (constant prices)/ Million R$ (constant basic prices)	30, 38
$\mathbf{a}_{ops}$	Vector with the weights of other production subsides on the production of each sector.	Million R$ (constant prices)/ Million R$ (constant basic prices)	30, 38
gdp^L	Lower limit for GDP.	Million R$ (constant prices)	31, 32, 31i, 32i
gdp^U	Upper limit for GDP.	Million R$ (constant prices)	31, 32
$gdpcurr^U$	Upper limit for GDP current.	Million R$ (current prices)	33
$gcurr^L$	Lower limit for the consumption of goods or services by the general government at current prices.	Million R$ (current prices)	33, 33i
$gcurr^U$	Upper limit for the consumption of goods or services by the general government at current prices.	Million R$ (current prices)	33, 33i
$gfcfcurr^L$	Lower limit for the gross fixed capital formation at current prices.	Million R$ (current prices)	33, 33i
$gfcfcurr^U$	Upper limit for the gross fixed capital formation at current prices.	Million R$ (current prices)	33, 33i
$wagcurr^U$	Upper limit for wages at current prices.	Million R$ (current prices)	34
psgdpcurr	Proportion of Corporation savings on the GDP at current prices.	%	35
$ydcurr^U$	Upper limit for household and NPISH disposable income at current prices.	Million R$ (current prices)	35
pi^L	Lower limit for the balance of primary incomes.	Million R$ (current prices)	35
pi^U	Upper limit for the balance of primary incomes.	Million R$ (current prices)	35
$itsub^U$	Upper limit for the total indirect taxes less subsides.	Million R$ (current prices)	35
$itsubg^U$	Upper limit for the net indirect taxes less subsides (total received – total paid) for the general government.	Million R$ (current prices)	35
ctr^L	Lower limit for current transferences.	Million R$ (current prices)	35
ctr^U	Upper limit for current transferences.	Million R$ (current prices)	35
dt^U	Upper limit for direct tax on households and NPISH disposable income.	Million R$ (current prices)	35
dtc^U	Upper limit for direct tax on (financial and non-financial) corporation's disposable income.	Million R$ (current prices)	35
ssc^U	Upper limit for social security contributions paid to the general government.	Million R$ (current prices)	35
$(pig^+ – pig^-)^U$	Upper limit for the balance of property incomes.	Million R$ (current prices)	35
$trgh^L$	Lower limit for the transferences from the general government to households.	Million R$ (current prices)	35
$trgh^U$	Upper limit for the transferences from the general government to households.	Million R$ (current prices)	35
dtydcurr	Proportional coefficient of direct tax rate on households and NPISHs disposable incomes.	%	36
dtcgdpcurr	Proportional coefficient of direct tax on corporation's income on GDP at current prices.	%	37
titsubg	Proportional coefficient of indirect taxes less subsides (paid/received) by the public administration on the total indirect taxes less subsides.	%	39
tssc	Proportional coefficient of social contributions on the general wages level.	%	40

repggdpcurr	Proportional coefficient for the balance of property incomes on the GDP at current prices.	%	41
$debt^U$	Upper limit for the general government gross debt.	Million R$ (current prices)	42
$debt_{-1}^L$	Lower limit for the general government gross debt in the previous period.	Million R$ (current prices)	42
$debt_{-1}^U$	Upper limit for the general government gross debt in the previous period.	Million R$ (current prices)	42
gbg^L	Lower limit for the general government structural balance.	Million R$ (current prices)	42
dat^L	Lower limit for the adjustment variable for the general government gross debt.	Million R$ (current prices)	42
$jurg^U$	Upper limit for the interest on the general government gross debt.	Million R$ (current prices)	43
$ctrg^U$	Upper limit for current transferences of the general government.	Million R$ (current prices)	44
tk^U	Upper limit for capital tax.	Million R$ (current prices)	44
$trkg^U$	Upper limit for capital transferences of the general government.	Million R$ (current prices)	44
$gfcfg^L$	Lower limit for gross fixed capital formation of the general government.	Million R$ (current prices)	44
tkgdpcurr	Proportional coefficient of capital tax on the GDP at current prices.	%	45
lp	Labor productivity (ratio of employees by total production) in each sector.	Employees/ Million R$ (constant basic prices)	46
$\mathbf{A}_E$	Technical coefficient matrix of intermediary energy consumption.	toe/ Million R$ (constant basic prices)	47, 48
$\mathbf{a}_{cfE}$	Technical coefficient vector of household energy consumption.	toe/ Million R$ (constant consumer prices)	47, 48, 55
$\mathbf{a}_{cnpishE}$	Technical coefficient vector of NPISH energy consumption.	toe/ Million R$ (constant consumer prices)	47, 48, 56
$\mathbf{a}_{gE}$	Technical coefficient vector of public administration energy consumption.	toe/ Million R$ (constant consumer prices)	47, 48, 54
$\mathbf{N}_E$	Technical coefficient matrix of intermediary energy consumption for non-energy purpose.	toe/ Million R$ (constant consumer prices) or toe (according to non-energy or energy sector).	48
$\mathbf{a}_{ncfE}$	Technical coefficient vector of household's energy consumption for non-energy purpose.	toe/ Million R$ (constant consumer prices)	48, 55
$\mathbf{a}_{ncnpishE}$	Technical coefficient vector of NPISH's energy consumption for non-energy purpose.	toe/ Million R$ (constant consumer prices)	48, 56
$\mathbf{a}_{ngE}$	Technical coefficient vector of public administration energy consumption for non-energy purpose.	toe/ Million R$ (constant consumer prices)	48, 54
$\mathbf{fecele}_w$	Vector of emission factors to the pollutants w (CO_2, CH_4 and N_2O) related to the electricity generation (excluding cogeneration) by fuel used.	g/TJ	49
$\mathbf{ctj}_E$	Diagonal matrix of transformation factor from toe to TJ by fuel (main diagonal = 0.041868 TJ/toe; other elements = 0).	TJ/toe	49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60
$\mathbf{A}_{Eele}$	Sub-matrix of matrix A_E with the fuel consumption coefficients for electricity generation (excluding cogeneration).	toe/toe	49
$\mathbf{N}_{Eele}$	Sub-matrix of matrix N_E with the coefficient of fuel consumption for non-energy purpose to electricity generation (excluding cogeneration).	toe/toe	49
$\mathbf{fecchp}_w$	Vector of emission factors to the pollutants w (CO_2, CH_4 and N_2O) related to the cogeneration by fuel used.	g/TJ	50
$\mathbf{a}_{Echp}$	Sub-vector of matrix A_E with the coefficients of fuel consumption for cogeneration in combined heat and power plants.	toe/toe	50

$\mathbf{n}_{Echp}$	Sub-vector of matrix N_E with the coefficient of fuel consumption for non-energy purpose to cogeneration in combined heat and power plants.	toe/toe	50
$\mathbf{fecref}_w$	Vector of emission factors to the pollutants w (CO_2, CH_4 and N_2O) related to the activities supporting the refining of petroleum products by fuel used.	g/TJ	51
$\mathbf{A}_{Eref}$	Sub-matrix of matrix A_E with the fuel consumption coefficients for the sector of refining of petroleum products.	toe/toe	51
$\mathbf{N}_{Eref}$	Sub-matrix of matrix N_E with the coefficient of fuel consumption for non-energy purpose to activities supporting the refining of petroleum products.	toe/toe	51
$\mathbf{fecpge}_w$	Vector of emission factors to the pollutants w (CO_2, CH_4 and N_2O) related to the petroleum and natural gas extraction by fuel used.	g/TJ	52
$\mathbf{A}_{Epge}$	Sub-matrix of matrix A_E with the fuel consumption coefficients for the sector of petroleum and natural gas extraction.	toe/toe	52
$\mathbf{N}_{Epge}$	Sub-matrix of matrix N_E with the coefficient of fuel consumption for non-energy purpose to petroleum and natural gas extraction.	toe/toe	52
$\mathbf{fecbio}_w$	Vector of emission factors to the pollutants w (CO_2, CH_4 and N_2O) related to the bioethanol production by fuel used.	g/TJ	53
$\mathbf{A}_{Ebio}$	Sub-matrix of matrix A_E with the fuel consumption coefficients for the sector of bioethanol production.	toe/toe	53
$\mathbf{N}_{Ebio}$	Sub-matrix of matrix N_E with the coefficient of fuel consumption for non-energy purpose in the bioethanol production.	toe/toe	53
$\mathbf{fecg}_w$	Vector of emission factors to the pollutants w (CO_2, CH_4 and N_2O) related to the combustion of fuels in the public sector by fuel used.	g/TJ	54
$\mathbf{A}_{Egi}$	Sub-matrix of matrix A_E with the fuel consumption coefficients for the public sector.	toe/ Million R$ (constant basic prices)	54
$\mathbf{N}_{Egi}$	Sub-matrix of matrix N_E with the coefficient of fuel consumption for non-energy purpose in the public sector.	toe/ Million R$ (constant basic prices)	54
$\mathbf{feccf}_w$	Vector of emission factors to the pollutants w (CO_2, CH_4 and N_2O) related to the combustion of fuels by households by fuel used.	g/TJ	55
$\mathbf{fecnpish}_w$	Vector of emission factors to the pollutants w (CO_2, CH_4 and N_2O) related to the combustion of fuels by NPISH by fuel used.	g/TJ	56
$\mathbf{feccs}_w$	Vector of emission factors to the pollutants w (CO_2, CH_4 and N_2O) related to the combustion of fuels in trade and service sectors by fuel used.	g/TJ	57
$\mathbf{A}_{Ecs}$	Sub-matrix of matrix A_E with the fuel consumption coefficients for the trade and service sectors.	toe/ Million R$ (constant basic prices)	57
$\mathbf{N}_{Ecs}$	Sub-matrix of matrix N_E with the coefficient of fuel consumption for non-energy purpose in trade and service sectors.	toe/ Million R$ (constant basic prices)	57
$\mathbf{fecal}_w$	Vector of emission factors to the pollutants w (CO_2, CH_4 and N_2O) related to the combustion of fuels in the agriculture & forestry and fishing & livestock sectors by fuel used.	g/TJ	58
$\mathbf{A}_{Eal}$	Sub-matrix of matrix A_E with the fuel consumption coefficients for the agriculture & forestry and fishing & livestock sectors.	toe/ Million R$ (constant basic prices)	58
$\mathbf{N}_{Eal}$	Sub-matrix of matrix N_E with the coefficient of fuel consumption for non-energy purpose in the agriculture & forestry and fishing & livestock sectors.	toe/ Million R$ (constant basic prices)	58
$\mathbf{fecind}_w$	Vector of emission factors to the pollutants w (CO_2, CH_4 and N_2O) related to the combustion of fuels in the manufacturing industries and construction sectors by fuel used.	g/TJ	59
$\mathbf{A}_{Eind}$	Sub-matrix of matrix A_E with the fuel consumption coefficients for the manufacturing industries and construction sectors.	toe/ Million R$ (constant basic prices)	59
$\mathbf{N}_{Eind}$	Sub-matrix of matrix N_E with the coefficient of fuel consumption for non-energy purpose in the manufacturing industries and construction sectors.	toe/ Million R$ (constant basic prices)	59

$\mathbf{fectr}_{tw}$	Vector of emission factors to the pollutants w (CO_2, CH_4 and N_2O) related to the combustion of fuels in the transportation sector by fuel used in each means of transport.	g/TJ	60
$\mathbf{A}_{Et}$	Sub-matrix of matrix A_E with the fuel consumption coefficients for each means of transport.	toe/ Million R$ (constant basic prices)	60
$\mathbf{N}_{Et}$	Sub-matrix of matrix N_E with the coefficient of fuel consumption for non-energy purpose in the transportation sector.	toe/ Million R$ (constant basic prices)	60
$\mathbf{a}_{cp}$	Row vector with the coefficients of coal production.	toe/toe	62, 63
ĉftoet	Diagonal Matrix with the conversion factors from toe to tons for each coal product.	ton/toe	62, 63
ur	Ratio of underground mining in the total coal production.	%	62, 63
sr	Ratio of surface mining in the total coal production.	%	62, 63
$efcpmu_w$	Emission factor for coal underground mining.	Gg/ ton	62
$efcpms_w$	Emission factor for coal surface mining.	Gg/ ton	62
$efpmmu_w$	Emission factor for coal underground post mining	Gg/ ton	63
$efpmms_w$	Emission factor for coal surface post mining	Gg/ ton	63
$\mathbf{a}_{gp}$	Vector with the coefficients of natural gas (wet and dry) production.	toe/toe	64, 65, 66, 67, 68, 69, 70
ĉftoem3	Diagonal matrix with the conversion factors from toe to cubic meters for natural gas (wet and dry), LPG and oil (according to the respective estimates).	m^3/toe	64, 65, 66, 67, 68, 69, 70, 71, 72, 73, 74
$efgpfl_w$	Emission factor for natural gas flaring.	Gg/ m^3	64
$efgpv_w$	Emission factor for gas venting	Gg/ m^3	65
$efgpf_w$	Emission factor for other fugitive emissions at natural gas facilities	Gg/ m^3	66
$\mathbf{A}_{ng}$	Sub-matrix of matrix **A** with the coefficients of natural gas (wet and dry) consumed by each sector.	toe/ Million R$ (constant consumer prices)	67, 68, 69
$\mathbf{a}_{cfng}$	Vector with the coefficients of natural gas (wet and dry) consumption by households.	toe/ Million R$ (constant consumer prices)	67, 68, 69
$\mathbf{a}_{cnpishng}$	Vector with the coefficients of natural gas (wet and dry) consumption by NPISH.	toe/ Million R$ (constant consumer prices)	67, 68, 69
$\mathbf{a}_{gng}$	Vector with the coefficients of natural gas (wet and dry) consumption by the general government.	toe/ Million R$ (constant consumer prices)	67, 68, 69
$efgtf_w$	Emission factor for gas transmission.	Gg/ m^3	67
$efgs_w$	Emission factor for natural gas storage.	Gg/ m^3	68
$efgd_w$	Emission factor for the distribution of natural gas to end user.	Gg/ m^3	69
$\mathbf{A}_{lpg}$	Sub-matrix of matrix **A** with the coefficients of LPG consumed by each sector.	toe/ Million R$ (constant consumer prices)	70
$\mathbf{a}_{cflpg}$	Vector with the coefficients of LPG consumption by households.	toe/ Million R$ (constant consumer prices)	70
$\mathbf{a}_{cnpishlpg}$	Vector with the coefficients of LPG consumption by NPISH.	toe/ Million R$ (constant consumer prices)	70
$\mathbf{a}_{glpg}$	Vector with the coefficients of LPG consumption by the general government.	toe/ Million R$ (constant consumer prices)	70
$eflpgd_w$	Emission factor for Liquified Petroleum Gas (LPG) distribution.	Gg/ m^3	70
$\mathbf{a}_{op}$	Vector with the coefficients of oil production.	toe/toe	71, 72, 73, 74
$efopv_w$	Emission factor for venting at oil facilities.	Gg/ m^3	71

$efopfl_w$	Emission factor for flaring at oil facilities.	Gg/ m^3	72
$efopf_w$	Emission factor for other fugitive emissions at oil facilities not specifically accounted for as venting or flaring.	Gg/ m^3	73
$efotp_w$	Emission factor for fugitive emissions (excluding venting and flaring) related to the transport of marketable crude oil to upgraders and refineries.	Gg/ m^3	74
$effeip_{zw}$	Emission factor for fugitive emissions in the industrial processes.	Gg/ Million R$ (constant basic prices)	75
a_{elub}	Technical coefficient of exports of lubricants.	toe/toe	75
cc_{lub}	Carbon content of lubricants.	Gg C/toe	75
odu_{lub}	Oxidized during use factor.	%	75
aep	Vector with the coefficients of number of heads of each livestock species/category (cattle, buffaloes, pigs, chickens, turkeys, ducks, lamb, sheep, horses, mules and asses) by millions of output of the livestock and fishing sector.	thousand of heads/Million R$ (constant basic prices)	78, 79, 82, 83, 88, 89
âmp	A diagonal matrix with the coefficients of nitrogen (N) excretion by each livestock species/category.	Gg N / thousand of heads	78, 79, 82, 83, 88, 89
$\mathbf{A}_{ma}$	Matrix with the fraction of total annual N excretion for each livestock species/category *i* that is managed in manure management system *j* (anaerobic lagoon, solid storage, dry lot and anaerobic digester) in the country.	%	78, 79, 83, 88
$\mathbf{efdmm}_w$	Column vector with the emission factors for direct N_2O emissions from each manure management system.	Gg N_2O-N/Gg N	78
$\mathbf{A}_{fv}$	Matrix with the percentage of managed manure nitrogen for livestock category *i* that volatilizes as NH_3 and NO_x in the manure management system *j*.	%	79, 83, 88
$\mathbf{e}_{15}$	Proper vector of 1	No dimension	79
$efadv_w$	Emission factor for N_2O emissions from atmospheric deposition of nitrogen on soils and water surfaces.	Gg N_2O-N/Gg NH3-N + NOx-N volatilized	79, 87
$efmm_{rw}$	CH_4 emission factor of manure management for the defined livestock population.	Gg/ thousand of heads	80
aep_r	Element of the vector **aep** with the coefficient of number of heads of each livestock species/category by millions of output of the livestock and fishing sector.	thousand of heads/Million R$ (constant basic prices)	80, 81
$efentf_{rw}$	Emissions factor for enteric fermentation	Gg/ thousand of heads	81
$\mathbf{\hat{a}}_{ga}$	Diagonal matrix with the fraction of total annual N excretion that is deposited directly in soil by grazing animals of each livestock species/category (cattle, buffaloes, pigs, chickens, turkeys, ducks, lamb, sheep, horses, mules and asses).	%	82, 89
$\mathbf{egm}_w$	Emission factor for N_2O emissions from urine and dung N deposited on pasture by grazing animals of each livestock species/category.	Gg N_2O-N/Gg N	82
$\mathbf{E}_1$	Proper matrix with all *i* x *j* elements equal to 1 (where *i* = 1,…, r and *j* = 1,…, s).	No dimension	83, 88
$\mathbf{e}_{16}$	Proper vector of 1.	No dimension	83
$eofmm_w$	Emission factor for N_2O from N inputs to soils (from N additions to the soils from organic and synthetic fertilizers).	Gg N_2O-N/ Gg N	83, 85
$aprod_q$	Coefficient of productivity of each crop *q* (*q* = rice, sugarcane, corn, soy, bean and cassava).	Gg/ ha	84, 91, 92
$aprodut_q$	Coefficient of area cultivated by unitary economic production of each crop *q*.	ha/ Million R$ (constant basic prices)	84, 91, 92
$apats_q$	Vector with the weights of the output of each crop *q* in the total output of the agriculture and forestry sector.	Million R$ (constant basic prices)/ Million R$ (constant basic prices)	84, 91, 92, 93

$aburn_q$	Ratio of the burnt area of crop *q* in the total area (considered only for sugarcane).	%	84, 91, 92
$admqp_q$	Ratio of dry matter (d.m.) produced by each crop output.	Gg (d.m.)/ Gg	84, 91, 92
$admag_q$	Ratio of above ground residues (d.m.) in the total dry matter produced by each crop *q*.	Gg (d.m.)/ Gg (d.m.)	84, 91
nag_q	N content of above-ground residues for each crop *q*.	Gg N/ Gg (d.m.)	84, 91
$admbg_q$	Ratio of below ground residues (d.m.) in the total dry matter produced by each crop.	Gg (d.m.)/ Gg (d.m.)	84, 91
nbg_q	N content of below-ground residues for each crop *q*.	Gg N/ Gg (d.m.)	84, 91
$efcr_w$	Emission factor for N_2O emissions from N additions to the soils from crop residues.	Gg N_2O-N/ Gg N	84, 91
afert	Coefficient of utilization of synthetic fertilizers N in the agriculture sector.	Gg N/ Million R$ (constant basic prices)	85, 87, 90
aofgav	Fraction of applied organic N fertilizers and manure N deposited by grazing animals that volatilizes as NH_3 and NO_x.	Gg N volatilized/ Gg of N applied or deposited	87
asfv	Fraction of synthetic fertilizer N that volatilizes as NH_3 and NO_x.	Gg N volatilized/ Gg of N applied	87
$\mathbf{e}_{17}$	Proper vector of 1.	No dimension	88
$\mathbf{e}_{18}$	Proper vector of 1.	No dimension	89
aflr	Fraction of all N added to managed soils in regions where leaching/runoff occurs that is lost through leaching and runoff.	Gg N/ Gg of N additions.	90
$eflr_w$	Emission factor for N_2O emissions from N leaching and runoff.	Gg N_2O–N/ Gg N leached and runoff	90
$admbdm_q$	Ratio of residues (d.m.) burnt in the total d.m. produced by each crop *q* (*q* = sugarcane).	Gg (d.m.)/ Gg (d.m.)	92
$efburn_{qw}$	Emission factor for dry matter burnt for each crop *q* and GHG.	Gg/ Gg (d.m.)	92
$arice_T$	Coefficient of annual harvested area of rice according to each water regime T (continuously flooded, intermittently flooded and regular rainfed).	ha/ Million R$ (constant basic prices)	93
$efrice_{Tw}$	Annual emission factor for each water regime T.	Gg CH_4/ ha	93
amsw	Coefficient of MSW disposal per capita.	Gg/ Habitant.	95
a_{up}	Fraction of urban population on the total human population in the country.	%	95
fmswswd	Fraction of MSW disposed to SWDS.	%	96
$amsw_u$	Coefficient of MSW by residue type.	%	96
$mcfmsw_u$	CH_4 correction factor for aerobic decomposition in the year of deposition.	%	97
$docmsw_u$	Fraction of degradable organic carbon in the year of deposition	Gg C/Gg waste	97
$docfmsw_u$	Fraction of DOC that can be decomposed.	%	97
$fch4glg_w$	Fraction of CH_4 in generated landfill gas.	%	97
fmswbt	Fraction of MSW carried to composting and anaerobic digestion processes on total MSW.	%	98
$efmswbt_w$	Emission factor for biological treatment of MSW.	Gg/Gg	99
$rfmsw_w$	Recovery factor of CH_4 (null values for CO_2 and N_2O).	%	99
a_{isw}	Coefficient of ISW production by monetary unity of output.	Gg/ Million R$ (constant basic prices)	100

fnhwisw	Coefficient of non-hazardous waste in the industrial waste.	%	101
fiswswd	Fraction of industrial solid waste to solid waste disposal.	%	101
fisworgswd	Fraction of organic waste in the industrial waste.	%	101
$efiworgswd_w$	Emission factor for organic ISW disposed.	Gg/Gg	102
fiswincin	Fraction of ISW incinerated (without energy recovery) in the total ISW.	%	103
$efiswincin_w$	Emission factor for ISW incineration.	Gg/Gg	104
acwincin	Coefficient of clinical waste incinerated per unit of output of the private and public health sectors.	Gg/ Million R$ (constant basic prices)	105
$\mathbf{e}_{19}$	Proper vector of 1.	No dimension	105
$efcwincin_w$	Emission factor for clinical waste incinerated.	Gg/Gg	106
fmswincin	Fraction of MSW incinerated.	%	107
ccmsw	Carbon content in MSW.	%	107
ffcmsw	Fraction of fossil carbon in MSW.	%	107
ccisw	Carbon content in ISW.	%	107
ffcisw	Fraction of fossil carbon in ISW.	%	107
cccw	Carbon content in CW.	%	107
ffccw	Fraction of fossil carbon in CW.	%	107
ceinc	Combustion efficiency of incinerators.	%	107
$efdww_j$	Emission factor for each domestic wastewater treatment and discharge pathway and system.	kg CH_4/ kg BOD	109, 111
$adwwt_j$	Degree of utilization of treatment/discharge pathway or system.	%	109
adwwrec	Coefficient of CH_4 recovered by CH_4 produced in the inventory year.	%	109
bod	Biochemical Oxygen Demand (BOD) per person.	kg BOD/ habitants/year	110
b_o	Maximum CH_4 producing potential for domestic wastewater.	kg CH_4/ kg BOD	111
mcf_j	Methane correction factor for the wastewater treatment and discharge system.	%	111
$\mathbf{Asp}_{yp}$	Matrix with the fraction of each selected product *p* (p = bioethanol, sugar, beer, milk, cotton, paper, swine, cattle and poultry) in the total output of the respective sector *y* (and 0 otherwise) (y = bioethanol; food and beverages; agriculture and forestry; pulp and cellulosic; and livestock and fishing).	%	112
$\mathbf{\hat{aprod}}_p$	A diagonal matrix of vector $\mathbf{aprod}_p$ with the coefficients of physical production of each product per unit of output of the respective sector (m^3 for beer production and ton otherwise).	ton/ Million R$ (constant basic prices) or (m^3/ Million R$ (constant basic prices) for beer production	112
$\mathbf{\hat{bod}}_p$	A diagonal matrix of vector $\mathbf{bod}_p$ with the biochemical oxygen demand in the wastewater from each product.	kg BOD/ ton of product or kg BOD/ m^3 for beer production	112
$\mathbf{efiww}_p$	Vector with the emission factor of CH_4 by BOD produced for each product p.	kg CH_4/ kg BOD	112, 113
$\mathbf{achnr}_p$	Coefficient of net amount of CH_4 from wastewater discounting the amount of CH_4 recovery from wastewater.	%	112
b_{oind}	Maximum CH_4 producing potential for industrial wastewater.	kg CH_4/ kg BOD	113
$\mathbf{mcf}_p$	Methane correction factor for industrial wastewater by each product.	%	113
pcprot	Annual per capita protein consumption.	kg/person/year	114

fnprot	Fraction of nitrogen in protein.	kg N/kg protein (default = 0.16)	114
fncprot	Factor for non-consumed protein added to the wastewater.	%	114
findcom	Factor for industrial and commercial co-discharged protein into the sewer system.	%	114
asludge	Coefficient for nitrogen removed with sludge.	kg N / kg N/ year (default = 0)	114
efn2oww	Emission factor for N_2O emissions from discharged to wastewater.	kg N_2O/kg N	114
Notation	**Coefficients Description - Interval**	**Unities**	**Expressions**
cf*	Upper interval limit for the final consumption expenditure of households on the territory.	Million R$ (constant consumer prices)	2i
cpe*	Upper interval limit for the total consumption of non-residents households on the territory.	Million R$ (constant prices)	3i
cpr*	Upper interval limit for the total final consumption expenditure of residents (households and NPISH).	Million R$ (constant consumer prices)	4i
yd*	Upper interval limit for the households and NPISH disposable income.	Million R$ (constant prices)	4i
cfr*	Upper interval limit for the final consumption expenditure of resident's households on the territory.	Million R$ (constant consumer prices)	5i
cpm*	Upper interval limit for the imports of tourism (or the final consumption expenditure - in tourism services - of resident households abroad).	Million R$ (constant prices)	5i
impwtfob*	Upper interval limit for the total imports (excluding tourism) at constant FOB prices.	Million R$ (constant FOB prices)	21i
impfob*	Upper interval limit for the total imports (including tourism) at constant FOB prices.	Million R$ (constant FOB prices)	22i
gdp*	Upper interval limit for GDP.	Million R$ (constant prices)	31i, 32i
gdpcurr*	Upper interval limit for GDP current.	Million R$ (current prices)	33i
wagcurr*	Upper interval limit for wages at current prices.	Million R$ (current prices)	34i
ydcurr*	Upper interval limit for household and NPISH disposable income at current prices.	Million R$ (current prices)	35i
psgdpcurr*	Proportion of Corporation savings on the GDP at current prices (interval coefficient).	%	35i
pi*	Upper interval limit for the balance of primary incomes.	Million R$ (current prices)	35i
itsub*	Upper interval limit for the total indirect taxes less subsides.	Million R$ (current prices)	35i
itsubg*	Upper interval limit for the net indirect taxes less subsides (total received – total paid) for the general government.	Million R$ (current prices)	35i
ctr*	Upper interval limit for current transferences.	Million R$ (current prices)	35i
dt*	Upper interval limit for direct tax on households and NPISH disposable income.	Million R$ (current prices)	35i
dtc*	Upper interval limit for direct tax on (financial and non-financial) corporation's disposable income.	Million R$ (current prices)	35i
ssc*	Upper interval limit for social security contributions paid to the general government.	Million R$ (current prices)	35i
pig*	Upper interval limit for the balance of property incomes.	Million R$ (current prices)	35i
trgh*	Upper interval limit for the transferences from the general government to households.	Million R$ (current prices)	35i
debt*	Upper interval limit for the general government gross debt.	Million R$ (current prices)	42i
debt-1*	Lower interval limit for the general government gross debt in the previous period.	Million R$ (current prices)	42i

gbg*	Lower interval limit for the general government structural balance.	Million R$ (current prices)	42i
dat*	Lower interval limit for the adjustment variable for the general government gross debt.	Million R$ (current prices)	42i
jurg*	Upper interval limit for the interest on the general government gross debt.	Million R$ (current prices)	43i
ctrg*	Upper interval limit for current transferences of the general government.	Million R$ (current prices)	44i
tk*	Upper interval limit for capital tax.	Million R$ (current prices)	44i
trkg*	Upper interval limit for capital transferences of the general government.	Million R$ (current prices)	44i
gfcfg*	Lower interval limit for gross fixed capital formation of the general government.	Million R$ (current prices)	44i

Table A.3 – Index in the model

Notation	Description
cp	Coal production sector.
gop	Petroleum and natural gas sector.
w	GHG gases: CO_2, CH_4 and N_2O.
z	Sectors: chemicals, cement, other products of nonmetallic minerals, manufacture of steel and steel products and metallurgy of nonferrous metals.
r	Animal types: cattle, buffaloes, pigs, chickens, turkeys, ducks, lamb, sheep, horses, mules and asses.
lf	Livestock and fishing sector.
s	Pasture, anaerobic lagoon, solid storage and anaerobic digester.
q	Rice, sugarcane, maize, soybean, bean and cassava (the main cultures in the Brazilian economic system).
af	Agriculture and forestry sector
d	Direct deposition, volatization and leaching.
H	Different ecosystems: irrigated, rainfed and deep water rice production.
b	Water regimes: continuously and intermittently flooded; regular rainfed; and deep water.
u	Food waste; garden (yard) and park waste; paper and cardboard; wood; textiles; nappies (disposable diapers); rubber and leather; plastics; metal; glass (and pottery and china); other (e.g., ash, dirt, dust, soil, electronic waste).
k	The reaction constant ($k = \ln(2)/t_{1/2}$) and n represents the period considered (1995 to 2015).
msw	MSW produced by residents, trade and service sectors and public treatment.
isw	ISW generated by industrial sectors.
cw	CW generated in the private and public health sectors
hs	Private and public health sectors.
j	Represents each treatment/discharge pathway or system: septic system; anaerobic lagoon; sea, river and lake discharge; anaerobic reactor; stagnant sewer; flowing sewer (open or closed); centralized, aerobic treatment plant; and anaerobic digester for sludge.
y	Sectors: bioethanol; food and beverages; agriculture and forestry; pulp and cellulosic; and livestock and fishing..
p	Products: bioethanol, sugar, beer, milk, cotton, paper, swine, cattle and poultry.

APPENDIX B – Numerical specification of the model presented in Chapter 5.

I. Assumptions for the construction of the technical coefficient matrix

The *Instituto Brasileiro de Geografia e Estatística* (*IBGE*)[1] provides a set of official input-output tables valued at consumer and basic prices for both national production and imported commodities. These matrices are useful to overcome the decomposition necessities regarding the origins of the production (i.e. breakdown the intermediate and final demand distinguishing between domestic and imported production), as well as the effects from non-productive inputs (i.e. the tables at basic prices are useful to homogenize the values and reducing the effects of other price components in the technical coefficients of the input-output model). However, it is important to stress that in this work the input-output tables provided by Guilhoto & Sesso Filho (2010) will be used as basis of the developments of the model treated in Chapter 5, since they are more recent than the last official input-output system recorded by *IBGE*. In addition, Guilhoto & Sesso Filho (2010) provide a more complete set of input-output tables including intermediate and final demand matrices for different taxes and distribution margins, which is useful for the development of the model proposed in this study. The set of matrices published by *IBGE* and Guilhoto & Sesso Filho (2010) based on the National Accounts System are outlined in table B.1. Two additional matrices to represent the distribution (trade and transport) margins for intermediate and final demand provided by Guilhoto & Sesso Filho (2010) are also included in table B.1:

Table B.1 – Schematic representation of the basic composition of information displayed in the Brazilian Make and Use tables.

	Commodities	Sectors	Final Demand	Total output
Sectors	**V**			**x**
Commodities (National)		**Un**	**Yn**	**q**
Value added		**z**		
Total output	$\mathbf{q}^T$	$\mathbf{x}^T$		
Commodities (Imports)		**Um**	**Ym**	
Commodities (Taxes – subsidies)		**Ut**	**Yt**	
Commodities (Distribution margins)		**Ud**	**Yd**	
employees		**e**		

where:

[1] The governmental institute responsible for compilation and reproduction of official statistics data in Brazil.

V – Production (or Make) (sector-by-commodities) matrix at basic prices, in which each element v_{ij} shows the value of the output of commodity *j* that is produced 'domestically' by sector *i*;

x – Column vector with the total output by each sector at basic prices;

Un – Matrix of the National intermediate consumption at basic prices, in which each element un_{ij} shows the domestic inputs of each commodity *i* by each sector *j*;

Yn – Matrix of final demand for domestic commodities at basic prices (shows the value of inputs of domestic origins consumed in the *m* categories of final demand[2]);

q – Column vector with the total output by product (or commodity) at basic prices;

z – Row vector with the total value added generated by each sector[3];

Um – Matrix of imported intermediate consumption at FOB prices, in which each element um_{ij} shows the imported inputs of each commodity *i* by each sector *j*;

Ym – Matrix of final demand for imported commodities at FOB prices (shows the value of commodities of external origins consumed in the *m* final demand elements);

Ut – Matrix (commodity by sector) that shows the allocation of taxes and subsidies in the intermediate demand. Here each element um_{ij} shows taxes and subsidies regarding each commodity *i* in each sector *j*;

Yt – Matrix of taxes and subsidies on the final demand (shows the allocation of taxes and subsidies on products consumed by the *m* final demand elements);

Ud – Matrix (commodity by sector) that shows the allocation of distribution margins in the intermediate demand. Here each element ud_{ij} shows the distribution margins regarding each commodity *i* in each sector *j*;

Yd – Matrix of distribution margins on the final demand (a matrix that shows the allocation of distribution margins on products consumed by the *m* final demand elements);

e – An additional row vector with the total (formal and informal) employees in each sector is also provided in the official System of National Accounts. However, a new row vector with only total formal employees by each sector was constructed from the Brazilian official employee database (MT CAGED, 2009) to be utilized in the model proposed in Chapter 5, in

[2] Consumption of public administration, consumption of non-profit institutions serving households, consumption of households, exports, gross fixed capital formation and changes in inventories.

[3] For reasons of simplification, the value added is considered as a vector. However, in practice it is a Matrix by sector which contains: the value added at factors cost and basic prices; wages, which includes wages and social contributions; gross operating surplus (obtained by balance); and taxes and subsidies on production by sectors.

order to overcome the inability of the model in capturing the substitution process between formal and informal employees overtime.

Some modifications are necessary in order to suit the supply and use tables (which can be considered a special non-symmetric format of input-output table) to the characteristics of the input-output transaction table required in this study. The first step to obtaining the hybrid IO framework is to disaggregate some sectors which are not explicitly available in the input-output system developed for Brazil by Guilhoto and Sesso Filho (2010). For this purpose, additional sectors are included in the V matrix in order to allocate the national production of sugarcane, wood, charcoal, mineral coal and distribution of electricity. Since the sugarcane appears as a commodity in matrix V, the value of its production was subtracted from the agriculture and forestry sector and allocated in the new vector corresponding to the artificial sector representing the sugarcane production. This procedure considers that all sugarcane is produced in this new artificial sector. The amount of sugarcane production subtracted from the agriculture and forestry sector is also subtracted in the total output of this sector and allocated as the output of the artificial sector for sugarcane in order to balance the table. The same method is applied for mineral coal production. The value regarding the mineral coal production (which appears as commoditiy in matrix V) is subtracted from the sector other extractive industry and allocated in the new vector representing the sector of production of mineral coal. Furthermore, the amount corresponding to the distribution of electricity is subtracted from the production of electricity, gas, water, sewer and street cleaning (EGWSS) in the EGWSS sector and allocated in the artificial sector distribution of elctricity. For this purpose, additional (or non-published) data for the total output of the electricity distribution sector provided personally by the IBGE directorate to the authors is used in this step. Finally, the same procedure is applied for wood and charcoal productions, which are subtracted from the production of forestry and silviculture commodities in the agriculture and forestry sector using additional data regarding the production of wood and charcoal provided by the IBGE directorate.

After disaggregating the sectors in matrix V, the same sectors are disaggregated in matrices U_n, U_m, U_t and U_d. Firstly, the sectors production of wood and charcoal, production of mineral coal and distribution of electricity are disaggregated from their original sectors. Since these sectors are split of their original sectors in the Use matrix in purchase's prices provided by the IBGE directorate, a simple method based on a proportional relation between the national production (at purchaser's prices), imports, taxes and distribution margins for each commodity in both aggregated and disagreggated sectors is considered. For this purpose, a vector with the ratio of national production (at purchaser's prices) of each disaggregated sector on the national production (at purchaser's prices) of each original (or aggregated) sector is calculated for each commodity. Next, each item of these ratio vectors is multiplied by the values of imports, taxes and distribution margins of the respective commodity in the original (or aggregated) sectors in matrices U_m, U_t and U_d in order to generate the respective vectors in matrices U_m, U_t and U_d for each disaggregated sector. It is important to stress that a different procedure is applied in the sector production of coal, in which only imports, taxes and distribution margins of the commodity mineral coal is considered to generate the corresponding vectors in matrices U_m, U_t and U_d. After that, the vector of national production at basic prices of each disaggregated sector is then obtained by subtracting the respective vectors for each disaggregated sector in matrices U_m, U_t and U_d from the corresponding vectors at purchaser's prices. The disaggregated vectors obtained for matrices U_n, U_m, U_t and U_d are subtracted from each orginal (or aggregated) vector to split the sectors and no further numerical adjustments are required. As the sugarcane sector is not disaggregated in the additional matrix at purchaser's prices provided by the IBGE directorate, another approach is used. The disaggregation of the sugarcane sector from the agriculture and forestry sector is based on the *bottom-up* methodology proposed by Cunha and Scaramucci (2006). Summarily a new vector for the sugarcane sector is calculated considering engineering estimates of the cost of the main inputs of this sector. Then, the transaction values of each commodity are subtracted from the transaction value of the respective commodity in the vector corresponding to the agriculture and forestry sector, so that further numerical adjustments are not necessary. A more detailed description of this methodology is outlined in Appendix E.

After these adjustments the number of commodities and sectors in matrices V and U (hereafter representing matrices U_n, U_m, U_t and U_d) are equalized. However, since matrices V and U are not computed as square matrices a method have been used to combine mathematically these matrices in order to obtain the traditional symmetric (or square) input-output matrix to be used in the further steps of this work. This method can be based on either the commodity technology assumption or the industry (or sector) technology assumption, in which both product-by-product or industry-by-industry matrices can be generated (IBGE, 2000; Miller & Blair, 2009). The commodity technology assumption is thought economically more reasonable than the industry technology assumption, but the last one is attractive because the method always generates positive symmetric input-output tables that are not guaranteed in the first one (which can also requires additional methods to adjust the data) (UN, 1999). Hence the sector technology assumption will be used used in this study by which a brief description will be following presented.

The industry technology assumption assumes homogeneity in the input structure, i.e. inputs are consumed in the same proportions by every (principal and secondary) product produced by a given industry, which uses the same technology (UN, 1999). As outlined in the table B.1, the Brazilian supply and use tables are accounted in a commodity–sector framework, in which both total sector output (**x**) and total commodity output (**q**) are accounted for. From Make matrix **V**, it is possible to estimates the total output of any sector by summing the rows over all α commodities produced by that sector, i.e. the total of the rows sums of **V**. Thus **x** can be obtained by multiplying **V** by an identity column vector with α dimension:

$$\mathbf{x} = \mathbf{V}\,\mathbf{i}_{\alpha} \Leftrightarrow \mathbf{x}^{T} = \mathbf{i}_{\alpha}^{T}\,\mathbf{V}^{T} \qquad \text{(B.1)}$$

In the same way, total output of any commodity can be found by summing over all n sectors that produce the commodity, i.e. the totals of the column sums of **V.** Thus, **q** can be obtained by multiplying the transpose of **V** by an identity column vector with n dimension:

$$\mathbf{q} = \mathbf{V}^{T}\,\mathbf{i}_{n} \Leftrightarrow \mathbf{q}^{T} = \mathbf{i}_{n}^{T}\,\mathbf{V} \qquad \text{(B.2)}$$

From the Use matrix[4] it is also possible to obtain two additional accounting identities. The total output of the sectors **x** can be obtained by multiplying the transpose of **U** by an identity column vector with α dimension plus the transposed of the total value added vector:

$$\mathbf{x} = \mathbf{U}^{T}\,\mathbf{i}_{\alpha} + \mathbf{z}^{T} \Leftrightarrow \mathbf{x}^{T} = \mathbf{i}_{\alpha}^{T}\,\mathbf{U} + \mathbf{z} \qquad \text{(B.3)}$$

In the same way, total output of the commodities can be found multiplying **U** by an identity column vector with n dimension plus the final demand matrix **Y** multiplied by an identity column vector with m dimension representing the final demand components:

$$\mathbf{q} = \mathbf{U}\,\mathbf{i}_{n} + \mathbf{Y}\,\mathbf{i}_{m} \Leftrightarrow \mathbf{q}^{T} = \mathbf{i}_{n}^{T}\,\mathbf{U}^{T} + \mathbf{i}_{m}^{T}\,\mathbf{Y}^{T} \qquad \text{(B.4)}$$

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[4] For reasons of simplicity there will be used a matrix **U** representing the matrices presented in table X.

In order to create symmetric total requirements tables under the sector-technology assumption, a "commodity-output proportions" or a market share matrix **D** must also be defined, in which each generic element d_{ij} denotes the fraction of total commodity j output that was produced by sector i. This matrix is derived from the make matrix V and the commodity total output vector (**q**) as:

$$= \mathbf{V}\,\hat{\mathbf{q}}^{-1} \quad \Leftrightarrow \mathbf{V} = \mathbf{D}\,\hat{\mathbf{q}} \tag{B.5}$$

where $\hat{\mathbf{q}}$ is a diagonal matrix version of the vector **q**, in which all off-diagonal elements are zeros:

$$\hat{\mathbf{q}} = \begin{bmatrix} & 0 & \cdots & 0 \\ 0 & q_2 & \cdots & 0 \\ \vdots & \vdots & \ddots & \vdots \\ 0 & 0 & \cdots & {}_{\alpha} \end{bmatrix} \tag{B.6}$$

A commodity-by-sector direct requirements matrix **B** can also be defined by (B.7)**,** in which each generic element b_{ij} represents the value of inputs of commodity i per value of output of sector j as follows:

$$\mathbf{B} = \mathbf{U}\,\hat{\mathbf{x}}^{-1} \Leftrightarrow \quad \mathbf{U} = \mathbf{B}\,\hat{\mathbf{x}} \tag{B.7}$$

where $\hat{\mathbf{x}}$ is a diagonal matrix version of the vector **x**, in which all off-diagonal elements are zeros:

$$\hat{\mathbf{x}} = \begin{bmatrix} x & 0 & \cdots & 0 \\ 0 & x_2 & \cdots & 0 \\ \vdots & \vdots & \ddots & \vdots \\ 0 & 0 & \cdots & x_n \end{bmatrix} \tag{B.8}$$

Substituting (B.7) in (B.4) and considering $\mathbf{Y}.\ \mathbf{i}_m$ as the column vector **y** of total final demand by each commodity it is possible to get:

$$\mathbf{q} = \mathbf{B}\ \hat{\mathbf{x}}\,\mathbf{i}_n + \mathbf{y} \Leftrightarrow \mathbf{q} = \mathbf{B}\,\mathbf{x} + \mathbf{y} \tag{B.9}$$

Multiplying both sides of (B.5) by $\mathbf{i}_\alpha$ and substituting by (B.1) it is possible to obtain:

$$\mathbf{i}_\alpha = \mathbf{D}\,\hat{\mathbf{q}}\,\mathbf{i}_\alpha \Leftrightarrow \mathbf{x} = \mathbf{D}\,\mathbf{q} \tag{B.10}$$

Thus, substituting (B.10) in (B.9) it is possible to get a 'commodity' input-output model as follows:

$$\mathbf{q} = \mathbf{B}\,\mathbf{D}\,\mathbf{q} + \mathbf{y} \Leftrightarrow \mathbf{q} - \mathbf{B}\,\mathbf{D}\,\mathbf{q} = \mathbf{y} \Leftrightarrow (\mathbf{I} - \mathbf{B}\,\mathbf{D})\,\mathbf{q} = \mathbf{y} \Leftrightarrow \mathbf{q} = (\mathbf{I} - \mathbf{B}\,\mathbf{D})^{-1}\,\mathbf{y} \qquad \text{(B.11)}$$

On the other hand, substituting (B.9) in (B.10) it is possible to obtain a 'sector' input-output model as follows:

$$\mathbf{x} = \mathbf{D}\,(\mathbf{B}\,\mathbf{x} + \mathbf{y}) \Leftrightarrow \mathbf{x} = \mathbf{D}\,\mathbf{B}\,\mathbf{x} + \mathbf{D}\,\mathbf{y} \Leftrightarrow \mathbf{x} - \mathbf{D}\,\mathbf{B}\,\mathbf{x} = \mathbf{D}\,\mathbf{y} \Leftrightarrow (\mathbf{I} - \mathbf{D}\,\mathbf{B})\,\mathbf{x} = \mathbf{D}\,\mathbf{y} \Leftrightarrow$$

$$\Leftrightarrow \mathbf{x} = (\mathbf{I} - \mathbf{D}\,\mathbf{B})^{-1}\,(\mathbf{D}\,\mathbf{y}) \qquad \text{(B.12)}$$

Therefore, (B.11) provides a commodity by commodity Leontief system, which is more indicated for the analysis of technologic relations. In this input-output matrix version the columns of the intermediate matrix represent the product technology (or the input structure) and the rows represent the distribution of the product to intermediate and final demand. On the other hand, (B.12) provides a sector by sector Leontief system which is more indicated for the analysis of intersectoral relations. The columns in this input-output matrix version represent the industry technology, describing the inputs structure in each sector, and the rows represent the distribution of the output of each sector (which includes secondary products) to all other sectors and to final demand (United Nations, 1999). According to IBGE (2000) there are no implicit properties that allow considering either formulation superior between them and only the objectives of the study indicate which of the two should be used. Hence, in the model presented in Chapter 5, the simple sector technology model without considering byproducts is utilized.

II. Assumptions for the construction of the technical coefficients

The system of symmetric (sector by sector) matrices is them adapted to allocate the energy flows. Artificial sectors are included in the adapted symmetric matrix of national production at basic prices. Data of production, transformation, imports, exports, consumption and other adjustments (e.g. changes in inventories, reinjection, lost and statistical adjustments) of primary and secondary energy commodities provided in the Brazilian Energy Report (BER) for 2009 (the same base year of the IO framework) are used to obtain a hybrid IO framework. Although no energy flows are allocated in matrices U_m, U_t and U_d, these matrices are also adapted to have the same number of sectors (and commodities) as the national production matrix. As a result a new structure of adapted symmetric matrices (A to I) is generated, in which its basic structure is displayed in figure B.1. The real and artificial sectors considered in the model are presented in table B.2. Is noteworthy that all energy imports are considered competitive, since all energy commodities coming from abroad are also produced to a greater or lesser extent in the country. These competitive imports are allocated in a vector in which only the entries of energy commodities should have positive values, while the entries for energy and non-energy sectors present null values.

	Energy and non-energy sectors and energy commodities	Final demand items	Competitive imports (energy commodities)	
Energy and non-energy sectors and energy commodities	(A) Intermediary consumption of national non-energy commodities (basic prices) and intermediary consumption of energy commodities (toe).	(B) Final demand of national non-energy commodities (basic prices) and final demand of energy commodities (toe).	(C) Competitive imports of energy commodities (toe).	(A) + (B) - (C) Total output of national production (basic prices and toe)
Energy and non-energy sectors and energy commodities	(D) Intermediary consumption of imported non-energy commodities. Other values are set to zero.	(E) Final demand of imported non-energy commodities. Other values are set to zero		(D) + (E) Total imports of non-energy commodities.
Energy and non-energy sectors and energy commodities	(F) Taxes less subsides on the intermediary consumption of non-energy commodities. Other values are set to zero	(G) Taxes less subsides on final demand of non-energy commodities. Other values are set to zero		(F) + (G) Total taxes less subsides on non-energy commodities.
Energy and non-energy sectors and energy commodities	(H) Distribution margins on the intermediary consumption of non-energy commodities. Other values are set to zero	(I) Distribution margins on final demand of non-energy commodities. Other values are set to zero		(H) + (I) Total Distribution margins non-energy commodities.
GVA	GVA (basic prices)			
Employment	Number of formal employees			

Figure B.1 – Schematic representation of the adapted symmetric IO matrices (based on Oliveira, 2008).

Table B.2- Sectors and fuels included in the model			
N01	Agriculture and forestry	A38	Molasses
N02	Production of sugarcane	A39	Sugarcane Bagasse
E01	Production of wood and charcoal	N14	Chemicals
A01	Wood	N15	Manufacture of resins and elastomers
A02	Charcoal	N16	Pharmaceutical products
N03	Livestock and fishing	N17	Agrochemicals
E02	Petroleum and natural gas	N18	Perfumes, soaps and cleaning supplies
A03	Crude Oil	N19	Paints, varnishes, enamels and lacquers
A04	Natural Gas Wet	N20	Chemical products and preparations
A05	Natural Gas Dry	N21	Rubber and plastic
N04	Iron ore	N22	Cement
N05	Other extractive industry	N23	Other products of nonmetallic minerals
E03	Coal production	N24	Manufacture of steel and steel products
A06	Steam Coal 3100	N25	Metallurgy of nonferrous metals
A07	Steam Coal 3300	N26	Metal products - except machinery and equipment
A08	Steam Coal 3700	N27	Machinery and equipment, including maintenance and repairs
A09	Steam Coal 4200	N28	Appliances
A10	Steam Coal 4500	N29	Office machines and computer equipment
A11	Steam Coal 4700	N30	Machinery, equipment and material
A12	Steam Coal 5200	N31	Electronic and communication equipment
A13	Steam Coal 5900	N32	Apparatus / instruments healthcare, optical and measurement
A14	Steam Coal 6000	N33	Cars, vans and utilities
A15	Steam Coal without specification	N34	Trucks and buses
A16	Metallurgical Coal	N35	Parts and accessories for motor vehicles
N06	Food and Beverage	N36	Other transportation equipment
N07	Tobacco products	N37	Furniture and products from other industries
N08	Textiles	N38	Gas, water, sewer and street cleaning
N09	Clothing and accessories	E06	Electricity Distribution
N10	Leather goods and footwear	A40	Uranium (U_30_8)
N11	Wood products - except furniture	A41	Hydro
N12	Pulp and paper products	A42	Bleach
N13	Newspapers, magazines, CDs and other products recorded	A43	Other Renewable
E04	Petroleum refining and coke	A44	Nuclear Power Plants (Uranium C,UO_2)
A17	Automotive gasoline	A45	Public service power plants
A18	Fuel oil	A46	Cogeneration
A19	Diesel oil	N39	Construction
A20	Aviation gasoline	N40	Trade
A21	Liquefied petroleum gas	N41	Transport, storage and mail
A22	Naphtha	A47	Road Transport
A23	Kerosene Illuminated	A48	Pipelines
A24	Jet Kerosene	A49	Railway Transport
A25	Gas coke	A50	Water-borne Transport
A26	Coke coal	A51	Aviation Transport
A27	Refinery Gas	N42	Information Services
A28	Petroleum Coke	N43	Financial intermediation and insurance
A29	Other energy petroleum products	N44	Real estate and rents
A30	Tar	N45	Maintenance and repair
A31	Asphalt	N46	Accommodation services and meals
A32	Lubricants	N47	Business services
A33	Solvents	N48	Private education
A34	Other non-energy petroleum products	N49	Private health
E05	Alcohol	N50	Services for families
A35	Anhydrous bioethanol	N51	Public Education
A36	Hydrous bioethanol	N52	Public health
A37	Sugarcane Juice	N53	Public service and social security

Table B.3 - Equivalence between the sectors in the IO tables and in the BER.	
Energy and non-energy sectors in the hybrid IO framework.	**Sectors in the Brazilian Energy Report**.
Agriculture and forestry	Agriculture and Livestock
Livestock and fishing	Agriculture and Livestock
Petroleum and natural gas	Energy sector – petroleum and natural gas extraction and gasification plants
Iron ore	Mining and pelletization
Other extractive industry	Mining and pelletization
Coal production	Energy sector – coal power plant
Food and Beverage	Food and Beverage
Tobacco products	Other Industries
Textiles	Textiles
Clothing and accessories	Other Industries
Leather goods and footwear	Other Industries
Wood products - except furniture	Other Industries
Pulp and paper products	Pulp and paper products
Newspapers, magazines, CDs and other products recorded	Other Industries
Petroleum refining and coke	Energy sector – refineries and coke plants
Alcohol	Energy sector – bioethanol distilleries
Chemicals	Chemicals
Manufacture of resins and elastomers	Chemicals
Pharmaceutical products	Chemicals
Agrochemicals	Chemicals
Perfumes, soaps and cleaning supplies	Chemicals
Paints, varnishes, enamels and lacquers	Chemicals
Chemical products and preparations	Chemicals
Rubber and plastic	Other Industries
Cement	Cement
Other products of nonmetallic minerals	Ceramic
Manufacture of steel and steel products	Pig Iron and Steel
Metallurgy of nonferrous metals	Iron alloys/ Metallurgy of nonferrous and other metals
Metal products - except machinery and equipment	Metallurgy of nonferrous and other metals
Machinery and equipment, including maintenance and repairs	Other Industries
Appliances	Other Industries
Office machines and computer equipment	Other Industries
Machinery, equipment and material	Other Industries
Electronic and communication equipment	Other Industries
Apparatus / instruments healthcare, optical and measurement	Other Industries
Cars, vans and utilities	Other Industries
Trucks and buses	Other Industries
Parts and accessories for motor vehicles	Other Industries
Other transportation equipment	Other Industries
Furniture and products from other industries	Other Industries
Gas, water, sewer and street cleaning	Public
Electricity	Energy sector – cogeneration, hydro, nuclear and thermal power plants
Construction	Other Industries
Trade	Trade
Transport, storage and mail	Transport
Road Transport	Road Transport
Railway Transport	Railway Transport
Water-borne Transport	Water-borne Transport
Aviation Transport	Aviation Transport
Information Services	Trade
Financial intermediation and insurance	Trade
Real estate and rents	Trade
Maintenance and repair	Trade
Accommodation services and meals	Trade
Business services	Trade
Private education	Trade
Private health	Trade
Services for families	Trade
Public Education	Public
Public health	Public
Public service and social security	Public

In order to allocate the energy flows between energy and non-energy sectors, the equivalence between the sectors in the IO tables and the sectors in the BER presented in table B.3 is considered.

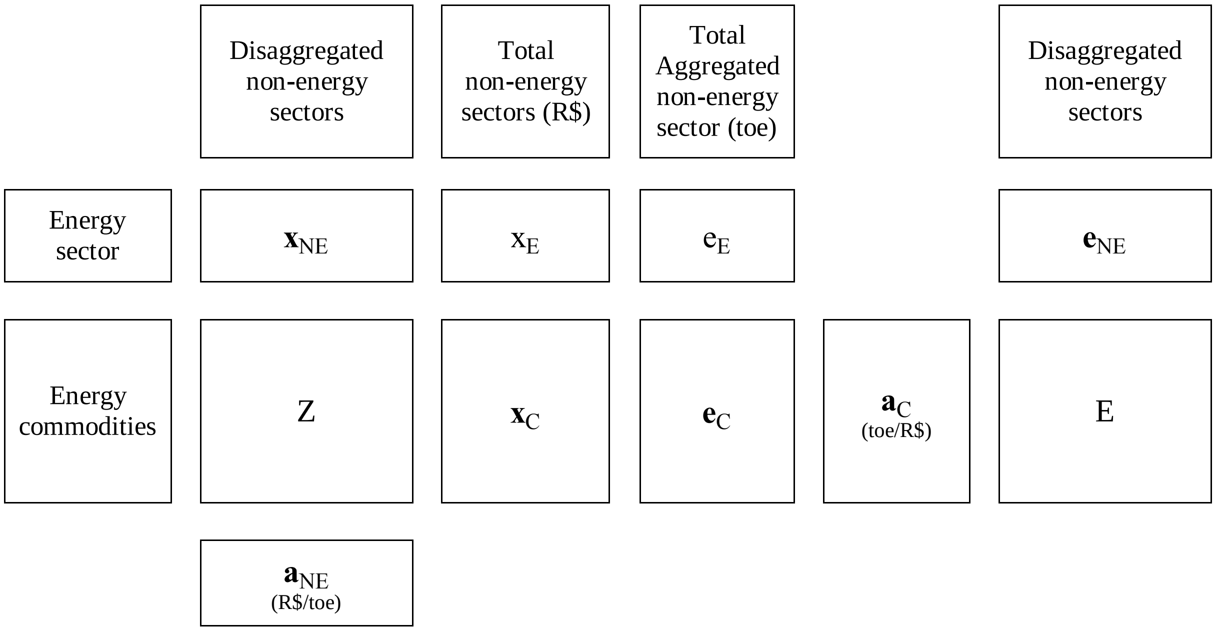

Figure B.2 – Schematic representation of matrices, vectors and scalars used to make the consumption of energy sources in the aggregated sectors of BER compatible with the corresponding disaggregated sectors in the IO system.

The symmetric IO tables (in monetary terms) used as basis in this study presents 55 economic sectors, whereas the BER has 17 energy consuming sectors and includes 10 different extractive and transformation centers (comprising 23 primary and 25 secondary energy sources). Since the number of sectors in the BER is lower than in the symmetric IO tables, an allocation procedure based on a proportional relation between the energy consumption of each commodity (e.g. steam and metallurgical coal) by an aggregated economic sector in BER (e.g. mining and pelletization) and the inputs from the corresponding energy sector in the IO table (e.g. coal production) to the respective disaggregated sectors in the IO table (e.g. iron ore and other extractive industry sectors) is considered. Hence, the central assumption is that the energy consumption of subsectors in energy terms (toe) is proportional to their respective monetary flows in the IO tables. Thus, a double adjustment procedure is made taking into account the relations presented in figure B.2 and equations B13 to B20. Note that for the sectors in which a direct correspondence is available none adjustment is necessary, by which a direct allocation is applied.

$$e_E = \sum_i \mathbf{e}_C \quad \text{(B.13)}$$

$$x_E = \sum_j \mathbf{x}_{NE} \quad \text{(B.14)}$$

$$a_{NE} = \frac{x_{NE}}{e_E} \quad \text{(B.15)}$$

$$Z = \mathbf{e}_C\ \mathbf{a}_{NE} \quad \text{(B.16)}$$

$$\mathbf{x}_C = \sum_j Z \quad \text{(B.17)}$$

$$a_C = \frac{e_C}{x_C} \quad \text{(B.18)}$$

$$E = \left[\mathbf{a}_C\ \mathbf{i}_C^{\,T}\right] Z \quad \text{(B.19)}$$

$$\mathbf{e}_{NE} = \sum_i E \quad \text{(B.20)}$$

where:

e_E = total energy from the energy sector E consumed by the aggregated non-energy sector NE computed in the BER (toe).

$\mathbf{e}_C$ = amount of each energy commodity C consumed by the aggregated non-energy sector NE computed in the BER (toe). This data is available in the BER.

e_C = scalar representing a generic element of the vector $\mathbf{e}_C$ (toe).

x_E = total inputs from energy sector E to all disaggregated non-energy sectors NE in monetary terms (R$, basic prices).

$\mathbf{x}_{NE}$ = inputs from energy sector E to each disaggregated non-energy sector NE computed in the IO system (R$, basic prices). This data is available in the IO framework.

x_{NE} = scalar representing a generic element of the vector $\mathbf{x}_{NE}$ (R$, basic prices).

$\mathbf{a}_{NE}$ = technical coefficient vector representing the amount of inputs (in monetary terms) from energy sector E to each sector NE by unit of energy from the energy sector E consumed by the corresponding aggregated non-energy sector NE computed in the BER (R$/toe).

a_{NE} = scalar representing a generic element of the vector $\mathbf{a}_{NE}$ (R$/toe).

Z = matrix with the inputs of energy commodity C to each non-energy sector NE (R$, basic prices).

$\mathbf{x}_C$ = vector with the total inputs of each energy commodity C consumed by all non-energy sectors NE (R$, basic prices).

x_C = scalar representing a generic element of the vector $\mathbf{x}_C$.

$\mathbf{a}_C$ = technical coefficient vector representing the amount of each energy commodity C consumed by the aggregated non-energy sector NE by unit of monetary input of each energy commodity C consumed by all non-energy sectors NE (toe/R$).

a_C = scalar representing a generic element of the vector $\mathbf{a}_C$ (toe/R$).

$\mathbf{i}_C$ = vector of proper dimension with all elements equal to 1.

E = Matrix representing the amount o energy commodity C consumed by each disaggregated non-energy sector NE (toe).

$\mathbf{e}_{NE}$ = vector with the amount of energy inputs from sector E to each disaggregated non-energy sector NE (toe).

After these estimates, the values from matrix E and vector $\mathbf{e}_{NE}$ and the values from the BER for the sectors in which a direct correspondence between the BER and IO table is available are allocated in the hybrid IO framework using artificial sectors in order to distinguish the consumption and production by type of energy commodity. The allocation of the energy flows between the sectors is represented in table B.4. The superscripts in some of the entries of this table describe general or particular assumptions assumed in the allocation process, which will be subsequently described.

Table B.4- Sectors and fuels included in the model

		Non-energy sectors	Energy sectors						Energy commodities						Transport sector	
		N1 to N53*	E1	E2	E3	E4	E5	E6	A1 to A2	A3 to A5	A6 to A16	A17 to A34	A35 toA39	A40 to A46	N41	A47 to A51
Non-energy sectors	N1 to N53*	$	$	$	$	$	$	$							$	
Energy sectors	E1								toe[1]							
	E2									toe[2]		toe[3]				
	E3										toe[4]					
	E4											toe[5]				
	E5												toe[6]			
	E6	toe		toe	toe	toe	toe	toe[7]						toe[8]		toe[9]
Energy commodities	A1 to A2	toe	toe[10]					toe[11]								
	A3 to A5	toe		toe[12]		toe[13]								toe[14]		
	A6 to A16	toe												toe[15]		
	A17 to A34	toe		toe[16]		toe[17]								toe[18]		toe[19]
	A35 to A39	toe					toe[20]							toe[21]		
	A40 to A46	toe[22]					toe[23]							toe[24]		
Transport sector	N41	$	$	$	$	$	$	$							$[25]	
	A47 to A51														toe[26]	

* Except sector N41 – Transport, storage and mail.

$ – this symbol represents the monetary flows between energy and non-energy sectors originally computed in the symmetric IO framework (R$, basic prices);

toe – the entries with this symbol represents the different energy flows in tons of oil equivalent (toe);

1) Allocation of the total national production of wood and charcoal;

2) Allocation of the total national production of crude oil, natural gas wet and natural gas dry;

3) Allocation of the production of petrol and LPG in natural gas power plants;

4) Allocation of the total national production of steam and metallurgical coal;

5) Allocation of the national production of energy commodities by refineries and coke plants;

6) Allocation of the total national production of sugarcane juice, molasses, sugarcane bagasse, anhydrous and hydrous bioethanol;

7) Allocation of the electricity consumption[5] in the electricity sector;

8) Allocation of the total national production of uranium (U308), hydro, bleach and other renewable;

9) Allocation of the electricity consumption in the railway transport;

10) Allocation of the amount of wood used to be transformed in charcoal and the amount of wood used as final energy in the charcoal transformation centers;

11) Amount of wood and charcoal used for cogeneration;

12) Amount of gas natural wet used to be transformed in natural gas natural dry and the amount of natural gas wet used in the process of petroleum extraction;

13) Allocation of the amount of crude oil used to be transformed in derivatives in the refineries and the amount of natural gas dry consumed as final energy in the refineries;

14) Allocation of the amount of natural gas dry used in national public service (or thermoelectric) power plants to generated electricity and the amount of natural gas dry and wet used for cogeneration;

15) Allocation of the amount of steam coal used in national public service (or thermoelectric) power plants to generated electricity and for cogeneration;

16) Allocation of the diesel oil used in the process of petroleum extraction;

17) Allocation of the fuel oil, LPG and refinery gas used in the refinement processes;

18) Allocation of the fuel oil and diesel oil used in national public service (or thermoelectric) power plants to generated electricity and the fuel oil, diesel oil, gas coke, refinery gas, other energy petroleum products and tar used for cogeneration;

19) Allocation of the amount of diesel oil used in the national road and railway transport, the amount of fuel oil and diesel oil used in the national waterborne transport and the amount of

[5] The consumption of energy commodities includes both domestic and imported sources, which are used for energy and non-energy purposes (i.e. for raw materials).

aviation gasoline and jet kerosene used in the national aviation transport;

20) Allocation of the amount of sugarcane juice, molasses and sugarcane bagasse used for transformation in alcohol distilleries;

21) Allocation of the amount of sugarcane bagasse used for cogeneration;

22) Allocation of the amount of bleach and other renewable used in paper and cellulose sector and the amount of other renewable used in the sectors food and beverage and other products of nonmetallic minerals;

23) Amount of electricity generated by national public service (hydro, nuclear and thermoelectric) power plants and cogeneration plants which is allocated as input for the electricity distribution sector;

24) Allocation of the amount of Uranium (U308) consumed by nuclear power plants (Uranium C,UO2), the amount of hydro, other renewable and Uranium C,UO2 consumed in national public service (hydro, nuclear and thermoelectric) power plants and the amount of hydro, other renewable and bleach used for cogeneration;

25) Allocation of the amount of transport services consumed in the transport, storage and mail;

26) Allocation of the amount of energy corresponding to each transportation means used by the transport, storage and mail sector.

Some adjustments are also applied in order to overcome remaining incompatibilities and no correspondence between the BER and the IO table considering some criteria. Firstly, the energy commodities which have positive values in the BER but do not present positive consumption in the IO framework are allocated in the changes in inventories vector (so that not allocated in the corresponding sector). This is the case of the fuel oil consumed in the public sector and the LPG consumed in the sectors metallurgy of nonferrous and other metals and mining and pelletization. Secondly, the energy commodities which have positive values in the IO framework but none consumption in the aggregated sector in the BER is verified are set to 0. This is the case of some energy commodities from the petroleum refining and coke and the alcohol sectors consumed in the trade, public, chemical, other industries, iron alloys, metallurgy of nonferrous and other metals, mining and pelletization, ceramic and agriculture and livestock sectors; and steam and mineral coal consumed in the chemical sector. Hence, these criteria consider the allocation of the energy consumption as the same observed in the BER maintaining the same sectoral structure, such that the total energy consumption and the sectoral consumption remain unchanged.

All production of coke, gas coke and tar is considered as from coke plants in the BER with no further details about its origins (steel mill or independent plants). As a simplification all production of coke, gas coke and tar is considered as made by independent coke plants, by which they are allocated in the sector petroleum refining and coke according to the class 19.10-1 in the *Classificação Nacional de Atividades Econômicas* – CNAE (2007). In addition, all production of molasses and sugarcane juice is considered as consumed by distilleries in the BER, by which they are allocated (produced and consumed) exclusively in the bioethanol sector. All bagasse is also considered as produced in the alcohol sector, while the allocation of its final consumption between the sectors is based on the data provided in BER. That is part of the bagasse is consumed in the alcohol and food and beverage[6] sectors (accounted as final consumption of these sectors in the BER) and part is used to produce electricity (accounted as used for cogeneration in the BER). Hence, the bagasse used for cogeneration is considered as used to produce electricity which is exported to the system, thus not used in distilleries and sugar mills. The same assumption is considered for other energy commodities used for cogeneration which are allocated in the specific collum vector with the artificial sector for cogeneration. However, it is noteworthy that since the amount of fuels (in energy terms, toe) consumed for cogeneration is lower than the total electricity (in energy terms, toe) produced by cogeneration plants, an adjustment is made in order to compatibilize the total inputs and total outputs. For this purpose the difference between the total inputs and the total output is allocated in the changes in inventories of the row vector of the artificial sector for cogeneration.

The energy commodities exported and fuels for bunkers are accounted in the vector corresponding to the exports in the final demand. The energy consumption of the public sector is allocated between the sectors public education, public health and public service and social security, so that the entries corresponding to the energy commodities in the final demand of the general government is considered as null. The consumption of NPISH is not distinguished in the BER, by which the entries corresponding to the energy commodities in the final demand of NPISH is also considered as null. The energy consumption of families in the BER is equivalent to the consumption of households in the IO tables, and thus allocated in the respective vector. However, is noteworthy that the consumption of natural gas dry, petrol,

[6] Represents the production of sugar in sugar mills.

anhydrous and hydrous bioethanol are accounted as final consumption of households in the IO framework, whereas the consumption of those fuels are recorded in the road transport in the BER. Since the majority of these fuels are consumed in light vehicles, their consumption are then allocated in the vector of consumption of households in order to keep the coherence in the IO framework and directly related to the final demand of households. But these adjustments affect the estimates of GHG emissions in the residential and transportation sector. Thus, the emissions from the consumption of these fuels are excluded from the estimates regarding the final consumption of households and computed as GHG emissions in the transportation sector applying the corresponding GHG coefficients for road transport. The values of other adjustments (e.g. changes in inventories, reinjection, lost and statistical adjustments) are allocated, as simplification, in the vector of changes in inventories.

After these adjustments technical coefficients matrices for the intermediary consumption and final demand are computed based on the same structure presented in figure B.1. Additional matrices to allocate the intersectoral consumption and final demand of energy commodities used for non-energy purposes are also constructed. The consumption of energy commodities used as raw materials in other sectors or transformed into other secondary energy sources are allocated in the corresponding sectors (and commodities) and final demand according to the flows computed in the BER. Note that all the flows in the final demand matrix is defined as 0, except the vector of changes in inventories which is used to allocate the necessary adjustments due to the non allocated energy from other transformations and other adjustments. These matrices are then used to compute the technical coefficients for the energy used for non-energy purposes, which are applied to estimate the net ammount of final energy consumed for energy purposes and the rescpective emissions from its combustion. All these technical coefficient matrices (and vectors) are outlined in tables B.5 to B.10.

Table B.5 – Technical Coefficients Matrix A (Part I).

	N01	N02	E01	A01	A02	N03	E02	A03	A04	A05	N04	N05	E03	A06	A07	A08
N01	0,05354127	0,05213988	0,01421628	0,00000000	0,00000000	0,05428674	0,00012756	0,00000000	0,00000000	0,00000000	0,00008050	0,00061645	0,00000430	0,00000000	0,00000000	0,00000000
N02	0,00212178	0,00000000	0,00000000	0,00000000	0,00000000	0,00065678	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
E01	0,00000000	0,00000000	0,00000000	1,00000000	1,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A01	0,00000000	0,00000000	0,29417028	0,00000000	0,00000000	0,01764975	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A02	0,00001257	0,00000000	0,00000000	0,00000000	0,00000000	0,00005250	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N03	0,00473889	0,00194819	0,00124231	0,00000000	0,00000000	0,05358760	0,00000342	0,00000000	0,00000000	0,00000000	0,00000086	0,00000017	0,00000003	0,00000000	0,00000000	0,00000000
E02	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	1,00000000	1,00000000	1,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A03	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A04	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,13423829	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A05	0,00000421	0,00000000	0,00000000	0,00000000	0,00000000	0,00001119	0,00000000	0,00000000	0,00000000	0,00000000	0,00340500	0,00375886	0,00000000	0,00000000	0,00000000	0,00000000
N04	0,00000017	0,00000000	0,00000136	0,00000000	0,00000000	0,00000019	0,00004077	0,00000000	0,00000000	0,00000000	0,07169479	0,00019459	0,00000115	0,00000000	0,00000000	0,00000000
N05	0,00005599	0,00661943	0,00000210	0,00000000	0,00000000	0,00933032	0,00001907	0,00000000	0,00000000	0,00000000	0,00576845	0,05291292	0,00000248	0,00000000	0,00000000	0,00000000
E03	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	1,00000000	1,00000000	0,00000000
A06	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A07	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A08	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A09	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A10	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A11	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A12	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A13	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A14	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A15	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A16	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,01231792	0,36908471	0,00000000	0,00000000	0,00000000	0,00000000
N06	0,01292942	0,00035878	0,00033795	0,00000000	0,00000000	0,17042427	0,00033096	0,00000000	0,00000000	0,00000000	0,00029923	0,00096909	0,00050606	0,00000000	0,00000000	0,00000000
N07	0,00000000	0,00000000	0,00000004	0,00000000	0,00000000	0,00000001	0,00000114	0,00000000	0,00000000	0,00000000	0,00000011	0,00000014	0,00000003	0,00000000	0,00000000	0,00000000
N08	0,00121116	0,00000848	0,00081178	0,00000000	0,00000000	0,00182139	0,00002769	0,00000000	0,00000000	0,00000000	0,00001121	0,02100142	0,00001611	0,00000000	0,00000000	0,00000000
N09	0,00000204	0,00000000	0,00000208	0,00000000	0,00000000	0,00000274	0,00003076	0,00000000	0,00000000	0,00000000	0,00000654	0,00072127	0,00000492	0,00000000	0,00000000	0,00000000
N10	0,00000543	0,00000512	0,00000037	0,00000000	0,00000000	0,00000107	0,00000571	0,00000000	0,00000000	0,00000000	0,00027573	0,00000778	0,00000477	0,00000000	0,00000000	0,00000000
N11	0,00209728	0,00000005	0,00071709	0,00000000	0,00000000	0,00000050	0,00001516	0,00000000	0,00000000	0,00000000	0,00001021	0,00000687	0,00047303	0,00000000	0,00000000	0,00000000
N12	0,00019192	0,00000018	0,00000826	0,00000000	0,00000000	0,00010096	0,00007316	0,00000000	0,00000000	0,00000000	0,00315207	0,00739633	0,00004866	0,00000000	0,00000000	0,00000000
N13	0,00000038	0,00000000	0,00000122	0,00000000	0,00000000	0,00000025	0,00009363	0,00000000	0,00000000	0,00000000	0,00542206	0,00003060	0,00002461	0,00000000	0,00000000	0,00000000
E04	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A17	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A18	0,00000148	0,00000000	0,00000000	0,00000000	0,00000000	0,00067625	0,00000000	0,00000000	0,00000000	0,00000000	0,00885492	0,00482746	0,00000000	0,00000000	0,00000000	0,00000000
A19	0,02586159	0,00000000	0,00000000	0,00000000	0,00000000	0,01595557	0,00118581	0,00000000	0,00000000	0,00000000	0,00247858	0,00811954	0,00000000	0,00000000	0,00000000	0,00000000
A20	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A21	0,00005044	0,00000000	0,00000000	0,00000000	0,00000000	0,00015271	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A22	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A23	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00003641	0,00003063	0,00000000	0,00000000	0,00000000	0,00000000
A24	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A25	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,01012456	0,00000000	0,00000000	0,00000000	0,00000000
A26	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00107452	0,00090411	0,00000000	0,00000000	0,00000000	0,00000000

Table B.5 – Technical Coefficients Matrix A (Part II).

	N01	N02	E01	A01	A02	N03	E02	A03	A04	A05	N04	N05	E03	A06	A07	A08
A27	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A28	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00968599	0,00814985	0,00000000	0,00000000	0,00000000	0,00000000
A29	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A30	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A31	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A32	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A33	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A34	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
E05	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A35	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A36	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A37	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A38	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A39	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N14	0,08499532	0,08640846	0,00272312	0,00000000	0,00000000	0,01696087	0,00424636	0,00000000	0,00000000	0,00000000	0,00403044	0,01199389	0,00073860	0,00000000	0,00000000	0,00000000
N15	0,00000073	0,00000105	0,00000016	0,00000000	0,00000000	0,00000217	0,00001458	0,00000000	0,00000000	0,00000000	0,00000526	0,00179807	0,00001247	0,00000000	0,00000000	0,00000000
N16	0,00223680	0,00004915	0,00000124	0,00000000	0,00000000	0,01537088	0,00004054	0,00000000	0,00000000	0,00000000	0,00002181	0,00013386	0,00023224	0,00000000	0,00000000	0,00000000
N17	0,05328866	0,04190674	0,00002175	0,00000000	0,00000000	0,00287870	0,00007010	0,00000000	0,00000000	0,00000000	0,00004038	0,00018628	0,00005267	0,00000000	0,00000000	0,00000000
N18	0,00000790	0,00020175	0,00000059	0,00000000	0,00000000	0,00028832	0,00001667	0,00000000	0,00000000	0,00000000	0,00010835	0,00148139	0,00338897	0,00000000	0,00000000	0,00000000
N19	0,00015733	0,00016755	0,00000527	0,00000000	0,00000000	0,00004054	0,00001418	0,00000000	0,00000000	0,00000000	0,00001128	0,00014728	0,00007593	0,00000000	0,00000000	0,00000000
N20	0,00058978	0,00057172	0,00001616	0,00000000	0,00000000	0,00010795	0,00117949	0,00000000	0,00000000	0,00000000	0,00015025	0,01097256	0,01456918	0,00000000	0,00000000	0,00000000
N21	0,00491008	0,00003141	0,00003357	0,00000000	0,00000000	0,00083868	0,00082436	0,00000000	0,00000000	0,00000000	0,00211590	0,02595663	0,02823225	0,00000000	0,00000000	0,00000000
N22	0,00000056	0,00010596	0,00000888	0,00000000	0,00000000	0,00009298	0,00314170	0,00000000	0,00000000	0,00000000	0,00004109	0,00048261	0,00000013	0,00000000	0,00000000	0,00000000
N23	0,00004495	0,00448204	0,00095421	0,00000000	0,00000000	0,00019322	0,00299303	0,00000000	0,00000000	0,00000000	0,00076299	0,00251087	0,00003860	0,00000000	0,00000000	0,00000000
N24	0,00031471	0,00041814	0,00004078	0,00000000	0,00000000	0,00007217	0,00171808	0,00000000	0,00000000	0,00000000	0,00047042	0,00368510	0,00014121	0,00000000	0,00000000	0,00000000
N25	0,00063968	0,00075658	0,00005506	0,00000000	0,00000000	0,00013735	0,00355859	0,00000000	0,00000000	0,00000000	0,00018279	0,00628154	0,00019040	0,00000000	0,00000000	0,00000000
N26	0,00268970	0,01208419	0,00289153	0,00000000	0,00000000	0,00163676	0,01908584	0,00000000	0,00000000	0,00000000	0,01051832	0,02153410	0,01230832	0,00000000	0,00000000	0,00000000
N27	0,00007862	0,00012146	0,00002359	0,00000000	0,00000000	0,00002480	0,01228703	0,00000000	0,00000000	0,00000000	0,01780200	0,02582077	0,01938055	0,00000000	0,00000000	0,00000000
N28	0,00000240	0,00001091	0,00000327	0,00000000	0,00000000	0,00000171	0,00003906	0,00000000	0,00000000	0,00000000	0,00002813	0,00005805	0,00003540	0,00000000	0,00000000	0,00000000
N29	0,00000073	0,00000039	0,00000015	0,00000000	0,00000000	0,00000014	0,00012131	0,00000000	0,00000000	0,00000000	0,00001147	0,00039591	0,00050722	0,00000000	0,00000000	0,00000000
N30	0,00000280	0,00040311	0,00058000	0,00000000	0,00000000	0,00018553	0,00617738	0,00000000	0,00000000	0,00000000	0,00076590	0,00428773	0,00540769	0,00000000	0,00000000	0,00000000
N31	0,00000766	0,00003853	0,00001433	0,00000000	0,00000000	0,00000608	0,00016250	0,00000000	0,00000000	0,00000000	0,00008204	0,00430170	0,00016378	0,00000000	0,00000000	0,00000000
N32	0,00000280	0,00000658	0,00000173	0,00000000	0,00000000	0,00000087	0,00026101	0,00000000	0,00000000	0,00000000	0,00002160	0,00004248	0,00002730	0,00000000	0,00000000	0,00000000
N33	0,00000281	0,00001116	0,00000102	0,00000000	0,00000000	0,00000069	0,00000114	0,00000000	0,00000000	0,00000000	0,00000333	0,00000432	0,00000163	0,00000000	0,00000000	0,00000000
N34	0,00000016	0,00000047	0,00000035	0,00000000	0,00000000	0,00000007	0,00003706	0,00000000	0,00000000	0,00000000	0,00004206	0,00012061	0,00004443	0,00000000	0,00000000	0,00000000
N35	0,00083757	0,00338143	0,00032141	0,00000000	0,00000000	0,00031970	0,00051575	0,00000000	0,00000000	0,00000000	0,00110788	0,00212567	0,00074727	0,00000000	0,00000000	0,00000000
N36	0,00000063	0,00000259	0,00000109	0,00000000	0,00000000	0,00000047	0,00002372	0,00000000	0,00000000	0,00000000	0,00001059	0,00155000	0,00001058	0,00000000	0,00000000	0,00000000
N37	0,00001028	0,00000968	0,00000236	0,00000000	0,00000000	0,00038139	0,00001826	0,00000000	0,00000000	0,00000000	0,00000959	0,00008017	0,00000692	0,00000000	0,00000000	0,00000000
N38	0,00085082	0,00266313	0,00008016	0,00000000	0,00000000	0,00146436	0,00344873	0,00000000	0,00000000	0,00000000	0,00449146	0,00772807	0,00437899	0,00000000	0,00000000	0,00000000
E06	0,00500768	0,00000000	0,00000000	0,00000000	0,00000000	0,00760330	0,00300782	0,00000000	0,00000000	0,00000000	0,01284305	0,01852706	0,00000000	0,00000000	0,00000000	0,00000000
A40	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A41	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A42	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A43	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000

Table B.5 – Technical Coefficients Matrix A (Part III).

	N01	N02	E01	A01	A02	N03	E02	A03	A04	A05	N04	N05	E03	A06	A07	A08
A44	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A45	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A46	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A47	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A48	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N39	0,00000451	0,00000000	0,00003674	0,00000000	0,00000000	0,00000510	0,01593623	0,00000000	0,00000000	0,00000000	0,00010270	0,00018786	0,00003103	0,00000000	0,00000000	0,00000000
N40	0,03733280	0,02530284	0,00542545	0,00000000	0,00000000	0,05154849	0,01212925	0,00000000	0,00000000	0,00000000	0,02501850	0,05356778	0,00069064	0,00000000	0,00000000	0,00000000
N41	0,02543117	0,00008585	0,00183257	0,00000000	0,00000000	0,01299662	0,06172351	0,00000000	0,00000000	0,00000000	0,09818138	0,09234927	0,04393469	0,00000000	0,00000000	0,00000000
A49	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A50	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A51	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A52	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A53	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N42	0,00123342	0,00391000	0,00019510	0,00000000	0,00000000	0,00336293	0,01371052	0,00000000	0,00000000	0,00000000	0,02090944	0,02234155	0,00000451	0,00000000	0,00000000	0,00000000
N43	0,00840828	0,00000000	0,00305399	0,00000000	0,00000000	0,00607369	0,00507974	0,00000000	0,00000000	0,00000000	0,06206160	0,02231811	0,01929912	0,00000000	0,00000000	0,00000000
N44	0,00019760	0,00000219	0,00158261	0,00000000	0,00000000	0,00022412	0,04630180	0,00000000	0,00000000	0,00000000	0,00442574	0,00584971	0,00133772	0,00000000	0,00000000	0,00000000
N45	0,00017592	0,00004390	0,00000984	0,00000000	0,00000000	0,00023553	0,00003190	0,00000000	0,00000000	0,00000000	0,00192834	0,00080522	0,00000728	0,00000000	0,00000000	0,00000000
N46	0,00004536	0,00002955	0,00001561	0,00000000	0,00000000	0,00006720	0,00128015	0,00000000	0,00000000	0,00000000	0,01663494	0,00375916	0,00000776	0,00000000	0,00000000	0,00000000
N47	0,00006773	0,00004395	0,00003949	0,00000000	0,00000000	0,00009297	0,05565345	0,00000000	0,00000000	0,00000000	0,01795457	0,00987512	0,02273066	0,00000000	0,00000000	0,00000000
N48	0,00001004	0,00000208	0,00005728	0,00000000	0,00000000	0,00001213	0,00166394	0,00000000	0,00000000	0,00000000	0,00016078	0,00021420	0,00004800	0,00000000	0,00000000	0,00000000
N49	0,00017113	0,00010918	0,00011215	0,00000000	0,00000000	0,00023469	0,00264441	0,00000000	0,00000000	0,00000000	0,00034855	0,00055345	0,00007514	0,00000000	0,00000000	0,00000000
N50	0,00114123	0,00066097	0,00041537	0,00000000	0,00000000	0,00158177	0,00895660	0,00000000	0,00000000	0,00000000	0,00191099	0,00285108	0,00023235	0,00000000	0,00000000	0,00000000
N51	0,00000141	0,00000006	0,00000109	0,00000000	0,00000000	0,00001393	0,00012950	0,00000000	0,00000000	0,00000000	0,00003850	0,00002191	0,00004143	0,00000000	0,00000000	0,00000000
N52	0,00000017	0,00000000	0,00000000	0,00000000	0,00000000	0,00000118	0,00000119	0,00000000	0,00000000	0,00000000	0,00000039	0,00000021	0,00000050	0,00000000	0,00000000	0,00000000
N53	0,00054812	0,00032250	0,00009317	0,00000000	0,00000000	0,00041349	0,00314428	0,00000000	0,00000000	0,00000000	0,00247438	0,00240171	0,00161805	0,00000000	0,00000000	0,00000000

Table B.5 – Technical Coefficients Matrix A (Part IV).

	A09	A10	A11	A12	A13	A14	A15	A16	N06	N07	N08	N09	N10	N11	N12	N13
N01	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,14407459	0,40376423	0,07362098	0,00194217	0,00177399	0,07602203	0,07538261	0,00029034
N02	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,02734326	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
E01	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A01	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00567967	0,00000000	0,00218086	0,00000000	0,00020367	0,03652195	0,03216850	0,00000000
A02	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000279	0,00049992	0,00000000	0,00000000
N03	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,15814692	0,00318133	0,00664670	0,00002715	0,00337655	0,00279606	0,00275325	0,00000714
E02	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A03	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A04	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A05	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00153896	0,00077413	0,00742039	0,00127106	0,00064521	0,00061151	0,01073054	0,00137167
N04	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000350	0,00000304	0,00000219	0,00000638	0,00000201	0,00000173	0,00000401	0,00000608
N05	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00022409	0,00000144	0,00000443	0,00000259	0,00081705	0,00003208	0,00192007	0,00000867
E03	1,00000000	1,00000000	1,00000000	1,00000000	1,00000000	1,00000000	0,00000000	1,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A06	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A07	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00001349	0,00000002	0,00000000	0,00000002	0,00000004	0,00000006	0,00000000	0,00000002
A08	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000006	0,00000000	0,00000006	0,00000011	0,00000015	0,00000000	0,00000006
A09	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00001302	0,00001379	0,00000000	0,00001542	0,00002852	0,00003703	0,00000000	0,00001556
A10	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000046	0,00001489	0,00000000	0,00001665	0,00003079	0,00003999	0,00000000	0,00001680
A11	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00010635	0,00002010	0,00000000	0,00002248	0,00004157	0,00005398	0,00000000	0,00002268
A12	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00004836	0,00000000	0,00005409	0,00010001	0,00012988	0,00186033	0,00005457
A13	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000392	0,00000000	0,00000438	0,00000810	0,00001052	0,00000000	0,00000442
A14	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00001109	0,00000000	0,00001241	0,00002294	0,00002979	0,00000000	0,00001252
A15	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A16	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000205	0,00000000	0,00000125	0,00000388	0,00000536	0,00000000	0,00000174
N06	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,17046861	0,00006995	0,00023247	0,00062396	0,06109729	0,00100305	0,00410235	0,00049260
N07	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000719	0,02242154	0,00000006	0,00000018	0,00000006	0,00000005	0,00000011	0,00000017
N08	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00026358	0,03131848	0,17121690	0,29129661	0,02219119	0,00012104	0,00795402	0,00020667
N09	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000439	0,00004815	0,00016378	0,00626758	0,00005377	0,00000295	0,00001964	0,00000898
N10	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000344	0,00000100	0,00000240	0,00114133	0,15768198	0,00000425	0,00040235	0,00001290
N11	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00029585	0,00013943	0,00000680	0,00000855	0,00045323	0,20095304	0,00735376	0,00114745
N12	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00578527	0,03740184	0,00357868	0,00154697	0,02042153	0,00902597	0,14877319	0,11294540
N13	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00028824	0,00784838	0,00029923	0,00002581	0,00005381	0,00001957	0,00455236	0,02608222
E04	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A17	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A18	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00129989	0,00033635	0,00263016	0,00020180	0,00021107	0,00094326	0,01107824	0,00000000
A19	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00022918	0,00001537	0,00006738	0,00003683	0,00006115	0,00030580	0,00150592	0,00000000
A20	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A21	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00028069	0,00000000	0,00025619	0,00000000	0,00000000	0,00000000	0,00066125	0,00000000
A22	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A23	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000038	0,00000000	0,00000030
A24	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A25	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A26	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000

Table B.5 – Technical Coefficients Matrix A (Part V).

	A09	A10	A11	A12	A13	A14	A15	A16	N06	N07	N08	N09	N10	N11	N12	N13
A27	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A28	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00021439	0,00000000	0,00000000	0,00000000	0,00000000	0,00022778	0,00000000	0,00017510
A29	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A30	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A31	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A32	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A33	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A34	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
E05	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A35	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A36	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A37	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A38	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A39	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,04499034	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00086193	0,00000000
N14	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00367023	0,00205434	0,01479217	0,00154694	0,02550315	0,00330927	0,02022505	0,00801726
N15	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00065934	0,00119229	0,03329409	0,00099665	0,00946959	0,00746907	0,00529973	0,01341405
N16	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00013622	0,00001746	0,00019246	0,00001323	0,00012549	0,00005673	0,00014772	0,00009527
N17	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00075540	0,00006909	0,00099539	0,00004844	0,01041402	0,00261585	0,00215997	0,00133202
N18	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00098996	0,00003626	0,00002944	0,00025218	0,00327886	0,00014179	0,00047749	0,00016566
N19	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00003953	0,00001920	0,00071819	0,00001528	0,00171399	0,00220942	0,00654655	0,00790713
N20	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00171656	0,00066527	0,00279618	0,00108144	0,00771553	0,00277772	0,01940185	0,01066667
N21	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,01257585	0,00256853	0,00777383	0,00287753	0,01657367	0,00795512	0,01618601	0,02549900
N22	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00002116	0,00000034	0,00000025	0,00000073	0,00003633	0,00000175	0,00003190	0,00000358
N23	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00204825	0,00000617	0,00001366	0,00000661	0,00308840	0,00015811	0,00143145	0,00034905
N24	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00067669	0,00007190	0,00001461	0,00000789	0,00013453	0,00205382	0,00044437	0,00034695
N25	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00047107	0,00008643	0,00004174	0,00003371	0,00031998	0,00042885	0,00301641	0,00302957
N26	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,01016081	0,00644049	0,00003738	0,00002137	0,01093622	0,01191563	0,01589922	0,00014695
N27	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00437733	0,00278061	0,00658364	0,00215861	0,00455859	0,00596814	0,01120170	0,00258291
N28	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00001529	0,00001095	0,00000902	0,00000792	0,00001778	0,00001790	0,00003001	0,00000754
N29	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00006160	0,00002209	0,00010318	0,00003266	0,00025697	0,00009553	0,00066551	0,00201030
N30	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00146778	0,00100846	0,00040104	0,00007452	0,00279634	0,00118051	0,00066356	0,00013414
N31	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00005784	0,00003272	0,00002829	0,00001358	0,00007118	0,00004908	0,00005905	0,00001554
N32	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00001414	0,00002489	0,00001099	0,00000503	0,00002329	0,00001377	0,00007625	0,00007899
N33	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000170	0,00000050	0,00000077	0,00000041	0,00000025	0,00000141	0,00000138	0,00000042
N34	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00001079	0,00000697	0,00001564	0,00000619	0,00001069	0,00001391	0,00002659	0,00000725
N35	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00063035	0,00020870	0,00024819	0,00009422	0,00032017	0,00054983	0,00058847	0,00015100
N36	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000514	0,00000352	0,00000339	0,00000397	0,00000504	0,00000549	0,00000923	0,00000313
N37	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00029419	0,00003616	0,00005691	0,00688186	0,00181000	0,00009970	0,00342769	0,00004460
N38	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00374333	0,00209391	0,01022122	0,00289758	0,00372420	0,00461222	0,01083448	0,00259727
E06	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00564074	0,00264091	0,01648056	0,00295325	0,00546094	0,00709181	0,03492887	0,00297965
A40	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A41	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A42	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,09621946	0,00000000
A43	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00002786	0,00000268	0,00000000	0,00000300	0,00000555	0,00000720	0,01744792	0,00000303

Table B.5 – Technical Coefficients Matrix A (Part VI).

	A09	A10	A11	A12	A13	A14	A15	A16	N06	N07	N08	N09	N10	N11	N12	N13
A44	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A45	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A46	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A47	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A48	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N39	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00053964	0,00042151	0,00070677	0,00047525	0,00033397	0,00074940	0,00101087	0,00048968
N40	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,07200597	0,03254791	0,06083592	0,09303530	0,08198679	0,04234686	0,04044938	0,04556683
N41	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,04611262	0,04482269	0,02756569	0,01818767	0,02840527	0,03173319	0,04134726	0,02580319
A49	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A50	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A51	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A52	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A53	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N42	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00326827	0,00439941	0,00170831	0,00047184	0,00443741	0,00163924	0,00291856	0,01388472
N43	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,02420832	0,04564099	0,02611870	0,01726105	0,02650652	0,02275986	0,04043463	0,02191800
N44	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00404907	0,00351189	0,00250674	0,00740812	0,00232916	0,00195973	0,00460203	0,00705406
N45	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00072938	0,00101932	0,00017572	0,00023328	0,00089866	0,00045361	0,00055866	0,00362009
N46	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00061772	0,00269530	0,00008324	0,00015083	0,00010863	0,00162085	0,00112787	0,00173001
N47	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,01835369	0,02605182	0,01917415	0,00934434	0,01132465	0,00523771	0,01256409	0,05699660
N48	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00015103	0,00012865	0,00009468	0,00027344	0,00009010	0,00007369	0,00016843	0,00025686
N49	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00053503	0,00033353	0,00039455	0,00081475	0,00048215	0,00029086	0,00042984	0,00058441
N50	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00307851	0,00158788	0,00248207	0,00404926	0,00346340	0,00148651	0,00187784	0,00236362
N51	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00004573	0,00005100	0,00003627	0,00002125	0,00002151	0,00001078	0,00002694	0,00011293
N52	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000041	0,00000057	0,00000041	0,00000020	0,00000024	0,00000011	0,00000028	0,00000124
N53	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00173223	0,00188640	0,00180508	0,00091536	0,00110416	0,00114833	0,00218230	0,00312621

Table B.5 – Technical Coefficients Matrix A (Part VII).

	E04	A17	A18	A19	A20	A21	A22	A23	A24	A25	A26	A27	A28	A29	A30	A31
N01	0,00012631	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N02	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
E01	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A01	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A02	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N03	0,00000258	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
E02	0,00000000	0,03705868	0,00000000	0,00000000	0,00000000	0,14933425	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A03	0,90658264	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A04	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A05	0,01909517	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N04	0,00000488	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N05	0,00005926	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
E03	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A06	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A07	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A08	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A09	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A10	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A11	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A12	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A13	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A14	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A15	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A16	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N06	0,00676024	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N07	0,00000009	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N08	0,00000425	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N09	0,00000311	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N10	0,00000115	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N11	0,00000289	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N12	0,00003905	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N13	0,00014801	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
E04	0,00000000	1,00000000	1,00000000	1,00000000	1,00000000	1,00000000	1,00000000	1,00000000	1,00000000	1,00000000	1,00000000	1,00000000	1,00000000	0,05686291	1,00000000	1,00000000
A17	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A18	0,00973381	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A19	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A20	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A21	0,00018114	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A22	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A23	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A24	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A25	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A26	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000

Table B.5 – Technical Coefficients Matrix A (Part VIII).

	E04	A17	A18	A19	A20	A21	A22	A23	A24	A25	A26	A27	A28	A29	A30	A31
A27	0,03721594	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A28	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A29	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A30	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A31	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A32	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A33	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A34	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
E05	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A35	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A36	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A37	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A38	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A39	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N14	0,01081549	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N15	0,00001360	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N16	0,00001210	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N17	0,00007008	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N18	0,00002731	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N19	0,00001371	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N20	0,00168741	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N21	0,00063742	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N22	0,00000036	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N23	0,00000878	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N24	0,00078038	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N25	0,00008676	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N26	0,00509532	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N27	0,00418293	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N28	0,00001229	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N29	0,00014456	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N30	0,00350526	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N31	0,00007889	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N32	0,00008622	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N33	0,00000087	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N34	0,00000994	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N35	0,00037353	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N36	0,00000383	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N37	0,00000315	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N38	0,00209145	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
E06	0,00264161	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A40	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A41	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A42	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A43	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000

Table B.5 – Technical Coefficients Matrix A (Part IX).

	E04	A17	A18	A19	A20	A21	A22	A23	A24	A25	A26	A27	A28	A29	A30	A31
A44	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A45	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A46	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A47	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A48	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N39	0,00115771	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N40	0,01794052	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N41	0,02257970	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A49	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A50	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A51	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A52	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A53	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N42	0,00554898	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N43	0,00092715	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N44	0,00363685	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N45	0,00130511	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N46	0,00206027	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N47	0,01772433	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N48	0,00014995	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N49	0,00027820	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N50	0,00196589	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N51	0,00003423	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N52	0,00000038	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N53	0,00099032	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000

Table B.5 – Technical Coefficients Matrix A (Part X).

	A32	A33	A34	E05	A35	A36	A37	A38	A39	N14	N15	N16	N17	N18	N19	N20
N01	0,00000000	0,00000000	0,00000000	0,00012531	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00226174	0,00976035	0,00242814	0,00336554	0,01958642	0,00247324	0,00748050
N02	0,00000000	0,00000000	0,00000000	0,17934350	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00024447	0,00000000	0,00000000
E01	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A01	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00004478	0,00001150	0,00004182	0,00002488	0,00141883	0,00009831	0,00000000
A02	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00001836	0,00000472	0,00001715	0,00001020	0,00058186	0,00004032	0,00000000
N03	0,00000000	0,00000000	0,00000000	0,00366046	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00004423	0,00028758	0,00037989	0,00008856	0,00265566	0,00008387	0,00039677
E02	0,00000000	0,00000000	0,07625983	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A03	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A04	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A05	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,04585758	0,00014997	0,00014819	0,00010986	0,00009436	0,00167427	0,00027789
N04	0,00000000	0,00000000	0,00000000	0,00000083	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00008159	0,00000146	0,00000423	0,00000207	0,00000175	0,00004000	0,00024135
N05	0,00000000	0,00000000	0,00000000	0,00000151	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,05725091	0,00098382	0,00034539	0,00180580	0,00033929	0,00699476	0,00627420
E03	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A06	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A07	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A08	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A09	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A10	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00003629	0,00006771	0,00000870	0,00001023	0,00000564	0,00001128	0,00003338
A11	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00046977	0,00087638	0,00011263	0,00013240	0,00007300	0,00014596	0,00043209
A12	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A13	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A14	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A15	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A16	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N06	0,00000000	0,00000000	0,00000000	0,01037657	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00142469	0,00201092	0,00967976	0,00857391	0,06800917	0,01899101	0,00346757
N07	0,00000000	0,00000000	0,00000000	0,00000002	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000016	0,00000004	0,00000008	0,00000006	0,00000005	0,00000007	0,00000012
N08	0,00000000	0,00000000	0,00000000	0,00060517	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00071880	0,00065055	0,00302293	0,00005320	0,00015906	0,00049984	0,00707191
N09	0,00000000	0,00000000	0,00000000	0,00000244	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000772	0,00000361	0,00000710	0,00000477	0,00000366	0,00000332	0,00002296
N10	0,00000000	0,00000000	0,00000000	0,00000098	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00001046	0,00006756	0,00005805	0,00001493	0,00001574	0,00001140	0,00001430
N11	0,00000000	0,00000000	0,00000000	0,00000258	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00053813	0,00019470	0,00002405	0,00102844	0,00595650	0,00000421	0,01567499
N12	0,00000000	0,00000000	0,00000000	0,00068549	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00306686	0,00056519	0,01357476	0,00956585	0,01987772	0,00037687	0,01860896
N13	0,00000000	0,00000000	0,00000000	0,00000197	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00165023	0,00016391	0,00750462	0,00349219	0,00100966	0,00388297	0,00943832
E04	1,00000000	0,99318382	0,92467464	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A17	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A18	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00628044	0,00226224	0,00001525	0,00021595	0,00000000	0,00000000	0,00126271
A19	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00089796	0,00116451	0,00059439	0,00042410	0,00000000	0,00185548	0,00000000
A20	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A21	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00538802	0,00000000
A22	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,11420661	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A23	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00011479	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A24	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A25	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A26	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000

Table B.5 – Technical Coefficients Matrix A (Part XI).

	A32	A33	A34	E05	A35	A36	A37	A38	A39	N14	N15	N16	N17	N18	N19	N20
A27	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00262845	0,00016170	0,00000799	0,00000446	0,00001489	0,00015455	0,00004383
A28	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00111205	0,00016323	0,00000806	0,00000450	0,00001503	0,00015602	0,00004425
A29	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,02849393	0,00418253	0,00020659	0,00011525	0,00038520	0,00399761	0,00113371
A30	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A31	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A32	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A33	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A34	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
E05	0,00000000	0,00000000	0,00000000	0,00000000	1,00000000	1,00000000	1,00000000	1,00000000	1,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A35	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00011600	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A36	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00027697	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A37	0,00000000	0,00000000	0,00000000	0,18429477	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A38	0,00000000	0,00000000	0,00000000	0,05141612	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A39	0,00000000	0,00000000	0,00000000	0,21000209	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N14	0,00000000	0,00000000	0,00000000	0,00042538	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,12707780	0,27360457	0,03680915	0,09995942	0,06994921	0,14616195	0,09029228
N15	0,00000000	0,00000000	0,00000000	0,00000052	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00112198	0,03319096	0,00013630	0,00039486	0,00841943	0,03555991	0,07647876
N16	0,00000000	0,00000000	0,00000000	0,00000259	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00011354	0,00050876	0,02016242	0,00079328	0,00028704	0,00024599	0,00099505
N17	0,00000000	0,00000000	0,00000000	0,00002671	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00159010	0,00609533	0,00703469	0,12284317	0,00180593	0,01112578	0,00378707
N18	0,00000000	0,00000000	0,00000000	0,00000233	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00381428	0,00042199	0,00306490	0,00112666	0,02738011	0,00084982	0,00151923
N19	0,00000000	0,00000000	0,00000000	0,00000212	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00035543	0,00080385	0,00012444	0,00035587	0,00108635	0,00261501	0,00357267
N20	0,00000000	0,00000000	0,00000000	0,00022850	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,01628361	0,02362468	0,01618461	0,02705402	0,04594701	0,00949441	0,04216182
N21	0,00000000	0,00000000	0,00000000	0,00341800	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00365289	0,00504324	0,01827317	0,05018084	0,01947201	0,00476063	0,01501395
N22	0,00000000	0,00000000	0,00000000	0,00000755	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00057294	0,00001327	0,00009748	0,00008252	0,00005581	0,00100558	0,00012749
N23	0,00000000	0,00000000	0,00000000	0,00082011	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00369455	0,00043318	0,01032417	0,00709074	0,00577653	0,00702123	0,00747979
N24	0,00000000	0,00000000	0,00000000	0,00004896	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00093907	0,00014401	0,00076201	0,00034803	0,00008636	0,00094262	0,00050874
N25	0,00000000	0,00000000	0,00000000	0,00006440	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00101683	0,00037792	0,00069311	0,00055680	0,00022797	0,00384200	0,00095663
N26	0,00000000	0,00000000	0,00000000	0,00425346	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00958320	0,00439173	0,00875377	0,02616600	0,00250569	0,02880301	0,01205140
N27	0,00000000	0,00000000	0,00000000	0,00394162	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,01213877	0,00771047	0,00248610	0,00299701	0,00507060	0,00306708	0,00305425
N28	0,00000000	0,00000000	0,00000000	0,00000794	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00002268	0,00001198	0,00001574	0,00002611	0,00000744	0,00003268	0,00001800
N29	0,00000000	0,00000000	0,00000000	0,00000985	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00053482	0,00072512	0,00054827	0,00089987	0,00159083	0,00028463	0,00139988
N30	0,00000000	0,00000000	0,00000000	0,00019839	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00144818	0,00031874	0,00482944	0,00044111	0,00035804	0,00080187	0,00332001
N31	0,00000000	0,00000000	0,00000000	0,00001908	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00007223	0,00005006	0,00010095	0,00003534	0,00038218	0,00004673	0,00008044
N32	0,00000000	0,00000000	0,00000000	0,00000550	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00001788	0,00004334	0,00007801	0,00028486	0,00002683	0,00080820	0,00002196
N33	0,00000000	0,00000000	0,00000000	0,00000047	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000179	0,00000026	0,00000111	0,00000091	0,00000023	0,00000180	0,00000189
N34	0,00000000	0,00000000	0,00000000	0,00000927	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00002911	0,00001807	0,00000613	0,00000691	0,00001198	0,00000716	0,00000775
N35	0,00000000	0,00000000	0,00000000	0,00018460	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00122414	0,00014611	0,00055218	0,00061310	0,00014107	0,00082128	0,00079700
N36	0,00000000	0,00000000	0,00000000	0,00000275	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000883	0,00000453	0,00000384	0,00000742	0,00000305	0,00000866	0,00000522
N37	0,00000000	0,00000000	0,00000000	0,00000777	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00017910	0,00001881	0,00004597	0,00008595	0,00006035	0,00002830	0,00004321
N38	0,00000000	0,00000000	0,00000000	0,00098510	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,01044746	0,01658728	0,00341544	0,00398261	0,00236591	0,00451342	0,01033679
E06	0,00000000	0,00000000	0,00000000	0,00641254	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,01421024	0,02650981	0,00340710	0,00400502	0,00220817	0,00441508	0,01307038
A40	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A41	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A42	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A43	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000

Table B.5 – Technical Coefficients Matrix A (Part XII).

	A32	A33	A34	E05	A35	A36	A37	A38	A39	N14	N15	N16	N17	N18	N19	N20
A44	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A45	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A46	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A47	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A48	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N39	0,00000000	0,00000000	0,00000000	0,00005561	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00074216	0,00080253	0,00071649	0,00028733	0,00029876	0,00704715	0,00037894
N40	0,00000000	0,00000000	0,00000000	0,00470288	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,06616289	0,04561107	0,05407530	0,07192701	0,07530531	0,04732511	0,04668623
N41	0,00000000	0,00000000	0,00000000	0,00760046	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,03856533	0,03438994	0,04110507	0,02640674	0,03739860	0,03046479	0,02917051
A49	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A50	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A51	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A52	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A53	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N42	0,00000000	0,00000000	0,00000000	0,00068096	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00861542	0,00296253	0,02120682	0,01414049	0,00363059	0,01379211	0,02196330
N43	0,00000000	0,00000000	0,00000000	0,00719549	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,06942347	0,06031241	0,02826214	0,06752384	0,02733384	0,02603536	0,03664293
N44	0,00000000	0,00000000	0,00000000	0,00096477	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00669489	0,00164566	0,00336854	0,00239837	0,00202961	0,00272991	0,00502588
N45	0,00000000	0,00000000	0,00000000	0,00015882	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00135213	0,00031473	0,00326385	0,00051858	0,00146117	0,00174066	0,00330048
N46	0,00000000	0,00000000	0,00000000	0,00047220	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00070319	0,00006091	0,00110301	0,00009696	0,00048030	0,00051814	0,00291997
N47	0,00000000	0,00000000	0,00000000	0,00387139	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,01288696	0,01286688	0,07470287	0,02534743	0,04874434	0,02323403	0,02581899
N48	0,00000000	0,00000000	0,00000000	0,00003501	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00047127	0,00006257	0,00012512	0,00009178	0,00007876	0,00010160	0,00018408
N49	0,00000000	0,00000000	0,00000000	0,00007377	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00065138	0,00028214	0,00041392	0,00044147	0,00043367	0,00035165	0,00047526
N50	0,00000000	0,00000000	0,00000000	0,00059180	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00334516	0,00147519	0,00311201	0,00243081	0,00242684	0,00174603	0,00444704
N51	0,00000000	0,00000000	0,00000000	0,00000759	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00002848	0,00002423	0,00013719	0,00004745	0,00008820	0,00004415	0,00005212
N52	0,00000000	0,00000000	0,00000000	0,00000008	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000028	0,00000028	0,00000317	0,00000059	0,00000107	0,00000050	0,00000059
N53	0,00000000	0,00000000	0,00000000	0,00031084	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00200182	0,00217421	0,00307552	0,00157350	0,00224642	0,00160601	0,00235116

Table B.5 – Technical Coefficients Matrix A (Part XIII).																
	N21	**N22**	**N23**	**N24**	**N25**	**N26**	**N27**	**N28**	**N29**	**N30**	**N31**	**N32**	**N33**	**N34**	**N35**	**N36**
N01	0,00608925	0,00021082	0,00318727	0,00062318	0,00034364	0,00056371	0,00005779	0,00000725	0,00000265	0,00004062	0,00006577	0,00003223	0,00000167	0,00000176	0,00035115	0,00001390
N02	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
E01	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A01	0,00029321	0,00000000	0,05174495	0,00000000	0,00242401	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00011317	0,00000000
A02	0,00000401	0,00461551	0,00000945	0,03863117	0,01496849	0,00012645	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000155	0,00000000
N03	0,00042491	0,00000010	0,00009095	0,00001499	0,00000432	0,00001311	0,00000065	0,00000007	0,00000005	0,00000089	0,00000007	0,00000076	0,00000002	0,00000003	0,00001853	0,00000006
E02	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A03	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A04	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A05	0,00089528	0,00214652	0,04259597	0,00985516	0,00304108	0,00462190	0,00109964	0,00103079	0,00031887	0,00068587	0,00064379	0,00053013	0,00029582	0,00061813	0,00070087	0,00058078
N04	0,00000355	0,00094339	0,00739952	0,07172497	0,00251770	0,00004466	0,00370039	0,00000236	0,00000175	0,00001958	0,00000183	0,00000242	0,00000132	0,00000111	0,00001851	0,00000234
N05	0,00004807	0,01642260	0,04601898	0,00959575	0,09266924	0,00454122	0,00150138	0,00002842	0,00000094	0,00099695	0,00000452	0,00004047	0,00002030	0,00002787	0,00145182	0,00000970
E03	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A06	0,00000000	0,00000000	0,00000000	0,00003373	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A07	0,00000006	0,00000000	0,00000011	0,00000000	0,00000000	0,00000000	0,00000003	0,00000002	0,00000001	0,00000005	0,00000003	0,00000003	0,00000002	0,00000004	0,00000004	0,00000003
A08	0,00000015	0,00000000	0,00000027	0,00000000	0,00000000	0,00000000	0,00000008	0,00000006	0,00000003	0,00000013	0,00000008	0,00000008	0,00000006	0,00000009	0,00000011	0,00000008
A09	0,00003843	0,00000000	0,00008908	0,00000000	0,00000000	0,00000000	0,00001951	0,00001396	0,00000783	0,00003357	0,00002066	0,00002050	0,00001422	0,00002240	0,00002728	0,00002021
A10	0,00004150	0,00000000	0,00017744	0,00000000	0,00000000	0,00000000	0,00002107	0,00001508	0,00000846	0,00003626	0,00002231	0,00002213	0,00001536	0,00002419	0,00002946	0,00002182
A11	0,00005601	0,00000367	0,00015377	0,00000000	0,00000000	0,00000000	0,00002844	0,00002035	0,00001142	0,00004894	0,00003011	0,00002987	0,00002073	0,00003265	0,00003976	0,00002945
A12	0,00013477	0,00111001	0,00027204	0,00000000	0,00000000	0,00000000	0,00006844	0,00004897	0,00002748	0,00011774	0,00007244	0,00007188	0,00004987	0,00007855	0,00009566	0,00007087
A13	0,00001092	0,00058378	0,00001927	0,00000000	0,00000000	0,00000000	0,00000555	0,00000397	0,00000223	0,00000954	0,00000587	0,00000582	0,00000404	0,00000637	0,00000775	0,00000574
A14	0,00003091	0,00020079	0,00005455	0,00000000	0,00000000	0,00000000	0,00001570	0,00001123	0,00000630	0,00002701	0,00001662	0,00001649	0,00001144	0,00001802	0,00002194	0,00001626
A15	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A16	0,00000504	0,00307984	0,00054414	0,02901841	0,00040836	0,00032509	0,00001823	0,00002803	0,00000148	0,00000391	0,00000109	0,00000199	0,00000798	0,00001819	0,00104254	0,00000501
N06	0,00053316	0,00035306	0,00031127	0,00012709	0,00033237	0,00016998	0,00014708	0,00017554	0,00008696	0,00022674	0,00042018	0,00096227	0,00010700	0,00010500	0,00028346	0,00007302
N07	0,00000010	0,00000010	0,00000011	0,00000006	0,00000005	0,00000009	0,00000010	0,00000007	0,00000005	0,00000009	0,00000005	0,00000007	0,00000002	0,00000003	0,00000006	0,00000006
N08	0,01042434	0,00326991	0,00556109	0,00002990	0,00003680	0,00011579	0,00248532	0,00034332	0,00000738	0,00067928	0,00002824	0,00010378	0,00007332	0,00009246	0,00047332	0,00007529
N09	0,00002088	0,00001140	0,00001869	0,00000451	0,00000409	0,00018596	0,00002955	0,00002218	0,00000221	0,00000564	0,00000237	0,00003015	0,00000630	0,00000748	0,00056450	0,00000422
N10	0,00002209	0,00000363	0,00000476	0,00000380	0,00000620	0,00042498	0,00046969	0,00000950	0,00000187	0,00000493	0,00000476	0,00137885	0,00105576	0,00003721	0,00000445	0,00000501
N11	0,00013843	0,00001029	0,01701494	0,00002023	0,00013156	0,00277634	0,00137609	0,00070739	0,00011460	0,00021662	0,00907433	0,00025970	0,00001508	0,00008975	0,00166046	0,00161764
N12	0,01540710	0,02029427	0,00754160	0,00011571	0,00110185	0,00545570	0,00340105	0,02506288	0,00119815	0,00528937	0,00687266	0,00561840	0,00208010	0,00008887	0,00164967	0,00126944
N13	0,00303138	0,00320216	0,00012393	0,00042298	0,00170411	0,00087169	0,00001205	0,00004718	0,00001000	0,00003952	0,00002425	0,00450203	0,00074118	0,00012790	0,00016966	0,00206513
E04	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A17	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A18	0,00105531	0,00241182	0,00886791	0,00161044	0,02218600	0,00502818	0,00042476	0,00016275	0,00000000	0,00033418	0,00001481	0,00000000	0,00032146	0,00037832	0,00088199	0,00015610
A19	0,00013160	0,00356632	0,00027879	0,00020446	0,00000000	0,00000000	0,00005743	0,00029634	0,00027261	0,00009067	0,00023642	0,00001044	0,00003876	0,00002733	0,00004049	0,00032413
A20	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A21	0,00000000	0,00010015	0,00932446	0,00127208	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A22	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A23	0,00000205	0,00000000	0,00000289	0,00001166	0,00000000	0,00000000	0,00000117	0,00000000	0,00000000	0,00000535	0,00000003	0,00000000	0,00000000	0,00000000	0,00000022	0,00000141
A24	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A25	0,00000000	0,00000000	0,00000000	0,01434431	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A26	0,00000000	0,00522709	0,00000000	0,07047041	0,00497425	0,00102519	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000

Table B.5 – Technical Coefficients Matrix A (Part XIV).

	N21	N22	N23	N24	N25	N26	N27	N28	N29	N30	N31	N32	N33	N34	N35	N36
A27	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A28	0,00121521	0,23012718	0,00566489	0,00693388	0,01492194	0,00374660	0,00068976	0,00000000	0,00000000	0,00316711	0,00001483	0,00000000	0,00000000	0,00000000	0,00013271	0,00083496
A29	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A30	0,00000000	0,00000000	0,00000000	0,00062780	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A31	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A32	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A33	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A34	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
E05	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A35	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A36	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A37	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A38	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A39	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N14	0,04912876	0,01330373	0,01967249	0,02198914	0,03411175	0,01722794	0,00844325	0,00140339	0,00008751	0,00460018	0,00048813	0,00428908	0,00019566	0,00015533	0,00341771	0,00032909
N15	0,14288500	0,00000923	0,00762162	0,00103796	0,00115637	0,00702408	0,00322820	0,02098154	0,00000022	0,02366482	0,00086289	0,00552938	0,00000578	0,00058287	0,00578330	0,00417484
N16	0,00082473	0,00003989	0,00006463	0,00003663	0,00004231	0,00005983	0,00003848	0,00016943	0,00002398	0,00014563	0,00002956	0,00106796	0,00027341	0,00020082	0,00017042	0,00010005
N17	0,00439467	0,00012074	0,00046083	0,00040331	0,00035895	0,00064640	0,00018904	0,00053389	0,00000023	0,00059581	0,00005006	0,00031473	0,00018750	0,00002895	0,00019869	0,00024594
N18	0,00010925	0,00216510	0,00128407	0,00013629	0,00223696	0,00073076	0,00110109	0,00002392	0,00075889	0,00005163	0,00005775	0,00017885	0,00000386	0,00012341	0,00020282	0,00000362
N19	0,00461727	0,00008012	0,00285426	0,00071049	0,00018824	0,00735470	0,00180855	0,00272249	0,00000039	0,00099079	0,00007702	0,00252440	0,00707959	0,00059763	0,00119907	0,00137006
N20	0,01088918	0,00669009	0,00294379	0,00067884	0,00420821	0,00198337	0,00031568	0,00027380	0,00000281	0,00480489	0,00829479	0,02748128	0,00003344	0,00005958	0,00198942	0,00005406
N21	0,04213720	0,00416106	0,00223460	0,00547060	0,01440520	0,01905389	0,01980250	0,03281436	0,01083009	0,01201298	0,01540695	0,01912940	0,06686553	0,05872981	0,02674195	0,02993499
N22	0,00000343	0,02348771	0,05240865	0,00013930	0,00019521	0,00005714	0,00002146	0,00022047	0,00000020	0,00008438	0,00003430	0,00002585	0,00007916	0,00004749	0,00009339	0,00000321
N23	0,00033994	0,02994033	0,04922990	0,00873444	0,00685837	0,00289386	0,00145046	0,02412686	0,00000634	0,00882888	0,00374785	0,00281208	0,00867784	0,00520844	0,00932279	0,00034521
N24	0,00937835	0,02187302	0,00757711	0,08918684	0,04007328	0,14459764	0,11888920	0,12988199	0,00290257	0,06152191	0,01054275	0,01969920	0,05278526	0,04423771	0,10298826	0,06638064
N25	0,00165090	0,00732309	0,00353215	0,03239032	0,08698244	0,04611970	0,04952186	0,00734118	0,00039340	0,04470543	0,01350310	0,03063720	0,00466586	0,00443828	0,00791111	0,01260700
N26	0,00918871	0,00478910	0,00660735	0,04045822	0,04392862	0,05053662	0,06232069	0,02509610	0,01482228	0,04291267	0,03119690	0,02174150	0,03586888	0,00757322	0,01792997	0,01406630
N27	0,00714172	0,01768115	0,01106582	0,01367181	0,01127796	0,00888989	0,02876951	0,04858665	0,00319889	0,00716567	0,00187704	0,00371989	0,01607515	0,02384377	0,01096831	0,00783928
N28	0,00002120	0,00003630	0,00002204	0,00006155	0,00013157	0,00010988	0,00028152	0,01179580	0,00007910	0,00017564	0,00166593	0,00007683	0,00008628	0,00005140	0,00003454	0,00004272
N29	0,00037605	0,00023378	0,00009898	0,00001882	0,00014134	0,00006773	0,00003197	0,00002625	0,03056613	0,00022564	0,00063515	0,00094887	0,00001322	0,00001487	0,00008370	0,00000718
N30	0,00370771	0,01374925	0,00197605	0,00079754	0,00192215	0,00076839	0,02859261	0,03219791	0,03338747	0,07405513	0,10133438	0,01953758	0,03510092	0,02106666	0,00368566	0,00703920
N31	0,00010757	0,00031973	0,00046077	0,00008384	0,00009805	0,00007407	0,00228856	0,00072931	0,19642550	0,00440196	0,11299176	0,00173541	0,00232599	0,00236610	0,00549002	0,00035615
N32	0,00019846	0,00005411	0,00001946	0,00001552	0,00001744	0,00002289	0,00386264	0,01133188	0,00017669	0,00155097	0,00040655	0,03642263	0,00140357	0,00091556	0,00056086	0,00002513
N33	0,00000737	0,00001091	0,00000259	0,00000127	0,00000108	0,00000051	0,00471321	0,00000023	0,00000039	0,00002593	0,00000038	0,00000303	0,02940214	0,00090959	0,00070155	0,00000247
N34	0,00001717	0,00004172	0,00002637	0,00003164	0,00002579	0,00002092	0,00010377	0,00011177	0,00000701	0,00003657	0,00000259	0,00000951	0,00027793	0,03801538	0,00504210	0,00861552
N35	0,00240590	0,00410549	0,00139159	0,00194625	0,00208661	0,00125992	0,01485694	0,00180110	0,00116925	0,01017769	0,00327283	0,00190150	0,21454370	0,26229016	0,20224279	0,00243891
N36	0,00000613	0,00000933	0,00000729	0,00001469	0,00001438	0,00002396	0,00006006	0,00002525	0,00000491	0,00009115	0,00000780	0,00004479	0,00001434	0,00001101	0,00099953	0,21908218
N37	0,00114694	0,00004509	0,00060870	0,00835204	0,00479941	0,00109035	0,00033403	0,00008739	0,00001649	0,00064686	0,00003418	0,00003902	0,00007120	0,00029569	0,00004923	0,00005094
N38	0,00608249	0,01267497	0,01358865	0,01046381	0,02027409	0,00549646	0,00345548	0,00274748	0,00173527	0,00623057	0,00205649	0,00373684	0,00300122	0,00319363	0,00407108	0,00351174
E06	0,00735872	0,03430978	0,01939489	0,01817170	0,07535952	0,01878447	0,00373682	0,00267412	0,00150033	0,00642924	0,00395572	0,00392469	0,00272333	0,00428902	0,00522358	0,00386958
A40	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A41	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A42	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A43	0,00000747	0,00000000	0,00131363	0,00000000	0,00000000	0,00000000	0,00000380	0,00000272	0,00000152	0,00000653	0,00000402	0,00000399	0,00000277	0,00000436	0,00000531	0,00000393

Table B.5 – Technical Coefficients Matrix A (Part XV).

	N21	N22	N23	N24	N25	N26	N27	N28	N29	N30	N31	N32	N33	N34	N35	N36
A44	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A45	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A46	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A47	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A48	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N39	0,00258855	0,00286505	0,00277130	0,00037118	0,00091244	0,00031471	0,00059606	0,00123755	0,00032706	0,00242754	0,00230234	0,00006529	0,00916618	0,00343661	0,00060419	0,00170134
N40	0,05034939	0,06827765	0,06988851	0,02950229	0,03630291	0,03135470	0,04787965	0,06317409	0,09699410	0,04511464	0,07001038	0,04041077	0,08428484	0,07518304	0,06021288	0,05154213
N41	0,03174611	0,09637197	0,03043055	0,05924832	0,04581488	0,03269982	0,03383189	0,04205039	0,02690252	0,03649499	0,04054675	0,02158010	0,03790634	0,03315292	0,02949909	0,01659598
A49	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A50	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A51	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A52	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A53	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N42	0,00982928	0,00823013	0,00371547	0,01965424	0,00232351	0,00538640	0,01650169	0,02338943	0,01089566	0,02284259	0,02683939	0,00815260	0,01483744	0,00648626	0,00337303	0,01558476
N43	0,03041511	0,04777112	0,02586199	0,04763610	0,04735345	0,02783739	0,05725572	0,04008975	0,02049217	0,04658021	0,07499751	0,02262455	0,04277306	0,05106191	0,03416728	0,03261443
N44	0,00394754	0,00396074	0,00452047	0,00236512	0,00192015	0,00353555	0,00396785	0,00266731	0,00202106	0,00353910	0,00196173	0,00281537	0,00083908	0,00103064	0,00252117	0,00260625
N45	0,00079418	0,00239658	0,00150055	0,00140059	0,00035720	0,00010965	0,00164936	0,00011120	0,00027450	0,00014386	0,00017224	0,00208489	0,00035240	0,00026779	0,00055413	0,00070043
N46	0,00134363	0,00862667	0,00251977	0,00077671	0,00452583	0,00034153	0,00007766	0,00008857	0,00023874	0,00209394	0,00009222	0,00006252	0,00209968	0,00070033	0,00050577	0,00313096
N47	0,01221739	0,02984422	0,01782169	0,00601001	0,00381489	0,00957448	0,00608061	0,02512573	0,06674163	0,01772708	0,03131284	0,01116149	0,03705930	0,03801662	0,01627923	0,02814223
N48	0,00014567	0,00014742	0,00016778	0,00008715	0,00007176	0,00012943	0,00014616	0,00010062	0,00008022	0,00013058	0,00007592	0,00010427	0,00003656	0,00004279	0,00009525	0,00009761
N49	0,00043489	0,00050716	0,00055101	0,00025428	0,00026164	0,00033161	0,00042476	0,00041970	0,00052918	0,00038899	0,00040875	0,00032882	0,00040658	0,00037859	0,00039835	0,00036573
N50	0,00285799	0,00365316	0,00331812	0,00180541	0,00199570	0,00199383	0,00247393	0,00215699	0,00399800	0,00456488	0,00410948	0,00176668	0,00319845	0,00292724	0,00247355	0,00183629
N51	0,00002521	0,00005774	0,00003511	0,00001258	0,00000941	0,00001963	0,00001334	0,00004633	0,00011987	0,00003416	0,00005687	0,00002282	0,00006677	0,00006829	0,00003062	0,00005265
N52	0,00000026	0,00000065	0,00000038	0,00000013	0,00000008	0,00000021	0,00000013	0,00000054	0,00000145	0,00000038	0,00000068	0,00000032	0,00000080	0,00000083	0,00000035	0,00000061
N53	0,00146824	0,00338991	0,00210596	0,00205313	0,00248119	0,00127964	0,00096446	0,00141836	0,00246060	0,00146481	0,00165720	0,00094042	0,00189995	0,00183763	0,00125177	0,00142895

Table B.5 – Technical Coefficients Matrix A (Part XVI).

	N37	N38	E06	A40	A41	A42	A43	A44	A45	A46	A47	A48	N39	N40	N41	A49
N01	0,00370178	0,00000484	0,00006576	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00027664	0,00006136	0,00001562	0,00000000
N02	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
E01	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A01	0,00093023	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,02628011	0,00000000	0,00000000	0,00000000	0,00000000
A02	0,00001273	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00105102	0,00000000	0,00000000	0,00000000	0,00000000
N03	0,00163881	0,00000014	0,00000005	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000006	0,00000043	0,00000015	0,00000115
E02	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A03	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A04	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,06380748	0,00000000	0,00000000	0,00000000	0,00000000
A05	0,00074021	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,04472043	0,06071794	0,00041511	0,00006814	0,00000000	0,00000000
N04	0,00002658	0,00000488	0,00000191	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000340	0,00001523	0,00000516	0,00000000
N05	0,00096213	0,00000614	0,00000102	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,01037946	0,00000652	0,00001753	0,00000000
E03	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A06	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00250341	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A07	0,00000003	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,01002942	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A08	0,00000008	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000001	0,00000000	0,00000000	0,00000000
A09	0,00002019	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00087533	0,00000000	0,00000213	0,00000000	0,00000000	0,00000000
A10	0,00002180	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,02738877	0,00000000	0,00000230	0,00000000	0,00000000	0,00000000
A11	0,00002943	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00230850	0,00000310	0,00000000	0,00000000	0,00000000
A12	0,00007080	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00280828	0,00000747	0,00000000	0,00000000	0,00000000
A13	0,00000574	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000061	0,00000000	0,00000000	0,00000000
A14	0,00001624	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00126678	0,00000000	0,00000171	0,00000000	0,00000000	0,00000000
A15	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A16	0,00000273	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000390	0,00000000	0,00000000	0,00000000
N06	0,00195551	0,00048658	0,00356781	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00039549	0,00170970	0,00061502	0,00000000
N07	0,00000009	0,00000014	0,00000005	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000006	0,00000043	0,00000015	0,00000000
N08	0,01762548	0,00001370	0,00000200	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00068410	0,00123730	0,00143001	0,00000000
N09	0,00008236	0,00091211	0,00000165	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00013076	0,00044698	0,00144820	0,00000000
N10	0,00005685	0,00000491	0,00000035	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00002136	0,00000255	0,00000255	0,00000000
N11	0,08651865	0,00000152	0,00000154	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,01847994	0,00036661	0,00000207	0,00000000
N12	0,02527276	0,00008510	0,00062497	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00066609	0,00344635	0,00065789	0,00000000
N13	0,00015822	0,00012766	0,00203044	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00039249	0,00223580	0,00138674	0,00000000
E04	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A17	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A18	0,00047059	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,02387493	0,03574081	0,00000000	0,00000000	0,00000000	0,00000000
A19	0,00003267	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,03866828	0,04046961	0,00022230	0,00006864	0,00000000	0,99999885
A20	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A21	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A22	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A23	0,00000059	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000048	0,00000000	0,00000000	0,00000000
A24	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A25	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,03935489	0,00000000	0,00000000	0,00000000	0,00000000
A26	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000

Table B.5 – Technical Coefficients Matrix A (Part XVII).

	N37	N38	E06	A40	A41	A42	A43	A44	A45	A46	A47	A48	N39	N40	N41	A49
A27	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,02533610	0,00000000	0,00000000	0,00000000	0,00000000
A28	0,00035045	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00028185	0,00000000	0,00000000	0,00000000
A29	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,01832946	0,00000000	0,00000000	0,00000000	0,00000000
A30	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00057990	0,00000000	0,00000000	0,00000000	0,00000000
A31	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A32	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A33	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A34	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
E05	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A35	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A36	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A37	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A38	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A39	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,31968041	0,00000000	0,00000000	0,00000000	0,00000000
N14	0,00882902	0,01401055	0,00000943	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00075343	0,00002965	0,00001894	0,00000000
N15	0,01926653	0,00000906	0,00000015	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00002940	0,00000082	0,00000057	0,00000000
N16	0,00013217	0,00004899	0,00001107	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00002641	0,00001865	0,00008789	0,00000000
N17	0,01194554	0,00014834	0,00000023	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00081775	0,00000174	0,00007061	0,00000000
N18	0,00023085	0,00409940	0,00000109	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00037992	0,00000670	0,00024409	0,00000000
N19	0,00416913	0,00008329	0,00000013	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,02022682	0,00000097	0,00023455	0,00000000
N20	0,00550837	0,01123664	0,00000263	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00155017	0,00000560	0,00001181	0,00000000
N21	0,03131468	0,00745195	0,00187783	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,01854688	0,00511316	0,01377549	0,00000000
N22	0,00020418	0,00000317	0,00000022	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,02826461	0,00000452	0,00000059	0,00000000
N23	0,02213020	0,00030038	0,00000563	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,08906085	0,00031173	0,00000405	0,00000000
N24	0,03360402	0,00005213	0,00000295	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,02670187	0,00003398	0,00001968	0,00000000
N25	0,01011275	0,00010125	0,00501299	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00386229	0,00002426	0,00012257	0,00000000
N26	0,02371727	0,00007634	0,00003774	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,02814770	0,00136086	0,00009271	0,00000000
N27	0,00434066	0,00049032	0,00164146	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00762408	0,00008183	0,00046567	0,00000000
N28	0,00004446	0,00000122	0,00004739	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00016689	0,00000367	0,00000533	0,00000000
N29	0,00018843	0,00038341	0,00000244	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00005898	0,00045056	0,00000179	0,00000000
N30	0,00761938	0,00035096	0,03866472	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00876874	0,00095039	0,00444988	0,00000000
N31	0,00104848	0,00002966	0,00068570	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00019910	0,00009786	0,00060005	0,00000000
N32	0,00008713	0,00000942	0,00006081	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00060698	0,00021046	0,00005783	0,00000000
N33	0,00000106	0,00001052	0,00000179	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000184	0,00003759	0,00008973	0,00000000
N34	0,00001019	0,00000245	0,00000362	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00003349	0,00005123	0,00194914	0,00000000
N35	0,00095549	0,00300346	0,00159243	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00132272	0,01073831	0,02589378	0,00000000
N36	0,00001031	0,00000185	0,00000119	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00041948	0,00118259	0,00383967	0,00000000
N37	0,01801467	0,00000572	0,00000152	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00266288	0,00001203	0,00135164	0,00000000
N38	0,00344954	0,00832971	0,10205717	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00045899	0,00439748	0,00286301	0,00000000
E06	0,00386599	0,00000000	0,00586076	1,00000000	1,00000000	1,00000000	1,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00040770	0,00335882	0,00000000	0,00000000
A40	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	1,01522843	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A41	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,90839612	0,19769272	0,00000000	0,00000000	0,00000000	0,00000000
A42	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,15336093	0,00000000	0,00000000	0,00000000	0,00000000
A43	0,00000393	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00429672	0,01248183	0,00000041	0,00000000	0,00000000	0,00000000

Table B.5 – Technical Coefficients Matrix A (Part XVIII).

	N37	N38	E06	A40	A41	A42	A43	A44	A45	A46	A47	A48	N39	N40	N41	A49
A44	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A45	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A46	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,09596399	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A47	0,00000000	0,00000000	0,41952008	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A48	0,00000000	0,00000000	0,05845289	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N39	0,00052247	0,00053915	0,00005172	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,02176943	0,00095713	0,00025110	0,00000000
N40	0,06325055	0,00967593	0,02138537	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,05896605	0,02756455	0,04251250	0,00000000
N41	0,01915617	0,06709447	0,00462563	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,01318601	0,04733994	0,08877608	0,00000000
A49	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,10932142	0,00000000
A50	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A51	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00286427	0,00000000
A52	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00505837	0,00000000
A53	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,01070070	0,00000000
N42	0,00153977	0,01746045	0,01323053	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00191198	0,01129044	0,00980990	0,00000000
N43	0,01688596	0,01120433	0,02022143	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,01078680	0,02476327	0,03004747	0,00000000
N44	0,00369110	0,00565196	0,00222904	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00227426	0,01768102	0,00599657	0,00000000
N45	0,00012720	0,00034124	0,00029039	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00042680	0,00108023	0,01758082	0,00000000
N46	0,00102266	0,00072597	0,00003721	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00171675	0,00193126	0,00448423	0,00000000
N47	0,00670740	0,08326568	0,04663510	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,01779002	0,04808894	0,03422307	0,00000000
N48	0,00013757	0,00020368	0,00008172	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00008599	0,00063724	0,00021824	0,00000000
N49	0,00047911	0,00035238	0,00021496	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00038039	0,00110582	0,00049006	0,00000000
N50	0,00275573	0,00163703	0,00419200	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00253265	0,00671618	0,00275358	0,00000000
N51	0,00001460	0,00015218	0,00008731	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00003329	0,00009807	0,00006573	0,00000000
N52	0,00000014	0,00000181	0,00000102	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000038	0,00000104	0,00000074	0,00000000
N53	0,00083697	0,00407631	0,00923254	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00078854	0,00260190	0,00262721	0,00000000

Table B.5 – Technical Coefficients Matrix A (Part XIX).

	A50	A51	A52	A53	N42	N43	N44	N45	N46	N47	N48	N49	N50	N51	N52	N53
N01	0,00000000	0,00000000	0,00000000	0,00000000	0,00002148	0,00001069	0,00000523	0,00008969	0,01578007	0,00002045	0,00118527	0,00052362	0,00300720	0,00215643	0,00029583	0,00039609
N02	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
E01	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A01	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00070806	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A02	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00068659	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N03	0,00000000	0,00000115	0,00000115	0,00000115	0,00000049	0,00000010	0,00000007	0,00000013	0,00818712	0,00000026	0,00001311	0,00035679	0,00255466	0,00088841	0,00029829	0,00033318
E02	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A03	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A04	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A05	0,00000000	0,00000000	0,00000000	0,00000000	0,00008818	0,00001618	0,00001368	0,00002155	0,00058997	0,00004054	0,00006496	0,00042210	0,00004288	0,00006566	0,00004786	0,00010191
N04	0,00000000	0,00000000	0,00000000	0,00000000	0,00001749	0,00000371	0,00000427	0,00000442	0,00000863	0,00000902	0,00001284	0,00000740	0,00000904	0,00001013	0,00000691	0,00001289
N05	0,00000000	0,00000000	0,00000000	0,00000000	0,00000668	0,00000140	0,00000216	0,00000250	0,00006872	0,00000338	0,00000860	0,00001564	0,00016550	0,00004211	0,00002008	0,00005248
E03	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A06	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A07	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A08	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A09	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A10	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A11	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A12	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A13	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A14	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A15	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A16	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N06	0,00000000	0,00000000	0,00000000	0,00000000	0,00017219	0,00018974	0,00015042	0,00013698	0,26818392	0,00014982	0,00270016	0,00753900	0,02368846	0,01524943	0,00506478	0,00563442
N07	0,00000000	0,00000000	0,00000000	0,00000000	0,00000049	0,00000010	0,00000007	0,00000013	0,00000025	0,00000025	0,00000032	0,00000020	0,00000024	0,00000020	0,00000017	0,00000032
N08	0,00000000	0,00000000	0,00000000	0,00000000	0,00001843	0,00000403	0,00003222	0,00291866	0,00267979	0,00002148	0,00001150	0,00525537	0,00844992	0,00001431	0,00003056	0,00005708
N09	0,00000000	0,00000000	0,00000000	0,00000000	0,00031395	0,00065671	0,00000314	0,00001157	0,00101586	0,00231387	0,00001104	0,00275105	0,00445464	0,00006461	0,00010531	0,00028260
N10	0,00000000	0,00000000	0,00000000	0,00000000	0,00000389	0,00000145	0,00000055	0,00004967	0,00000272	0,00000502	0,00000685	0,00002161	0,00065482	0,00000425	0,00000340	0,00000596
N11	0,00000000	0,00000000	0,00000000	0,00000000	0,00006209	0,00000157	0,00000208	0,00000275	0,00000233	0,00000380	0,00000889	0,00000462	0,00038814	0,00004748	0,00003382	0,00012120
N12	0,00000000	0,00000000	0,00000000	0,00000000	0,00202707	0,00287235	0,00105612	0,00427243	0,00136517	0,00173036	0,00342419	0,00857523	0,00652821	0,00087121	0,00159486	0,00154339
N13	0,00000000	0,00000000	0,00000000	0,00000000	0,01365854	0,01091888	0,00156306	0,00044575	0,00014186	0,05147168	0,00147154	0,00484073	0,00699662	0,00659591	0,00397315	0,00298554
E04	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A17	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A18	0,00000000	0,00000000	0,72552099	0,00000000	0,00058961	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A19	0,00000000	0,82216010	0,27447786	0,00000000	0,00001174	0,00000824	0,00000333	0,00001506	0,00000139	0,00004075	0,00006693	0,00000131	0,00002268	0,00002422	0,00013080	0,00018276
A20	0,00000000	0,00000000	0,00000000	0,01619323	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A21	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00077670	0,00000000	0,00000000	0,00046909	0,00000000	0,00063455	0,00029953	0,00056856
A22	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A23	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A24	0,00000000	0,00000000	0,00000000	0,98380562	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A25	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A26	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000

Table B.5 – Technical Coefficients Matrix A (Part XX).

	A50	A51	A52	A53	N42	N43	N44	N45	N46	N47	N48	N49	N50	N51	N52	N53
A27	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A28	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A29	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A30	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A31	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A32	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A33	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A34	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
E05	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A35	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A36	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A37	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A38	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A39	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N14	0,00000000	0,00000000	0,00000000	0,00000000	0,00056140	0,00002176	0,00001000	0,00071992	0,00010372	0,00007975	0,00015982	0,00848931	0,00043503	0,00011597	0,00842270	0,00005716
N15	0,00000000	0,00000000	0,00000000	0,00000000	0,00000099	0,00000066	0,00000098	0,00000365	0,00000072	0,00000099	0,00000698	0,00000345	0,00001253	0,00000388	0,00000602	0,00000258
N16	0,00000000	0,00000000	0,00000000	0,00000000	0,00002330	0,00000410	0,00000682	0,00001783	0,00001216	0,00001049	0,00070610	0,01798602	0,00028160	0,00131221	0,03673124	0,00208424
N17	0,00000000	0,00000000	0,00000000	0,00000000	0,00000602	0,00000200	0,00000225	0,00003046	0,00181032	0,00188289	0,00014642	0,00399730	0,00000756	0,00006588	0,00011110	0,00004021
N18	0,00000000	0,00000000	0,00000000	0,00000000	0,00087870	0,00003567	0,00013130	0,00031110	0,00228829	0,00114942	0,00058914	0,00543508	0,00433627	0,00009499	0,00008574	0,00014700
N19	0,00000000	0,00000000	0,00000000	0,00000000	0,00000204	0,00000252	0,00006737	0,00082183	0,00000066	0,00000346	0,00517513	0,00003267	0,00013662	0,00233155	0,00095215	0,00140242
N20	0,00000000	0,00000000	0,00000000	0,00000000	0,00000816	0,00043920	0,00000140	0,00087402	0,00001058	0,00056108	0,00232440	0,00301367	0,00018393	0,00075574	0,00594142	0,00048362
N21	0,00000000	0,00000000	0,00000000	0,00000000	0,01322391	0,00019540	0,00100270	0,00375270	0,00187277	0,01233231	0,00004866	0,02697036	0,00276697	0,00006591	0,00052552	0,00007792
N22	0,00000000	0,00000000	0,00000000	0,00000000	0,00000196	0,00000038	0,00000030	0,00000051	0,00000158	0,00000101	0,00000129	0,00010863	0,00003412	0,00000349	0,00003849	0,00000444
N23	0,00000000	0,00000000	0,00000000	0,00000000	0,00001154	0,00000283	0,00000541	0,00000513	0,00000544	0,00000665	0,00003206	0,01178641	0,00345922	0,00026928	0,00413304	0,00030696
N24	0,00000000	0,00000000	0,00000000	0,00000000	0,00003021	0,00000374	0,00000613	0,00008485	0,00001649	0,00001105	0,00001970	0,00007205	0,00001457	0,00001680	0,00006847	0,00003986
N25	0,00000000	0,00000000	0,00000000	0,00000000	0,00442851	0,00002202	0,00000432	0,00010665	0,00001238	0,00002253	0,00003013	0,00013358	0,00005450	0,00006961	0,00010825	0,00005240
N26	0,00000000	0,00000000	0,00000000	0,00000000	0,00105109	0,00000488	0,00001057	0,00410732	0,00084966	0,00005230	0,00006666	0,00364055	0,00053067	0,00046719	0,00323024	0,00253250
N27	0,00000000	0,00000000	0,00000000	0,00000000	0,00202894	0,00001108	0,00057051	0,00037117	0,00002553	0,00116371	0,00988853	0,00093670	0,00008735	0,00003231	0,00005666	0,00027948
N28	0,00000000	0,00000000	0,00000000	0,00000000	0,00001294	0,00000071	0,00000144	0,00556488	0,00065154	0,00000329	0,00001137	0,00000712	0,00085114	0,00000172	0,00000442	0,00000425
N29	0,00000000	0,00000000	0,00000000	0,00000000	0,00231607	0,00029182	0,00000078	0,00005581	0,00000052	0,00039089	0,00008378	0,00059685	0,00001080	0,00018643	0,00026591	0,00015860
N30	0,00000000	0,00000000	0,00000000	0,00000000	0,00749613	0,00030420	0,00034055	0,01412890	0,00005066	0,00101987	0,00004792	0,00229715	0,00711951	0,00013784	0,00089159	0,00040124
N31	0,00000000	0,00000000	0,00000000	0,00000000	0,00518852	0,00001192	0,00011942	0,00953777	0,00000273	0,00186375	0,00003436	0,00004715	0,00056166	0,00002160	0,00002111	0,00002201
N32	0,00000000	0,00000000	0,00000000	0,00000000	0,00002582	0,00000295	0,00000433	0,00479308	0,00000402	0,00102365	0,00001426	0,00166275	0,00092435	0,00028265	0,00185355	0,00010762
N33	0,00000000	0,00000000	0,00000000	0,00000000	0,00000231	0,00000016	0,00000272	0,00623750	0,00000037	0,00001129	0,00000032	0,00000025	0,00000046	0,00000035	0,00000044	0,00000105
N34	0,00000000	0,00000000	0,00000000	0,00000000	0,00000842	0,00000077	0,00000199	0,00015773	0,00000198	0,00000506	0,00002545	0,00000351	0,00000193	0,00000166	0,00000135	0,00002459
N35	0,00000000	0,00000000	0,00000000	0,00000000	0,00096955	0,00003849	0,00077634	0,06711585	0,00005556	0,00324316	0,00003881	0,00018362	0,00029834	0,00008356	0,00013615	0,00025267
N36	0,00000000	0,00000000	0,00000000	0,00000000	0,00000727	0,00000236	0,00000320	0,00261234	0,00000314	0,00000381	0,00001006	0,00000385	0,00000488	0,00000831	0,00000406	0,00055221
N37	0,00000000	0,00000000	0,00000000	0,00000000	0,00002612	0,00558764	0,00042289	0,00501237	0,00000880	0,00103341	0,00292838	0,00008972	0,00802742	0,01534412	0,00063249	0,00031074
N38	0,00000000	0,00000000	0,00000000	0,00000000	0,00297621	0,00148083	0,00031564	0,00142292	0,00424322	0,00214356	0,00432882	0,00559833	0,01126645	0,00685727	0,00470556	0,00411454
E06	0,00000000	0,17783875	0,00000000	0,00000000	0,00258621	0,00121481	0,00028060	0,00118124	0,00311650	0,00165354	0,00399548	0,00475652	0,00980408	0,00550125	0,00423556	0,00409986
A40	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A41	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A42	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A43	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000

Table B.5 – Technical Coefficients Matrix A (Part XXI).

	A50	A51	A52	A53	N42	N43	N44	N45	N46	N47	N48	N49	N50	N51	N52	N53
A44	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A45	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A46	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A47	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A48	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N39	0,00000000	0,00000000	0,00000000	0,00000000	0,00558062	0,00533973	0,02518126	0,00016892	0,00033565	0,00248829	0,02302414	0,00412991	0,00990816	0,04458611	0,01599878	0,02390945
N40	0,00000000	0,00000000	0,00000000	0,00000000	0,02049109	0,01010079	0,00289607	0,02947004	0,11931805	0,02708311	0,01542515	0,04156963	0,03040487	0,01753808	0,03187823	0,01171769
N41	0,00000000	0,00000000	0,00000000	0,00000000	0,02327187	0,00844823	0,00171412	0,00422735	0,01076299	0,01274616	0,01315033	0,01717062	0,02934322	0,00576958	0,01187588	0,00648385
A49	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A50	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A51	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A52	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A53	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N42	0,00000000	0,00000000	0,00000000	0,00000000	0,15152151	0,04919450	0,00239430	0,00625136	0,00511049	0,12014336	0,05674957	0,02787288	0,02613468	0,01756852	0,02245018	0,06100345
N43	0,00000000	0,00000000	0,00000000	0,00000000	0,03411088	0,12637605	0,00764830	0,00596702	0,00848426	0,02071262	0,01153524	0,00785308	0,00455379	0,00032125	0,00062443	0,07784151
N44	0,00000000	0,00000000	0,00000000	0,00000000	0,01996278	0,00391167	0,00301776	0,00514772	0,01004543	0,01033040	0,01318462	0,00831542	0,00977235	0,00834887	0,00681148	0,01317172
N45	0,00000000	0,00000000	0,00000000	0,00000000	0,01566894	0,00447231	0,00161883	0,00102303	0,00084309	0,00500766	0,01072144	0,01417593	0,00446112	0,00080845	0,00216068	0,00172480
N46	0,00000000	0,00000000	0,00000000	0,00000000	0,00361238	0,00345250	0,00061930	0,00006359	0,00208976	0,00211228	0,02154212	0,01781069	0,01085816	0,00100048	0,02076139	0,01125694
N47	0,00000000	0,00000000	0,00000000	0,00000000	0,08199258	0,06024277	0,01501118	0,00187930	0,00713909	0,03538446	0,06684758	0,08106140	0,04114280	0,03231102	0,10341001	0,04541697
N48	0,00000000	0,00000000	0,00000000	0,00000000	0,00071814	0,00184304	0,00010820	0,00018722	0,00037027	0,00037299	0,00047413	0,00050305	0,00035315	0,00216085	0,00360772	0,00181915
N49	0,00000000	0,00000000	0,00000000	0,00000000	0,00117876	0,00025332	0,00017840	0,00041396	0,00107802	0,00068414	0,00078697	0,00062332	0,00067083	0,00054032	0,00051277	0,00078300
N50	0,00000000	0,00000000	0,00000000	0,00000000	0,00845419	0,00345917	0,00075880	0,00174409	0,00845606	0,00662938	0,00396485	0,00658032	0,00657030	0,00194923	0,01110647	0,00331849
N51	0,00000000	0,00000000	0,00000000	0,00000000	0,00016313	0,00011795	0,00002917	0,00000676	0,00001951	0,00008346	0,00013091	0,00015404	0,00008318	0,00007016	0,00020211	0,00009559
N52	0,00000000	0,00000000	0,00000000	0,00000000	0,00000178	0,00000131	0,00000033	0,00000004	0,00000015	0,00000077	0,00000151	0,00000314	0,00000091	0,00000080	0,00000507	0,00000114
N53	0,00000000	0,00000000	0,00000000	0,00000000	0,00342086	0,00236780	0,00053455	0,00031011	0,00096085	0,00317430	0,00246539	0,00311427	0,00255294	0,00189159	0,00385452	0,00199037

Table B.6 – Vectors $\mathbf{a}_{exp}$, $\mathbf{a}_{g}$, $\mathbf{a}_{npish}$, $\mathbf{a}_{cf}$, $\mathbf{a}_{gfcf}$, $\mathbf{a}_{sc}$ (Part I).						
	$\mathbf{a}_{exp}$	$\mathbf{a}_{g}$	$\mathbf{a}_{npish}$	$\mathbf{a}_{cf}$	$\mathbf{a}_{gfcf}$	$\mathbf{a}_{sc}$
N01	0,07977220	0,00000001	0,00000000	0,01906835	0,00654622	0,16052070
N02	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
E01	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A01	0,00000000	0,00000000	0,00000000	0,00390411	0,00000000	0,00000000
A02	0,00000000	0,00000000	0,00000000	0,00030286	0,00000000	-0,01594326
N03	0,01169021	0,00000000	0,00000000	0,01065281	0,01669765	-0,05299145
E02	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	-0,14835380
A03	0,07841040	0,00000000	0,00000000	0,00000000	0,00000000	-0,16589902
A04	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	-0,27663186
A05	0,00000000	0,00000000	0,00000000	0,00108430	0,00000000	-0,74113642
N04	0,06534757	0,00000000	0,00000000	0,00001295	0,00003601	0,13723574
N05	0,00807770	0,00000000	0,00000000	0,00021026	0,00002827	0,05230728
E03	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A06	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	-0,00188712
A07	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00124950
A08	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000964
A09	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00192027
A10	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	-0,00244134
A11	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	-0,00019159
A12	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00116667
A13	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	-0,00003473
A14	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	-0,00070089
A15	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A16	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00647099
N06	0,13490145	0,00000282	0,00000000	0,09710093	0,00039564	0,46605513
N07	0,00925983	0,00000000	0,00000000	0,00416299	0,00000024	0,01021271
N08	0,00717263	0,00000000	0,00000000	0,00563370	0,00005265	0,00166424
N09	0,00069553	0,00000000	0,00000000	0,01976794	0,00005149	-0,00808847
N10	0,01036987	0,00000000	0,00000000	0,00842214	0,00000920	-0,02587149
N11	0,00770958	0,00000000	0,00000000	0,00034048	0,00043837	0,04627574
N12	0,02560855	0,00000127	0,00000000	0,00384495	0,00020074	-0,02262928
N13	0,00040250	0,00000000	0,00000000	0,00609984	0,00001543	0,10861490
E04	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A17	0,00560565	0,00000000	0,00000000	0,00760917	0,00000000	0,10566037
A18	0,02075890	0,00000000	0,00000000	0,00000000	0,00000000	-0,04490773
A19	0,00493638	0,00000000	0,00000000	0,00000000	0,00000000	0,17920912
A20	0,00001326	0,00000000	0,00000000	0,00000000	0,00000000	0,00115405
A21	0,00003558	0,00000000	0,00000000	0,00317091	0,00000000	0,01693716
A22	0,00011169	0,00000000	0,00000000	0,00000000	0,00000000	-0,40404689
A23	0,00000000	0,00000000	0,00000000	0,00000426	0,00000000	0,00000000
A24	0,00484703	0,00000000	0,00000000	0,00000000	0,00000000	-0,01172871
A25	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	-0,00001305
A26	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00004537
A27	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	-0,00473521
A28	0,00062640	0,00000000	0,00000000	0,00000000	0,00000000	-0,01980916
A29	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	-0,00035555
A30	0,00000120	0,00000000	0,00000000	0,00000000	0,00000000	-0,01914485
A31	0,00018784	0,00000000	0,00000000	0,00000000	0,00000000	-0,28012373
A32	0,00013112	0,00000000	0,00000000	0,00000000	0,00000000	-0,11953544
A33	0,00104046	0,00000000	0,00000000	0,00000000	0,00000000	-0,06401879
A34	0,00002527	0,00000000	0,00000000	0,00000000	0,00000000	-0,35392719
E05	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A35	0,00232138	0,00000000	0,00000000	0,00175899	0,00000000	0,06097985
A36	0,00264688	0,00000000	0,00000000	0,00435593	0,00000000	-0,05404286
A37	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A38	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A39	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N14	0,01756787	0,00000053	0,00000000	0,00059619	0,00047331	-0,01503928
N15	0,01012387	0,00000000	0,00000000	0,00000308	0,00001753	-0,00131507
N16	0,00419161	0,00412696	0,00000000	0,01327178	0,00004326	-0,00330697

Table B.6 – Vectors a_{exp}, a_g, a_{npish}, a_{cf} , a_{gfcf} , a_{sc} (Part II).						
	a_{exp}	a_g	a_{npish}	a_{cf}	a_{gfcf}	a_{sc}
N17	0,00229625	0,00000000	0,00000000	0,00014889	0,00000490	-0,06587258
N18	0,00204809	0,00000084	0,00000000	0,01113656	0,00001958	-0,02741562
N19	0,00092485	0,00000000	0,00000000	0,00093852	0,00000623	0,01389192
N20	0,00466154	0,00000095	0,00000000	0,00024562	0,00004282	0,00283067
N21	0,01033948	0,00000000	0,00000000	0,00206073	0,00027542	0,07988580
N22	0,00016559	0,00000000	0,00000000	0,00035433	0,00000097	-0,01181105
N23	0,00654282	0,00000000	0,00000000	0,00043378	0,00016575	0,04269584
N24	0,04121164	0,00000000	0,00000000	0,00002808	0,00036601	0,33474946
N25	0,02853580	0,00000000	0,00000000	0,00007377	0,00053248	-0,07760510
N26	0,00813031	0,00000000	0,00000000	0,00165607	0,02473794	0,09327153
N27	0,02682271	0,00000000	0,00000000	0,00111444	0,08636639	-0,17440978
N28	0,00104775	0,00000000	0,00000000	0,00664023	0,00075305	-0,05785772
N29	0,00158332	0,00000000	0,00000000	0,00143748	0,02588348	-0,01411568
N30	0,01315822	0,00000000	0,00000000	0,00095270	0,01487762	-0,05285665
N31	0,00912343	0,00000000	0,00000000	0,00330537	0,01486241	0,05755653
N32	0,00286609	0,00000000	0,00000000	0,00262144	0,01127549	0,01492685
N33	0,01613922	0,00000000	0,00000000	0,02498678	0,05032165	-0,24698967
N34	0,00745579	0,00000000	0,00000000	0,00032247	0,02831102	-0,03819582
N35	0,01907249	0,00000000	0,00000000	0,00055163	0,00183875	0,18453585
N36	0,02800237	0,00000000	0,00000000	0,00337245	0,01149368	-0,16058209
N37	0,00403948	0,00000000	0,00000000	0,01325452	0,01405495	0,07474882
N38	0,00122187	0,00000005	0,00000000	0,00758721	0,00002868	-0,00478635
E06	0,00026905	0,00000000	0,00000000	0,00448800	0,00000000	-0,91853185
A40	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A41	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A42	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A43	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A44	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A45	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A46	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A47	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A48	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	-0,46861626
N39	0,00438380	0,00000000	0,00000000	0,00034993	0,41036747	0,00000000
N40	0,10006691	0,00238526	0,00000000	0,10755609	0,08165220	0,14057760
N41	0,02734960	0,00005368	0,00000000	0,04956362	0,01222400	0,02447064
A49	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A50	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A51	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A52	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A53	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N42	0,00314186	0,00000000	0,00000000	0,03116932	0,00003346	0,00000000
N43	0,00780480	0,00276793	0,00000000	0,06763628	0,00008117	0,00000000
N44	0,00614147	0,00000021	0,00000000	0,10430720	0,01010501	0,00000433
N45	0,00017562	0,00000415	0,00000000	0,01137943	0,00014453	0,00027223
N46	0,00362110	0,00000280	0,00000000	0,04789201	0,00015264	0,00016452
N47	0,06373065	0,00000412	0,00000000	0,00948491	0,00437454	0,00023827
N48	0,00027585	0,00000020	0,00000000	0,02401030	0,00036287	0,00001159
N49	0,00095950	0,02005355	0,06816383	0,04077103	0,00090890	0,00060828
N50	0,00578364	0,00006253	0,90606100	0,05165983	0,00385088	0,00368238
N51	0,00011979	0,21317062	0,00003980	0,00012331	0,00001636	0,00002165
N52	0,00000670	0,13868064	0,00182922	0,00106061	0,00000009	-0,00000031
N53	0,00261565	0,61468850	0,00068383	0,00329972	0,00049643	0,00260940

Table B.7 – Technical Coefficients Matrix of imports A_m (Part I).

	N01	N02	E01	A01	A02	N03	E02	A03	A04	A05	N04	N05	E03	A06	A07	A08
N01	0,00159826	0,00000000	0,00000000	0,00000000	0,00000000	0,00132125	0,00005649	0,00000000	0,00000000	0,00000000	0,00003300	0,00021967	0,00000000	0,00000000	0,00000000	0,00000000
N02	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
E01	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A01	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A02	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N03	0,00011709	0,00000000	0,00000000	0,00000000	0,00000000	0,00048301	0,00000149	0,00000000	0,00000000	0,00000000	0,00000044	0,00000004	0,00000000	0,00000000	0,00000000	0,00000000
E02	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A03	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A04	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A05	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N04	0,00000008	0,00000000	0,00000000	0,00000000	0,00000000	0,00000004	0,00000785	0,00000000	0,00000000	0,00000000	0,00021014	0,00006427	0,00000000	0,00000000	0,00000000	0,00000000
N05	0,00033424	0,00004276	0,00000000	0,00000000	0,00000000	0,00332773	0,00000356	0,00000000	0,00000000	0,00000000	0,00189062	0,01887632	0,00000000	0,00000000	0,00000000	0,00000000
E03	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A06	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A07	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A08	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A09	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A10	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A11	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A12	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A13	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A14	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A15	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A16	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N06	0,00022334	0,00055590	0,00000000	0,00000000	0,00000000	0,00267274	0,00007075	0,00000000	0,00000000	0,00000000	0,00002144	0,00014863	0,00000005	0,00000000	0,00000000	0,00000000
N07	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000022	0,00000000	0,00000000	0,00000000	0,00000002	0,00000003	0,00000000	0,00000000	0,00000000	0,00000000
N08	0,00011585	0,00000777	0,00000000	0,00000000	0,00000000	0,00015487	0,00000619	0,00000000	0,00000000	0,00000000	0,00000370	0,00179749	0,00000000	0,00000000	0,00000000	0,00000000
N09	0,00000024	0,00000000	0,00000000	0,00000000	0,00000000	0,00000025	0,00000651	0,00000000	0,00000000	0,00000000	0,00000198	0,00003166	0,00000000	0,00000000	0,00000000	0,00000000
N10	0,00000029	0,00000777	0,00000000	0,00000000	0,00000000	0,00000023	0,00000120	0,00000000	0,00000000	0,00000000	0,00003467	0,00000184	0,00000000	0,00000000	0,00000000	0,00000000
N11	0,00003338	0,00000000	0,00000000	0,00000000	0,00000000	0,00000003	0,00000405	0,00000000	0,00000000	0,00000000	0,00000373	0,00000669	0,00000000	0,00000000	0,00000000	0,00000000
N12	0,00001271	0,00000000	0,00000000	0,00000000	0,00000000	0,00000809	0,00001603	0,00000000	0,00000000	0,00000000	0,00022635	0,00052572	0,00000190	0,00000000	0,00000000	0,00000000
N13	0,00000009	0,00000000	0,00000000	0,00000000	0,00000000	0,00000004	0,00000857	0,00000000	0,00000000	0,00000000	0,00006345	0,00000853	0,00000000	0,00000000	0,00000000	0,00000000
E04	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A17	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A18	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A19	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A20	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A21	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A22	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A23	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A24	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A25	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A26	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000

Table B.7 – Technical Coefficients Matrix of imports A_m (Part II).

	N01	N02	E01	A01	A02	N03	E02	A03	A04	A05	N04	N05	E03	A06	A07	A08
A27	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A28	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A29	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A30	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A31	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A32	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A33	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A34	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
E05	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A35	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A36	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A37	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A38	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A39	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N14	0,00400956	0,14064819	0,00000000	0,00000000	0,00000000	0,00409486	0,00172245	0,00000000	0,00000000	0,00000000	0,00123494	0,00321888	0,00009527	0,00000000	0,00000000	0,00000000
N15	0,00000039	0,00000000	0,00000000	0,00000000	0,00000000	0,00000080	0,00000687	0,00000000	0,00000000	0,00000000	0,00000258	0,00075399	0,00000000	0,00000000	0,00000000	0,00000000
N16	0,00066068	0,00008036	0,00000000	0,00000000	0,00000000	0,00462390	0,00000941	0,00000000	0,00000000	0,00000000	0,00000548	0,00003853	0,00000032	0,00000000	0,00000000	0,00000000
N17	0,00574074	0,06851946	0,00000000	0,00000000	0,00000000	0,00073557	0,00003164	0,00000000	0,00000000	0,00000000	0,00001458	0,00005605	0,00000000	0,00000000	0,00000000	0,00000000
N18	0,00001058	0,00000777	0,00000000	0,00000000	0,00000000	0,00010055	0,00000489	0,00000000	0,00000000	0,00000000	0,00003829	0,00052281	0,00065753	0,00000000	0,00000000	0,00000000
N19	0,00000773	0,00026046	0,00000000	0,00000000	0,00000000	0,00001094	0,00000401	0,00000000	0,00000000	0,00000000	0,00000336	0,00005049	0,00000002	0,00000000	0,00000000	0,00000000
N20	0,00003603	0,00092597	0,00000000	0,00000000	0,00000000	0,00002672	0,00034320	0,00000000	0,00000000	0,00000000	0,00004484	0,00361861	0,00000010	0,00000000	0,00000000	0,00000000
N21	0,00048473	0,00000000	0,00000000	0,00000000	0,00000000	0,00011652	0,00015892	0,00000000	0,00000000	0,00000000	0,00047266	0,00495129	0,00000000	0,00000000	0,00000000	0,00000000
N22	0,00000374	0,00000000	0,00000000	0,00000000	0,00000000	0,00003346	0,00004722	0,00000000	0,00000000	0,00000000	0,00001284	0,00016940	0,00000000	0,00000000	0,00000000	0,00000000
N23	0,00005022	0,00001555	0,00000000	0,00000000	0,00000000	0,00006925	0,00016624	0,00000000	0,00000000	0,00000000	0,00006958	0,00044387	0,00000000	0,00000000	0,00000000	0,00000000
N24	0,00001764	0,00047427	0,00000000	0,00000000	0,00000000	0,00001452	0,00020669	0,00000000	0,00000000	0,00000000	0,00012310	0,00066320	0,00000000	0,00000000	0,00000000	0,00000000
N25	0,00003320	0,00099907	0,00000000	0,00000000	0,00000000	0,00002935	0,00009895	0,00000000	0,00000000	0,00000000	0,00002902	0,00177809	0,00000000	0,00000000	0,00000000	0,00000000
N26	0,00040557	0,00000000	0,00000000	0,00000000	0,00000000	0,00013574	0,00160420	0,00000000	0,00000000	0,00000000	0,00089720	0,00193946	0,00000951	0,00000000	0,00000000	0,00000000
N27	0,00000706	0,00008552	0,00000000	0,00000000	0,00000000	0,00000435	0,00460743	0,00000000	0,00000000	0,00000000	0,00672123	0,01052600	0,00000000	0,00000000	0,00000000	0,00000000
N28	0,00000041	0,00000000	0,00000000	0,00000000	0,00000000	0,00000018	0,00000836	0,00000000	0,00000000	0,00000000	0,00000781	0,00001653	0,00000000	0,00000000	0,00000000	0,00000000
N29	0,00000007	0,00000000	0,00000000	0,00000000	0,00000000	0,00000001	0,00004866	0,00000000	0,00000000	0,00000000	0,00000386	0,00013774	0,00000000	0,00000000	0,00000000	0,00000000
N30	0,00004028	0,00000000	0,00000000	0,00000000	0,00000000	0,00004679	0,00157799	0,00000000	0,00000000	0,00000000	0,00020026	0,00126606	0,00000000	0,00000000	0,00000000	0,00000000
N31	0,00000267	0,00000000	0,00000000	0,00000000	0,00000000	0,00000119	0,00004357	0,00000000	0,00000000	0,00000000	0,00002561	0,00377650	0,00000000	0,00000000	0,00000000	0,00000000
N32	0,00000062	0,00000000	0,00000000	0,00000000	0,00000000	0,00000016	0,00019524	0,00000000	0,00000000	0,00000000	0,00000703	0,00001492	0,00000015	0,00000000	0,00000000	0,00000000
N33	0,00000081	0,00000000	0,00000000	0,00000000	0,00000000	0,00000012	0,00000022	0,00000000	0,00000000	0,00000000	0,00000060	0,00000080	0,00000000	0,00000000	0,00000000	0,00000000
N34	0,00000005	0,00000000	0,00000000	0,00000000	0,00000000	0,00000001	0,00001238	0,00000000	0,00000000	0,00000000	0,00001574	0,00005180	0,00000000	0,00000000	0,00000000	0,00000000
N35	0,00024003	0,00000000	0,00000000	0,00000000	0,00000000	0,00007463	0,00007620	0,00000000	0,00000000	0,00000000	0,00020681	0,00049043	0,00000000	0,00000000	0,00000000	0,00000000
N36	0,00000012	0,00000000	0,00000000	0,00000000	0,00000000	0,00000004	0,00000485	0,00000000	0,00000000	0,00000000	0,00000311	0,00070026	0,00000000	0,00000000	0,00000000	0,00000000
N37	0,00000140	0,00000000	0,00000000	0,00000000	0,00000000	0,00002245	0,00000314	0,00000000	0,00000000	0,00000000	0,00000264	0,00001697	0,00000000	0,00000000	0,00000000	0,00000000
N38	0,00002222	0,00000000	0,00000000	0,00000000	0,00000000	0,00002628	0,00008441	0,00000000	0,00000000	0,00000000	0,00008249	0,00014989	0,00000000	0,00000000	0,00000000	0,00000000
E06	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A40	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A41	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A42	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A43	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000

Table B.7 – Technical Coefficients Matrix of imports A_m (Part III).

	N01	N02	E01	A01	A02	N03	E02	A03	A04	A05	N04	N05	E03	A06	A07	A08
A44	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A45	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A46	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A47	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A48	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N39	0,00000227	0,00000000	0,00000000	0,00000000	0,00000000	0,00000101	0,00023087	0,00000000	0,00000000	0,00000000	0,00002027	0,00002753	0,00000000	0,00000000	0,00000000	0,00000000
N40	0,00001359	0,00001944	0,00000000	0,00000000	0,00000000	0,00000571	0,00034846	0,00000000	0,00000000	0,00000000	0,00003966	0,00005486	0,00000000	0,00000000	0,00000000	0,00000000
N41	-0,00035109	0,00000000	0,00000000	0,00000000	0,00000000	-0,00000729	-0,00092925	0,00000000	0,00000000	0,00000000	-0,00150401	-0,00164283	0,00000000	0,00000000	0,00000000	0,00000000
A49	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A50	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A51	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A52	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A53	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N42	0,00006595	0,00000000	0,00000000	0,00000000	0,00000000	0,00012252	0,00052417	0,00000000	0,00000000	0,00000000	0,00076339	0,00081642	0,00000000	0,00000000	0,00000000	0,00000000
N43	0,00017128	0,00000000	0,00000000	0,00000000	0,00000000	0,00011558	0,00016399	0,00000000	0,00000000	0,00000000	0,00118417	0,00047325	0,00000000	0,00000000	0,00000000	0,00000000
N44	0,00009759	0,00000000	0,00000000	0,00000000	0,00000000	0,00004335	0,00913566	0,00000000	0,00000000	0,00000000	0,00087322	0,00118341	0,00000000	0,00000000	0,00000000	0,00000000
N45	0,00000015	0,00000000	0,00000000	0,00000000	0,00000000	0,00000015	0,00000306	0,00000000	0,00000000	0,00000000	0,00000197	0,00000193	0,00000000	0,00000000	0,00000000	0,00000000
N46	0,00000059	0,00000000	0,00000000	0,00000000	0,00000000	0,00000040	0,00019263	0,00000000	0,00000000	0,00000000	0,00231902	0,00051821	0,00000000	0,00000000	0,00000000	0,00000000
N47	0,00000187	0,00000000	0,00000000	0,00000000	0,00000000	0,00000083	0,00457813	0,00000000	0,00000000	0,00000000	0,00145068	0,00100493	0,00000000	0,00000000	0,00000000	0,00000000
N48	0,00000351	0,00000000	0,00000000	0,00000000	0,00000000	0,00000156	0,00032820	0,00000000	0,00000000	0,00000000	0,00003135	0,00004248	0,00000000	0,00000000	0,00000000	0,00000000
N49	0,00000549	0,00000000	0,00000000	0,00000000	0,00000000	0,00000244	0,00051377	0,00000000	0,00000000	0,00000000	0,00004908	0,00006651	0,00000000	0,00000000	0,00000000	0,00000000
N50	0,00001730	0,00000000	0,00000000	0,00000000	0,00000000	0,00000801	0,00159019	0,00000000	0,00000000	0,00000000	0,00015303	0,00020755	0,00000000	0,00000000	0,00000000	0,00000000
N51	0,00000008	0,00000000	0,00000000	0,00000000	0,00000000	0,00000022	0,00001414	0,00000000	0,00000000	0,00000000	0,00000348	0,00000263	0,00000000	0,00000000	0,00000000	0,00000000
N52	0,00000005	0,00000000	0,00000000	0,00000000	0,00000000	0,00000035	0,00000010	0,00000000	0,00000000	0,00000000	0,00000003	0,00000002	0,00000000	0,00000000	0,00000000	0,00000000
N53	0,00000102	0,00000000	0,00000000	0,00000000	0,00000000	0,00001187	0,00019871	0,00000000	0,00000000	0,00000000	0,00003254	0,00002346	0,00000000	0,00000000	0,00000000	0,00000000

Table B.7 – Technical Coefficients Matrix of imports A_m (Part IV).

	A09	A10	A11	A12	A13	A14	A15	A16	N06	N07	N08	N09	N10	N11	N12	N13
N01	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00928446	0,00252940	0,00184979	0,00042440	0,00047648	0,00345079	0,00349742	0,00015100
N02	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
E01	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A01	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A02	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N03	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00053575	0,00001946	0,00003675	0,00000111	0,00005812	0,00012847	0,00012858	0,00000390
E02	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A03	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A04	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A05	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N04	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000069	0,00000059	0,00000042	0,00000125	0,00000039	0,00000033	0,00000078	0,00000120
N05	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00007761	0,00000035	0,00000146	0,00000056	0,00029279	0,00001111	0,00068872	0,00000161
E03	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A06	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A07	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A08	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A09	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A10	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A11	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A12	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A13	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A14	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A15	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A16	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N06	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00329424	0,00001326	0,00004584	0,00002664	0,00098038	0,00007430	0,00024346	0,00011793
N07	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000359	0,01131156	0,00000001	0,00000004	0,00000001	0,00000001	0,00000002	0,00000003
N08	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00002647	0,00266636	0,02871143	0,03493809	0,00227282	0,00004468	0,00074768	0,00007997
N09	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000091	0,00000448	0,00002024	0,00029407	0,00000507	0,00000075	0,00000263	0,00000135
N10	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000048	0,00000019	0,00000046	0,00014185	0,01603417	0,00000057	0,00005063	0,00000147
N11	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000548	0,00000286	0,00000185	0,00000119	0,00000828	0,00299970	0,00011231	0,00001822
N12	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00040100	0,00257248	0,00025261	0,00011020	0,00141419	0,00054135	0,01699295	0,00776377
N13	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000526	0,00009276	0,00001970	0,00000220	0,00001089	0,00000540	0,00006816	0,00031465
E04	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A17	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A18	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A19	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A20	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A21	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A22	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A23	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A24	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A25	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A26	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000

Table B.7 – Technical Coefficients Matrix of imports A_m (Part V).

	A09	A10	A11	A12	A13	A14	A15	A16	N06	N07	N08	N09	N10	N11	N12	N13
A27	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A28	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A29	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A30	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A31	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A32	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A33	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A34	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
E05	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A35	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A36	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A37	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A38	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A39	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N14	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00111598	0,00110976	0,00718045	0,00078460	0,01241948	0,00091052	0,00668568	0,00424313
N15	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00027752	0,00050122	0,01399309	0,00034344	0,00399117	0,00314025	0,00222641	0,00564234
N16	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00004067	0,00000595	0,00008089	0,00000417	0,00004685	0,00002050	0,00004797	0,00003810
N17	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00020036	0,00003408	0,00044053	0,00002313	0,00281639	0,00068759	0,00057363	0,00039324
N18	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00018938	0,00000440	0,00001077	0,00004824	0,00063784	0,00002823	0,00010326	0,00002948
N19	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000842	0,00000780	0,00019392	0,00000579	0,00015279	0,00015659	0,00040738	0,00050153
N20	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00049492	0,00018958	0,00086106	0,00028532	0,00226875	0,00080783	0,00558826	0,00309744
N21	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00118220	0,00032744	0,00087463	0,00029549	0,00201048	0,00092220	0,00165586	0,00232555
N22	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000184	0,00000007	0,00000005	0,00000014	0,00000446	0,00000020	0,00000764	0,00000029
N23	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00011229	0,00000177	0,00000457	0,00000180	0,00017255	0,00001183	0,00009766	0,00002297
N24	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00008027	0,00000681	0,00000398	0,00000182	0,00001474	0,00024715	0,00005509	0,00004303
N25	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00009589	0,00000939	0,00001208	0,00000370	0,00006587	0,00010033	0,00090277	0,00095514
N26	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00085020	0,00053802	0,00001260	0,00000567	0,00091795	0,00099500	0,00133426	0,00001667
N27	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00163450	0,00103332	0,00247753	0,00078474	0,00169248	0,00221409	0,00420581	0,00096438
N28	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000292	0,00000193	0,00000279	0,00000136	0,00000334	0,00000352	0,00000681	0,00000246
N29	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00001746	0,00000635	0,00003339	0,00000939	0,00007356	0,00002740	0,00019110	0,00087406
N30	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00037121	0,00025595	0,00010457	0,00001876	0,00071041	0,00029947	0,00016444	0,00002857
N31	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00002042	0,00000817	0,00000956	0,00000316	0,00001825	0,00001307	0,00001692	0,00000373
N32	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000288	0,00000288	0,00000285	0,00000118	0,00000384	0,00000308	0,00000882	0,00001353
N33	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000031	0,00000009	0,00000014	0,00000008	0,00000005	0,00000025	0,00000025	0,00000008
N34	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000393	0,00000251	0,00000583	0,00000208	0,00000396	0,00000519	0,00000989	0,00000249
N35	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00010703	0,00003568	0,00004656	0,00001609	0,00005298	0,00009285	0,00010037	0,00002227
N36	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000106	0,00000073	0,00000113	0,00000079	0,00000101	0,00000120	0,00000222	0,00000079
N37	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00001759	0,00000332	0,00000638	0,00037378	0,00009912	0,00000346	0,00002159	0,00000465
N38	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00006891	0,00003916	0,00018402	0,00005544	0,00006771	0,00008343	0,00019264	0,00004992
E06	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A40	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A41	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A42	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A43	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000

Table B.7 – Technical Coefficients Matrix of imports A_m (Part VI).

	A09	A10	A11	A12	A13	A14	A15	A16	N06	N07	N08	N09	N10	N11	N12	N13
A44	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A45	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A46	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A47	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A48	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N39	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00001908	0,00001651	0,00001228	0,00003429	0,00001099	0,00000985	0,00002221	0,00003272
N40	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00038163	0,00003665	0,00145156	0,00111705	0,00007422	0,00031556	0,00006163	0,00117518
N41	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	-0,00062938	-0,00069824	-0,00017295	0,00011564	-0,00016706	-0,00032343	-0,00044843	-0,00026857
A49	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A50	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A51	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A52	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A53	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N42	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00012113	0,00016200	0,00006353	0,00002119	0,00016275	0,00006071	0,00010871	0,00050909
N43	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00046529	0,00087123	0,00049929	0,00033836	0,00050639	0,00043476	0,00077402	0,00042622
N44	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00079755	0,00069249	0,00049380	0,00146038	0,00045826	0,00038606	0,00090755	0,00139136
N45	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000140	0,00000107	0,00000210	0,00000222	0,00000100	0,00000103	0,00000080	0,00000530
N46	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00007594	0,00037215	0,00000410	0,00000960	0,00000266	0,00022035	0,00015246	0,00023793
N47	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00147586	0,00209872	0,00154136	0,00075688	0,00090469	0,00042031	0,00101524	0,00459559
N48	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00002868	0,00002488	0,00001782	0,00005254	0,00001646	0,00001389	0,00003259	0,00005007
N49	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00004634	0,00003894	0,00003231	0,00008626	0,00002576	0,00002296	0,00005102	0,00008288
N50	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00014912	0,00012333	0,00011534	0,00028085	0,00008308	0,00007484	0,00015818	0,00026999
N51	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000319	0,00000426	0,00000307	0,00000230	0,00000191	0,00000103	0,00000244	0,00000919
N52	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000003	0,00000005	0,00000003	0,00000002	0,00000002	0,00000001	0,00000002	0,00000010
N53	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00004705	0,00005725	0,00005764	0,00003879	0,00002912	0,00002124	0,00004964	0,00014900

Table B.7 – Technical Coefficients Matrix of imports A_m (Part VII).

	E04	A17	A18	A19	A20	A21	A22	A23	A24	A25	A26	A27	A28	A29	A30	A31
N01	0,00005410	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N02	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
E01	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A01	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A02	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N03	0,00000140	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
E02	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A03	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A04	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A05	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N04	0,00000118	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N05	0,00001964	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
E03	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A06	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A07	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A08	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A09	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A10	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A11	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A12	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A13	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A14	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A15	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A16	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N06	0,00002731	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N07	0,00000002	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N08	0,00000125	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N09	0,00000079	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N10	0,00000029	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N11	0,00000098	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N12	0,00000523	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N13	0,00000303	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
E04	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A17	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A18	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A19	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A20	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A21	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A22	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A23	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A24	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A25	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A26	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000

Table B.7 – Technical Coefficients Matrix of imports A_m (Part VIII).

	E04	A17	A18	A19	A20	A21	A22	A23	A24	A25	A26	A27	A28	A29	A30	A31
A27	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A28	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A29	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A30	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A31	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A32	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A33	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A34	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
E05	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A35	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A36	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A37	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A38	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A39	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N14	0,00175945	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N15	0,00000709	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N16	0,00000389	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N17	0,00003328	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N18	0,00000470	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N19	0,00000430	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N20	0,00049022	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N21	0,00014272	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N22	0,00000007	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N23	0,00000266	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N24	0,00009628	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N25	0,00001272	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N26	0,00042902	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N27	0,00156617	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N28	0,00000285	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N29	0,00005712	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N30	0,00089709	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N31	0,00002093	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N32	0,00006465	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N33	0,00000016	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N34	0,00000363	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N35	0,00007238	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N36	0,00000090	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N37	0,00000067	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N38	0,00003918	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
E06	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A40	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A41	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A42	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A43	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000

Table B.7 – Technical Coefficients Matrix of imports A_m (Part IX).

	E04	A17	A18	A19	A20	A21	A22	A23	A24	A25	A26	A27	A28	A29	A30	A31
A44	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A45	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A46	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A47	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A48	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N39	0,00001801	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N40	0,00004519	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N41	-0,00011706	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A49	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A50	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A51	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A52	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A53	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N42	0,00020390	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N43	0,00002290	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N44	0,00071735	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N45	0,00000133	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N46	0,00028593	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N47	0,00143812	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N48	0,00002580	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N49	0,00004034	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N50	0,00012741	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N51	0,00000305	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N52	0,00000003	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N53	0,00004433	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000

Table B.7 – Technical Coefficients Matrix of imports A_m (Part X).

	A32	A33	A34	E05	A35	A36	A37	A38	A39	N14	N15	N16	N17	N18	N19	N20
N01	0,00000000	0,00000000	0,00000000	0,00000040	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00092021	0,00528557	0,00059282	0,00169710	0,00188677	0,00077111	0,00155001
N02	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
E01	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A01	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A02	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N03	0,00000000	0,00000000	0,00000000	0,00000001	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00001735	0,00013676	0,00002209	0,00004373	0,00008440	0,00001994	0,00004998
E02	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A03	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A04	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A05	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N04	0,00000000	0,00000000	0,00000000	0,00000016	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00002643	0,00000028	0,00000100	0,00000041	0,00000034	0,00001287	0,00000415
N05	0,00000000	0,00000000	0,00000000	0,00000028	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,02053868	0,00035366	0,00011995	0,00064724	0,00011989	0,00247912	0,00224774
E03	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A06	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A07	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A08	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A09	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A10	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A11	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A12	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A13	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A14	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A15	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A16	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N06	0,00000000	0,00000000	0,00000000	0,00001857	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00028351	0,00054367	0,00029552	0,00036855	0,00599606	0,00024661	0,00072641
N07	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000003	0,00000001	0,00000002	0,00000001	0,00000001	0,00000001	0,00000002
N08	0,00000000	0,00000000	0,00000000	0,00005202	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00006950	0,00021322	0,00047614	0,00000736	0,00005647	0,00020551	0,00117322
N09	0,00000000	0,00000000	0,00000000	0,00000052	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000186	0,00000095	0,00000112	0,00000088	0,00000076	0,00000104	0,00000323
N10	0,00000000	0,00000000	0,00000000	0,00000018	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000263	0,00000714	0,00000782	0,00000266	0,00000346	0,00000230	0,00000322
N11	0,00000000	0,00000000	0,00000000	0,00000085	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00001125	0,00000999	0,00000161	0,00001804	0,00009115	0,00000150	0,00023610
N12	0,00000000	0,00000000	0,00000000	0,00004950	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00029413	0,00006386	0,00093677	0,00066008	0,00137695	0,00002752	0,00127441
N13	0,00000000	0,00000000	0,00000000	0,00000041	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00002719	0,00002521	0,00009368	0,00005171	0,00003532	0,00006395	0,00016010
E04	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A17	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A18	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A19	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A20	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A21	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A22	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A23	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A24	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A25	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A26	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000

Table B.7 – Technical Coefficients Matrix of imports A_m (Part XI).

	A32	A33	A34	E05	A35	A36	A37	A38	A39	N14	N15	N16	N17	N18	N19	N20
A27	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A28	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A29	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A30	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A31	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A32	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A33	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A34	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
E05	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A35	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A36	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A37	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A38	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A39	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N14	0,00000000	0,00000000	0,00000000	0,00010417	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,04009866	0,14260566	0,01680094	0,04833088	0,03244324	0,04529845	0,04210581
N15	0,00000000	0,00000000	0,00000000	0,00000016	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00048884	0,01411273	0,00007164	0,00021324	0,00356758	0,01497294	0,03219405
N16	0,00000000	0,00000000	0,00000000	0,00000065	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00004363	0,00025498	0,00607222	0,00025716	0,00010500	0,00010514	0,00036307
N17	0,00000000	0,00000000	0,00000000	0,00000687	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00058492	0,00319367	0,00195960	0,03194358	0,00079937	0,00315296	0,00162700
N18	0,00000000	0,00000000	0,00000000	0,00000056	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00102732	0,00019189	0,00060269	0,00026515	0,00525438	0,00020798	0,00036634
N19	0,00000000	0,00000000	0,00000000	0,00000054	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00010636	0,00031801	0,00003984	0,00008934	0,00017563	0,00036124	0,00061447
N20	0,00000000	0,00000000	0,00000000	0,00006554	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00472962	0,00738904	0,00470486	0,00793777	0,01332098	0,00281888	0,01235298
N21	0,00000000	0,00000000	0,00000000	0,00032081	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00048293	0,00057743	0,00200396	0,00458621	0,00197113	0,00059222	0,00213859
N22	0,00000000	0,00000000	0,00000000	0,00000041	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00019902	0,00000369	0,00000610	0,00000994	0,00000399	0,00003677	0,00002529
N23	0,00000000	0,00000000	0,00000000	0,00004511	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00055432	0,00003810	0,00055364	0,00039446	0,00032061	0,00041474	0,00044649
N24	0,00000000	0,00000000	0,00000000	0,00000512	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00023509	0,00002788	0,00009550	0,00004066	0,00001761	0,00018940	0,00007554
N25	0,00000000	0,00000000	0,00000000	0,00000794	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00024705	0,00011877	0,00018806	0,00008808	0,00005816	0,00107769	0,00026174
N26	0,00000000	0,00000000	0,00000000	0,00035809	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00081510	0,00037530	0,00073421	0,00217506	0,00025719	0,00239532	0,00100548
N27	0,00000000	0,00000000	0,00000000	0,00148436	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00457003	0,00290844	0,00091105	0,00107296	0,00190324	0,00110988	0,00112007
N28	0,00000000	0,00000000	0,00000000	0,00000187	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000584	0,00000335	0,00000303	0,00000307	0,00000224	0,00000456	0,00000317
N29	0,00000000	0,00000000	0,00000000	0,00000285	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00015394	0,00020848	0,00015710	0,00025708	0,00046287	0,00008157	0,00040192
N30	0,00000000	0,00000000	0,00000000	0,00005038	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00037161	0,00008345	0,00122884	0,00009718	0,00008958	0,00020237	0,00084416
N31	0,00000000	0,00000000	0,00000000	0,00000576	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00002145	0,00002673	0,00002514	0,00000670	0,00033126	0,00000937	0,00001947
N32	0,00000000	0,00000000	0,00000000	0,00000161	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000537	0,00003056	0,00004901	0,00021596	0,00000443	0,00065135	0,00000356
N33	0,00000000	0,00000000	0,00000000	0,00000008	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000032	0,00000005	0,00000020	0,00000016	0,00000004	0,00000032	0,00000034
N34	0,00000000	0,00000000	0,00000000	0,00000347	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00001077	0,00000678	0,00000219	0,00000253	0,00000446	0,00000260	0,00000274
N35	0,00000000	0,00000000	0,00000000	0,00003126	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00032946	0,00002801	0,00010003	0,00008400	0,00002281	0,00013938	0,00015126
N36	0,00000000	0,00000000	0,00000000	0,00000072	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000236	0,00000133	0,00000070	0,00000102	0,00000091	0,00000110	0,00000094
N37	0,00000000	0,00000000	0,00000000	0,00000090	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00003437	0,00000496	0,00000372	0,00000787	0,00000916	0,00000628	0,00000748
N38	0,00000000	0,00000000	0,00000000	0,00001809	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00019010	0,00029743	0,00006274	0,00007240	0,00004331	0,00008204	0,00018731
E06	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A40	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A41	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A42	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A43	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000

Table B.7 – Technical Coefficients Matrix of imports A_m (Part XII).

	A32	A33	A34	E05	A35	A36	A37	A38	A39	N14	N15	N16	N17	N18	N19	N20
A44	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A45	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A46	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A47	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A48	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N39	0,00000000	0,00000000	0,00000000	0,00000446	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00003139	0,00000848	0,00001622	0,00001125	0,00000959	0,00002127	0,00002334
N40	0,00000000	0,00000000	0,00000000	0,00000830	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00066794	0,00066307	0,00173957	0,00143226	0,00166610	0,00018730	0,00022329
N41	0,00000000	0,00000000	0,00000000	-0,00005765	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	-0,00029672	-0,00027925	0,00024638	-0,00021133	-0,00047140	-0,00027822	-0,00026020
A49	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A50	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A51	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A52	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A53	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N42	0,00000000	0,00000000	0,00000000	0,00002530	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00031717	0,00010871	0,00077360	0,00051596	0,00013320	0,00050342	0,00080203
N43	0,00000000	0,00000000	0,00000000	0,00013795	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00132718	0,00114692	0,00054123	0,00128486	0,00052166	0,00049804	0,00070269
N44	0,00000000	0,00000000	0,00000000	0,00019036	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00132017	0,00032405	0,00066396	0,00047219	0,00039943	0,00053737	0,00099103
N45	0,00000000	0,00000000	0,00000000	0,00000020	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000153	0,00000032	0,00000581	0,00000270	0,00000396	0,00000159	0,00000326
N46	0,00000000	0,00000000	0,00000000	0,00006548	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00008997	0,00000188	0,00014844	0,00000417	0,00005738	0,00006572	0,00040187
N47	0,00000000	0,00000000	0,00000000	0,00031289	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00104254	0,00103241	0,00601117	0,00203620	0,00391720	0,00186834	0,00208154
N48	0,00000000	0,00000000	0,00000000	0,00000683	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00004786	0,00001163	0,00002398	0,00001706	0,00001446	0,00001930	0,00003560
N49	0,00000000	0,00000000	0,00000000	0,00001070	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00007423	0,00001821	0,00004427	0,00003182	0,00002898	0,00003022	0,00005573
N50	0,00000000	0,00000000	0,00000000	0,00003381	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00023164	0,00005708	0,00016500	0,00011699	0,00011034	0,00009478	0,00017903
N51	0,00000000	0,00000000	0,00000000	0,00000069	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000274	0,00000206	0,00001117	0,00000394	0,00000724	0,00000370	0,00000444
N52	0,00000000	0,00000000	0,00000000	0,00000001	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000002	0,00000002	0,00000059	0,00000006	0,00000009	0,00000004	0,00000006
N53	0,00000000	0,00000000	0,00000000	0,00001039	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00008376	0,00005267	0,00018830	0,00006429	0,00010925	0,00006412	0,00008108

Table B.7 – Technical Coefficients Matrix of imports A_m (Part XIII).

	N21	N22	N23	N24	N25	N26	N27	N28	N29	N30	N31	N32	N33	N34	N35	N36
N01	0,00096724	0,00007503	0,00043287	0,00033642	0,00015514	0,00028860	0,00001924	0,00000050	0,00000034	0,00001962	0,00000165	0,00001552	0,00000014	0,00000017	0,00003855	0,00000059
N02	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
E01	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A01	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A02	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N03	0,00003890	0,00000002	0,00000721	0,00000829	0,00000238	0,00000707	0,00000032	0,00000001	0,00000001	0,00000046	0,00000002	0,00000040	0,00000000	0,00000000	0,00000105	0,00000001
E02	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A03	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A04	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A05	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N04	0,00000067	0,00000790	0,00006700	0,00024854	0,00078803	0,00001448	0,00001620	0,00000045	0,00000034	0,00000607	0,00000033	0,00000048	0,00000014	0,00000017	0,00000587	0,00000044
N05	0,00001715	0,00588976	0,01641261	0,00314686	0,03126932	0,00159438	0,00051284	0,00000374	0,00000024	0,00033576	0,00000054	0,00001326	0,00000253	0,00000480	0,00049026	0,00000339
E03	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A06	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A07	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A08	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A09	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A10	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A11	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A12	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A13	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A14	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A15	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A16	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N06	0,00015272	0,00008679	0,00005479	0,00003768	0,00007717	0,00004545	0,00002876	0,00002884	0,00000401	0,00005372	0,00008088	0,00026497	0,00000982	0,00001350	0,00003180	0,00000810
N07	0,00000002	0,00000002	0,00000002	0,00000001	0,00000001	0,00000002	0,00000002	0,00000001	0,00000001	0,00000002	0,00000001	0,00000001	0,00000000	0,00000000	0,00000001	0,00000001
N08	0,00165927	0,00028046	0,00070468	0,00000878	0,00001032	0,00004295	0,00025579	0,00013099	0,00000113	0,00016671	0,00000713	0,00003680	0,00001173	0,00001804	0,00010841	0,00002659
N09	0,00000281	0,00000232	0,00000307	0,00000140	0,00000117	0,00000813	0,00000591	0,00001111	0,00000050	0,00000186	0,00000048	0,00002239	0,00000199	0,00000233	0,00002274	0,00000101
N10	0,00000288	0,00000105	0,00000078	0,00000064	0,00000115	0,00005186	0,00005876	0,00000162	0,00000023	0,00000076	0,00000080	0,00017261	0,00013116	0,00000477	0,00000062	0,00000055
N11	0,00000458	0,00000367	0,00025633	0,00000354	0,00000569	0,00004457	0,00002735	0,00002021	0,00000238	0,00000564	0,00013602	0,00000533	0,00000395	0,00000668	0,00002752	0,00002609
N12	0,00106402	0,00140557	0,00051810	0,00001576	0,00008271	0,00037963	0,00025038	0,00175059	0,00010254	0,00036792	0,00047998	0,00038826	0,00015195	0,00001966	0,00011927	0,00009134
N13	0,00010275	0,00004135	0,00000719	0,00000617	0,00002231	0,00001480	0,00000329	0,00001272	0,00000696	0,00001375	0,00000835	0,00006621	0,00000922	0,00000263	0,00000610	0,00002618
E04	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A17	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A18	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A19	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A20	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A21	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A22	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A23	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A24	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A25	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A26	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000

Table B.7 – Technical Coefficients Matrix of imports A_m (Part XIV).

	N21	N22	N23	N24	N25	N26	N27	N28	N29	N30	N31	N32	N33	N34	N35	N36
A27	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A28	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A29	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A30	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A31	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A32	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A33	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A34	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
E05	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A35	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A36	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A37	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A38	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A39	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N14	0,02352832	0,00329659	0,00688405	0,00999959	0,00954934	0,00815104	0,00219997	0,00054868	0,00001303	0,00156468	0,00012593	0,00132918	0,00003460	0,00005182	0,00113551	0,00011478
N15	0,06010474	0,00000279	0,00320549	0,00044115	0,00048576	0,00295933	0,00135724	0,00882250	0,00000007	0,00995142	0,00036195	0,00232220	0,00000053	0,00024487	0,00243201	0,00175524
N16	0,00034205	0,00000943	0,00002482	0,00001595	0,00001278	0,00002606	0,00001309	0,00006137	0,00000538	0,00005690	0,00000784	0,00032897	0,00006156	0,00004599	0,00004453	0,00002664
N17	0,00183914	0,00002994	0,00016686	0,00019456	0,00011836	0,00023039	0,00005325	0,00020052	0,00000005	0,00024086	0,00001686	0,00009544	0,00001018	0,00000641	0,00007118	0,00007123
N18	0,00003810	0,00049614	0,00045648	0,00004861	0,00049800	0,00016022	0,00021440	0,00000263	0,00014431	0,00001555	0,00001535	0,00005057	0,00000053	0,00002370	0,00004407	0,00000098
N19	0,00090975	0,00002250	0,00021146	0,00005248	0,00003616	0,00043741	0,00011538	0,00024028	0,00000006	0,00016554	0,00001800	0,00019484	0,00038214	0,00003493	0,00009387	0,00009264
N20	0,00339092	0,00191995	0,00086811	0,00021248	0,00120892	0,00060640	0,00009048	0,00010769	0,00000080	0,00140672	0,00238420	0,00790375	0,00000772	0,00001421	0,00056483	0,00002135
N21	0,00473709	0,00090440	0,00043679	0,00065487	0,00175192	0,00178097	0,00205962	0,00389466	0,00163817	0,00151047	0,00187562	0,00181542	0,01069312	0,00863544	0,00482845	0,00398711
N22	0,00000032	0,00040472	0,00091682	0,00001637	0,00005192	0,00001273	0,00000385	0,00001172	0,00000004	0,00000566	0,00000184	0,00000151	0,00000420	0,00000253	0,00000748	0,00000021
N23	0,00002620	0,00169609	0,00287532	0,00049057	0,00046454	0,00018434	0,00010182	0,00129839	0,00000165	0,00048154	0,00020297	0,00016108	0,00046626	0,00028508	0,00050434	0,00002357
N24	0,00114218	0,00268391	0,00108448	0,01153049	0,00769498	0,01766527	0,01460481	0,01580298	0,00034781	0,00770346	0,00127052	0,00238999	0,00645762	0,00550345	0,01300083	0,00807338
N25	0,00048789	0,00025325	0,00072241	0,00328726	0,01922389	0,01318482	0,01482193	0,00183937	0,00010328	0,01319864	0,00398005	0,00828560	0,00136795	0,00052043	0,00130443	0,00368719
N26	0,00077413	0,00042649	0,00056152	0,00337647	0,00366038	0,00421240	0,00523717	0,00220358	0,00124385	0,00358672	0,00260420	0,00195464	0,00306347	0,00073864	0,00156426	0,00125754
N27	0,00266183	0,00666178	0,00416470	0,00511202	0,00419175	0,00328194	0,01076913	0,01833594	0,00115526	0,00257778	0,00056721	0,00146176	0,00582170	0,00877007	0,00398933	0,00291827
N28	0,00000496	0,00001074	0,00000620	0,00001207	0,00003332	0,00002504	0,00005102	0,00091342	0,00003726	0,00004299	0,00016221	0,00001909	0,00001893	0,00001507	0,00000820	0,00001078
N29	0,00011712	0,00006774	0,00002943	0,00000553	0,00004042	0,00001894	0,00001289	0,00000837	0,01453574	0,00007966	0,00038024	0,00027438	0,00000333	0,00000411	0,00003200	0,00000201
N30	0,00094428	0,00351560	0,00050119	0,00019040	0,00047378	0,00017998	0,00733465	0,00831656	0,00912432	0,01894388	0,02623444	0,00527789	0,00895197	0,00536551	0,00093154	0,00179572
N31	0,00002770	0,00008589	0,00036863	0,00002139	0,00002363	0,00001594	0,00159319	0,00020623	0,17669575	0,00305753	0,10070259	0,00132491	0,00053528	0,00047595	0,00381805	0,00021803
N32	0,00013939	0,00001329	0,00000545	0,00000522	0,00000502	0,00000849	0,00307572	0,00912454	0,00012401	0,00118054	0,00024665	0,02949714	0,00084371	0,00039920	0,00020604	0,00000623
N33	0,00000132	0,00000195	0,00000046	0,00000023	0,00000019	0,00000009	0,00078671	0,00000004	0,00000007	0,00000462	0,00000007	0,00000054	0,00491290	0,00016212	0,00012504	0,00000044
N34	0,00000630	0,00001557	0,00000981	0,00001189	0,00000969	0,00000782	0,00003154	0,00004223	0,00000258	0,00000824	0,00000091	0,00000359	0,00005392	0,00217881	0,00031280	0,00390501
N35	0,00042306	0,00074872	0,00032407	0,00016745	0,00019067	0,00014176	0,00264215	0,00036482	0,00027320	0,00191839	0,00077469	0,00035803	0,03827330	0,04676520	0,03600481	0,00073158
N36	0,00000144	0,00000295	0,00000203	0,00000288	0,00000254	0,00000635	0,00002115	0,00000783	0,00000081	0,00003736	0,00000081	0,00001830	0,00000288	0,00000358	0,00045134	0,09933557
N37	0,00003615	0,00001156	0,00001702	0,00004654	0,00003119	0,00001431	0,00002355	0,00001146	0,00000163	0,00004101	0,00000280	0,00000385	0,00000715	0,00001953	0,00000547	0,00000619
N38	0,00011001	0,00022862	0,00024468	0,00018003	0,00035878	0,00009903	0,00006373	0,00005042	0,00003199	0,00011314	0,00003771	0,00006819	0,00005405	0,00005759	0,00007402	0,00006407
E06	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A40	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A41	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A42	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A43	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000

Table B.7 – Technical Coefficients Matrix of imports A_m (Part XV).

	N21	N22	N23	N24	N25	N26	N27	N28	N29	N30	N31	N32	N33	N34	N35	N36
A44	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A45	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A46	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A47	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A48	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N39	0,00002121	0,00002161	0,00002404	0,00001122	0,00000987	0,00001648	0,00001879	0,00001366	0,00000958	0,00001915	0,00001180	0,00001288	0,00001531	0,00000898	0,00001221	0,00001398
N40	0,00091629	0,00192041	0,00107987	0,00008300	0,00006043	0,00006780	0,00048041	0,00005287	0,00007607	0,00022079	0,00007777	0,00003830	0,00009562	0,00009345	0,00007968	0,00063322
N41	-0,00035881	-0,00142976	-0,00025688	-0,00075245	-0,00041455	-0,00030156	-0,00019903	0,00028955	-0,00004793	0,00003440	-0,00022399	0,00050147	-0,00001520	-0,00002049	0,00004958	0,00001699
A49	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A50	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A51	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A52	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A53	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N42	0,00035988	0,00030163	0,00013764	0,00071660	0,00008560	0,00019797	0,00060272	0,00085275	0,00039766	0,00083332	0,00097793	0,00029820	0,00054048	0,00023663	0,00012412	0,00056863
N43	0,00058293	0,00091230	0,00049736	0,00090742	0,00090140	0,00053342	0,00109230	0,00076465	0,00039181	0,00088909	0,00142605	0,00043344	0,00081289	0,00097047	0,00065205	0,00062271
N44	0,00077810	0,00078064	0,00089089	0,00046642	0,00037840	0,00069727	0,00078261	0,00052592	0,00039720	0,00069753	0,00038576	0,00055494	0,00016361	0,00020217	0,00049660	0,00051346
N45	0,00000244	0,00000531	0,00000317	0,00000134	0,00000054	0,00000030	0,00000235	0,00000055	0,00000037	0,00000042	0,00000030	0,00000190	0,00000213	0,00000155	0,00000149	0,00000217
N46	0,00018164	0,00119635	0,00034302	0,00010459	0,00062638	0,00004382	0,00000500	0,00000304	0,00001828	0,00028620	0,00000224	0,00000322	0,00027968	0,00008594	0,00006172	0,00043014
N47	0,00098583	0,00240287	0,00143549	0,00048473	0,00030615	0,00077365	0,00049208	0,00201803	0,00535896	0,00142751	0,00251316	0,00089847	0,00297085	0,00304953	0,00130665	0,00226310
N48	0,00002801	0,00002816	0,00003207	0,00001674	0,00001358	0,00002504	0,00002812	0,00001884	0,00001427	0,00002505	0,00001386	0,00001993	0,00000586	0,00000724	0,00001783	0,00001848
N49	0,00004697	0,00005121	0,00005417	0,00002621	0,00002126	0,00003920	0,00004568	0,00002949	0,00002233	0,00003922	0,00002169	0,00003120	0,00000917	0,00001133	0,00002791	0,00003124
N50	0,00015786	0,00018426	0,00018174	0,00008281	0,00006793	0,00012323	0,00014769	0,00009231	0,00007385	0,00014164	0,00008492	0,00009898	0,00003045	0,00003694	0,00008767	0,00010423
N51	0,00000229	0,00000495	0,00000318	0,00000119	0,00000089	0,00000184	0,00000139	0,00000394	0,00000980	0,00000304	0,00000473	0,00000198	0,00000543	0,00000557	0,00000266	0,00000443
N52	0,00000002	0,00000005	0,00000003	0,00000001	0,00000001	0,00000002	0,00000001	0,00000004	0,00000012	0,00000003	0,00000005	0,00000004	0,00000006	0,00000007	0,00000003	0,00000005
N53	0,00004198	0,00008045	0,00006675	0,00002067	0,00003325	0,00002945	0,00002364	0,00006122	0,00015158	0,00006056	0,00007000	0,00003680	0,00008118	0,00008410	0,00004175	0,00007431

Table B.7 – Technical Coefficients Matrix of imports A_m (Part XVI).

	N37	N38	E06	A40	A41	A42	A43	A44	A45	A46	A47	A48	N39	N40	N41	A49
N01	0,00029472	0,00000092	0,00000039	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00005053	0,00000305	0,00000109	0,00000000
N02	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
E01	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A01	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A02	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N03	0,00001247	0,00000000	0,00000001	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000001	0,00000009	0,00000003	0,00000000
E02	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A03	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A04	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A05	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N04	0,00000843	0,00000096	0,00000038	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000038	0,00000300	0,00000102	0,00000000
N05	0,00031947	0,00000135	0,00000025	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00370970	0,00000142	0,00000677	0,00000000
E03	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A06	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A07	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A08	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A09	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A10	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A11	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A12	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A13	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A14	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A15	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A16	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N06	0,00009064	0,00012337	0,00000455	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00002219	0,00002371	0,00001638	0,00000000
N07	0,00000002	0,00000003	0,00000001	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000001	0,00000009	0,00000003	0,00000000
N08	0,00235188	0,00000247	0,00000047	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00005728	0,00010602	0,00012200	0,00000000
N09	0,00000838	0,00003549	0,00000037	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000613	0,00001897	0,00005614	0,00000000
N10	0,00000683	0,00000104	0,00000007	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000149	0,00000037	0,00000021	0,00000000
N11	0,00129251	0,00000030	0,00000047	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00027738	0,00000608	0,00000036	0,00000000
N12	0,00170538	0,00000806	0,00004367	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00004275	0,00023825	0,00004594	0,00000000
N13	0,00001418	0,00000694	0,00002364	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000574	0,00002829	0,00001679	0,00000000
E04	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A17	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A18	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A19	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A20	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A21	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A22	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A23	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A24	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A25	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A26	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000

Table B.7 – Technical Coefficients Matrix of imports A_m (Part XVII).

	N37	N38	E06	A40	A41	A42	A43	A44	A45	A46	A47	A48	N39	N40	N41	A49
A27	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A28	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A29	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A30	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A31	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A32	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A33	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A34	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
E05	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A35	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A36	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A37	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A38	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A39	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N14	0,00443592	0,00335306	0,00000652	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00023039	0,00000529	0,00000472	0,00000000
N15	0,00809797	0,00000258	0,00000004	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000678	0,00000014	0,00000007	0,00000000
N16	0,00005230	0,00001132	0,00000247	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000592	0,00000389	0,00001959	0,00000000
N17	0,00315209	0,00003729	0,00000005	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00010165	0,00000034	0,00001680	0,00000000
N18	0,00004642	0,00078675	0,00000012	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00012463	0,00000074	0,00004704	0,00000000
N19	0,00031960	0,00002265	0,00000003	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00109710	0,00000019	0,00001298	0,00000000
N20	0,00162189	0,00322438	0,00000077	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00044444	0,00000099	0,00000326	0,00000000
N21	0,00287077	0,00127659	0,00035375	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00199340	0,00057223	0,00269520	0,00000000
N22	0,00001134	0,00000025	0,00000004	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00047512	0,00000049	0,00000012	0,00000000
N23	0,00117805	0,00001911	0,00000178	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00478657	0,00001756	0,00000094	0,00000000
N24	0,00410700	0,00001216	0,00000074	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00323897	0,00000501	0,00000363	0,00000000
N25	0,00275097	0,00002372	0,00158500	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00073146	0,00000257	0,00000543	0,00000000
N26	0,00197377	0,00001465	0,00001019	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00234377	0,00011855	0,00001793	0,00000000
N27	0,00157311	0,00017246	0,00058425	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00281419	0,00001562	0,00013932	0,00000000
N28	0,00000908	0,00000033	0,00001269	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00001730	0,00000065	0,00000138	0,00000000
N29	0,00005477	0,00011007	0,00000067	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00001655	0,00021037	0,00000100	0,00000000
N30	0,00193472	0,00008879	0,00988819	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00222387	0,00024146	0,00113566	0,00000000
N31	0,00082750	0,00000599	0,00017548	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00004982	0,00001867	0,00035285	0,00000000
N32	0,00004678	0,00000175	0,00001552	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00047759	0,00015262	0,00001093	0,00000000
N33	0,00000019	0,00000188	0,00000032	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000033	0,00000671	0,00001600	0,00000000
N34	0,00000372	0,00000064	0,00000128	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00001378	0,00002191	0,00017116	0,00000000
N35	0,00014592	0,00053558	0,00036877	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00023730	0,00191597	0,00462873	0,00000000
N36	0,00000138	0,00000039	0,00000033	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00018666	0,00053476	0,00174046	0,00000000
N37	0,00096976	0,00000063	0,00000026	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00014678	0,00000151	0,00007519	0,00000000
N38	0,00006350	0,00015174	0,00182621	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000930	0,00008735	0,00005413	0,00000000
E06	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A40	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A41	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A42	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A43	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000

Table B.7 – Technical Coefficients Matrix of imports A_m (Part XVIII).

	N37	N38	E06	A40	A41	A42	A43	A44	A45	A46	A47	A48	N39	N40	N41	A49
A44	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A45	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A46	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A47	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A48	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N39	0,00001744	0,00002641	0,00001021	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00003771	0,00008170	0,00002761	0,00000000
N40	0,00124994	0,00007822	0,00006029	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00006841	0,00212511	0,00059036	0,00000000
N41	-0,00010874	-0,00125489	0,00005220	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00010981	-0,00055819	0,04075034	0,00000000
A49	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A50	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A51	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A52	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A53	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N42	0,00005804	0,00063857	0,00048275	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00007081	0,00042051	0,00035980	0,00000000
N43	0,00032582	0,00022087	0,00038699	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00020800	0,00049574	0,00057895	0,00000000
N44	0,00072743	0,00111515	0,00043953	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00044605	0,00348867	0,00118270	0,00000000
N45	0,00000235	0,00000089	0,00000042	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000061	0,00000550	0,00001553	0,00000000
N46	0,00013506	0,00010190	0,00000255	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00023078	0,00027353	0,00062198	0,00000000
N47	0,00054099	0,00670974	0,00375280	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00142774	0,00390687	0,00276090	0,00000000
N48	0,00002622	0,00004006	0,00001579	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00001602	0,00012549	0,00004249	0,00000000
N49	0,00004602	0,00006272	0,00002472	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00002518	0,00020475	0,00006651	0,00000000
N50	0,00015858	0,00020241	0,00013865	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00008376	0,00070956	0,00020998	0,00000000
N51	0,00000145	0,00001268	0,00000702	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000286	0,00000927	0,00000577	0,00000000
N52	0,00000001	0,00000015	0,00000008	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000003	0,00000008	0,00000006	0,00000000
N53	0,00002552	0,00018754	0,00024704	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00004446	0,00013696	0,00073692	0,00000000

Table B.7 – Technical Coefficients Matrix of imports A_m (Part XIX).

	A50	A51	A52	A53	N42	N43	N44	N45	N46	N47	N48	N49	N50	N51	N52	N53
N01	0,00000000	0,00000000	0,00000000	0,00000000	0,00000328	0,00000067	0,00000049	0,00001823	0,00063774	0,00000199	0,00000382	0,00002239	0,00012137	0,00006639	0,00001240	0,00001687
N02	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
E01	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A01	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A02	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N03	0,00000000	0,00000000	0,00000000	0,00000000	0,00000010	0,00000002	0,00000001	0,00000002	0,00026349	0,00000006	0,00000008	0,00000492	0,00002065	0,00001207	0,00000332	0,00000403
E02	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A03	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A04	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A05	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N04	0,00000000	0,00000000	0,00000000	0,00000000	0,00000338	0,00000066	0,00000051	0,00000087	0,00000170	0,00000175	0,00000224	0,00000141	0,00000166	0,00000142	0,00000115	0,00000223
N05	0,00000000	0,00000000	0,00000000	0,00000000	0,00000132	0,00000024	0,00000028	0,00000051	0,00002196	0,00000067	0,00000134	0,00000165	0,00005770	0,00001324	0,00000503	0,00001746
E03	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A06	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A07	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A08	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A09	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A10	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A11	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A12	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A13	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A14	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A15	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A16	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N06	0,00000000	0,00000000	0,00000000	0,00000000	0,00002350	0,00000864	0,00000357	0,00001457	0,01058951	0,00001752	0,00004983	0,00017680	0,00050195	0,00036663	0,00019299	0,00016060
N07	0,00000000	0,00000000	0,00000000	0,00000000	0,00000010	0,00000002	0,00000001	0,00000002	0,00000005	0,00000005	0,00000006	0,00000004	0,00000005	0,00000004	0,00000003	0,00000006
N08	0,00000000	0,00000000	0,00000000	0,00000000	0,00000272	0,00000045	0,00000293	0,00047505	0,00022801	0,00000222	0,00000314	0,00044658	0,00100974	0,00000160	0,00000336	0,00000545
N09	0,00000000	0,00000000	0,00000000	0,00000000	0,00001405	0,00002551	0,00000040	0,00000402	0,00004002	0,00009025	0,00000235	0,00010752	0,00017419	0,00000334	0,00000570	0,00001210
N10	0,00000000	0,00000000	0,00000000	0,00000000	0,00000055	0,00000014	0,00000008	0,00000241	0,00000024	0,00000047	0,00000084	0,00000255	0,00002996	0,00000036	0,00000064	0,00000072
N11	0,00000000	0,00000000	0,00000000	0,00000000	0,00000200	0,00000017	0,00000022	0,00000042	0,00000037	0,00000069	0,00000245	0,00000067	0,00000615	0,00000101	0,00000071	0,00000226
N12	0,00000000	0,00000000	0,00000000	0,00000000	0,00014152	0,00019639	0,00007293	0,00029514	0,00009564	0,00011467	0,00024211	0,00059396	0,00045025	0,00005967	0,00011229	0,00010710
N13	0,00000000	0,00000000	0,00000000	0,00000000	0,00015959	0,00012588	0,00001839	0,00000667	0,00000313	0,00059125	0,00002015	0,00005827	0,00008187	0,00007707	0,00004899	0,00003635
E04	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A17	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A18	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A19	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A20	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A21	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A22	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A23	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A24	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A25	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A26	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000

Table B.7 – Technical Coefficients Matrix of imports A_m (Part XX).

	A50	A51	A52	A53	N42	N43	N44	N45	N46	N47	N48	N49	N50	N51	N52	N53
A27	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A28	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A29	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A30	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A31	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A32	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A33	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A34	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
E05	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A35	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A36	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A37	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A38	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A39	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N14	0,00000000	0,00000000	0,00000000	0,00000000	0,00013218	0,00000568	0,00000230	0,00017018	0,00001604	0,00002171	0,00004578	0,00201940	0,00009756	0,00002678	0,00201461	0,00001205
N15	0,00000000	0,00000000	0,00000000	0,00000000	0,00000018	0,00000013	0,00000004	0,00000055	0,00000010	0,00000025	0,00000099	0,00000080	0,00000164	0,00000032	0,00000142	0,00000026
N16	0,00000000	0,00000000	0,00000000	0,00000000	0,00000483	0,00000078	0,00000117	0,00000465	0,00000226	0,00000240	0,00021119	0,00540906	0,00008355	0,00039331	0,01105043	0,00062576
N17	0,00000000	0,00000000	0,00000000	0,00000000	0,00000135	0,00000053	0,00000016	0,00000341	0,00046360	0,00048230	0,00001006	0,00102290	0,00000112	0,00000438	0,00002304	0,00000275
N18	0,00000000	0,00000000	0,00000000	0,00000000	0,00016702	0,00000621	0,00002478	0,00005881	0,00043337	0,00021879	0,00011285	0,00103529	0,00082405	0,00001669	0,00002040	0,00002815
N19	0,00000000	0,00000000	0,00000000	0,00000000	0,00000043	0,00000069	0,00000365	0,00004567	0,00000014	0,00000094	0,00028221	0,00000821	0,00000784	0,00012681	0,00006133	0,00007637
N20	0,00000000	0,00000000	0,00000000	0,00000000	0,00000186	0,00012605	0,00000027	0,00025066	0,00000192	0,00016090	0,00066773	0,00086170	0,00005190	0,00021669	0,00170461	0,00013861
N21	0,00000000	0,00000000	0,00000000	0,00000000	0,00132358	0,00003073	0,00014654	0,00057995	0,00017630	0,00106885	0,00000996	0,00266363	0,00025662	0,00001033	0,00011259	0,00000906
N22	0,00000000	0,00000000	0,00000000	0,00000000	0,00000039	0,00000008	0,00000006	0,00000010	0,00000041	0,00000020	0,00000026	0,00000587	0,00000243	0,00000041	0,00000217	0,00000056
N23	0,00000000	0,00000000	0,00000000	0,00000000	0,00000252	0,00000044	0,00000051	0,00000080	0,00000126	0,00000151	0,00000671	0,00062594	0,00018480	0,00001484	0,00022075	0,00001738
N24	0,00000000	0,00000000	0,00000000	0,00000000	0,00000494	0,00000062	0,00000069	0,00001148	0,00000228	0,00000223	0,00000456	0,00001116	0,00000217	0,00000177	0,00001044	0,00000434
N25	0,00000000	0,00000000	0,00000000	0,00000000	0,00009544	0,00000134	0,00000076	0,00001575	0,00000113	0,00000316	0,00000759	0,00002146	0,00000640	0,00000534	0,00001992	0,00000906
N26	0,00000000	0,00000000	0,00000000	0,00000000	0,00009395	0,00000080	0,00000231	0,00038094	0,00007486	0,00001364	0,00002135	0,00031818	0,00005579	0,00004051	0,00027561	0,00021223
N27	0,00000000	0,00000000	0,00000000	0,00000000	0,00074750	0,00000204	0,00021308	0,00009218	0,00000399	0,00043314	0,00373996	0,00033312	0,00002251	0,00000744	0,00001771	0,00009807
N28	0,00000000	0,00000000	0,00000000	0,00000000	0,00000378	0,00000015	0,00000036	0,00042397	0,00004933	0,00000110	0,00000401	0,00000131	0,00006572	0,00000021	0,00000057	0,00000061
N29	0,00000000	0,00000000	0,00000000	0,00000000	0,00108852	0,00013374	0,00000038	0,00003121	0,00000007	0,00018083	0,00002438	0,00025945	0,00000419	0,00008241	0,00008784	0,00007105
N30	0,00000000	0,00000000	0,00000000	0,00000000	0,00192878	0,00007715	0,00008716	0,00366223	0,00001128	0,00027148	0,00001576	0,00059261	0,00182593	0,00003555	0,00024056	0,00010200
N31	0,00000000	0,00000000	0,00000000	0,00000000	0,00458292	0,00000172	0,00009820	0,00808253	0,00000050	0,00164074	0,00001193	0,00001234	0,00041864	0,00000636	0,00000540	0,00001074
N32	0,00000000	0,00000000	0,00000000	0,00000000	0,00000776	0,00000040	0,00000082	0,00379199	0,00000065	0,00082025	0,00000415	0,00133563	0,00073821	0,00022683	0,00149977	0,00008383
N33	0,00000000	0,00000000	0,00000000	0,00000000	0,00000042	0,00000003	0,00000049	0,00104310	0,00000007	0,00000202	0,00000006	0,00000005	0,00000009	0,00000007	0,00000008	0,00000019
N34	0,00000000	0,00000000	0,00000000	0,00000000	0,00000246	0,00000015	0,00000062	0,00005580	0,00000039	0,00000146	0,00000917	0,00000103	0,00000038	0,00000033	0,00000027	0,00001044
N35	0,00000000	0,00000000	0,00000000	0,00000000	0,00015830	0,00000634	0,00013890	0,01199472	0,00000922	0,00057839	0,00001093	0,00003018	0,00006694	0,00001155	0,00002491	0,00004495
N36	0,00000000	0,00000000	0,00000000	0,00000000	0,00000147	0,00000027	0,00000026	0,00118352	0,00000060	0,00000078	0,00000228	0,00000067	0,00000064	0,00000061	0,00000046	0,00024830
N37	0,00000000	0,00000000	0,00000000	0,00000000	0,00000268	0,00030021	0,00002280	0,00026954	0,00000116	0,00005648	0,00015819	0,00000652	0,00043177	0,00082427	0,00003415	0,00001710
N38	0,00000000	0,00000000	0,00000000	0,00000000	0,00006302	0,00002840	0,00000712	0,00002796	0,00008077	0,00004340	0,00008388	0,00010419	0,00020627	0,00012672	0,00008748	0,00008004
E06	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A40	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A41	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A42	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A43	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000

Table B.7 – Technical Coefficients Matrix of imports A_m (Part XXI).

	A50	A51	A52	A53	N42	N43	N44	N45	N46	N47	N48	N49	N50	N51	N52	N53
A44	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A45	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A46	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A47	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A48	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N39	0,00000000	0,00000000	0,00000000	0,00000000	0,00009791	0,00002452	0,00004541	0,00002364	0,00004611	0,00005016	0,00008898	0,00004304	0,00005695	0,00009409	0,00005113	0,00009004
N40	0,00000000	0,00000000	0,00000000	0,00000000	0,00023470	0,00007514	0,00003118	0,00006367	0,00007455	0,00012856	0,00017828	0,00011479	0,00010511	0,00007984	0,00010943	0,00013573
N41	0,00000000	0,00000000	0,00000000	0,00000000	0,00073487	0,00027078	0,00004202	0,00003057	0,00012075	0,00044128	0,00047894	0,00120519	0,00142043	0,00029224	0,00069379	0,00024728
A49	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A50	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A51	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A52	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A53	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N42	0,00000000	0,00000000	0,00000000	0,00000000	0,00552532	0,00179253	0,00008873	0,00023030	0,00019144	0,00437832	0,00207236	0,00101860	0,00095640	0,00064394	0,00082075	0,00222744
N43	0,00000000	0,00000000	0,00000000	0,00000000	0,00067645	0,00338481	0,00014953	0,00012075	0,00017565	0,00040813	0,00023813	0,00016116	0,00010067	0,00001826	0,00002178	0,00149638
N44	0,00000000	0,00000000	0,00000000	0,00000000	0,00393869	0,00077132	0,00059336	0,00101532	0,00198003	0,00203795	0,00259974	0,00163991	0,00192705	0,00164337	0,00134226	0,00259704
N45	0,00000000	0,00000000	0,00000000	0,00000000	0,00001436	0,00000396	0,00000156	0,00000123	0,00000119	0,00000480	0,00000980	0,00001239	0,00000431	0,00000119	0,00000222	0,00000228
N46	0,00000000	0,00000000	0,00000000	0,00000000	0,00050866	0,00048182	0,00008708	0,00000589	0,00027485	0,00029432	0,00300879	0,00248221	0,00151365	0,00013953	0,00289443	0,00157358
N47	0,00000000	0,00000000	0,00000000	0,00000000	0,00663708	0,00485278	0,00121371	0,00015861	0,00058004	0,00286556	0,00540428	0,00653303	0,00332685	0,00261492	0,00832793	0,00368070
N48	0,00000000	0,00000000	0,00000000	0,00000000	0,00014150	0,00003106	0,00002132	0,00003648	0,00007114	0,00007321	0,00009339	0,00005931	0,00006923	0,00006270	0,00005483	0,00009595
N49	0,00000000	0,00000000	0,00000000	0,00000000	0,00022151	0,00004338	0,00003337	0,00005710	0,00011136	0,00011461	0,00014633	0,00009223	0,00010838	0,00009242	0,00007549	0,00014606
N50	0,00000000	0,00000000	0,00000000	0,00000000	0,00075666	0,00017274	0,00010654	0,00017753	0,00041069	0,00043252	0,00047022	0,00036513	0,00040589	0,00028702	0,00040769	0,00046632
N51	0,00000000	0,00000000	0,00000000	0,00000000	0,00001450	0,00000925	0,00000256	0,00000095	0,00000237	0,00000663	0,00001172	0,00001305	0,00000741	0,00000578	0,00001612	0,00000847
N52	0,00000000	0,00000000	0,00000000	0,00000000	0,00000014	0,00000011	0,00000003	0,00000000	0,00000001	0,00000006	0,00000013	0,00000056	0,00000008	0,00000009	0,00000103	0,00000013
N53	0,00000000	0,00000000	0,00000000	0,00000000	0,00023651	0,00015029	0,00004009	0,00001623	0,00004803	0,00012693	0,00018357	0,00021909	0,00013063	0,00010096	0,00027513	0,00013724

Table B.8 – Vectors am_g, am_{cnpish}, am_{cf} , am_{gfcf} , am_{sc} (Part I).					
	am_g	am_{cnpish}	am_{cf}	am_{gfcf}	am_{sc}
N01	0,00000000	0,00000000	0,00083053	0,00026225	-0,00156081
N02	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
E01	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A01	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A02	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N03	0,00000000	0,00000000	0,00020586	0,00005279	-0,00017570
E02	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A03	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A04	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A05	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N04	0,00000000	0,00000000	0,00000255	0,00000172	0,00015198
N05	0,00000000	0,00000000	0,00007223	0,00000415	0,01899380
E03	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A06	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A07	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A08	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A09	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A10	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A11	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A12	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A13	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A14	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A15	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A16	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N06	0,00000035	0,00000000	0,00294648	0,00005222	-0,00470330
N07	0,00000000	0,00000000	0,00210010	0,00000005	0,00515228
N08	0,00000000	0,00000000	0,00047695	0,00001647	0,00193906
N09	0,00000000	0,00000000	0,00076031	0,00001489	-0,00031101
N10	0,00000000	0,00000000	0,00048356	0,00000224	-0,00279949
N11	0,00000000	0,00000000	0,00000582	0,00002321	0,00065424
N12	0,00000038	0,00000000	0,00027054	0,00006172	-0,01054703
N13	0,00000000	0,00000000	0,00007242	0,00000473	0,00124108
E04	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A17	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A18	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A19	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A20	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A21	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A22	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A23	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A24	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A25	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A26	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A27	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A28	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A29	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A30	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A31	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A32	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A33	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A34	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
E05	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A35	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A36	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A37	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A38	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A39	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N14	0,00000016	0,00000000	0,00018435	0,00014726	-0,01290382
N15	0,00000000	0,00000000	0,00000081	0,00000166	-0,00054755
N16	0,00124167	0,00000000	0,00399050	0,00000766	-0,00106848

Table B.8 – Vectors am_g, am_{cnpish}, am_{cf} , am_{gfcf} , am_{sc} (Part II).					
	am_g	**am_{cpish}**	**am_{cf}**	**am_{gfcf}**	**am_{sc}**
N17	0,00000000	0,00000000	0,00003428	0,00000059	-0,01713516
N18	0,00000025	0,00000000	0,00211644	0,00000277	-0,00488913
N19	0,00000000	0,00000000	0,00005127	0,00000052	0,00076264
N20	0,00000029	0,00000000	0,00006913	0,00001412	0,00063146
N21	0,00000000	0,00000000	0,00035213	0,00009563	0,02253673
N22	0,00000000	0,00000000	0,00000622	0,00000019	0,00009604
N23	0,00000000	0,00000000	0,00002555	0,00004029	0,00263488
N24	0,00000000	0,00000000	0,00000392	0,00004417	0,04309309
N25	0,00000000	0,00000000	0,00000626	0,00009580	-0,03455911
N26	0,00000000	0,00000000	0,00016872	0,00221984	0,00750311
N27	0,00000000	0,00000000	0,00039633	0,03260149	-0,06607518
N28	0,00000000	0,00000000	0,00050255	0,00008798	-0,00446263
N29	0,00000000	0,00000000	0,00067475	0,01211958	-0,00653825
N30	0,00000000	0,00000000	0,00026599	0,00396754	-0,01331927
N31	0,00000000	0,00000000	0,00295723	0,01307354	0,05161512
N32	0,00000000	0,00000000	0,00211861	0,00908678	0,01199364
N33	0,00000000	0,00000000	0,00416795	0,00839394	-0,04119180
N34	0,00000000	0,00000000	0,00009220	0,00188956	-0,00499596
N35	0,00000000	0,00000000	0,00009893	0,00039025	0,03232896
N36	0,00000000	0,00000000	0,00152713	0,00519045	-0,07282173
N37	0,00000000	0,00000000	0,00071301	0,00075926	0,00707420
N38	0,00000000	0,00000000	0,00014305	0,00000535	-0,00002348
E06	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A40	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A41	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A42	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A43	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A44	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A45	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A46	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A47	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A48	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N39	0,00000000	0,00000000	0,00006905	0,00056210	0,00000000
N40	0,00000000	0,00000000	0,00012597	0,00008611	-0,00020630
N41	0,00000000	0,00000000	-0,00056612	0,00002604	-0,00003260
A49	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A50	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A51	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A52	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A53	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N42	0,00000000	0,00000000	0,00114233	0,00000660	0,00000000
N43	0,00005253	0,00000000	0,00130551	0,00001602	0,00000000
N44	0,00000000	0,00000000	0,00297354	0,00195936	-0,00000557
N45	0,00000000	0,00000000	0,00001035	0,00000065	0,00000620
N46	0,00000000	0,00000000	-0,00114778	0,00001136	0,00000000
N47	0,00000000	0,00000000	0,00078210	0,00036265	-0,00000227
N48	0,00000000	0,00000000	0,00015295	0,00007029	0,00000000
N49	0,00000758	0,00002579	0,00018216	0,00011003	0,00000000
N50	0,00000000	0,00364710	0,00099948	0,00034022	0,00000000
N51	0,00000000	0,00000007	0,00000440	0,00000193	0,00000034
N52	0,00000030	0,00000069	0,00000072	0,00000001	-0,00000009
N53	0,00000251	0,00001223	0,00008839	0,00002900	-0,00001427

Table B.9 – Technical Coefficients Matrix of taxes less subsidies A_{ts} (Part I).																
	N01	**N02**	**E01**	**A01**	**A02**	**N03**	**E02**	**A03**	**A04**	**A05**	**N04**	**N05**	**E03**	**A06**	**A07**	**A08**
N01	0,00158542	0,00000000	0,00009276	0,00000000	0,00000000	-0,00023932	0,00000757	0,00000000	0,00000000	0,00000000	0,00000820	0,00007748	0,00000000	0,00000000	0,00000000	0,00000000
N02	0,00005933	0,00000000	0,00000000	0,00000000	0,00000000	0,00001837	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
E01	0,00020211	0,00000000	0,00001022	0,00000000	0,00000000	0,00005940	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A01	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A02	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N03	0,00013832	0,00000000	0,00000984	0,00000000	0,00000000	0,00302295	0,00000020	0,00000000	0,00000000	0,00000000	0,00000006	0,00000001	0,00000000	0,00000000	0,00000000	0,00000000
E02	0,00002537	0,00000000	0,00000000	0,00000000	0,00000000	0,00007674	0,00001826	0,00000000	0,00000000	0,00000000	0,00000066	0,00000098	0,00000000	0,00000000	0,00000000	0,00000000
A03	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A04	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A05	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N04	0,00000001	0,00000000	0,00000000	0,00000000	0,00000000	0,00000001	0,00000109	0,00000000	0,00000000	0,00000000	0,00172485	0,00000558	0,00000000	0,00000000	0,00000000	0,00000000
N05	0,00011883	0,00000126	0,00000005	0,00000000	0,00000000	0,00118090	0,00000095	0,00000000	0,00000000	0,00000000	0,00050127	0,00608656	0,00000000	0,00000000	0,00000000	0,00000000
E03	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000003	0,00000000	0,00000000	0,00000000	0,00010898	0,00000006	0,00065395	0,00000000	0,00000000	0,00000000
A06	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A07	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A08	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A09	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A10	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A11	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A12	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A13	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A14	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A15	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A16	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N06	0,00148043	0,00000000	0,00001837	0,00000000	0,00000000	0,01869037	0,00001525	0,00000000	0,00000000	0,00000000	0,00002874	0,00010564	0,00000009	0,00000000	0,00000000	0,00000000
N07	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000003	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N08	0,00012409	0,00000000	0,00000626	0,00000000	0,00000000	0,00016739	0,00000196	0,00000000	0,00000000	0,00000000	0,00000179	0,00193195	0,00000000	0,00000000	0,00000000	0,00000000
N09	0,00000020	0,00000000	0,00000001	0,00000000	0,00000000	0,00000024	0,00000131	0,00000000	0,00000000	0,00000000	0,00000083	0,00009730	0,00000000	0,00000000	0,00000000	0,00000000
N10	0,00000025	0,00000000	0,00000001	0,00000000	0,00000000	0,00000005	0,00000034	0,00000000	0,00000000	0,00000000	0,00002756	0,00000098	0,00000000	0,00000000	0,00000000	0,00000000
N11	0,00021304	0,00000000	0,00001077	0,00000000	0,00000000	0,00000008	0,00000148	0,00000000	0,00000000	0,00000000	0,00000185	0,00000709	0,00000000	0,00000000	0,00000000	0,00000000
N12	0,00002408	0,00000000	0,00000009	0,00000000	0,00000000	0,00001373	0,00000728	0,00000000	0,00000000	0,00000000	0,00040666	0,00095385	0,00000335	0,00000000	0,00000000	0,00000000
N13	0,00000003	0,00000000	0,00000000	0,00000000	0,00000000	0,00000001	0,00000546	0,00000000	0,00000000	0,00000000	0,00040305	0,00000379	0,00000000	0,00000000	0,00000000	0,00000000
E04	0,00140768	0,03691510	0,00029137	0,00000000	0,00000000	0,00428725	0,00079978	0,00000000	0,00000000	0,00000000	0,00368022	0,00937442	0,00000000	0,00000000	0,00000000	0,00000000
A17	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A18	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A19	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A20	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A21	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A22	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A23	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A24	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A25	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A26	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000

Table B.9 – Technical Coefficients Matrix of taxes less subsidies A_{ts} (Part II).																
	N01	**N02**	**E01**	**A01**	**A02**	**N03**	**E02**	**A03**	**A04**	**A05**	**N04**	**N05**	**E03**	**A06**	**A07**	**A08**
A27	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A28	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A29	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A30	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A31	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A32	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A33	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A34	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
E05	0,00004845	0,00000000	0,00000000	0,00000000	0,00000000	0,00004953	0,00000141	0,00000000	0,00000000	0,00000000	0,00000148	0,00015272	0,00000000	0,00000000	0,00000000	0,00000000
A35	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A36	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A37	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A38	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A39	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N14	0,00330498	0,00000031	0,00016528	0,00000000	0,00000000	0,00063864	0,00025099	0,00000000	0,00000000	0,00000000	0,00019851	0,00070388	0,00002786	0,00000000	0,00000000	0,00000000
N15	0,00000008	0,00000000	0,00000000	0,00000000	0,00000000	0,00000024	0,00000109	0,00000000	0,00000000	0,00000000	0,00000052	0,00013348	0,00000000	0,00000000	0,00000000	0,00000000
N16	0,00066860	0,00000000	0,00000002	0,00000000	0,00000000	0,00467284	0,00000179	0,00000000	0,00000000	0,00000000	0,00000185	0,00001342	0,00000057	0,00000000	0,00000000	0,00000000
N17	0,00697600	0,00000000	0,00000132	0,00000000	0,00000000	0,00033237	0,00000462	0,00000000	0,00000000	0,00000000	0,00000206	0,00001523	0,00000000	0,00000000	0,00000000	0,00000000
N18	0,00000413	0,00000031	0,00000002	0,00000000	0,00000000	0,00003760	0,00000137	0,00000000	0,00000000	0,00000000	0,00001371	0,00018669	0,00116053	0,00000000	0,00000000	0,00000000
N19	0,00000622	0,00000006	0,00000031	0,00000000	0,00000000	0,00000235	0,00000114	0,00000000	0,00000000	0,00000000	0,00000087	0,00001687	0,00000004	0,00000000	0,00000000	0,00000000
N20	0,00003453	0,00000038	0,00000091	0,00000000	0,00000000	0,00000590	0,00014371	0,00000000	0,00000000	0,00000000	0,00001722	0,00155547	0,00000018	0,00000000	0,00000000	0,00000000
N21	0,00040440	0,00000000	0,00000181	0,00000000	0,00000000	0,00006881	0,00006965	0,00000000	0,00000000	0,00000000	0,00017616	0,00238470	0,00000000	0,00000000	0,00000000	0,00000000
N22	0,00000202	0,00000000	0,00000004	0,00000000	0,00000000	0,00001179	0,00050894	0,00000000	0,00000000	0,00000000	0,00000509	0,00006098	0,00000000	0,00000000	0,00000000	0,00000000
N23	0,00009436	0,00000006	0,00000465	0,00000000	0,00000000	0,00002433	0,00034169	0,00000000	0,00000000	0,00000000	0,00008968	0,00030193	0,00000000	0,00000000	0,00000000	0,00000000
N24	0,00001634	0,00000000	0,00000083	0,00000000	0,00000000	0,00000365	0,00011262	0,00000000	0,00000000	0,00000000	0,00002452	0,00020452	0,00000000	0,00000000	0,00000000	0,00000000
N25	0,00002969	0,00000000	0,00000148	0,00000000	0,00000000	0,00000636	0,00018718	0,00000000	0,00000000	0,00000000	0,00002023	0,00035439	0,00000000	0,00000000	0,00000000	0,00000000
N26	0,00050080	0,00000000	0,00002530	0,00000000	0,00000000	0,00016928	0,00197677	0,00000000	0,00000000	0,00000000	0,00109530	0,00238055	0,00001678	0,00000000	0,00000000	0,00000000
N27	0,00000586	0,00000044	0,00000027	0,00000000	0,00000000	0,00000185	0,00236596	0,00000000	0,00000000	0,00000000	0,00345285	0,00540671	0,00000000	0,00000000	0,00000000	0,00000000
N28	0,00000047	0,00000000	0,00000002	0,00000000	0,00000000	0,00000018	0,00000518	0,00000000	0,00000000	0,00000000	0,00000455	0,00000891	0,00000000	0,00000000	0,00000000	0,00000000
N29	0,00000007	0,00000000	0,00000000	0,00000000	0,00000000	0,00000001	0,00001747	0,00000000	0,00000000	0,00000000	0,00000190	0,00005848	0,00000000	0,00000000	0,00000000	0,00000000
N30	0,00002548	0,00000000	0,00000127	0,00000000	0,00000000	0,00002937	0,00098123	0,00000000	0,00000000	0,00000000	0,00012295	0,00078257	0,00000000	0,00000000	0,00000000	0,00000000
N31	0,00000160	0,00000000	0,00000008	0,00000000	0,00000000	0,00000081	0,00002575	0,00000000	0,00000000	0,00000000	0,00001393	0,00115076	0,00000000	0,00000000	0,00000000	0,00000000
N32	0,00000036	0,00000000	0,00000001	0,00000000	0,00000000	0,00000009	0,00007341	0,00000000	0,00000000	0,00000000	0,00000371	0,00000773	0,00000026	0,00000000	0,00000000	0,00000000
N33	0,00000039	0,00000000	0,00000002	0,00000000	0,00000000	0,00000006	0,00000003	0,00000000	0,00000000	0,00000000	0,00000029	0,00000038	0,00000000	0,00000000	0,00000000	0,00000000
N34	0,00000002	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000568	0,00000000	0,00000000	0,00000000	0,00000802	0,00001708	0,00000000	0,00000000	0,00000000	0,00000000
N35	0,00011917	0,00000000	0,00000591	0,00000000	0,00000000	0,00003264	0,00005545	0,00000000	0,00000000	0,00000000	0,00010540	0,00023149	0,00000000	0,00000000	0,00000000	0,00000000
N36	0,00000011	0,00000000	0,00000001	0,00000000	0,00000000	0,00000005	0,00000175	0,00000000	0,00000000	0,00000000	0,00000164	0,00011944	0,00000000	0,00000000	0,00000000	0,00000000
N37	0,00000106	0,00000050	0,00000002	0,00000000	0,00000000	0,00008049	0,00000132	0,00000000	0,00000000	0,00000000	0,00000131	0,00000887	0,00000000	0,00000000	0,00000000	0,00000000
N38	0,00026890	0,00000000	0,00001359	0,00000000	0,00000000	0,00032341	0,00073778	0,00000000	0,00000000	0,00000000	0,00099054	0,00181348	0,00000000	0,00000000	0,00000000	0,00000000
E06	0,00075146	0,00000000	0,00003798	0,00000000	0,00000000	0,00090387	0,00205599	0,00000000	0,00000000	0,00000000	0,00276786	0,00506765	0,00000000	0,00000000	0,00000000	0,00000000
A40	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A41	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A42	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A43	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000

Table B.9 – Technical Coefficients Matrix of taxes less subsidies A_{ts} (Part III).

	N01	N02	E01	A01	A02	N03	E02	A03	A04	A05	N04	N05	E03	A06	A07	A08
A44	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A45	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A46	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A47	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A48	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N39	0,00000030	0,00000000	0,00000002	0,00000000	0,00000000	0,00000014	0,00043766	0,00000000	0,00000000	0,00000000	0,00000273	0,00000514	0,00000000	0,00000000	0,00000000	0,00000000
N40	0,00002043	0,00001840	0,00000086	0,00000000	0,00000000	0,00001096	0,00012003	0,00000000	0,00000000	0,00000000	0,00011925	0,00011809	0,00000000	0,00000000	0,00000000	0,00000000
N41	0,00130067	0,00000000	0,00006575	0,00000000	0,00000000	0,00028204	0,00392796	0,00000000	0,00000000	0,00000000	0,00550740	0,00582813	0,00000000	0,00000000	0,00000000	0,00000000
A49	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A50	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A51	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A52	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A53	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N42	0,00034055	0,00000000	0,00001721	0,00000000	0,00000000	0,00064108	0,00258859	0,00000000	0,00000000	0,00000000	0,00398418	0,00425662	0,00000000	0,00000000	0,00000000	0,00000000
N43	0,00073169	0,00000000	0,00003698	0,00000000	0,00000000	0,00049926	0,00039656	0,00000000	0,00000000	0,00000000	0,00510048	0,00200974	0,00000000	0,00000000	0,00000000	0,00000000
N44	0,00001303	0,00000000	0,00000066	0,00000000	0,00000000	0,00000584	0,00123172	0,00000000	0,00000000	0,00000000	0,00011792	0,00015985	0,00000000	0,00000000	0,00000000	0,00000000
N45	0,00000395	0,00000000	0,00000000	0,00000000	0,00000000	0,00000517	0,00000042	0,00000000	0,00000000	0,00000000	0,00006678	0,00002548	0,00000000	0,00000000	0,00000000	0,00000000
N46	0,00000025	0,00000000	0,00000001	0,00000000	0,00000000	0,00000114	0,00012997	0,00000000	0,00000000	0,00000000	0,00203672	0,00045085	0,00000000	0,00000000	0,00000000	0,00000000
N47	0,00000026	0,00000000	0,00000001	0,00000000	0,00000000	0,00000012	0,00232637	0,00000000	0,00000000	0,00000000	0,00075218	0,00051681	0,00000000	0,00000000	0,00000000	0,00000000
N48	0,00000047	0,00000000	0,00000002	0,00000000	0,00000000	0,00000021	0,00004424	0,00000000	0,00000000	0,00000000	0,00000423	0,00000573	0,00000000	0,00000000	0,00000000	0,00000000
N49	0,00000073	0,00000000	0,00000004	0,00000000	0,00000000	0,00000033	0,00006925	0,00000000	0,00000000	0,00000000	0,00000662	0,00000896	0,00000000	0,00000000	0,00000000	0,00000000
N50	0,00000309	0,00000000	0,00000011	0,00000000	0,00000000	0,00000221	0,00021810	0,00000000	0,00000000	0,00000000	0,00002369	0,00003579	0,00000000	0,00000000	0,00000000	0,00000000
N51	0,00000012	0,00000000	0,00000000	0,00000000	0,00000000	0,00000143	0,00000498	0,00000000	0,00000000	0,00000000	0,00000181	0,00000113	0,00000000	0,00000000	0,00000000	0,00000000
N52	0,00000005	0,00000000	0,00000000	0,00000000	0,00000000	0,00000036	0,00000005	0,00000000	0,00000000	0,00000000	0,00000002	0,00000001	0,00000000	0,00000000	0,00000000	0,00000000
N53	0,00004732	0,00000119	0,00000230	0,00000000	0,00000000	0,00004036	0,00019272	0,00000000	0,00000000	0,00000000	0,00019600	0,00024898	0,00000000	0,00000000	0,00000000	0,00000000

Table B.9 – Technical Coefficients Matrix of taxes less subsidies A_{ts} (Part IV).

	A09	A10	A11	A12	A13	A14	A15	A16	N06	N07	N08	N09	N10	N11	N12	N13
N01	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00186423	0,01911240	-0,00410576	0,00017079	0,00013403	0,00429577	0,00419198	0,00002134
N02	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00076465	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
E01	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00002920	0,00000000	0,00000797	0,00000000	0,00001138	0,00194595	0,00190487	0,00000000
A01	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A02	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N03	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,01088513	0,00014876	0,00001095	0,00000252	0,00031664	0,00015609	0,00015336	0,00000052
E02	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00006866	0,00000023	0,00000028	0,00000039	0,00000022	0,00000024	0,00000049	0,00000038
A03	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A04	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A05	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N04	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000009	0,00000008	0,00000006	0,00000017	0,00000005	0,00000005	0,00000011	0,00000016
N05	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00002797	0,00000009	0,00000038	0,00000011	0,00010335	0,00000394	0,00024288	0,00000066
E03	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000001	0,00000001	0,00000002	0,00000000	0,00000001	0,00000001	0,00001676	0,00000001
A06	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A07	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A08	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A09	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A10	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A11	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A12	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A13	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A14	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A15	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A16	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N06	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,01353209	0,00000406	0,00001909	0,00005108	0,00573950	0,00005877	0,00041655	0,00004974
N07	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000572	0,01809034	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N08	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00002426	0,00287910	0,01664032	0,03385359	0,00222763	0,00000954	0,00072932	0,00001560
N09	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000034	0,00000439	0,00001944	0,00085215	0,00000731	0,00000033	0,00000198	0,00000071
N10	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000031	0,00000009	0,00000024	0,00011404	0,02109320	0,00000038	0,00004001	0,00000105
N11	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00002867	0,00001352	0,00000094	0,00000091	0,00004384	0,01935409	0,00070873	0,00011051
N12	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00074425	0,00481043	0,00045897	0,00019574	0,00262670	0,00111172	0,01722216	0,01452648
N13	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00002166	0,00058459	0,00002249	0,00000179	0,00000569	0,00000193	0,00034411	0,00194305
E04	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00112957	0,00030835	0,00211372	0,00040653	0,00062567	0,00293001	0,00157158	0,00046165
A17	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A18	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A19	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A20	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A21	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A22	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A23	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A24	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A25	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A26	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000

Table B.9 – Technical Coefficients Matrix of taxes less subsidies A_{ts} (Part V).

	A09	A10	A11	A12	A13	A14	A15	A16	N06	N07	N08	N09	N10	N11	N12	N13
A27	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A28	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A29	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A30	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A31	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A32	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A33	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A34	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
E05	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00005839	0,00000025	0,00003750	0,00001367	0,00000038	0,00000050	0,00005698	0,00000829
A35	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A36	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A37	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A38	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A39	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N14	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00017747	0,00015472	0,00100422	0,00011142	0,00173333	0,00016284	0,00100755	0,00061192
N15	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00004859	0,00008782	0,00245271	0,00009105	0,00069751	0,00054962	0,00039054	0,00098726
N16	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00003806	0,00000128	0,00001431	0,00000088	0,00001068	0,00000453	0,00003021	0,00000729
N17	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00008689	0,00000519	0,00007292	0,00000366	0,00120913	0,00029985	0,00022960	0,00012843
N18	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00032669	0,00000450	0,00000309	0,00008193	0,00107699	0,00004225	0,00010160	0,00002045
N19	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000309	0,00000157	0,00005164	0,00000134	0,00011920	0,00015137	0,00045034	0,00054156
N20	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00021071	0,00007982	0,00032251	0,00012829	0,00093954	0,00033918	0,00239166	0,00131152
N21	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00103729	0,00022191	0,00064329	0,00025792	0,00138695	0,00065580	0,00136221	0,00212599
N22	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000241	0,00000001	0,00000001	0,00000002	0,00000424	0,00000019	0,00000385	0,00000035
N23	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00023458	0,00000083	0,00000200	0,00000071	0,00035368	0,00001836	0,00016449	0,00003920
N24	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00004572	0,00000738	0,00000118	0,00000044	0,00001292	0,00013055	0,00003374	0,00002120
N25	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00003237	0,00000941	0,00000395	0,00000645	0,00002623	0,00003159	0,00017207	0,00016324
N26	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00105569	0,00066713	0,00000646	0,00000354	0,00114365	0,00123490	0,00164953	0,00001557
N27	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00084234	0,00053323	0,00127353	0,00040727	0,00087243	0,00114545	0,00216337	0,00049535
N28	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000201	0,00000140	0,00000152	0,00000090	0,00000237	0,00000242	0,00000394	0,00000077
N29	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000767	0,00000279	0,00001353	0,00000407	0,00003188	0,00001195	0,00008265	0,00029748
N30	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00023224	0,00016007	0,00006374	0,00001139	0,00044432	0,00018712	0,00010358	0,00001838
N31	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000995	0,00000502	0,00000506	0,00000249	0,00001141	0,00000775	0,00000965	0,00000219
N32	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000192	0,00000330	0,00000167	0,00000059	0,00000334	0,00000203	0,00001021	0,00001151
N33	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000014	0,00000004	0,00000006	0,00000002	0,00000002	0,00000012	0,00000011	0,00000003
N34	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000196	0,00000124	0,00000295	0,00000096	0,00000200	0,00000263	0,00000501	0,00000118
N35	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00006001	0,00002154	0,00002392	0,00000996	0,00003706	0,00005299	0,00005779	0,00001337
N36	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000060	0,00000038	0,00000053	0,00000042	0,00000065	0,00000073	0,00000125	0,00000025
N37	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00005966	0,00000336	0,00000519	0,00145326	0,00038110	0,00000959	0,00010794	0,00000383
N38	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00082514	0,00046093	0,00225818	0,00063629	0,00082179	0,00101848	0,00234349	0,00057028
E06	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00230563	0,00128778	0,00631097	0,00177737	0,00229648	0,00284625	0,00652700	0,00159294
A40	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A41	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A42	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A43	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000

Table B.9 – Technical Coefficients Matrix of taxes less subsidies A_{ts} (Part VI).

	A09	A10	A11	A12	A13	A14	A15	A16	N06	N07	N08	N09	N10	N11	N12	N13
A44	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A45	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A46	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A47	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A48	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N39	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00001477	0,00001153	0,00001940	0,00001292	0,00000914	0,00002059	0,00002773	0,00001333
N40	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00004754	0,00005720	0,00017366	0,00006081	0,00004193	0,00003048	0,00004613	0,00010362
N41	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00256529	0,00274964	0,00129168	0,00067721	0,00129576	0,00156431	0,00212683	0,00135555
A49	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A50	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A51	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A52	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A53	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N42	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00062086	0,00083679	0,00032433	0,00008586	0,00084471	0,00031143	0,00055388	0,00264309
N43	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00198849	0,00375085	0,00214625	0,00141578	0,00217822	0,00187035	0,00332230	0,00179881
N44	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00010766	0,00009338	0,00006663	0,00019686	0,00006183	0,00005211	0,00012247	0,00018756
N45	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00002141	0,00003410	0,00000261	0,00000256	0,00002682	0,00001348	0,00001733	0,00012532
N46	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00006360	0,00032446	0,00000039	0,00000114	0,00000036	0,00019191	0,00013023	0,00020224
N47	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00076559	0,00109239	0,00080144	0,00038414	0,00046973	0,00021670	0,00052423	0,00239196
N48	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000386	0,00000335	0,00000239	0,00000707	0,00000222	0,00000187	0,00000439	0,00000674
N49	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000604	0,00000525	0,00000374	0,00001107	0,00000347	0,00000292	0,00000688	0,00001055
N50	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00002286	0,00003414	0,00001944	0,00004333	0,00002434	0,00000935	0,00002367	0,00003261
N51	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000243	0,00000221	0,00000157	0,00000083	0,00000089	0,00000047	0,00000119	0,00000492
N52	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000002	0,00000002	0,00000002	0,00000001	0,00000001	0,00000000	0,00000001	0,00000005
N53	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00013392	0,00012757	0,00021424	0,00007298	0,00009434	0,00011383	0,00024419	0,00019704

Table B.9– Technical Coefficients Matrix of taxes less subsidies A_{ts} (Part VII).

	E04	A17	A18	A19	A20	A21	A22	A23	A24	A25	A26	A27	A28	A29	A30	A31
N01	0,00000978	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N02	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
E01	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A01	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A02	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N03	0,00000019	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
E02	0,00044471	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A03	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A04	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A05	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N04	0,00000013	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N05	0,00000187	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
E03	0,00000257	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A06	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A07	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A08	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A09	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A10	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A11	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A12	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A13	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A14	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A15	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A16	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N06	0,00064903	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N07	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N08	0,00000051	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N09	0,00000024	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N10	0,00000012	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N11	0,00000044	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N12	0,00000520	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N13	0,00001103	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
E04	0,06648424	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A17	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A18	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A19	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A20	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A21	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A22	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A23	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A24	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A25	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A26	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000

Table B.9 – Technical Coefficients Matrix of taxes less subsidies A_{ts} (Part VIII).

	E04	A17	A18	A19	A20	A21	A22	A23	A24	A25	A26	A27	A28	A29	A30	A31
A27	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A28	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A29	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A30	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A31	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A32	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A33	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A34	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
E05	0,00461424	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A35	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A36	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A37	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A38	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A39	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N14	0,00253286	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N15	0,00000109	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N16	0,00000093	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N17	0,00000498	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N18	0,00000285	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N19	0,00000133	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N20	0,00020725	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N21	0,00005321	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N22	0,00000001	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N23	0,00000124	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N24	0,00004959	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N25	0,00000918	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N26	0,00052867	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N27	0,00077911	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N28	0,00000181	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N29	0,00002054	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N30	0,00055931	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N31	0,00001265	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N32	0,00002458	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N33	0,00000007	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N34	0,00000181	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N35	0,00004118	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N36	0,00000045	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N37	0,00000034	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N38	0,00046038	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
E06	0,00128623	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A40	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A41	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A42	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A43	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000

Table B.9 – Technical Coefficients Matrix of taxes less subsidies A_{ts} (Part IX).

	E04	A17	A18	A19	A20	A21	A22	A23	A24	A25	A26	A27	A28	A29	A30	A31
A44	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A45	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A46	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A47	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A48	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N39	0,00003179	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N40	0,00004587	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N41	0,00137639	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A49	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A50	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A51	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A52	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A53	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N42	0,00105587	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N43	0,00007457	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N44	0,00009675	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N45	0,00004510	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N46	0,00024849	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N47	0,00074207	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N48	0,00000410	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N49	0,00000544	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N50	0,00002599	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N51	0,00000143	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N52	0,00000002	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N53	0,00007511	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000

Table B.9 – Technical Coefficients Matrix of taxes less subsidies A_{ts} (Part X).																
	A32	**A33**	**A34**	**E05**	**A35**	**A36**	**A37**	**A38**	**A39**	**N14**	**N15**	**N16**	**N17**	**N18**	**N19**	**N20**
N01	0,00000000	0,00000000	0,00000000	0,00001141	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00019782	0,00069813	0,00005300	0,00024556	0,00114933	0,00016601	0,00059772
N02	0,00000000	0,00000000	0,00000000	0,00501529	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000684	0,00000000	0,00000000
E01	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000975	0,00000213	0,00001242	0,00000733	0,00045016	0,00002976	0,00000000
A01	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A02	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N03	0,00000000	0,00000000	0,00000000	0,00010236	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000301	0,00002051	0,00003622	0,00000635	0,00022375	0,00000560	0,00003821
E02	0,00000000	0,00000000	0,00000000	0,00000014	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000146	0,00000027	0,00000021	0,00000018	0,00000022	0,00003171	0,00000030
A03	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A04	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A05	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N04	0,00000000	0,00000000	0,00000000	0,00000002	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000233	0,00000004	0,00000012	0,00000006	0,00000005	0,00000114	0,00000585
N05	0,00000000	0,00000000	0,00000000	0,00000017	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00701095	0,00012425	0,00003906	0,00022831	0,00004244	0,00076155	0,00076810
E03	0,00000000	0,00000000	0,00000000	0,00000001	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00001058	0,00000002	0,00000001	0,00000001	0,00000001	0,00000001	0,00000201
A06	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A07	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A08	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A09	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A10	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A11	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A12	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A13	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A14	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A15	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A16	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N06	0,00000000	0,00000000	0,00000000	0,00071345	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00011851	0,00018941	0,00102517	0,00083322	0,00814170	0,00269033	0,00043370
N07	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N08	0,00000000	0,00000000	0,00000000	0,00005580	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00006620	0,00006276	0,00030215	0,00000505	0,00001409	0,00003704	0,00088318
N09	0,00000000	0,00000000	0,00000000	0,00000027	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000072	0,00000048	0,00000069	0,00000044	0,00000038	0,00000037	0,00000287
N10	0,00000000	0,00000000	0,00000000	0,00000011	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000080	0,00001015	0,00000579	0,00000143	0,00000169	0,00000071	0,00000146
N11	0,00000000	0,00000000	0,00000000	0,00000044	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00005234	0,00001889	0,00000235	0,00009903	0,00057384	0,00000045	0,00150968
N12	0,00000000	0,00000000	0,00000000	0,00008836	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00037478	0,00006733	0,00174745	0,00122759	0,00257138	0,00004818	0,00238917
N13	0,00000000	0,00000000	0,00000000	0,00000019	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00012376	0,00001376	0,00055927	0,00026176	0,00007916	0,00028906	0,00070489
E04	0,00000000	0,00000000	0,00000000	0,00049264	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,01583384	0,00290989	0,00078028	0,00053262	0,00027028	0,00345312	0,00073071
A17	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A18	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A19	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A20	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A21	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A22	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A23	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A24	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A25	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A26	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000

Table B.9 – Technical Coefficients Matrix of taxes less subsidies A_{ts} (Part XI).

	A32	A33	A34	E05	A35	A36	A37	A38	A39	N14	N15	N16	N17	N18	N19	N20
A27	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A28	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A29	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A30	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A31	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A32	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A33	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A34	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
E05	0,00000000	0,00000000	0,00000000	0,00001468	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00018434	0,00004098	0,00082020	0,00511233	0,00226110	0,00110634	0,00000102
A35	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A36	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A37	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A38	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A39	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N14	0,00000000	0,00000000	0,00000000	0,00001929	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00585578	0,01917693	0,00234180	0,00662295	0,00471352	0,00639026	0,00589626
N15	0,00000000	0,00000000	0,00000000	0,00000007	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00008373	0,00244313	0,00001078	0,00003023	0,00062132	0,00261653	0,00562885
N16	0,00000000	0,00000000	0,00000000	0,00000024	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00001888	0,00003838	0,00611421	0,00018387	0,00005334	0,00001899	0,00018022
N17	0,00000000	0,00000000	0,00000000	0,00000292	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00009701	0,00044532	0,00080831	0,01457060	0,00014803	0,00118282	0,00029751
N18	0,00000000	0,00000000	0,00000000	0,00000029	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00090574	0,00003954	0,00099609	0,00030585	0,00911327	0,00022676	0,00039784
N19	0,00000000	0,00000000	0,00000000	0,00000020	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00002695	0,00006246	0,00001261	0,00003093	0,00008698	0,00017617	0,00025920
N20	0,00000000	0,00000000	0,00000000	0,00002819	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00195868	0,00279152	0,00198938	0,00330617	0,00565844	0,00108956	0,00514674
N21	0,00000000	0,00000000	0,00000000	0,00028222	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00030297	0,00041480	0,00150569	0,00413233	0,00160721	0,00039050	0,00123289
N22	0,00000000	0,00000000	0,00000000	0,00000086	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00007231	0,00000162	0,00001116	0,00000964	0,00000641	0,00015840	0,00001529
N23	0,00000000	0,00000000	0,00000000	0,00009415	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00043702	0,00005036	0,00118116	0,00081171	0,00066142	0,00080345	0,00085703
N24	0,00000000	0,00000000	0,00000000	0,00000515	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00004083	0,00000886	0,00004916	0,00003108	0,00000496	0,00005387	0,00003307
N25	0,00000000	0,00000000	0,00000000	0,00000706	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00005075	0,00002350	0,00004297	0,00004550	0,00001335	0,00020819	0,00005750
N26	0,00000000	0,00000000	0,00000000	0,00044155	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00100285	0,00045748	0,00091626	0,00271009	0,00035196	0,00298313	0,00125099
N27	0,00000000	0,00000000	0,00000000	0,00076344	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00234169	0,00149285	0,00047054	0,00055916	0,00097748	0,00057098	0,00057717
N28	0,00000000	0,00000000	0,00000000	0,00000119	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000347	0,00000195	0,00000206	0,00000296	0,00000124	0,00000347	0,00000224
N29	0,00000000	0,00000000	0,00000000	0,00000131	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00006655	0,00009002	0,00006789	0,00011124	0,00019815	0,00003529	0,00017342
N30	0,00000000	0,00000000	0,00000000	0,00003132	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00023075	0,00005067	0,00076833	0,00006381	0,00005567	0,00012592	0,00052681
N31	0,00000000	0,00000000	0,00000000	0,00000321	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00001206	0,00001058	0,00001570	0,00000471	0,00010142	0,00000634	0,00001218
N32	0,00000000	0,00000000	0,00000000	0,00000088	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000296	0,00001185	0,00001990	0,00008176	0,00000481	0,00024286	0,00000293
N33	0,00000000	0,00000000	0,00000000	0,00000004	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000015	0,00000002	0,00000009	0,00000008	0,00000002	0,00000015	0,00000016
N34	0,00000000	0,00000000	0,00000000	0,00000177	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000543	0,00000346	0,00000108	0,00000126	0,00000226	0,00000130	0,00000133
N35	0,00000000	0,00000000	0,00000000	0,00001793	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00013765	0,00001611	0,00005950	0,00005828	0,00001436	0,00008007	0,00008086
N36	0,00000000	0,00000000	0,00000000	0,00000040	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000119	0,00000070	0,00000040	0,00000081	0,00000045	0,00000089	0,00000053
N37	0,00000000	0,00000000	0,00000000	0,00000075	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00003173	0,00000209	0,00000587	0,00000739	0,00000772	0,00000304	0,00000414
N38	0,00000000	0,00000000	0,00000000	0,00021726	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00230595	0,00366614	0,00075309	0,00087892	0,00052168	0,00099621	0,00228245
E06	0,00000000	0,00000000	0,00000000	0,00060708	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00644394	0,01024614	0,00210435	0,00245616	0,00145776	0,00278391	0,00637847
A40	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A41	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A42	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A43	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000

Table B.9 – Technical Coefficients Matrix of taxes less subsidies A_{ts} (Part XII).

	A32	A33	A34	E05	A35	A36	A37	A38	A39	N14	N15	N16	N17	N18	N19	N20
A44	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A45	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A46	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A47	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A48	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N39	0,00000000	0,00000000	0,00000000	0,00000151	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00002028	0,00002205	0,00001965	0,00000786	0,00000818	0,00019392	0,00001032
N40	0,00000000	0,00000000	0,00000000	0,00000778	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00026455	0,00013170	0,00011974	0,00007281	0,00007441	0,00010076	0,00012575
N41	0,00000000	0,00000000	0,00000000	0,00030928	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00178650	0,00156179	0,00232971	0,00127386	0,00203631	0,00137413	0,00145937
A49	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A50	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A51	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A52	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A53	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N42	0,00000000	0,00000000	0,00000000	0,00012929	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00163887	0,00056394	0,00404131	0,00269484	0,00069097	0,00262807	0,00418462
N43	0,00000000	0,00000000	0,00000000	0,00059115	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00570472	0,00495793	0,00232209	0,00555049	0,00224637	0,00213930	0,00301037
N44	0,00000000	0,00000000	0,00000000	0,00002571	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00017810	0,00004378	0,00008951	0,00006367	0,00005389	0,00007255	0,00013362
N45	0,00000000	0,00000000	0,00000000	0,00000534	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00004389	0,00000843	0,00011224	0,00001399	0,00004713	0,00005873	0,00011400
N46	0,00000000	0,00000000	0,00000000	0,00005679	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00007346	0,00000025	0,00012609	0,00000037	0,00004722	0,00005550	0,00034931
N47	0,00000000	0,00000000	0,00000000	0,00016222	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00053543	0,00053750	0,00313714	0,00106026	0,00204415	0,00097311	0,00108121
N48	0,00000000	0,00000000	0,00000000	0,00000092	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00001427	0,00000157	0,00000321	0,00000229	0,00000193	0,00000260	0,00000480
N49	0,00000000	0,00000000	0,00000000	0,00000144	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00001000	0,00000245	0,00000503	0,00000358	0,00000303	0,00000407	0,00000751
N50	0,00000000	0,00000000	0,00000000	0,00000630	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00004006	0,00001233	0,00005448	0,00002938	0,00001738	0,00002086	0,00004428
N51	0,00000000	0,00000000	0,00000000	0,00000032	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000118	0,00000107	0,00000582	0,00000202	0,00000371	0,00000188	0,00000229
N52	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000001	0,00000001	0,00000054	0,00000004	0,00000005	0,00000002	0,00000003
N53	0,00000000	0,00000000	0,00000000	0,00002579	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00023597	0,00031762	0,00020086	0,00012572	0,00013174	0,00013603	0,00025453

Table B.9 – Technical Coefficients Matrix of taxes less subsidies A_{ts} (Part XIII).

	N21	N22	N23	N24	N25	N26	N27	N28	N29	N30	N31	N32	N33	N34	N35	N36
N01	0,00058067	0,00002634	0,00022550	0,00004819	0,00003460	0,00004394	0,00000509	0,00000053	0,00000012	0,00000314	0,00000618	0,00000233	0,00000005	0,00000008	0,00002189	0,00000116
N02	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
E01	0,00001986	0,00000000	0,00005922	0,00000000	0,00000000	0,00000023	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000723	0,00000000
A01	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A02	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N03	0,00004394	0,00000000	0,00000517	0,00000111	0,00000032	0,00000096	0,00000004	0,00000000	0,00000000	0,00000006	0,00000000	0,00000005	0,00000000	0,00000000	0,00000133	0,00000000
E02	0,00000036	0,00000063	0,00016229	0,00000045	0,00000037	0,00000038	0,00000090	0,00000136	0,00000016	0,00000032	0,00000011	0,00000021	0,00000042	0,00000063	0,00000038	0,00000031
A03	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A04	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A05	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N04	0,00000009	0,00002277	0,00017866	0,00172612	0,00007154	0,00000128	0,00008910	0,00000006	0,00000005	0,00000056	0,00000005	0,00000006	0,00000004	0,00000003	0,00000053	0,00000006
N05	0,00000557	0,00203535	0,00536831	0,00059383	0,00398175	0,00043780	0,00012903	0,00000348	0,00000008	0,00006906	0,00000044	0,00000482	0,00000165	0,00000171	0,00012268	0,00000127
E03	0,00000002	0,00007527	0,00000058	0,00051374	0,00000003	0,00000002	0,00000007	0,00000011	0,00000001	0,00000001	0,00000000	0,00000001	0,00000003	0,00000005	0,00000081	0,00000002
A06	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A07	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A08	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A09	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A10	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A11	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A12	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A13	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A14	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A15	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A16	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N06	0,00005109	0,00003315	0,00002257	0,00000903	0,00002643	0,00001393	0,00001128	0,00001746	0,00000151	0,00002159	0,00004250	0,00011326	0,00000580	0,00000724	0,00002511	0,00000340
N07	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N08	0,00100356	0,00030192	0,00066699	0,00000321	0,00000359	0,00000921	0,00022816	0,00002887	0,00000072	0,00005691	0,00000247	0,00000855	0,00000720	0,00000910	0,00004503	0,00000606
N09	0,00000222	0,00000130	0,00000234	0,00000062	0,00000054	0,00002526	0,00000440	0,00000475	0,00000019	0,00000074	0,00000019	0,00000835	0,00000098	0,00000118	0,00007715	0,00000044
N10	0,00000208	0,00000043	0,00000041	0,00000040	0,00000056	0,00004328	0,00004688	0,00000108	0,00000017	0,00000049	0,00000048	0,00013755	0,00010511	0,00000374	0,00000046	0,00000044
N11	0,00001356	0,00000184	0,00163921	0,00000257	0,00001300	0,00026762	0,00013377	0,00007054	0,00001115	0,00002100	0,00087391	0,00002503	0,00000209	0,00000971	0,00016036	0,00015609
N12	0,00197998	0,00261337	0,00096698	0,00001600	0,00014304	0,00070110	0,00043978	0,00322835	0,00015735	0,00068042	0,00088288	0,00072132	0,00026713	0,00001194	0,00021247	0,00016209
N13	0,00022635	0,00023926	0,00000964	0,00003151	0,00012700	0,00006507	0,00000119	0,00000486	0,00000216	0,00000341	0,00000343	0,00033674	0,00005528	0,00000970	0,00001284	0,00015349
E04	0,00311807	0,00750950	0,00417837	0,00110330	0,00302767	0,00037448	0,00160026	0,00312195	0,00221066	0,00516769	0,00279697	0,00016436	0,00043496	0,00034322	0,00070726	0,00386989
A17	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A18	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A19	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A20	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A21	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A22	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A23	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A24	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A25	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A26	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000

Table B.9 – Technical Coefficients Matrix of taxes less subsidies A_{ts} (Part XIV).																
	N21	N22	N23	N24	N25	N26	N27	N28	N29	N30	N31	N32	N33	N34	N35	N36
A27	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A28	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A29	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A30	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A31	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A32	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A33	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A34	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
E05	0,00000991	0,00000148	0,00000865	0,00000112	0,00001626	0,00000073	0,00000527	0,00002908	0,00000025	0,00000056	0,00005191	0,00000028	0,00000199	0,00000189	0,00000085	0,00000065
A35	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A36	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A37	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A38	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A39	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N14	0,00332205	0,00057579	0,00113725	0,00137795	0,00144093	0,00114693	0,00036311	0,00013048	0,00001405	0,00026967	0,00005479	0,00028079	0,00002574	0,00002438	0,00018352	0,00002880
N15	0,01051252	0,00000117	0,00056158	0,00007602	0,00008513	0,00051683	0,00023767	0,00154386	0,00000003	0,00174121	0,00006381	0,00040789	0,00000047	0,00004300	0,00042561	0,00030717
N16	0,00006306	0,00000373	0,00000496	0,00000290	0,00000377	0,00000459	0,00000360	0,00001416	0,00000201	0,00001108	0,00000257	0,00031274	0,00002236	0,00001655	0,00001372	0,00000796
N17	0,00033823	0,00000627	0,00003055	0,00002763	0,00001809	0,00004569	0,00001141	0,00003898	0,00000001	0,00004385	0,00000517	0,00002706	0,00001276	0,00000207	0,00001413	0,00002327
N18	0,00001186	0,00061419	0,00016712	0,00002046	0,00065997	0,00021857	0,00036259	0,00000320	0,00025454	0,00000658	0,00000715	0,00002212	0,00000046	0,00004115	0,00005991	0,00000048
N19	0,00032589	0,00000797	0,00019774	0,00004844	0,00001322	0,00050110	0,00012294	0,00018675	0,00000004	0,00007032	0,00000773	0,00017982	0,00048142	0,00004074	0,00008243	0,00009347
N20	0,00125889	0,00082337	0,00035305	0,00006048	0,00049826	0,00023324	0,00002989	0,00002457	0,00000037	0,00057564	0,00102685	0,00339978	0,00000282	0,00000428	0,00022976	0,00000447
N21	0,00345814	0,00034781	0,00018663	0,00044452	0,00117697	0,00155373	0,00162595	0,00270139	0,00096324	0,00099449	0,00132488	0,00157712	0,00546799	0,00480977	0,00217662	0,00244694
N22	0,00000036	0,00380041	0,00848570	0,00001764	0,00002400	0,00000690	0,00000253	0,00002520	0,00000001	0,00000967	0,00000391	0,00000294	0,00000905	0,00000542	0,00001076	0,00000034
N23	0,00003882	0,00343046	0,00564249	0,00100068	0,00078644	0,00033023	0,00016663	0,00276389	0,00000090	0,00100881	0,00042826	0,00032087	0,00099310	0,00059776	0,00106725	0,00003953
N24	0,00057471	0,00133139	0,00043988	0,00517295	0,00197140	0,00879726	0,00719621	0,00792109	0,00018345	0,00365527	0,00065561	0,00120867	0,00321357	0,00264662	0,00605485	0,00404733
N25	0,00009659	0,00036104	0,00018703	0,00162804	0,00451331	0,00247009	0,00267987	0,00041820	0,00004662	0,00241266	0,00076124	0,00162767	0,00028234	0,00023684	0,00041519	0,00068008
N26	0,00095226	0,00050708	0,00068834	0,00418335	0,00455114	0,00522085	0,00645644	0,00261943	0,00153896	0,00444054	0,00323103	0,00228790	0,00370452	0,00077877	0,00184275	0,00144719
N27	0,00136934	0,00342308	0,00214120	0,00263529	0,00215934	0,00169710	0,00554887	0,00943142	0,00060263	0,00134597	0,00032148	0,00072974	0,00301080	0,00451717	0,00204882	0,00150066
N28	0,00000291	0,00000609	0,00000323	0,00000703	0,00001068	0,00000934	0,00008860	0,00765363	0,00001516	0,00002016	0,00100660	0,00000756	0,00001195	0,00000847	0,00000452	0,00000471
N29	0,00004818	0,00002946	0,00001271	0,00000266	0,00001772	0,00000849	0,00000544	0,00000448	0,00475254	0,00003105	0,00012593	0,00011810	0,00000193	0,00000232	0,00001241	0,00000106
N30	0,00058719	0,00219403	0,00031393	0,00012171	0,00029958	0,00011619	0,00456687	0,00519315	0,00542839	0,01181946	0,01623271	0,00318882	0,00558109	0,00333884	0,00057047	0,00112112
N31	0,00001637	0,00005097	0,00011679	0,00001300	0,00001488	0,00001062	0,00053381	0,00012169	0,05317827	0,00103235	0,03042770	0,00042961	0,00026959	0,00024386	0,00120636	0,00007847
N32	0,00005393	0,00000839	0,00000312	0,00000271	0,00000287	0,00000417	0,00115031	0,00340484	0,00004172	0,00044756	0,00009760	0,01098661	0,00032718	0,00016255	0,00008557	0,00000368
N33	0,00000064	0,00000095	0,00000022	0,00000011	0,00000009	0,00000004	0,00115999	0,00000002	0,00000003	0,00000226	0,00000003	0,00000026	0,00716285	0,00007960	0,00006139	0,00000021
N34	0,00000318	0,00000793	0,00000497	0,00000607	0,00000495	0,00000391	0,00002152	0,00002164	0,00000130	0,00000539	0,00000044	0,00000157	0,00006198	0,00489159	0,00064678	0,00065797
N35	0,00021939	0,00038604	0,00014481	0,00013719	0,00015320	0,00010153	0,00137330	0,00022673	0,00017166	0,00103859	0,00049359	0,00020880	0,01893270	0,02299318	0,01769590	0,00021084
N36	0,00000079	0,00000149	0,00000103	0,00000195	0,00000184	0,00000247	0,00000620	0,00000428	0,00000056	0,00000744	0,00000078	0,00000364	0,00000194	0,00000192	0,00007664	0,01667960
N37	0,00010516	0,00000566	0,00002429	0,00025839	0,00015041	0,00004026	0,00006232	0,00000810	0,00000146	0,00013219	0,00000302	0,00000331	0,00000620	0,00005486	0,00000526	0,00000433
N38	0,00133219	0,00279986	0,00299362	0,00219105	0,00441197	0,00119860	0,00076165	0,00060575	0,00038217	0,00137542	0,00045333	0,00082450	0,00066273	0,00070521	0,00089847	0,00077479
E06	0,00371815	0,00782472	0,00836261	0,00606898	0,01229949	0,00334292	0,00212819	0,00169264	0,00106784	0,00384365	0,00126673	0,00230399	0,00185214	0,00197083	0,00251076	0,00216510
A40	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A41	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A42	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A43	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000

Table B.9 – Technical Coefficients Matrix of taxes less subsidies A_{ts} (Part XV).

	N21	N22	N23	N24	N25	N26	N27	N28	N29	N30	N31	N32	N33	N34	N35	N36
A44	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A45	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A46	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A47	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A48	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N39	0,00007117	0,00007878	0,00007618	0,00001017	0,00002507	0,00000859	0,00001632	0,00003401	0,00000896	0,00006674	0,00006333	0,00000174	0,00025229	0,00009457	0,00001658	0,00004677
N40	0,00007953	0,00017756	0,00007574	0,00009608	0,00004572	0,00003878	0,00008196	0,00006522	0,00005743	0,00013012	0,00009582	0,00004921	0,00008700	0,00007040	0,00005341	0,00006464
N41	0,00161287	0,00558581	0,00135482	0,00295178	0,00207425	0,00158410	0,00134138	0,00181493	0,00081203	0,00159120	0,00187392	0,00105324	0,00197981	0,00176016	0,00146810	0,00066208
A49	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A50	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A51	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A52	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A53	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N42	0,00187191	0,00156679	0,00070577	0,00374606	0,00044193	0,00102508	0,00314404	0,00445826	0,00207638	0,00435350	0,00511646	0,00155267	0,00282862	0,00123617	0,00064170	0,00297008
N43	0,00249883	0,00392578	0,00212423	0,00391540	0,00389237	0,00228709	0,00470557	0,00329483	0,00168388	0,00382806	0,00616515	0,00185883	0,00351628	0,00419767	0,00280797	0,00268026
N44	0,00010499	0,00010545	0,00012024	0,00006303	0,00005115	0,00009409	0,00010583	0,00007148	0,00005358	0,00009412	0,00005203	0,00007484	0,00002234	0,00002756	0,00006707	0,00006931
N45	0,00002510	0,00008072	0,00004884	0,00004780	0,00001047	0,00000198	0,00005546	0,00000016	0,00000382	0,00000240	0,00000186	0,00007129	0,00000773	0,00000518	0,00001613	0,00002175
N46	0,00015569	0,00104755	0,00029699	0,00009001	0,00054952	0,00003554	0,00000061	0,00000041	0,00001437	0,00024881	0,00000030	0,00000043	0,00024538	0,00007475	0,00005216	0,00037569
N47	0,00050912	0,00124926	0,00074325	0,00025011	0,00015738	0,00039951	0,00025130	0,00105147	0,00279950	0,00074142	0,00131143	0,00046578	0,00155243	0,00159324	0,00067966	0,00117919
N48	0,00000377	0,00000378	0,00000431	0,00000226	0,00000183	0,00000338	0,00000379	0,00000254	0,00000192	0,00000338	0,00000187	0,00000269	0,00000079	0,00000098	0,00000240	0,00000249
N49	0,00000590	0,00000591	0,00000675	0,00000353	0,00000287	0,00000528	0,00000593	0,00000398	0,00000301	0,00000529	0,00000292	0,00000421	0,00000124	0,00000153	0,00000376	0,00000389
N50	0,00002998	0,00003391	0,00002770	0,00001627	0,00001626	0,00002416	0,00002171	0,00001917	0,00003012	0,00012435	0,00010837	0,00002717	0,00000909	0,00000957	0,00001600	0,00001524
N51	0,00000108	0,00000256	0,00000151	0,00000055	0,00000052	0,00000082	0,00000053	0,00000193	0,00000503	0,00000145	0,00000238	0,00000098	0,00000284	0,00000288	0,00000128	0,00000225
N52	0,00000001	0,00000003	0,00000002	0,00000001	0,00000000	0,00000001	0,00000001	0,00000002	0,00000006	0,00000002	0,00000003	0,00000003	0,00000003	0,00000003	0,00000001	0,00000003
N53	0,00015138	0,00034347	0,00027143	0,00022776	0,00037608	0,00012963	0,00008709	0,00009549	0,00011905	0,00015053	0,00010158	0,00009293	0,00012268	0,00012089	0,00010635	0,00010932

Table B.9 – Technical Coefficients Matrix of taxes less subsidies A_{ts} (Part XVI).																
	N37	N38	E06	A40	A41	A42	A43	A44	A45	A46	A47	A48	N39	N40	N41	A49
N01	0,00024484	0,00000014	0,00000589	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00003012	0,00000355	0,00000132	0,00000000
N02	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
E01	0,00006800	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A01	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A02	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N03	0,00016275	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000001	0,00000000	0,00000000
E02	0,00000027	0,00009392	0,00000013	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000029	0,00000080	0,00000028	0,00000000
A03	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A04	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A05	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N04	0,00000076	0,00000013	0,00000005	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000009	0,00000041	0,00000014	0,00000000
N05	0,00004457	0,00000022	0,00000006	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00131485	0,00000030	0,00000242	0,00000000
E03	0,00000001	0,00000000	0,00003085	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000002	0,00000000	0,00000000	0,00000000
A06	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A07	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A08	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A09	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A10	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A11	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A12	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A13	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A14	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A15	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A16	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N06	0,00018359	0,00005094	0,00032517	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00002702	0,00012675	0,00008955	0,00000000
N07	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000001	0,00000000	0,00000000
N08	0,00229879	0,00000135	0,00000019	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00006456	0,00011332	0,00013150	0,00000000
N09	0,00001115	0,00012435	0,00000010	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00001771	0,00005990	0,00019755	0,00000000
N10	0,00000566	0,00000049	0,00000003	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000161	0,00000015	0,00000026	0,00000000
N11	0,00833296	0,00000009	0,00000017	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00178010	0,00003509	0,00000015	0,00000000
N12	0,00322851	0,00001278	0,00008012	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00008061	0,00044144	0,00008399	0,00000000
N13	0,00001301	0,00001012	0,00015083	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00002929	0,00016562	0,00010286	0,00000000
E04	0,00080635	0,00208405	0,00531398	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00230638	0,00227419	0,02199324	0,00000000
A17	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A18	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A19	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A20	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A21	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A22	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A23	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A24	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A25	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A26	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000

Table B.9 – Technical Coefficients Matrix of taxes less subsidies A_{ts} (Part XVII).

	N37	N38	E06	A40	A41	A42	A43	A44	A45	A46	A47	A48	N39	N40	N41	A49
A27	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A28	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A29	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A30	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A31	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A32	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A33	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A34	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
E05	0,00000036	0,00002208	0,00008075	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000604	0,00047312	0,00012519	0,00000000
A35	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A36	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A37	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A38	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A39	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N14	0,00064673	0,00054119	0,00000122	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00009430	0,00000121	0,00000290	0,00000000
N15	0,00141932	0,00000110	0,00000001	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000224	0,00000003	0,00000004	0,00000000
N16	0,00001060	0,00000462	0,00000084	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000220	0,00000089	0,00000695	0,00000000
N17	0,00139367	0,00000865	0,00000001	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00007015	0,00000005	0,00000805	0,00000000
N18	0,00006163	0,00136131	0,00000011	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00005996	0,00000058	0,00008068	0,00000000
N19	0,00028642	0,00000807	0,00000001	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00137686	0,00000004	0,00001600	0,00000000
N20	0,00066918	0,00138527	0,00000022	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00019198	0,00000030	0,00000127	0,00000000
N21	0,00258338	0,00060785	0,00016060	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00152621	0,00042031	0,00112149	0,00000000
N22	0,00002334	0,00000031	0,00000001	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00455305	0,00000036	0,00000002	0,00000000
N23	0,00253110	0,00003417	0,00000051	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,01018884	0,00003502	0,00000028	0,00000000
N24	0,00205220	0,00000187	0,00000025	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00163828	0,00000233	0,00000145	0,00000000
N25	0,00056139	0,00000380	0,00027556	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00022090	0,00000239	0,00000790	0,00000000
N26	0,00245317	0,00002112	0,00000584	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00291496	0,00013936	0,00000901	0,00000000
N27	0,00082067	0,00008046	0,00030700	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00145821	0,00000637	0,00006900	0,00000000
N28	0,00000481	0,00000014	0,00000687	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00008597	0,00000031	0,00000079	0,00000000
N29	0,00002363	0,00004748	0,00000039	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000740	0,00006899	0,00000034	0,00000000
N30	0,00121110	0,00005499	0,00617174	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00139444	0,00014889	0,00070739	0,00000000
N31	0,00026461	0,00000311	0,00010927	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00003131	0,00000963	0,00011912	0,00000000
N32	0,00002000	0,00000105	0,00000960	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00017927	0,00005740	0,00000554	0,00000000
N33	0,00000009	0,00000091	0,00000015	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000016	0,00000326	0,00000784	0,00000000
N34	0,00000185	0,00000024	0,00000062	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000454	0,00000375	0,00024257	0,00000000
N35	0,00010137	0,00026335	0,00021814	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00013962	0,00094092	0,00227462	0,00000000
N36	0,00000140	0,00000008	0,00000012	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00003238	0,00008978	0,00029227	0,00000000
N37	0,00383024	0,00000042	0,00000013	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00055876	0,00000085	0,00028704	0,00000000
N38	0,00076041	0,00183853	0,02256204	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00010003	0,00096270	0,00062963	0,00000000
E06	0,00212477	0,00513770	0,06305744	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00027927	0,00268831	0,00175895	0,00000000
A40	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A41	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A42	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A43	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000

Table B.9 – Technical Coefficients Matrix of taxes less subsidies A_{ts} (Part XVIII).

	N37	N38	E06	A40	A41	A42	A43	A44	A45	A46	A47	A48	N39	N40	N41	A49
A44	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A45	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A46	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A47	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A48	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N39	0,00001430	0,00001472	0,00000138	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00059917	0,00002596	0,00000678	0,00000000
N40	0,00002774	0,00010295	0,00005127	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00002382	0,00008991	0,00031989	0,00000000
N41	0,00076693	0,00411532	0,00033059	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00039376	0,00306740	0,00579699	0,00000000
A49	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A50	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A51	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A52	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A53	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N42	0,00029155	0,00332607	0,00252144	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00036327	0,00214286	0,00186497	0,00000000
N43	0,00138663	0,00091861	0,00166152	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00088583	0,00202790	0,00246767	0,00000000
N44	0,00009809	0,00015032	0,00005926	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00006047	0,00047024	0,00015943	0,00000000
N45	0,00000063	0,00001161	0,00000900	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00001151	0,00003657	0,00061958	0,00000000
N46	0,00011447	0,00008483	0,00000034	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00020111	0,00022355	0,00054216	0,00000000
N47	0,00027650	0,00349955	0,00195924	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00074335	0,00201546	0,00143503	0,00000000
N48	0,00000352	0,00000540	0,00000213	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000216	0,00001689	0,00000573	0,00000000
N49	0,00000551	0,00000845	0,00000333	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000338	0,00002645	0,00000897	0,00000000
N50	0,00001987	0,00007816	0,00039156	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00004161	0,00039218	0,00004869	0,00000000
N51	0,00000061	0,00000638	0,00000408	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000140	0,00000400	0,00000277	0,00000000
N52	0,00000001	0,00000008	0,00000004	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000002	0,00000004	0,00000003	0,00000000
N53	0,00007814	0,00030806	0,00178138	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00003380	0,00018623	0,00018014	0,00000000

Table B.9 – Technical Coefficients Matrix of taxes less subsidies A_{ts} (Part XIX).

	A50	A51	A52	A53	N42	N43	N44	N45	N46	N47	N48	N49	N50	N51	N52	N53
N01	0,00000000	0,00000000	0,00000000	0,00000000	0,00000078	0,00000059	0,00000019	0,00000761	0,00184585	0,00000108	0,00006168	0,00005451	0,00029496	0,00018986	0,00003409	0,00003953
N02	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
E01	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000297	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A01	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A02	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N03	0,00000000	0,00000000	0,00000000	0,00000000	0,00000001	0,00000000	0,00000000	0,00000000	0,00049341	0,00000001	0,00000067	0,00003211	0,00018216	0,00008177	0,00002879	0,00003089
E02	0,00000000	0,00000000	0,00000000	0,00000000	0,00000095	0,00000018	0,00000015	0,00000023	0,00012440	0,00000049	0,00000085	0,00007525	0,00000044	0,00000689	0,00000338	0,00000644
A03	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A04	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A05	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N04	0,00000000	0,00000000	0,00000000	0,00000000	0,00000047	0,00000010	0,00000012	0,00000012	0,00000023	0,00000024	0,00000034	0,00000020	0,00000024	0,00000027	0,00000018	0,00000034
N05	0,00000000	0,00000000	0,00000000	0,00000000	0,00000021	0,00000004	0,00000009	0,00000012	0,00000811	0,00000011	0,00000052	0,00000134	0,00002058	0,00000478	0,00000196	0,00000610
E03	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000002	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A06	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A07	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A08	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A09	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A10	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A11	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A12	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A13	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A14	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A15	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A16	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N06	0,00000000	0,00000000	0,00000000	0,00000000	0,00000677	0,00001322	0,00001243	0,00000812	0,06371315	0,00000798	0,00018083	0,00094272	0,00329275	0,00189332	0,00064964	0,00075062
N07	0,00000000	0,00000000	0,00000000	0,00000000	0,00000001	0,00000000	0,00000000	0,00000000	0,00000001	0,00000001	0,00000001	0,00000001	0,00000001	0,00000001	0,00000000	0,00000001
N08	0,00000000	0,00000000	0,00000000	0,00000000	0,00000122	0,00000036	0,00000288	0,00032720	0,00024628	0,00000201	0,00000120	0,00048342	0,00110840	0,00000108	0,00000275	0,00000494
N09	0,00000000	0,00000000	0,00000000	0,00000000	0,00004160	0,00008952	0,00000011	0,00000181	0,00013809	0,00031583	0,00000066	0,00037544	0,00060861	0,00000811	0,00001410	0,00003768
N10	0,00000000	0,00000000	0,00000000	0,00000000	0,00000025	0,00000019	0,00000003	0,00001052	0,00000023	0,00000050	0,00000055	0,00000212	0,00014154	0,00000043	0,00000028	0,00000048
N11	0,00000000	0,00000000	0,00000000	0,00000000	0,00000581	0,00000016	0,00000012	0,00000026	0,00000013	0,00000029	0,00000118	0,00000034	0,00003735	0,00000455	0,00000314	0,00001146
N12	0,00000000	0,00000000	0,00000000	0,00000000	0,00025763	0,00036790	0,00013537	0,00054945	0,00017607	0,00021551	0,00044078	0,00110464	0,00084057	0,00011043	0,00020606	0,00019723
N13	0,00000000	0,00000000	0,00000000	0,00000000	0,00101433	0,00081136	0,00011608	0,00003323	0,00001022	0,00382449	0,00010927	0,00035996	0,00051981	0,00048991	0,00029549	0,00022146
E04	0,00000000	0,00000000	0,00000000	0,00000000	0,00030776	0,00038761	0,00020577	0,00051533	0,00054713	0,00099574	0,00187494	0,00119134	0,00107156	0,00013582	0,00032546	0,00161291
A17	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A18	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A19	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A20	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A21	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A22	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A23	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A24	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A25	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A26	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000

Table B.9 – Technical Coefficients Matrix of taxes less subsidies A_{ts} (Part XX).																
	A50	A51	A52	A53	N42	N43	N44	N45	N46	N47	N48	N49	N50	N51	N52	N53
A27	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A28	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A29	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A30	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A31	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A32	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A33	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A34	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
E05	0,00000000	0,00000000	0,00000000	0,00000000	0,00000183	0,00001073	0,00008208	0,00000003	0,00001566	0,00000393	0,00002720	0,00010020	0,00002163	0,00000999	0,00003706	0,00011408
A35	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A36	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A37	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A38	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A39	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N14	0,00000000	0,00000000	0,00000000	0,00000000	0,00002662	0,00000229	0,00000160	0,00003035	0,00002369	0,00001401	0,00002353	0,00033972	0,00004766	0,00000786	0,00030814	0,00000570
N15	0,00000000	0,00000000	0,00000000	0,00000000	0,00000004	0,00000005	0,00000003	0,00000045	0,00000004	0,00000008	0,00000059	0,00000037	0,00000171	0,00000023	0,00000064	0,00000015
N16	0,00000000	0,00000000	0,00000000	0,00000000	0,00000130	0,00000021	0,00000040	0,00000162	0,00000118	0,00000080	0,00021156	0,00546262	0,00008352	0,00039662	0,01116676	0,00063097
N17	0,00000000	0,00000000	0,00000000	0,00000000	0,00000019	0,00000021	0,00000013	0,00000205	0,00021592	0,00022458	0,00001038	0,00047136	0,00000043	0,00000457	0,00000649	0,00000277
N18	0,00000000	0,00000000	0,00000000	0,00000000	0,00029388	0,00001025	0,00004363	0,00010189	0,00076586	0,00038444	0,00019301	0,00181901	0,00145223	0,00002832	0,00001974	0,00004729
N19	0,00000000	0,00000000	0,00000000	0,00000000	0,00000008	0,00000029	0,00000457	0,00005608	0,00000005	0,00000039	0,00035251	0,00000266	0,00000937	0,00015870	0,00006593	0,00009546
N20	0,00000000	0,00000000	0,00000000	0,00000000	0,00000044	0,00005434	0,00000010	0,00010783	0,00000106	0,00006935	0,00028799	0,00036978	0,00002253	0,00009346	0,00073334	0,00005973
N21	0,00000000	0,00000000	0,00000000	0,00000000	0,00109015	0,00001671	0,00008233	0,00031508	0,00015460	0,00101581	0,00000643	0,00221981	0,00023200	0,00000573	0,00004335	0,00000651
N22	0,00000000	0,00000000	0,00000000	0,00000000	0,00000005	0,00000001	0,00000001	0,00000001	0,00000010	0,00000003	0,00000003	0,00001235	0,00000384	0,00000033	0,00000435	0,00000040
N23	0,00000000	0,00000000	0,00000000	0,00000000	0,00000072	0,00000014	0,00000027	0,00000034	0,00000028	0,00000047	0,00000347	0,00134791	0,00039528	0,00002984	0,00047225	0,00003429
N24	0,00000000	0,00000000	0,00000000	0,00000000	0,00000185	0,00000010	0,00000025	0,00000770	0,00000109	0,00000053	0,00000163	0,00000503	0,00000075	0,00000082	0,00000461	0,00000312
N25	0,00000000	0,00000000	0,00000000	0,00000000	0,00021524	0,00000460	0,00000071	0,00001438	0,00000119	0,00000275	0,00000588	0,00000953	0,00000945	0,00001324	0,00000710	0,00000460
N26	0,00000000	0,00000000	0,00000000	0,00000000	0,00011124	0,00000045	0,00000150	0,00042804	0,00009489	0,00000996	0,00001224	0,00039636	0,00007022	0,00004854	0,00033591	0,00026177
N27	0,00000000	0,00000000	0,00000000	0,00000000	0,00038367	0,00000097	0,00010910	0,00005565	0,00000206	0,00022135	0,00191907	0,00017112	0,00001303	0,00000377	0,00000756	0,00004967
N28	0,00000000	0,00000000	0,00000000	0,00000000	0,00000193	0,00000006	0,00000018	0,00362692	0,00042475	0,00000047	0,00000198	0,00000088	0,00055179	0,00000010	0,00000045	0,00000038
N29	0,00000000	0,00000000	0,00000000	0,00000000	0,00035670	0,00004429	0,00000014	0,00001057	0,00000003	0,00005985	0,00001062	0,00008828	0,00000156	0,00002778	0,00003480	0,00002379
N30	0,00000000	0,00000000	0,00000000	0,00000000	0,00119579	0,00004826	0,00005401	0,00227697	0,00000859	0,00016354	0,00000763	0,00036631	0,00113950	0,00002189	0,00014490	0,00006267
N31	0,00000000	0,00000000	0,00000000	0,00000000	0,00138954	0,00000188	0,00003040	0,00246808	0,00000022	0,00049662	0,00000642	0,00000743	0,00013742	0,00000439	0,00000325	0,00000407
N32	0,00000000	0,00000000	0,00000000	0,00000000	0,00000363	0,00000029	0,00000044	0,00141591	0,00000038	0,00030585	0,00000212	0,00049864	0,00027611	0,00008447	0,00055859	0,00003124
N33	0,00000000	0,00000000	0,00000000	0,00000000	0,00000017	0,00000001	0,00000023	0,00150756	0,00000002	0,00000097	0,00000001	0,00000001	0,00000003	0,00000002	0,00000003	0,00000007
N34	0,00000000	0,00000000	0,00000000	0,00000000	0,00000097	0,00000002	0,00000028	0,00001971	0,00000005	0,00000059	0,00000451	0,00000041	0,00000005	0,00000005	0,00000004	0,00000181
N35	0,00000000	0,00000000	0,00000000	0,00000000	0,00009248	0,00000496	0,00006862	0,00592164	0,00000461	0,00028594	0,00000588	0,00002107	0,00004210	0,00001040	0,00001437	0,00002270
N36	0,00000000	0,00000000	0,00000000	0,00000000	0,00000034	0,00000021	0,00000014	0,00019893	0,00000010	0,00000020	0,00000101	0,00000022	0,00000035	0,00000064	0,00000018	0,00004179
N37	0,00000000	0,00000000	0,00000000	0,00000000	0,00000232	0,00119195	0,00008968	0,00106872	0,00000078	0,00021759	0,00062399	0,00001273	0,00171130	0,00327293	0,00013427	0,00006541
N38	0,00000000	0,00000000	0,00000000	0,00000000	0,00064732	0,00032528	0,00006817	0,00031173	0,00093227	0,00046831	0,00094998	0,00123313	0,00248553	0,00151154	0,00103658	0,00090262
E06	0,00000000	0,00000000	0,00000000	0,00000000	0,00180657	0,00090860	0,00019015	0,00087056	0,00260427	0,00130753	0,00265335	0,00344535	0,00694543	0,00422345	0,00000000	0,00000000
A40	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A41	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A42	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A43	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000

Table B.9 – Technical Coefficients Matrix of taxes less subsidies A_{ts} (Part XXI).

	A50	A51	A52	A53	N42	N43	N44	N45	N46	N47	N48	N49	N50	N51	N52	N53
A44	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A45	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A46	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A47	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A48	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N39	0,00000000	0,00000000	0,00000000	0,00000000	0,00015318	0,00014689	0,00069306	0,00000454	0,00000902	0,00006827	0,00063347	0,00011350	0,00027252	0,00122707	0,00044023	0,00065784
N40	0,00000000	0,00000000	0,00000000	0,00000000	0,00046018	0,00014882	0,00002984	0,00003892	0,00002707	0,00026897	0,00024029	0,00023391	0,00011894	0,00005451	0,00009606	0,00014186
N41	0,00000000	0,00000000	0,00000000	0,00000000	0,00136549	0,00047470	0,00010503	0,00008374	0,00019749	0,00076725	0,00074444	0,00137618	0,00217999	0,00042617	0,00094598	0,00041227
A49	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A50	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A51	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A52	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A53	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N42	0,00000000	0,00000000	0,00000000	0,00000000	0,02887806	0,00937734	0,00045466	0,00118899	0,00096880	0,02290176	0,01081198	0,00530824	0,00497722	0,00334513	0,00427661	0,01162421
N43	0,00000000	0,00000000	0,00000000	0,00000000	0,00279539	0,01038843	0,00062745	0,00048825	0,00069298	0,00169822	0,00094239	0,00064187	0,00036995	0,00002262	0,00004824	0,00639387
N44	0,00000000	0,00000000	0,00000000	0,00000000	0,00053098	0,00010403	0,00008028	0,00013686	0,00026696	0,00027474	0,00035083	0,00022112	0,00025988	0,00022207	0,00018112	0,00035034
N45	0,00000000	0,00000000	0,00000000	0,00000000	0,00055321	0,00015765	0,00005711	0,00003441	0,00002248	0,00017557	0,00037841	0,00049904	0,00015599	0,00002754	0,00007454	0,00006034
N46	0,00000000	0,00000000	0,00000000	0,00000000	0,00043053	0,00042062	0,00007405	0,00000079	0,00023436	0,00025015	0,00263615	0,00217709	0,00132385	0,00011590	0,00254108	0,00137344
N47	0,00000000	0,00000000	0,00000000	0,00000000	0,00344165	0,00253200	0,00063030	0,00007544	0,00028868	0,00148344	0,00280685	0,00340425	0,00172548	0,00135529	0,00434508	0,00190557
N48	0,00000000	0,00000000	0,00000000	0,00000000	0,00001907	0,00006315	0,00000287	0,00000492	0,00000959	0,00000987	0,00001259	0,00001498	0,00000933	0,00007290	0,00012383	0,00005955
N49	0,00000000	0,00000000	0,00000000	0,00000000	0,00002986	0,00000585	0,00000450	0,00000770	0,00001501	0,00001545	0,00001971	0,00001243	0,00001461	0,00001246	0,00001018	0,00001969
N50	0,00000000	0,00000000	0,00000000	0,00000000	0,00052325	0,00024926	0,00003447	0,00002931	0,00045185	0,00052539	0,00016239	0,00052834	0,00047472	0,00004616	0,00109929	0,00015093
N51	0,00000000	0,00000000	0,00000000	0,00000000	0,00000682	0,00000502	0,00000122	0,00000024	0,00000077	0,00000387	0,00000563	0,00000665	0,00000362	0,00000292	0,00000866	0,00000402
N52	0,00000000	0,00000000	0,00000000	0,00000000	0,00000007	0,00000006	0,00000001	0,00000000	0,00000001	0,00000003	0,00000008	0,00000049	0,00000004	0,00000006	0,00000095	0,00000009
N53	0,00000000	0,00000000	0,00000000	0,00000000	0,00022732	0,00014073	0,00002844	0,00003026	0,00009495	0,00024157	0,00017292	0,00022719	0,00027686	0,00018104	0,00025547	0,00015357

Table B.10 – Vectors a_{expts}, a_{gts}, $a_{cpishts}$, a_{cfts}, a_{gfcfts}, a_{scts} (Part I).						
	a_{expts}	a_{gts}	$a_{cnpishts}$	a_{cfts}	a_{gfcfts}	a_{scts}
N01	0,00323379	0,00000000	0,00000000	0,00191890	0,00065802	-0,00943250
N02	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
E01	0,00000000	0,00000000	0,00000000	0,00000980	0,00002134	-0,00055995
A01	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A02	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N03	0,00066661	0,00000000	0,00000000	0,00077727	0,00168241	-0,00599663
E02	0,00003403	0,00000000	0,00000000	0,00023618	0,00000266	-0,00058541
A03	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A04	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A05	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N04	0,00156730	0,00000000	0,00000000	0,00000034	0,00000098	0,00329814
N05	0,00035089	0,00000000	0,00000000	0,00002589	0,00000233	0,00861016
E03	0,00000004	0,00000000	0,00000000	0,00000000	0,00000020	0,00028355
A06	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A07	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A08	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A09	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A10	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A11	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A12	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A13	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A14	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A15	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A16	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N06	0,01044414	0,00000035	0,00000000	0,01378398	0,00002769	0,03158975
N07	0,00495897	0,00000000	0,00000000	0,00335855	0,00000001	0,00823994
N08	0,00042079	0,00000000	0,00000000	0,00052134	0,00000835	0,00084072
N09	0,00008128	0,00000000	0,00000000	0,00270231	0,00000677	-0,00110481
N10	0,00138958	0,00000000	0,00000000	0,00167821	0,00000135	-0,00321589
N11	0,00072526	0,00000000	0,00000000	0,00003288	0,00004546	0,00445003
N12	0,00181785	0,00000039	0,00000000	0,00050011	0,00003208	-0,00046129
N13	0,00002898	0,00000000	0,00000000	0,00045291	0,00000175	0,00807051
E04	0,00294354	0,00000000	0,00000000	0,00423897	0,00005042	0,03048635
A17	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A18	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A19	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A20	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A21	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A22	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A23	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A24	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A25	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A26	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A27	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A28	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A29	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A30	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A31	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A32	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A33	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A34	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
E05	0,00054742	0,00000000	0,00000000	0,00051552	0,00001077	0,01759534
A35	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A36	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A37	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A38	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A39	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N14	0,00059512	0,00000016	0,00000000	0,00011423	0,00008030	-0,00128247
N15	0,00027358	0,00000000	0,00000000	0,00000023	0,00000117	-0,00009183
N16	0,00091747	0,00125499	0,00000000	0,00403086	0,00000379	-0,00117538

Table B.10 – Vectors $\mathbf{a}_{expts}$, $\mathbf{a}_{gts}$, $\mathbf{a}_{cpishts}$, $\mathbf{a}_{cfts}$, $\mathbf{a}_{gfcfts}$, $\mathbf{a}_{scts}$ (Part II).						
	$\mathbf{a}_{expts}$	$\mathbf{a}_{gts}$	$\mathbf{a}_{cnpishts}$	$\mathbf{a}_{cfts}$	$\mathbf{a}_{gfcfts}$	$\mathbf{a}_{scts}$
N17	0,00016645	0,00000000	0,00000000	0,00001614	0,00000031	-0,00785710
N18	0,00054341	0,00000026	0,00000000	0,00373345	0,00000329	-0,00967722
N19	0,00004989	0,00000000	0,00000000	0,00006397	0,00000037	0,00094859
N20	0,00033893	0,00000029	0,00000000	0,00003076	0,00000728	0,00026817
N21	0,00058396	0,00000000	0,00000000	0,00017440	0,00004783	0,00640443
N22	0,00002140	0,00000000	0,00000000	0,00005716	0,00000003	-0,00196492
N23	0,00067416	0,00000000	0,00000000	0,00004918	0,00002211	0,00488887
N24	0,00152984	0,00000000	0,00000000	0,00000202	0,00003880	0,01895489
N25	0,00103003	0,00000000	0,00000000	0,00001335	0,00007684	-0,00423465
N26	0,00071134	0,00000000	0,00000000	0,00021110	0,00260655	0,00946254
N27	0,00309656	0,00000000	0,00000000	0,00022244	0,01678135	-0,03415388
N28	0,00056945	0,00000000	0,00000000	0,00433648	0,00042877	-0,03765642
N29	0,00013694	0,00000000	0,00000000	0,00022126	0,00397519	-0,00215049
N30	0,00139154	0,00000000	0,00000000	0,00017524	0,00241313	-0,00857689
N31	0,00108562	0,00000000	0,00000000	0,00089275	0,00397675	0,01547346
N32	0,00039947	0,00000000	0,00000000	0,00078965	0,00338882	0,00445663
N33	0,00309439	0,00000000	0,00000000	0,00618779	0,01246189	-0,06127069
N34	0,00081447	0,00000000	0,00000000	0,00005644	0,00367528	-0,00482855
N35	0,00127065	0,00000000	0,00000000	0,00012629	0,00036533	0,01528314
N36	0,00133203	0,00000000	0,00000000	0,00025684	0,00087773	-0,01223051
N37	0,00077155	0,00000000	0,00000000	0,00282649	0,00299235	0,02739453
N38	0,00026171	0,00000000	0,00000000	0,00166896	0,00000072	-0,00014672
E06	0,00073078	0,00000000	0,00000000	0,00466257	0,00000073	0,00000000
A40	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A41	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A42	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A43	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A44	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A45	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A46	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A47	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A48	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N39	0,00011976	0,00000000	0,00000000	0,00000931	0,01129535	0,00000000
N40	0,00004787	0,00000000	0,00000000	0,00019789	0,00001771	-0,00005238
N41	0,00127048	0,00000000	0,00000000	0,00405302	0,00000935	-0,00001775
A49	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A50	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A51	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A52	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A53	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
N42	0,00057468	0,00000000	0,00000000	0,00593340	0,00000089	0,00000000
N43	0,00062680	0,00022757	0,00000000	0,00555396	0,00000216	0,00000000
N44	0,00013646	0,00000000	0,00000000	0,00040088	0,00026997	-0,00000243
N45	0,00000011	0,00000000	0,00000000	0,00039600	0,00000009	0,00000224
N46	0,00291460	0,00000000	0,00000000	0,00585772	0,00000153	-0,00000002
N47	0,00247219	0,00000000	0,00000000	0,00038699	0,00017521	0,00000029
N48	0,00000655	0,00000000	0,00000000	0,00083341	0,00000947	0,00000000
N49	0,00001851	0,00116703	0,00396888	0,00232113	0,00001483	0,00000000
N50	0,00025294	0,00000000	0,01538117	0,00301077	0,00004586	0,00000000
N51	0,00000499	0,00000063	0,00000249	0,00000557	0,00000073	0,00000154
N52	0,00000042	0,00003141	0,00010651	0,00006200	0,00000000	-0,00000009
N53	0,00011590	0,00000328	0,00007739	0,00027522	0,00000919	0,00018583

III. Assumptions for the households and NPISH consumption (expressions 5.2 to 5.7)

Some deterministic and interval bounds for the main variables are also defined in order to provide basis for obtaining more realistic results and taken into account the uncertainties associated. However, only a small set of variables presents official projections for the year of analysis by which some procedures are applied in this study to overcome the lack of data.

The calculation of the deflator of consumption of resident's households (pcpr) are based on the consolidated time series of the consumption of resident's households at current prices and the real growth rates of consumption of resident's households for the period of 2000 to 2012 provided by IBGE. For the period from 2013 to 2018 the Brazilian implicit price deflator for GDP (hereafter called the GDP deflator) provided by the IMF is considered.

The computation of the consumption of resident's households (cpr) at constant prices of 2009 for the period of 2000 to 2012 uses as basis the consolidated time series of the consumption of resident's households at current prices provided by IBGE. Another procedure to obtain the consumption of resident's households at current prices for the period 2013 to 2018 is adopted. A ratio of the consumption of resident's households at current prices on the total GDP at current prices is estimated for each year of the period 2000-2012 considering the consolidated values. Next, the minimum, maximum and average ratio are multiplied by the corresponding values estimated for the GDP at current prices in the period 2013–2018 obtaining the minimum, maximum and average values of consumption of resident's households at current prices. Thus, the values at current prices of the whole series are used to estimate the values at constant prices of 2009 (the base year) considering the deflator of consumption of resident's households.

The exports (cpe) and imports (cpm) of tourism services, and the consumption of NPISH (cnpish) at constant prices of 2009 are computed based on the their consolidated values at current prices provided by IBGE for the period 2000–2012 and the real growth rate of the consumption of resident's households such that minimum, maximum and average values for the whole series are obtained. The final consumption expenditure of resident's households on the territory (cfr) at constant prices of 2009 is obtained by subtracting cpm and cnpish from cpr, whereas the total final consumption expenditure of households on the territory (cf) is calculated by the sum of cfr and cpe.

The disposable income of households and NPISH at current prices is estimate from the values of their components presented in subsequent sections. The disposable income of households and NPISH at constant prices of 2009 is estimated from the values of current prices and the deflator of the consumption of resident's households such that maximum, minimum and average values for the period 2013 to 2018 are obtained.

The average propensity to consume is used in the calculation of the consumption of resident's households instead of the marginal propensity to consume in order to overcome problems of stability in the series used. Hence, the consumption of resident's households shall only be linearly dependent on disposable income at constant prices such that the autonomous component of consumption becomes null.

Thus, deterministic and interval bounds are defined (according to the model used) considering the estimated values for the year of analysis (2018). The upper bounds have considered the maximum value calculated for each variable in the year of analysis plus a positive deviation of 0.5% in the deterministic approach and a variation of ± 0.5% of this value in the interval approach. The lower bound is defined (for both deterministic and interval approaches) as the values obtained for this variable in the base year (2009).

$cpr \leq cpr^U \Leftrightarrow cpr \leq 2{,}781{,}980.57$,

$cpr \leq cpr^* \Leftrightarrow cpr \leq [2{,}754{,}299.18 - 2{,}781{,}980.57]$,

$cf \leq cf^U \Leftrightarrow cf \leq 2{,}687{,}409.23$

$cf^* \leq [2660668.84 - 2687409.23]$

$cfr \leq cfr^U \Leftrightarrow cfr \leq 2676754.88$

$cfr \leq cfr^* \Leftrightarrow cfr \leq [2650120.50 - 2676754.88]$

$cpm \leq cpm^U \Leftrightarrow cpm \leq 36{,}457.03$

$cpm^* \leq [36{,}094.27 - 36{,}457.03]$

$cpe^L \leq cpe \leq cpe^U \Leftrightarrow 10{,}439.08 \leq cpe \leq 10{,}654.35$

$cpe \leq cpe^* \Leftrightarrow cpe \leq [10{,}439.08 - 11{,}131.41]$

$cnpish^L \leq cnpish \leq cnpish^U \Leftrightarrow 39{,}229.00 \leq cnpish \leq 68{,}768.67$

$yd \leq yd^U \Leftrightarrow yd \leq 3023925.32$

$yd \leq yd^* \Leftrightarrow yd \leq [3008805.69 - 3039044.95]$

$\beta 1 = 0.940623$

$\beta 1^* = [0.939847 - 0.941399]$

$\alpha = 0.009472$

$\alpha^* = [0.00946386 - 0.009479488]$

The vectors $\mathbf{a}_{cf}$ and $\mathbf{a}_{npish}$ are calculated from the hybrid IO framework and previously given in table B.6. The basic data used to obtain the bounds are outlined in table B.11.

Table B.11 – Auxiliary table for the calculation of the consumption bounds.

		yd	cpr	cnpish	cpm	cpe
2000		1,553,156.79	1,455,418.11	33,137.89	13,743.55	5,852.80
2001		1,564,418.40	1,465,358.69	33,511.64	13,951.75	5,903.51
2002		1,601,869.36	1,493,826.98	35,911.20	12,302.61	7,238.76
2003		1,577,689.16	1,482,101.22	33,724.66	12,103.47	8,252.67
2004		1,634,633.23	1,538,728.49	35,223.81	13,713.27	9,496.83
2005		1,688,360.55	1,607,424.25	36,029.56	14,875.08	10,081.89
2006		1,778,441.50	1,690,992.46	36,625.60	17,619.28	10,131.09
2007		1,892,182.56	1,793,851.73	35,683.00	21,121.16	10,511.99
2008		1,992,053.83	1,895,590.57	37,126.84	24,364.34	9,984.86
2009		2,091,050.96	1,979,751.00	39,229.00	22,513.17	10,439.08
2010		2,309,277.15	2,117,243.81	41,953.44	30,580.92	9,705.68
2011 E	Maximum	2,214,613.36	2,159,894.98	43,670.24	33,562.12	9,276.44
	Minimum	2,532,970.52	2,159,894.98	43,670.24	33,562.12	9,276.44
	Average	2,370,803.92	2,159,894.98	43,670.24	33,562.12	9,276.44
2012 E	Maximum	2,180,602.87	2,250,308.06	44,590.12	36,916.47	10,664.55
	Minimum	2,499,199.50	2,250,308.06	44,590.12	36,916.47	10,664.55
	Average	2,336,956.78	2,250,308.06	44,590.12	36,916.47	10,664.55
2013 E	Maximum	2,585,142.46	2,366,472.44	58,497.59	33,259.09	9,107.25
	Minimum	2,161,803.86	2,161,566.18	47,887.15	18,382.31	9,460.12
	Average	2,381,093.91	2,239,711.17	52,494.42	25,141.34	9,315.73
2014 E	Maximum	2,649,822.72	2,425,681.58	59,961.20	31,947.95	8,550.82
	Minimum	2,215,892.19	2,215,648.57	49,085.29	17,555.54	9,368.04
	Average	2,440,668.88	2,295,748.74	53,807.83	24,003.51	9,044.07
2015 E	Maximum	2,734,060.59	2,502,794.00	61,867.36	32,685.30	8,637.38
	Minimum	2,286,335.41	2,286,084.03	50,645.71	17,242.86	9,471.58
	Average	2,518,257.74	2,368,730.60	55,518.38	23,909.61	9,142.55
2016 E	Maximum	2,824,831.40	2,585,886.76	63,921.36	33,944.98	9,157.49
	Minimum	2,362,241.74	2,361,982.02	52,327.15	17,110.94	9,423.54
	Average	2,601,863.90	2,447,372.45	57,361.59	24,118.59	9,270.99
2017 E	Maximum	2,922,683.56	2,675,461.88	66,135.60	34,917.40	10,155.23
	Minimum	2,444,069.80	2,443,801.08	54,139.76	16,551.81	8,807.71
	Average	2,691,992.46	2,532,149.43	59,348.59	24,537.01	9,420.71
2018 E	Maximum	3,023,925.32	2,768,139.87	68,426.53	36,275.65	10,601.34
	Minimum	2,528,732.37	2,528,454.35	56,015.16	16,007.25	7,779.14
	Average	2,785,243.08	2,619,863.09	61,404.43	24,814.49	9,634.31

IV. Assumptions for the consumption of the general government (expression 5.8)

The consumption of goods or services by the general government (g) at constant prices of 2009 is estimated similarly to the consumption of resident's households at constant prices using as basis the consolidated time series of the general government at current prices and the real growth rates for the period from 2000 to 2012, while the estimated the minimum, maximum and average values and the GDP deflator are used for the period 2013-2018. Thus, the lower bound is defined as the value of this variable in the base year and the upper bound is defined as the maximum value of this variable obtained in the year of analysis plus a positive deviation of 0.5% :

$g^L \leq g \leq g^U \Leftrightarrow 687{,}001.00 \leq g \leq 922{,}815.62$

The vectors $\mathbf{a}_g$ is calculated from the hybrid IO framework and previously given in table B.6. The basic data used to obtain the bounds are outlined in table B.12.

Table B.12 – Auxiliary table for the calculation of the consumption of the general government, GFCF, changes in inventories, exports and imports bounds.

		g	gfcf	sc	expcpt	impfob
2000		516,618.87	430,534.94	51,283.16	208,854.87	220,285.25
2001		530,788.56	432,412.21	39,146.26	230,413.25	223,622.33
2002		555,978.30	409,788.62	24,566.82	253,299.78	197,189.42
2003		562,394.90	390,962.80	49,821.93	278,115.04	193,997.56
2004		585,411.39	426,626.26	63,758.82	321,444.93	219,800.01
2005		598,896.98	442,094.59	41,205.86	350,792.08	238,421.78
2006		614,324.89	485,300.73	35,450.28	369,205.89	282,406.46
2007		645,812.77	552,516.22	44,862.12	391,795.26	338,535.58
2008		666,290.75	627,510.06	57,045.19	394,202.14	390,518.18
2009		687,001.00	585,317.00	-7,471.00	355,653.00	360,847.00
2010		716,090.07	710,188.34	32,576.52	397,510.98	490,159.12
2011		729,893.96	743,676.42	66,707.66	416,416.13	537,942.65
2012		774,476.70	654,888.36	-18,227.25	453,302.22	504,895.79
2013 E	Maximum	784,986.69	709,379.88	357,826.55	408,821.35	472,956.50
	Minimum	709,496.85	565,496.30	-95,269.60	424,661.60	517,613.21
	Average	744,428.51	626,120.43	171,068.04	418,179.96	498,073.84
2014 E	Maximum	804,627.06	727,014.74	347,542.47	388,742.78	454,311.56
	Minimum	727,248.46	579,645.01	-97,710.46	418,292.61	494,332.98
	Average	763,054.11	641,785.96	163,002.37	405,985.25	475,532.29
2015 E	Maximum	830,206.16	755,411.32	351,043.15	406,034.67	464,797.07
	Minimum	750,367.69	598,071.93	-114,992.27	414,618.42	485,528.41
	Average	787,311.60	662,188.34	159,692.49	410,405.86	473,672.08
2016 E	Maximum	857,769.00	787,730.86	358,798.55	430,810.61	482,710.07
	Minimum	775,279.90	617,927.92	-134,863.74	412,448.77	481,813.74
	Average	813,450.34	684,172.99	161,268.28	416,171.51	477,812.16
2017 E	Maximum	887,482.12	821,755.27	372,625.28	456,945.52	496,538.28
	Minimum	802,135.59	639,332.94	-160,377.33	392,903.86	466,069.58
	Average	841,628.26	707,872.74	166,287.95	422,892.37	486,101.59
2018 E	Maximum	918,224.50	857,321.56	383,289.06	437,098.89	515,853.14
	Minimum	829,921.57	661,479.43	-135,243.50	377,279.49	450,735.71
	Average	870,782.27	732,393.45	165,767.35	432,480.64	491,598.62

V. Assumptions for the GFCF and the changes in inventories (expressions 5.9 and 5.10)

The GFCF and the changes in inventories (sc) at constant prices of 2009 are estimated similarly to the consumption of resident's households at constant prices using as basis the consolidated time series at current prices and the real growth rates for the period from 2000 to 2012, while the respective estimated minimum, maximum and average values at current prices and the GDP deflator are used for the period 2013-2018. Thus, the lower bound for gfcf is defined as the value of this variable in the base year and the upper bound is defined by the maximum value of this variable obtained in the year of analysis plus a positive deviation of 0.5%. The lower and upper bounds for sc are defined as the minimum and maximum values of this variable in the year of analysis plus a deviation of 0.5%, respectively.

$$gfcf^L \leq gfcf \leq gfcf^U \Leftrightarrow 585{,}317.00 \leq gfcf \leq 861{,}608.17$$
$$sc^L \leq sc \leq sc^U \Leftrightarrow -135{,}243.50 \leq sc \leq 385{,}205.51$$

The vectors $\mathbf{a}_{gfcf}$ and $\mathbf{a}_{sc}$ are calculated from the hybrid IO framework and previously given in table B.6. The basic data used to obtain the bounds are outlined in table B.12.

VI. Assumptions for the consumption of the exports and imports (expressions 5.11 to 5.22)

The CIF/FOB coefficient (a_{ciffob}) is calculated from the values in the base year of the study available in the Guilhoto & Sesso Filho (2010) as follows:

$$a_{ciffob} = \frac{\text{CIF-FOB adjustment}}{\text{total imports at CIF prices – excluding tourism}} = \frac{11825.00}{350158.83} = 0.03377039 \qquad \text{(B.21)}$$

The vector $\mathbf{p}_{exp}$ which is used to transform the exports of energy commodities from toe to R$ is estimated by the monetary values of exports of each commodity (million R$) and the total exports of each commodity in energy terms (toe) in the base year, considering the values available in Guilhoto & Sesso Filho (2010) and BER (2010) (see table B.13). The vector $\mathbf{p}_{imp}$ which is used to transform the imports of energy commodities from toe to R$ is estimated by the monetary values of imports of each commodity (million R$) and the total imports of each commodity in energy terms (toe) in the base year, considering the values available in Guilhoto & Sesso Filho (2010) and BER (2010) (see table B.13).

In order to avoid specialization problems upper bounds are defined for the imports of each energy commodity, such that the amount of imports (in energy terms, toe) of each one shall not exceed 2.5 times the values of the base year. Since Brazil has diminished the net imports of crude oil due to the new extraction areas, the bound of this commodity is set to the same values of the base year. For the energy commodities which the imports are null in the base year the bounds are set to 0.

Table B.13 – Average price of exports and imports of energy products			
		p_{exp}	p_{imp}
A01	Wood	0.00000000	0.00000000
A02	Charcoal	0.00000000	0.16234361
A03	Crude Oil	0.65584084	0.03642907
A04	Natural Gas Wet	0.00000000	0.03642907
A05	Natural Gas Dry	0.00000000	0.03642907
A06	Steam Coal 3100	0.00000000	0.57520766
A07	Steam Coal 3300	0.00000000	0.57520766
A08	Steam Coal 3700	0.00000000	0.57520766
A09	Steam Coal 4200	0.00000000	0.57520766
A10	Steam Coal 4500	0.00000000	0.57520766
A11	Steam Coal 4700	0.00000000	0.57520766
A12	Steam Coal 5200	0.00000000	0.57520766
A13	Steam Coal 5900	0.00000000	0.57520766
A14	Steam Coal 6000	0.00000000	0.57520766
A15	Steam Coal without specification	0.00000000	0.57520766
A16	Metallurgical Coal	0.00000000	0.57520766
A17	Automotive gasoline	0.85884522	0.16625970
A18	Fuel oil	0.85884522	0.16625970
A19	Diesel oil	0.85884522	0.16625970
A20	Aviation gasoline	0.85884522	0.16625970
A21	Liquefied petroleum gas	0.85884522	0.16625970
A22	Naphtha	0.85884522	0.16625970
A23	Kerosene Illuminated	0.00000000	0.16625970
A24	Jet Kerosene	0.85884522	0.16625970
A25	Gas coke	0.00000000	0.16625970
A26	Coke coal	0.00000000	0.16625970
A27	Refinery Gas	0.00000000	0.16625970
A28	Petroleum Coke	0.85884522	0.16625970
A29	Other energy petroleum products	0.00000000	0.16625970
A30	Tar	0.00000000	0.16625970
A31	Asphalt	0.85884522	0.16625970
A32	Lubricants	0.85884522	0.16625970
A33	Solvents	0.85884522	0.16625970
A34	Other non-energy petroleum products	0.85884522	0.16625970
A35	Anhydrous bioethanol	1.55547048	0.00000000
A36	Hydrous bioethanol	1.55547048	0.00000000
A37	Sugarcane Juice	0.00000000	0.00000000
A38	Molasses	0.00000000	0.00000000
A39	Sugarcane Bagasse	0.00000000	0.00000000
A40	Uranium (U_30_8)	0.00000000	0.21834036
A41	Hydro	0.00000000	0.21834036
A42	Bleach	0.00000000	0.21834036
A43	Other Renewable	0.00000000	0.21834036
A44	Nuclear Power Plants (Uranium C,UO_2)	0.00000000	0.21834036
A45	Public service power plants	0.00000000	0.21834036
A46	Cogeneration	0.00000000	0.21834036

The exports (including tourism) at FOB (constant 2009) prices (expcpt) is calculate using as basis the consolidated time series at current prices and the real growth rates for the period from 2000 to 2012 provided by IBGE. For the period 2013-2018 is used the projections of the minimum, maximum and average values of total exports at current prices calculated by the Brazilian Central Bank (applied to estimate the value of exports at current prices and the GDP deflator are used. Thus, the upper bound is defined by the maximum value of total exports (including tourism) at FOB (constant 2009) prices obtained in the year of analysis plus a positive deviation of 0.5%. The lower bound for the exports (excluding tourism) at FOB (constant 2009) prices (expcpwt) is defined as 70% of the value of this variable in the base year (see table B.12):

$expcpt \leq expcpt^U \Leftrightarrow expcpt \leq 439{,}284.39$
$expcpwt \geq expcpwt^L \Leftrightarrow expcpwt \geq 241{,}649.74$.

The total imports (including tourism expenditure) at constant FOB prices (impfob) are estimated similarly to the exports (including tourism) at FOB (constant 2009) prices. Hence, the consolidated time series at current prices and the real growth rates provided by IBGE is used for the period from 2000 to 2012, while the projections of the minimum, maximum and average values of total imports at current prices calculated by the Brazilian Central Bank and the GDP deflator are used for the period 2013-2018. The upper bound is then defined considering the maximum value of total imports (including tourism) at FOB (constant 2009) prices obtained in the year of analysis plus a positive deviation of 0.5% in the deterministic approach and a variation of ± 0.5% of this value in the interval approach. The upper bound for the total imports (excluding tourism) at constant FOB prices (impwtfob) is calculate by subtracting the imports of tourism services from the maximum value of the total imports (including tourism) considering a positive deviation of 1% in the deterministic approach and a variation of ±1% of this value in the interval approach:

$impwtfob \leq impwtfob^U \Leftrightarrow impwtfob \leq 484{,}373.26$
$impwtfob \leq impwtfob^* \Leftrightarrow impwtfob \leq [474{,}781.71 – 484{,}373.26]$
$impfob \leq impfob^U \Leftrightarrow impfob \leq 521{,}011.67$
$impfob \leq impfob^* \Leftrightarrow impfob \leq [510694.60 – 521{,}011.67]$

Moreover, a lower bound for total imports (excluding tourism expenditure) at constant CIF prices (impwtcif) is defined as the 70% of the value of this variable in the base year, according to the values from Guilhoto & Sesso Filho (2010).

$impwtcif \geq impwtcif^L \Leftrightarrow impwtcif \geq 245{,}111.18$

The matrix $\mathbf{A}_m$ and vectors $\mathbf{a}_{exp}$, $\mathbf{a}_{expts}$, $\mathbf{a}_{expctm}$, $\mathbf{am}_{cf}$, $\mathbf{am}_{cnpish}$, $\mathbf{am}_{g}$, $\mathbf{am}_{gfcf}$ and $\mathbf{am}_{sc}$ are calculated from the hybrid IO framework and previously given in tables B.6 to B10. The basic data used to obtain the bounds are outlined in table B.12.

VII. Assumptions for the taxes less subsides on good and services (expressions 5.23 to 5.29)

The matrix A_{ts} and vectors $\mathbf{a}_{cfts}$, $\mathbf{a}_{cnpishts}$, $\mathbf{a}_{gts}$, $\mathbf{a}_{gfcfts}$, $\mathbf{a}_{scts}$ and $\mathbf{a}_{expts}$ are calculated from the hybrid IO framework and previously given in tables B.9 and B.10. A lower bound for the taxes less subsidies on goods or services (ts) is defined as 80% of the value of this variable in the base year according to the values from Guilhoto & Sesso Filho (2010):

$$ts \geq ts^{L} \Leftrightarrow ts \geq 354{,}904.35$$

VIII. Assumptions for the GVA components and employment (coefficients of the expressions 5.30 and 5.46)

The vectors $\mathbf{a}_{wag}$, $\mathbf{a}_{gmi}$, $\mathbf{a}_{gos}$, $\mathbf{a}_{opt}$, $\mathbf{a}_{ops}$ and $\mathbf{lp}$ are calculated from the hybrid IO framework and given in table B.14.

Table B.14 – Coefficients vectors of GVA (a_{wag}, a_{gmi}, a_{gos}, a_{opt}, a_{ops}) and employment (lp) (Part I).

	N01	N02	E01	A01	A02	N03	E02	A03	A04	A05	N04	N05	E03	A06	A07	A08
a_{wag}	0,15076996	0,33097862	0,03046452	0,00000000	0,00000000	0,21957271	0,09062019	0,00000000	0,00000000	0,00000000	0,08778290	0,15747711	0,10961333	0,00000000	0,00000000	0,00000000
a_{gmi}	0,30129360	0,00000000	0,00000000	0,00000000	0,00000000	0,23427068	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,01339646	0,00000000	0,00000000	0,00000000	0,00000000
a_{gos}	0,18053220	0,01135180	0,05742151	0,00000000	0,00000000	0,04517010	0,12015279	0,00000000	0,00000000	0,00000000	0,39578534	0,17995828	0,01928818	0,00000000	0,00000000	0,00000000
a_{opt}	0,00272015	0,03621074	0,00089463	0,00000000	0,00000000	0,00654682	0,00487708	0,00000000	0,00000000	0,00000000	0,00941862	0,00948291	0,00564532	0,00000000	0,00000000	0,00000000
a_{ops}	-0,00011234	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
lp	4,19775012	9,25256336	3,95992140	0,00000000	0,00000000	5,18967854	0,49108810	0,00000000	0,00000000	0,00000000	1,12179835	5,56125249	2,44976313	0,00000000	0,00000000	0,00000000

Table B.14 – Coefficients vectors of GVA (a_{wag}, a_{gmi}, a_{gos}, a_{opt}, a_{ops}) and employment (lp) (Part II).

	A09	A10	A11	A12	A13	A14	A15	A16	N06	N07	N08	N09	N10	N11	N12	N13
a_{wag}	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,11503153	0,11009818	0,18199836	0,23882070	0,27587772	0,22058595	0,16724012	0,21248869
a_{gmi}	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00574781	0,00000000	0,05936130	0,12503008	0,00944758	0,03360124	0,00139848	0,04082741
a_{gos}	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,05555014	0,09475806	0,13111018	0,05405535	0,05024960	0,14664247	0,11389820	0,25036846
a_{opt}	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00982116	0,00937938	0,00956321	0,00897714	0,01328438	0,00922997	0,01129881	0,01067873
a_{ops}	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	-0,00022289	0,00000000	-0,00200679	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
lp	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	4,04771829	1,38753506	7,39788916	15,70370638	15,90865960	10,00031112	3,62232236	2,96385262

Table B.14 – Coefficients vectors of GVA (a_{wag}, a_{gmi}, a_{gos}, a_{opt}, a_{ops}) and employment (lp) (Part III).

	E04	A17	A18	A19	A20	A21	A22	A23	A24	A25	A26	A27	A28	A29	A30	A31
a_{wag}	0,04411349	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
a_{gmi}	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
a_{gos}	0,25679507	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
a_{opt}	0,00754989	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
a_{ops}	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
lp	0,20236471	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000

Table B.14 – Coefficients vectors of GVA (a_{wag}, a_{gmi}, a_{gos}, a_{opt}, a_{ops}) and employment (lp) (Part IV).

	A32	A33	A34	E05	A35	A36	A37	A38	A39	N14	N15	N16	N17	N18	N19	N20
a_{wag}	0,00000000	0,00000000	0,00000000	0,04385761	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,09151706	0,09176481	0,18969010	0,11962952	0,12451780	0,17235799	0,15689457
a_{gmi}	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00152077	0,00000000	0,00263745
a_{gos}	0,00000000	0,00000000	0,00000000	0,08067402	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,09831334	0,03602893	0,28225643	0,05073200	0,18312315	0,19355883	0,11117874
a_{opt}	0,00000000	0,00000000	0,00000000	0,00279250	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00924791	0,00913475	0,01134292	0,01027786	0,00986647	0,01100502	0,01034693
a_{ops}	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
lp	0,00000000	0,00000000	0,00000000	1,94035661	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,77209180	0,71441157	2,32760280	0,46764267	2,97199555	2,05267843	5,02306080

Table B.14 – Coefficients vectors of GVA (a_{wag}, a_{gmi}, a_{gos}, a_{opt}, a_{ops}) and employment (lp) (Part V).

	N21	N22	N23	N24	N25	N26	N27	N28	N29	N30	N31	N32	N33	N34	N35	N36
a_{wag}	0,19223869	0,09319539	0,22049643	0,11854310	0,13916237	0,21051842	0,23086192	0,14813068	0,11437657	0,19956106	0,12807420	0,20952319	0,10677569	0,12371971	0,20699411	0,16752264
a_{gmi}	0,00305668	0,00000000	0,00839774	0,00000000	0,00000000	0,02805813	0,00310698	0,00000000	0,00000000	0,00156764	0,00006947	0,03432015	0,00000000	0,00000000	0,00018253	0,00326555
a_{gos}	0,11449266	0,19160569	0,14459473	0,18985618	0,10647820	0,19271778	0,07104716	0,09046817	0,03960301	0,09699236	0,03852300	0,30121823	0,00420724	0,02025899	0,06908930	0,06338133
a_{opt}	0,01136288	0,00975692	0,01159334	0,01033955	0,01033919	0,01036246	0,01220348	0,01064331	0,00876855	0,01218283	0,01028206	0,00982447	0,00966987	0,01019718	0,01177347	0,01131067
a_{ops}	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	-0,00194952	-0,00193744	-0,00208825	-0,00178262	-0,00176920	-0,00378630	-0,00150642	-0,00210362	0,00000000	0,00000000	-0,00092029
lp	6,88650409	1,23643704	8,87799742	1,62804584	3,56242091	7,21887138	5,27037851	3,29653082	1,95557911	3,66253107	2,09163540	4,85505633	0,96308486	0,91458738	5,19652880	2,49654149

Table B.14 – Coefficients vectors of GVA (a_{wag}, a_{gmi}, a_{gos}, a_{opt}, a_{ops}) and employment (lp) (Part VI).

	N37	N38	E06	A40	A41	A42	A43	A44	A45	A46	A47	A48	N39	N40	N41	A49
a_{wag}	0,17854166	0,23496203	0,12915785	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,21889075	0,32438257	0,24583608	0,00000000
a_{gmi}	0,06223954	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,09404717	0,09884696	0,08024520	0,00000000
a_{gos}	0,18216836	0,27153579	0,61476657	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,19602654	0,26806051	0,16461546	0,00000000
a_{opt}	0,00759129	0,00894419	0,01532058	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00669487	0,01643293	0,01046159	0,00000000
a_{ops}	0,00000000	-0,00119551	-0,00383909	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	-0,00116021	0,00000000	-0,00141473	0,00000000
lp	7,06870453	6,53906440	1,40681072	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	7,78586926	15,65314253	7,16153588	0,00000000

Table B.14 – Coefficients vectors of GVA (a_{wag}, a_{gmi}, a_{gos}, a_{opt}, a_{ops}) and employment (lp) (Part VII).

	A50	A51	A52	A53	N42	N43	N44	N45	N46	N47	N48	N49	N50	N51	N52	N53
a_{wag}	0,00000000	0,00000000	0,00000000	0,00000000	0,18699592	0,23986441	0,03620161	0,22720901	0,19781849	0,35979517	0,58333500	0,32601972	0,47902486	0,72509624	0,57610013	0,56043071
a_{gmi}	0,00000000	0,00000000	0,00000000	0,00000000	0,05549800	0,00383361	0,01011359	0,29579224	0,09929733	0,04656224	0,04519356	0,11576858	0,08017770	0,00000000	0,00000000	0,00000000
a_{gos}	0,00000000	0,00000000	0,00000000	0,00000000	0,21981836	0,39903002	0,87359982	0,21428753	0,17701174	0,18519974	0,00942283	0,10285392	0,06443006	0,03626875	0,02576028	0,08680320
a_{opt}	0,00000000	0,00000000	0,00000000	0,00000000	0,02141688	0,00762220	0,00141102	0,00374646	0,00575074	0,00969327	0,01312394	0,00959030	0,00918302	0,00018352	0,00001027	0,00033538
a_{ops}	0,00000000	0,00000000	0,00000000	0,00000000	-0,00087623	0,00000000	0,00000000	0,00000000	0,00000000	-0,00107079	0,00000000	0,00000000	-0,00013650	0,00000000	0,00000000	0,00000000
lp	0,00000000	0,00000000	0,00000000	0,00000000	3,37546353	2,45693941	0,92534625	2,38787369	12,34926987	17,67084334	4,71327398	1,81518531	7,74146693	8,08892943	14,19630793	19,96058343

IX. Assumptions for the GDP and remuneration at current prices (expressions 5.31 to 5.34).

The gdp at current prices is obtained from the consolidated time series from IBGE for the period 2000 to 2012 and from the prospective values estimated by IMF for the period 2013 to 2018. For the period 2013 to 2018 a variation of ± 1% is considered in order to obtain minimum, maximum and average values for this variable. The GDP at constant values of 2009 is obtained by considering the GDP deflator provided by IBGE for the period from 2000 to 2012 and IMF for the period 2013-2018. Therefore, minimum, maximum and average values for this variable are also obtained. The upper bounds defined for GDP at constant and current prices considered the maximum value calculated for each variable in the year of analysis plus a positive deviation of 0.5% in the deterministic approach and a variation of ± 0.5% in the interval approach. A lower bound is also defined for the gdp at constant prices considering for both deterministic and interval approaches the values obtained for this variable in the base year. The basic data used to obtain the bounds are outlined in table B.15.

$gdp^L \leq gdp_{ex} \leq gdp^U \Leftrightarrow 3{,}239{,}404.00 \leq gdp_{ex} \leq 4{,}351{,}336.63$

$gdp^L \leq gdp_{ex} \leq gdp^* \Leftrightarrow 3{,}239{,}404.00 \leq gdp_{ex} \leq [4{,}308{,}039.75 – 4{,}351{,}336.63]$

$gdp^L \leq gdp_{in} \leq gdp^U \Leftrightarrow 3{,}239{,}404.00 \leq gdpin \leq 4{,}351{,}336.63$

$gdp^L \leq gdp_{in} \leq gdp^* \Leftrightarrow 3{,}239{,}404.00 \leq gdp_{in} \leq [4{,}308{,}039.75 – 4{,}351{,}336.63]$

$gdp_{curr} \leq gdp_{curr}^U \Leftrightarrow gdp_{curr} \leq 7{,}321{,}390.20$

$gdp_{curr} \leq gdp_{curr}^* \Leftrightarrow gdp_{curr} \leq [7{,}248{,}540.54 – 7{,}321{,}390.20]$

The consumption of goods and services by the general government at current prices (gcurr) and the GFCF at current prices (gfcfcurr) are obtained from the consolidate values for the period 2000-2012. A ratio of each variable on the total GDP at current prices for each year in the period 2000-2012 is estimated and the respective minimum, maximum and average ratio are multiplied by the corresponding values estimated for the GDP at current prices in the period 2013–2018. Hence, minimum, maximum and average values for gcurr and gfcfcurr are obtained (see table B.15). Then, upper bounds are defined considering the maximum value calculated for each variable in the year of analysis plus a positive deviation of 0.5%, while the lower bounds are defined as the minimum values of each variable in the year of analysis:

$gcurr^L \leq gcurr \leq gcurr^U \Leftrightarrow 1{,}368{,}742.47 \leq gcurr \leq 1{,}552{,}693.76$

$gfcfcurr^L \leq gfcfcurr \leq gfcfcurr^U \Leftrightarrow 1{,}090{,}940.43 \leq gfcfcurr \leq 1{,}449{,}708.47$

Table B.15 – Auxiliary table for the calculation of the GDP and remuneration bounds.

		gdp	gcurr	gfcfcurr	gdpcurr	pcpr	psc	pexpcpt	pimpfob	wagcurr	iucl
2000		2,442,424.69	226,085.00	198,151.00	1,179,482.00	0.52	1.58	0.56	0.63	477,334.00	0.48
2001		2,474,496.63	258,043.00	221,772.00	1,302,136.00	0.56	1.99	0.69	0.79	528,389.00	0.53
2002		2,540,271.08	304,044.00	242,162.00	1,477,822.00	0.61	1.56	0.82	0.94	588,474.00	0.58
2003		2,569,398.33	329,596.00	259,714.00	1,699,948.00	0.71	1.86	0.92	1.06	671,872.00	0.66
2004		2,716,169.88	373,284.00	312,516.00	1,941,498.00	0.75	2.27	0.99	1.11	763,237.00	0.71
2005		2,801,991.98	427,553.00	342,237.00	2,147,239.00	0.81	5.85	0.93	1.04	860,886.00	0.77
2006		2,912,867.79	474,773.00	389,328.00	2,369,484.00	0.85	5.77	0.92	0.96	969,391.00	0.81
2007		3,090,302.52	539,061.00	464,137.00	2,661,344.00	0.89	3.15	0.91	0.93	1,099,903.00	0.86
2008		3,250,120.53	612,105.00	579,531.00	3,032,203.00	0.94	3.18	1.05	1.05	1,267,673.00	0.93
2009		3,239,404.00	687,001.00	585,317.00	3,239,404.00	1.00	1.00	1.00	1.00	1,412,999.00	1.00
2010		3,483,450.59	797,332.20	733,712.34	3,770,084.87	1.06	2.12	1.03	0.92	1,594,202.15	1.08
2011E	Maximum	3,578,646.51	856,646.97	798,720.11	4,143,013.34	1.13	1.43	1.18	0.97	1,837,368.40	1.16
	Minimum	3,578,646.51	856,646.97	798,720.11	4,143,013.34	1.13	1.43	1.18	0.97	1,764,715.85	1.16
	Average	3,578,646.51	856,646.97	798,720.11	4,143,013.34	1.13	1.43	1.18	0.97	1,798,642.80	1.16
2012E	Maximum	3,609,852.31	944,543.47	798,694.81	4,402,537.11	1.22	1.22	1.22	1.22	2,117,625.20	1.22
	Minimum	3,609,852.31	944,543.47	798,694.81	4,402,537.11	1.22	1.22	1.22	1.22	1,953,467.48	1.22
	Average	3,609,852.31	944,543.47	798,694.81	4,402,537.11	1.22	1.22	1.22	1.22	2,029,300.95	1.22
2013E	Maximum	3,701,434.26	1,024,414.01	925,746.50	4,830,401.76	1.31	1.31	1.31	1.31	2,440,630.03	1.31
	Minimum	3,701,434.26	907,564.51	723,363.85	4,734,750.24	1.28	1.28	1.28	1.28	2,162,407.72	1.28
	Average	3,701,434.26	961,866.58	809,002.22	4,782,576.00	1.29	1.29	1.29	1.29	2,289,538.72	1.29
2014E	Maximum	3,794,044.15	1,114,489.04	1,006,988.20	5,255,131.00	1.39	1.39	1.39	1.39	2,812,903.31	1.39
	Minimum	3,794,044.15	987,365.16	786,968.03	5,151,069.00	1.36	1.36	1.36	1.36	2,393,695.93	1.36
	Average	3,794,044.15	1,046,441.92	880,136.45	5,203,100.00	1.37	1.37	1.37	1.37	2,583,149.42	1.37
2015E	Maximum	3,914,656.81	1,207,521.92	1,098,734.00	5,693,807.33	1.45	1.45	1.45	1.45	3,241,960.05	1.45
	Minimum	3,914,656.81	1,069,786.27	852,660.83	5,581,058.67	1.43	1.43	1.43	1.43	2,649,722.42	1.43
	Average	3,914,656.81	1,133,794.51	953,606.55	5,637,433.00	1.44	1.44	1.44	1.44	2,914,412.78	1.44
2016E	Maximum	4,044,623.41	1,309,706.15	1,202,766.65	6,175,634.90	1.53	1.53	1.53	1.53	3,736,461.51	1.53
	Minimum	4,044,623.41	1,160,314.89	924,815.62	6,053,345.10	1.50	1.50	1.50	1.50	2,933,133.15	1.50
	Average	4,044,623.41	1,229,739.70	1,034,303.69	6,114,490.00	1.51	1.51	1.51	1.51	3,288,157.39	1.51
2017E	Maximum	4,184,729.17	1,422,482.22	1,317,133.31	6,707,405.96	1.60	1.60	1.60	1.60	4,306,390.08	1.60
	Minimum	4,184,729.17	1,260,227.19	1,004,449.57	6,574,586.04	1.57	1.57	1.57	1.57	3,246,857.11	1.57
	Average	4,184,729.17	1,335,630.03	1,123,365.42	6,640,996.00	1.59	1.59	1.59	1.59	3,709,831.05	1.59
2018E	Maximum	4,329,688.19	1,544,968.92	1,442,495.99	7,284,965.37	1.68	1.68	1.68	1.68	4,963,250.79	1.68
	Minimum	4,329,688.19	1,368,742.47	1,090,940.43	7,140,708.63	1.65	1.65	1.65	1.65	3,594,136.56	1.65
	Average	4,329,688.19	1,450,638.08	1,220,095.85	7,212,837.00	1.67	1.67	1.67	1.67	4,185,580.19	1.67

The deflator of consumption of households (pcpr), exports (pexpcpt), imports (pimpfob), change in inventories (psc) and unitary cost index are based on the real growth rates of the corresponding variables and wages in the period 2000 to 2012 from IBGE. Due to a lack of data to estimate the values of these deflators for the period 2013 to 2018, the GDP deflator which is computed based on the real growth rate of GDP provided by IMF is considered. In the deterministic model the average value obtained in the year of analysis is used, while in the interval model a variation of ± 0.0825% (0.5% for iucl) of the average values is considered (see table B.15).

pcpr = 1.6659

pcpr* = [1.6645 – 1.6673]

psc = 1.6659

psc* = [1.6645 – 1.6673]

pexpcpt = 1.6659

pexpcpt* = [1.6645 – 1.6673]

pimpfob = 1.6659

pimpfob* = [1.6645 – 1.6673]

iucl = 1.6659

iucl* = [1.6645 – 1.6673]

The wages at current prices are obtained similarly to gcurr and gfcfcurr, based on the consolidate values for the period 2000-2009 from IBGE, thus obtaining the respective minimum, maximum and average values for the period 2013–2018. An upper bound is then defined in the deterministic approach considering the maximum value calculated for this variable in the year of analysis plus a positive deviation of 0.5%, while in the interval approach the upper bound consider a variation of ± 0.5% of this value.

$wagcurr \leq wagcurr^{U} \Leftrightarrow wagcurr \leq 4{,}988{,}067.04$

$wagcurr \leq wagcurr^{*} \Leftrightarrow wagcurr \leq [4{,}938{,}434.53 - 4{,}988{,}067.04]$.

X. Assumptions for the estimates of the item of the national disposable income, public administration global balance and public debt at current prices (expressions 5.35 to 5.45).

Data series for the items in the households and NPISH disposable income, general government's structural balance and general government gross debt are gathered for the period from 2000 to 2009 (in some cases until 2012) from IBGE. However, forecast data for the period 2013 to 2018 is available only for the general government's structural balance and general government gross debt obtained from the IMF database. For that reason some procedures are applied to estimate a range of possible values for the remaining items in order to overcome the data shortage. Thus, the ratio of each variable at current prices in relation to the GDP at current prices for each year of the period in which consolidated data is available (2000-2009 or 2000-2012) has been estimated for the majority of the variables. Then, minimum, maximum and average ratios in the period 2000-2009 (or 2000-2012) are multiplied by the corresponding minimum, maximum and average values of the GDP at current prices in the period 2010 to 2018 (or 2013 to 2018).

Table B.16 – Auxiliary table for the calculation of the national disposable income bounds (Part I).

		ydcurr	psgdpcurr	pi	ctr	ctrg	pi (%gdp)	ctr (% gdp)	ctrg (% gdp)
2000		810,082.25	12.7%	32,589.00	580.00	2,210.00	2.8%	0.0%	0.2%
2001		882,534.68	13.4%	45,504.00	17,667.00	-13,800.00	3.5%	1.4%	-1.1%
2002		978,324.90	14.0%	51,936.00	-906.00	8,171.00	3.5%	-0.1%	0.6%
2003		1,120,896.91	14.8%	55,142.00	-12,937.00	21,688.00	3.2%	-0.8%	1.3%
2004		1,233,225.45	15.4%	58,481.00	10,870.00	-1,307.00	3.0%	0.6%	-0.1%
2005		1,359,654.29	14.9%	61,586.00	-4,712.00	13,347.00	2.9%	-0.2%	0.6%
2006		1,503,003.52	16.6%	58,586.00	6,770.00	2,596.00	2.5%	0.3%	0.1%
2007		1,681,455.94	17.3%	54,811.00	32,668.00	-24,838.00	2.1%	1.2%	-0.9%
2008		1,877,737.73	16.0%	71,775.00	4,462.00	3,390.00	2.4%	0.1%	0.1%
2009		2,091,050.96	14.1%	64,077.33	-25,662.58	32,346.00	2.0%	-0.8%	1.0%
2010		2,452,573.40	14.9%	68,163.06	-1,863.20	6,775.38	1.8%	0.0%	0.2%
2011 E	Maximum	2,872,714.73	17.3%	78,128.08	48,620.29	52,856.72	1.9%	1.2%	1.3%
	Minimum	2,511,656.72	12.7%	78,128.08	-48,143.96	-43,907.54	1.9%	-1.2%	-1.1%
	Average	2,688,796.92	14.9%	78,128.08	-2,732.84	7,445.59	1.9%	-0.1%	0.2%
2012 E	Maximum	3,047,996.87	17.3%	68,817.02	52,238.76	56,167.73	3.5%	1.2%	1.3%
	Minimum	2,659,439.85	12.7%	68,817.02	-50,586.94	-46,657.96	1.8%	-1.1%	-1.1%
	Average	2,850,127.40	14.9%	68,817.02	-2,331.20	7,911.99	2.6%	-0.1%	0.2%
2013 E	Maximum	3,306,827.31	17.3%	169,757.76	55,564.61	61,626.45	3.5%	1.2%	1.3%
	Minimum	2,821,171.59	12.7%	85,604.19	-36,760.48	-50,178.75	1.8%	-0.8%	-1.1%
	Average	3,076,581.07	14.9%	125,196.22	6,682.99	8,594.98	2.6%	0.1%	0.2%
2014 E	Maximum	3,597,591.16	17.3%	184,684.27	60,450.32	67,045.16	3.5%	1.2%	1.3%
	Minimum	3,069,232.54	12.7%	93,131.22	-39,992.77	-54,590.88	1.8%	-0.8%	-1.1%
	Average	3,347,099.76	14.9%	136,204.51	7,270.61	9,350.72	2.6%	0.1%	0.2%
2015 E	Maximum	3,897,903.01	17.3%	200,100.94	65,496.46	72,641.81	3.5%	1.2%	1.3%
	Minimum	3,325,439.22	12.7%	100,905.43	-43,331.20	-59,147.90	1.8%	-0.8%	-1.1%
	Average	3,626,501.63	14.9%	147,574.30	7,877.53	10,131.28	2.6%	0.1%	0.2%
2016 E	Maximum	4,227,755.61	17.3%	217,034.10	71,038.97	78,788.98	3.5%	1.2%	1.3%
	Minimum	3,606,848.17	12.7%	109,444.36	-46,998.02	-64,153.18	1.8%	-0.8%	-1.1%
	Average	3,933,387.40	14.9%	160,062.49	8,544.15	10,988.62	2.6%	0.1%	0.2%
2017 E	Maximum	4,591,798.84	17.3%	235,722.46	77,155.99	85,573.34	3.5%	1.2%	1.3%
	Minimum	3,917,426.35	12.7%	118,868.38	-51,044.92	-69,677.27	1.8%	-0.8%	-1.1%
	Average	4,272,083.20	14.9%	173,845.14	9,279.87	11,934.82	2.6%	0.1%	0.2%
2018 E	Maximum	4,987,188.15	17.3%	256,019.98	83,799.72	92,941.86	3.5%	1.2%	1.3%
	Minimum	4,254,746.99	12.7%	129,103.87	-55,440.28	-75,677.03	1.8%	-0.8%	-1.1%
	Average	4,639,942.53	14.9%	188,814.55	10,078.94	12,962.51	2.6%	0.1%	0.2%

This procedure is applied for the balance of primary incomes (pi), current transferences (ctr) and the current transferences of the general government (ctrg) (see table B.16). Thus, the upper bound for the balance of primary incomes is defined in the deterministic approach considering the maximum value calculated for this variable in the year of analysis plus a positive deviation of 0.5%, while in the interval approach a variation of ± 0.5% of this value is considered. The lower bound for the balance of primary incomes is defined as the value of this variable in the base year.

$$pi^L \leq (pi^+ - pi^-) \leq pi^U \Leftrightarrow 64{,}077.33 \leq pi^+ - pi^- \leq 257{,}300.08$$

$$pi^+ - pi^- \leq pi^* \Leftrightarrow pi^+ - pi^- \leq [254{,}739.88 - 257{,}300.08]$$

The upper bound for the current transferences is defined in the deterministic approach considering the maximum value calculated for this variable in the year of analysis plus a positive deviation of 0.5%, while in the interval approach a variation of ± 0.5% of this value is considered. The lower bound for the balance of current transferences is defined as the minimum value of this variable in the year of analysis minus a deviation of 0.5%.

$ctr^L \leq ctr \leq ctr^U \Leftrightarrow 55163.08 \leq ctr \leq 55717.48$

$ctr \leq ctr^* \Leftrightarrow ctr \leq [55163.08 - 55717.48]$

The upper bound for the current transferences of the general government is defined in the deterministic approach considering the maximum value calculated for this variable in the year of analysis plus a positive deviation of 0.5%, while in the interval approach a variation of ± 0.5% of this value is considered.

$ctrg \leq ctrg^U \Leftrightarrow ctrg \leq 93{,}406.57$

$ctrg \leq ctrg^* \Leftrightarrow ctrg \leq [92{,}477.15 - 93{,}406.57]$

The households and NPISH disposable income at current prices (ydcurr) is obtained by the corresponding items according to the equation 5.35 of Chapter 5. The upper bound for ydcurr is defined in the deterministic approach considering the maximum value calculated for this variable in the year of analysis, while in the interval approach a variation of ± 0.5% of this value is considered. The corporations' savings (psgdpcurr) is calculated as a fixed proportion of GDP at current prices by which is considered the average values in the deterministic approach, while a variation of ±0.0825% is considered in the interval approach. The basic data used to obtain the bounds are outlined in table B.16.

$ydcurr \leq ydcurr^U \Leftrightarrow ydcurr \leq 4987188.15$

$ydcurr \leq ydcurr^* \Leftrightarrow ydcurr \leq [4{,}962{,}252.21 - 5{,}012{,}124.09]$,

$psgdpcurr = 14.93\%$

$psgdpcurr^* = [14.92\% - 14.94\%]$

The upper bound for the balance of property incomes (pig) (which includes the gross operating surplus and property incomes of the general government minus the interest expenses) and transferences from the general government to households (trgh) are estimated similarly to the current transferences. Hence, the maximum value calculated for this variable in the year of analysis plus a positive deviation of 0.5% is used in the deterministic approach, while a variation of ± 0.5% of this value in the interval approach is considered. A lower bound for trgh is also defined in the deterministic approach as minimum value of this variable in the year of analysis. The proportional coefficient of the balance of property incomes of the general government on the GDP at current prices (repggdpcurr) is set as the average value obtained in the year of analysis for the deterministic approach, while a variation of ± 0.55% of this value in the interval approach is considered. The basic data used to obtain the bounds are outlined in table B.17.

$pig^{+} - pig^{-} \leq pig^{U} \Leftrightarrow pig^{+} - pig^{-} \leq 304793.14$

$pig^{+} - pig^{-} \leq pig^{*} \Leftrightarrow pig^{+} - pig^{-} \leq [301760.37 - 304793.14]$

$trgh^{L} \leq trgh \leq trgh^{U} \Leftrightarrow 890{,}704.24 \leq trgh \leq 1{,}059{,}889.37$

$trgh \leq trgh^{*} \Leftrightarrow trgh \leq [1{,}049{,}343.21 - 1{,}059{,}889.37]$

repggdpcurr = 3.03%

repggdpcurr* = [3.01% – 3.05%]

Table B.17 – Auxiliary table for the calculation of the national disposable income bounds (Part II).

		pig	repgdpcurr	trgh	trgh (%gdp)
2000		36,773.00	3.12%	147,124.00	12.5%
2001		48,135.00	3.70%	167,004.00	12.8%
2002		62,340.00	4.22%	199,399.00	13.5%
2003		70,552.00	4.15%	237,475.00	14.0%
2004		40,172.00	2.07%	262,605.00	13.5%
2005		59,136.00	2.75%	296,449.00	13.8%
2006		77,873.00	3.29%	335,224.00	14.1%
2007		79,744.00	3.00%	374,143.00	14.1%
2008		69,878.00	2.30%	416,935.00	13.8%
2009		55,117.00	1.70%	468,956.00	14.5%
2010		112,859.28	2.99%	519,447.74	13.8%
2011 E	Maximum	172,475.72	4.16%	599,768.03	14.5%
	Minimum	95,760.44	2.31%	516,783.38	12.5%
	Average	125,512.55	3.03%	565,629.37	13.7%
2012 E	Maximum	183,279.82	4.16%	637,338.29	14.5%
	Minimum	101,758.99	2.31%	549,155.37	12.5%
	Average	133,374.82	3.03%	601,061.14	13.7%
2013 E	Maximum	201,092.04	4.16%	699,278.60	14.5%
	Minimum	109,437.67	2.31%	590,594.34	12.5%
	Average	144,888.10	3.03%	652,946.36	13.7%
2014 E	Maximum	218,773.73	4.16%	760,765.01	14.5%
	Minimum	119,060.35	2.31%	642,524.32	12.5%
	Average	157,627.87	3.03%	710,358.85	13.7%
2015 E	Maximum	237,036.05	4.16%	824,270.49	14.5%
	Minimum	128,999.01	2.31%	696,159.56	12.5%
	Average	170,785.98	3.03%	769,656.63	13.7%
2016 E	Maximum	257,094.77	4.16%	894,022.80	14.5%
	Minimum	139,915.30	2.31%	755,070.74	12.5%
	Average	185,238.42	3.03%	834,787.36	13.7%
2017 E	Maximum	279,232.66	4.16%	971,005.24	14.5%
	Minimum	151,963.12	2.31%	820,088.31	12.5%
	Average	201,188.91	3.03%	906,669.16	13.7%
2018 E	Maximum	303,276.75	4.16%	1,054,616.29	14.5%
	Minimum	165,048.31	2.31%	890,704.24	12.5%
	Average	218,512.83	3.03%	984,740.37	13.7%

The direct taxes on households and NPISH (dt) and corporation's income (dtc), social security contributions (sc) and capital tax (tk) are estimated analogously to the previous items (i.e. in relation to the gdp at current prices), such that minimum, maximum and average values are obtained. Thus, upper bounds are defined in the deterministic approach as the maximum value calculated for each variable in the year of analysis plus a positive deviation of 0.5%, while a variation of ± 0.5% of this value is considered in the interval approach. The basic data used to obtain the bounds are outlined in table B.18.

$dt \leq dt^{U} \Leftrightarrow dt \leq 295{,}861.54$

$dt \leq dt^{*} \Leftrightarrow dt \leq [292{,}917.65 - 295{,}861.54]$

$dtc \leq dtc^{U} \Leftrightarrow dtc \leq 467{,}264.95$

$dtc \leq dtc^{*} \Leftrightarrow dtc \leq [462{,}615.55 - 467{,}264.95]$

$ssc \leq ssc^{U} \Leftrightarrow ssc \leq 833{,}387.44$

$sss \leq ssc^{*} \Leftrightarrow sss \leq [825{,}095.03 - 833{,}387.44]$

$tk \leq tk^{U} \Leftrightarrow tk \leq 14{,}618.21$

$tk \leq tk^{*} \Leftrightarrow tk \leq [14{,}472.76 - 14{,}618.21]$

Table B.18 – Auxiliary table for the calculation of the national disposable income bounds (Part III).

		dt	dtydcurr	dtc	dtcgdpcurr	tk	tkgdpcurr	css	tcss
2000		38,641.00	4.77%	48,793.00	4.14%	1,666.50	0.14%	116,570.97	24.42%
2001		44,291.00	5.02%	60,070.00	4.61%	1,686.96	0.13%	133,519.34	25.27%
2002		55,623.00	5.69%	74,614.00	5.05%	2,155.92	0.15%	150,637.01	25.60%
2003		55,236.00	4.93%	92,041.00	5.41%	2,689.56	0.16%	172,377.40	25.66%
2004		59,837.00	4.85%	105,981.00	5.46%	2,729.24	0.14%	199,638.82	26.16%
2005		74,655.00	5.49%	127,787.00	5.95%	3,247.11	0.15%	224,550.04	26.08%
2006		82,127.00	5.46%	138,740.00	5.86%	3,849.62	0.16%	251,797.06	25.97%
2007		86,957.00	5.17%	169,852.00	6.38%	4,941.98	0.19%	287,824.46	26.17%
2008		93,180.00	4.96%	172,162.00	5.68%	5,732.04	0.19%	332,244.60	26.21%
2009		95,690.00	4.58%	171,862.00	5.31%	6,467.94	0.20%	368,738.52	26.10%
2010		148,477.57	6.05%	202,995.80	5.38%	6,696.33	0.18%	408,974.27	25.65%
	Maximum	135,422.77	5.39%	264,414.94	6.38%	8,272.13	0.20%	471,595.58	25.67%
2011 E	Minimum	170,803.78	5.95%	171,388.84	4.14%	6,265.16	0.15%	433,260.49	24.55%
	Average	154,886.70	5.76%	223,075.70	5.38%	7,358.71	0.18%	449,429.10	24.99%
	Maximum	143,905.83	5.41%	280,978.23	6.38%	8,790.30	0.20%	501,136.95	23.67%
2012 E	Minimum	181,503.15	5.95%	182,124.86	4.14%	6,657.62	0.15%	460,400.49	23.57%
	Average	164,589.01	5.77%	237,049.45	5.38%	7,819.67	0.18%	477,581.93	23.53%
	Maximum	157,891.45	5.60%	308,285.36	6.38%	9,644.60	0.20%	549,840.41	22.53%
2013 E	Minimum	195,199.28	5.90%	195,867.90	4.14%	7,160.00	0.15%	495,142.07	22.90%
	Average	178,796.77	5.81%	257,512.20	5.38%	8,494.69	0.18%	518,808.09	22.66%
	Maximum	171,774.59	5.60%	335,392.38	6.38%	10,492.63	0.20%	598,186.96	21.27%
2014 E	Minimum	212,362.83	5.90%	213,090.25	4.14%	7,789.57	0.15%	538,679.09	22.50%
	Average	194,518.08	5.81%	280,154.82	5.38%	9,241.61	0.18%	564,426.02	21.85%
	Maximum	186,113.61	5.60%	363,389.54	6.38%	11,368.51	0.20%	648,121.11	19.99%
2015 E	Minimum	230,089.99	5.90%	230,878.13	4.14%	8,439.81	0.15%	583,645.77	22.03%
	Average	210,755.63	5.81%	303,540.97	5.38%	10,013.06	0.18%	611,541.95	20.98%
	Maximum	201,863.12	5.60%	394,140.68	6.38%	12,330.55	0.20%	702,967.12	18.81%
2016 E	Minimum	249,560.92	5.90%	250,415.75	4.14%	9,154.01	0.15%	633,035.68	21.58%
	Average	228,590.42	5.81%	329,227.55	5.38%	10,860.40	0.18%	663,292.51	20.17%
	Maximum	219,245.13	5.60%	428,079.32	6.38%	13,392.31	0.20%	763,498.15	17.73%
2017 E	Minimum	271,050.09	5.90%	271,978.53	4.14%	9,942.25	0.15%	687,545.06	21.18%
	Average	248,273.87	5.81%	357,576.65	5.38%	11,795.56	0.18%	720,407.25	19.42%
	Maximum	238,123.83	5.60%	464,940.25	6.38%	14,545.49	0.20%	829,241.24	16.71%
2018 E	Minimum	294,389.59	5.90%	295,397.98	4.14%	10,798.35	0.15%	746,747.99	20.78%
	Average	269,652.17	5.81%	388,366.75	5.38%	12,811.25	0.18%	782,439.88	18.69%

The average direct tax rate on the households and NPISH disposable income (dtydcurr) and the proportional coefficient of direct taxes on corporation's income in relation to the GDP current (dtcgdpcurr) are defined as the average values obtained in the year of analysis for the deterministic approach, while a variation of ± 0.825% of this values in the interval approach is considered (see table B.18):

dtydcurr = 5.812%

dtydcurr* = [5.807% – 5.816%]

dtcgdpcurr = 5.384%

dtcgdpcurr* = [5.380% – 5.389%]

The proportional coefficient of social security contributions on the general wages at current prices (tssc) and the capital taxes rate on GDP at current prices are both defined as the average value obtained in the year of analysis for the deterministic approach, while a variation of ± 0.825% of this value in the interval approach is considered (see table B.18):

tssc =18.694%

tssc* = [18.678% – 18.709%]

tkgdpcurr = 0.1776%

tkgdpcurr* = [0.1775% – 0.1778%]

The evolution index of the indirect tax rate (itrei) is based on the weight of indirect taxes less subsidies on the private consumption. The average value for the year of analysis is considered in the deterministic approach, while a variation of ± 0.825% of this values in the interval approach is considered (see table B.19). As a simplification the proportional coefficient of net indirect taxes less subsides (received – paid) for the general government (titsubg) is set to 1.

itrei = 0.9997

itrei* = [0.9989 – 1.0005]

titsubg = 1

The upper value for the total indirect taxes less subsides (itsub) and the net indirect taxes less subsides (received – paid) for the general government (itsubg) are set in the deterministic approach as the maximum values estimated for the year of analysis plus a positive deviation of 0.5%, while a variation of ± 0.5% of these values are set in the interval approach:

$itsub \leq itsub^U \Leftrightarrow itsub \leq 1{,}288{,}336.45$

$itsub \leq itsub^* \Leftrightarrow itsub \leq [1{,}275{,}517.18 – 1{,}288{,}336.45]$

$itsubg \leq itsubg^U \Leftrightarrow itsubg \leq 1{,}288{,}336.45$

$itsubg \leq itsubg^* \Leftrightarrow itsubg \leq [1{,}275{,}517.18 – 1{,}288{,}336.45]$

Table B.19 – Auxiliary table for the calculation of the national disposable income, general government gross debt and general government's structural balance bounds (Part III).

		itisub	itrei	dat	deb	rg	gfcfg	trkg	jurg
2000		166,970.78	0.89	-59,018.25	786,135.00	14.13%	21,293.00	-2,595.50	111,070.00
2001		194,733.98	0.95	41,352.32	914,602.00	15.04%	25,935.00	-8,498.96	127,908.00
2002		219,996.10	0.97	172,120.11	1,179,337.00	17.17%	30,468.00	-7,560.92	179,763.00
2003		247,440.69	0.95	9,174.09	1,271,255.00	16.53%	25,604.00	-10,989.56	202,519.00
2004		298,316.73	1.04	44,943.55	1,373,771.00	12.00%	33,405.00	-13,302.24	158,669.00
2005		330,411.67	1.03	49,934.71	1,485,151.00	15.02%	37,490.00	-14,815.11	214,655.00
2006		362,176.42	1.02	-15,168.52	1,579,919.00	16.22%	48,245.00	-15,107.62	248,630.00
2007		405,811.60	1.03	26,759.06	1,734,951.00	15.29%	55,848.00	-10,025.98	253,353.00
2008		491,801.67	1.11	105,282.27	1,926,797.00	14.23%	74,392.00	-11,764.04	260,476.00
2009		490,136.60	1.00	91,750.12	2,167,856.00	13.22%	83,272.00	-20,203.94	270,729.00
2010		556,547.10	1.00	117,295.53	2,456,354.00	16.05%	75,363.92	3,334.23	371,152.82
2011 E	Maximum	687,948.05	1.11	128,435.01	2,690,630.00	19.58%	106,500.15	9,039.69	503,958.19
	Minimum	549,900.07	0.89	-15,509.18	2,690,630.00	13.16%	62,400.56	-5,904.63	338,587.93
	Average	618,637.74	1.00	68,165.93	2,690,630.00	15.85%	82,818.75	3,664.04	407,866.44
2012 E	Maximum	755,370.29	1.11	201,368.25	3,014,376.00	18.77%	113,171.46	9,605.95	535,526.79
	Minimum	603,792.94	0.89	43,525.35	3,014,376.00	12.61%	66,309.42	-6,274.50	359,797.52
	Average	679,267.23	1.00	134,872.79	3,014,376.00	15.19%	88,006.63	3,893.56	433,415.72
2013 E	Maximum	850,000.13	1.11	215,692.69	3,331,195.56	18.52%	124,170.13	10,539.51	587,572.46
	Minimum	608,314.31	0.89	-47,968.33	3,200,560.44	12.45%	71,313.09	-6,747.98	386,947.65
	Average	716,257.12	1.00	88,890.88	3,265,878.00	14.99%	95,603.60	4,229.67	470,829.34
2014 E	Maximum	924,739.24	1.11	219,558.51	3,660,772.86	18.28%	135,088.20	11,466.23	639,236.74
	Minimum	661,802.38	0.89	61,911.26	3,517,213.14	12.53%	77,583.53	-7,341.31	420,971.32
	Average	779,236.42	1.00	146,205.75	3,588,993.00	14.94%	104,009.86	4,601.57	512,228.58
2015 E	Maximum	1,001,932.60	1.11	177,041.00	3,957,016.56	18.18%	146,364.80	12,423.39	692,597.54
	Minimum	717,046.87	0.89	8,620.11	3,801,839.44	12.46%	84,059.88	-7,954.14	456,112.24
	Average	844,283.81	1.00	98,758.10	3,879,428.00	14.86%	112,692.17	4,985.70	554,987.28
2016 E	Maximum	1,086,719.23	1.11	177,670.84	4,263,977.40	18.28%	158,750.64	13,474.69	751,207.29
	Minimum	777,725.59	0.89	-4,439.52	4,096,762.60	12.53%	91,173.29	-8,627.24	494,709.87
	Average	915,729.72	1.00	93,044.81	4,180,370.00	14.94%	122,228.53	5,407.60	601,952.02
2017 E	Maximum	1,180,294.36	1.11	169,657.11	4,574,057.40	18.46%	172,420.33	14,634.97	815,892.18
	Minimum	844,693.92	0.89	-27,220.18	4,394,682.60	12.66%	99,024.03	-9,370.11	537,308.30
	Average	994,581.30	1.00	78,201.22	4,484,370.00	15.09%	132,753.37	5,873.24	653,784.86
2018 E	Maximum	1,281,926.81	1.11	180,477.88	4,907,049.66	18.69%	187,267.05	15,895.15	886,146.79
	Minimum	917,428.59	0.89	-33,203.52	4,714,616.34	12.81%	107,550.76	-10,176.95	583,574.69
	Average	1,080,222.42	1.00	81,221.20	4,810,833.00	15.28%	144,184.46	6,378.97	710,080.78

The upper bound for the interest on the general government gross debt (jurg) is set as the maximum value estimated in the year of analysis plus a positive deviation of 0.5% in the deterministic approach, while in the interval approach a variation of ± 0.5% in this value is accepted:

$jurg \leq jurg^U \Leftrightarrow jurg \leq 890{,}577.53$

$jurg \leq jurg^* \Leftrightarrow jurg \leq [881{,}716.06 - 890{,}577.53]$

A lower bound for the general government's structural balance (gbg^*) is defined considering the minimum value obtained in the year of analysis plus a negative deviation of 1% in the deterministic approach, while in the interval approach a variation o ±1% is considered:

$(gbg^+ - gbg^-) \geq gbg^L \Leftrightarrow (gbg^+ - gbg^-) \geq -356{,}668.63$

$(gbg^+ - gbg^-) \geq gbg^* \Leftrightarrow (gbg^+ - gbg^-) \geq [-356{,}668.63 - -349{,}605.88]$

The gross fixed capital formation of the general government (gfcfg) and the capital transferences of the general government (trkg) are obtained analogously to the other items based on the consolidated values in the period 2000 to 2009 and minimum, maximum and average ratios in relation to the GDP at current prices. The gfcfg is lower bounded by the minimum value obtained in the year of analysis plus a negative deviation of 0.5% in the deterministic approach and a variation of ±0.5% of this value in the interval approach:

$gfcfg \geq gfcfg^L \Leftrightarrow gfcfg \geq 107{,}013.01$

$gfcfg \geq gfcfg^* \Leftrightarrow gfcfg \geq [107{,}013.01 - 108{,}088.52]$

$trkg \leq trkg^U \Leftrightarrow trkg \leq 15{,}974.63$

$trkg \leq trkg^* \Leftrightarrow trkg \leq [15{,}815.68 - 15{,}974.63]$

The values of the general government gross debt (debt) is computed based on the consolidated values (2000 to 2012) and projections (2013 to 2018) from the IMF database. A variation of ±2% is considered in order to obtain minimum, maximum and average values. The adjustment variable (dat) is calculated based on the values obtained for the general government's structural balance and the general government gross debt in the year of analysis (debt) and in the previous period ($debt_{-1}$). The $debt_{-1}$ is limited in the deterministic approach by lower and upper bounds defined as the average value obtained in the year of analysis and a deviation of -0.5% and 0.5% respectively, while in the interval approach a lower bound is set as the average value obtained in the year of analysis plus a variation ±0.5%. A lower bound for dat is set as the minimum value obtained in the year of analysis plus a negative deviation of 0.5% in the deterministic approach and a the minimum value plus a variation of ±0.5% is considered in the interval approach. The debt is upper bounded in the deterministic approach by the maximum value obtained in the year of analysis plus a positive deviation of 0.5%, whereas in the interval approach a variation of ±0.5% of this maximum value is considered:

$debt_{-1}^{L} \leq debt_{-1} \leq debt_{-1}^{U} \Leftrightarrow 4{,}461{,}948.15 \leq debt_{-1} \leq 4{,}506{,}791.85$

$debt_{-1} \geq debt_{-1}^{*} \Leftrightarrow debt_{-1} \geq [4{,}461{,}948.15 - 4{,}506{,}791.85]$

$dat \geq dat^{L} \Leftrightarrow dat \geq -33{,}369.54$

$dat \geq dat^{*} \Leftrightarrow dat \geq [-33{,}369.54 - -33037.50\ ]$

$debt \leq debt^{U} \Leftrightarrow debt \leq 4{,}931{,}584.91$

$debt \leq debt^{*} \Leftrightarrow debt \leq [4{,}882{,}514.41 - 4{,}931{,}584.91]$

The debt interest rate (rg) is computed based on the estimated values of the interest expenses (jurg) and the projections for the general government gross debt (debt) in the period. In the deterministic approach the average value in the year of analysis is used, while in the interval approach a variation of ±0.05% of this value is considered:

rg = 15.75%

rg* = [15.74% – 15.76%]

XI. Assumptions for the computation of the energy consumption (expressions 5.47 and 5.48).

The sub-matrix $\mathbf{A}_E$ displays the coefficients of production and use of energy commodities (primary and secondary) by sectors in the matrix of technical coefficients which are obtained from the BER (see table B.5). The coefficient vectors of energy use in the final demand $\mathbf{a}_{cfE}$, $\mathbf{a}_{cnpishE}$ and $\mathbf{a}_{gE}$ are obtained analogously (see table B.6). The coefficient matrix $\mathbf{N}_E$ is obtained by using the information of energy used for transformation or as raw materials provided in the BER (see table B.20). The vectors $\mathbf{a}_{cfE}$, $\mathbf{a}_{cnpishE}$ and $\mathbf{a}_{gE}$ of energy used for non-energy purposes are analogously obtained (see table B.6)[7].

[7] The sub-vectors and sub-matrices $\mathbf{A}_{Eele}$, $\mathbf{N}_{Eele}$, $\mathbf{a}_{Echp}$, $\mathbf{n}_{Echp}$, $\mathbf{A}_{Eref}$, $\mathbf{N}_{Eref}$, $\mathbf{A}_{Epge}$, $\mathbf{N}_{Epge}$, $\mathbf{A}_{Ebio}$, $\mathbf{N}_{Ebio}$, $\mathbf{A}_{Egi}$, $\mathbf{N}_{Egi}$, $\mathbf{A}_{cs}$, $\mathbf{N}_{Ecs}$, $\mathbf{A}_{Eal}$, $\mathbf{N}_{Eal}$, $\mathbf{A}_{Eind}$, $\mathbf{N}_{Eind}$, $\mathbf{A}_{Et}$ and $\mathbf{N}_{Et}$ are obtained from the corresponding matrices and vectors.

Table B.20 – Technical coefficient matrix N_E (Part I)

	N01	N02	E01	A01	A02	N03	E02	A03	A04	A05	N04	N05	E03	A06	A07	A08
A01	0,00000000	0,00000000	0,27188864	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A02	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A03	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A04	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,11187777	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A05	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A06	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A07	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A08	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A09	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A10	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A11	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A12	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A13	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A14	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A15	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A16	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,36812617	0,00000000	0,00000000	0,00000000	0,00000000
A17	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A18	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A19	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A20	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A21	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A22	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A23	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A24	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A25	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A26	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A27	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A28	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A29	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A30	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A31	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A32	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A33	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A34	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A35	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A36	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A37	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A38	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A39	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
E06	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A40	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A41	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A42	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A43	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A44	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A45	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A46	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A47	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A48	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000

Table B.20 – Technical coefficient matrix N_E (Part II)

	A09	A10	A11	A12	A13	A14	A15	A16	N06	N07	N08	N09	N10	N11	N12	N13
A01	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A02	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A03	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A04	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A05	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A06	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A07	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A08	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A09	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A10	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A11	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A12	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A13	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A14	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A15	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A16	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A17	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A18	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A19	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A20	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A21	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A22	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A23	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A24	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A25	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A26	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A27	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A28	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A29	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A30	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A31	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A32	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A33	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A34	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A35	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A36	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A37	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A38	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A39	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
E06	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A40	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A41	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A42	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A43	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A44	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A45	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A46	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A47	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A48	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000

Table B.20 – Technical coefficient matrix N_E (Part III)																
	E04	**A17**	**A18**	**A19**	**A20**	**A21**	**A22**	**A23**	**A24**	**A25**	**A26**	**A27**	**A28**	**A29**	**A30**	**A31**
A01	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A02	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A03	0,90658264	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A04	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A05	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A06	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A07	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A08	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A09	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A10	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A11	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A12	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A13	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A14	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A15	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A16	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A17	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A18	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A19	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A20	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A21	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A22	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A23	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A24	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A25	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A26	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A27	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A28	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A29	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A30	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A31	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A32	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A33	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A34	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A35	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A36	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A37	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A38	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A39	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
E06	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A40	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A41	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A42	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A43	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A44	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A45	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A46	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A47	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A48	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000

Table B.20 – Technical coefficient matrix N_E (Part IV)

	A32	A33	A34	E05	A35	A36	A37	A38	A39	N14	N15	N16	N17	N18	N19	N20
A01	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A02	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A03	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A04	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A05	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,01112948	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A06	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A07	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A08	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A09	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A10	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A11	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A12	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A13	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A14	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A15	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A16	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A17	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A18	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A19	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A20	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A21	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A22	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,11420661	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A23	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00011479	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A24	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A25	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A26	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A27	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00152683	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A28	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A29	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A30	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A31	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A32	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A33	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A34	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A35	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00011600	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A36	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00027697	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A37	0,00000000	0,00000000	0,00000000	0,18429477	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A38	0,00000000	0,00000000	0,00000000	0,05141612	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A39	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
E06	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A40	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A41	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A42	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A43	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A44	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A45	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A46	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A47	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A48	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000

Table B.20 – Technical coefficient matrix N_E (Part V)

	N21	N22	N23	N24	N25	N26	N27	N28	N29	N30	N31	N32	N33	N34	N35	N36
A01	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A02	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A03	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A04	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A05	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A06	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A07	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A08	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A09	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A10	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A11	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A12	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A13	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A14	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A15	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A16	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A17	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A18	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A19	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A20	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A21	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A22	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A23	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A24	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A25	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A26	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A27	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A28	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A29	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A30	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A31	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A32	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A33	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A34	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A35	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A36	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A37	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A38	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A39	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
E06	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A40	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A41	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A42	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A43	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A44	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A45	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A46	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A47	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A48	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000

Table B.20 – Technical coefficient matrix N_E (Part VI)

	N37	N38	E06	A40	A41	A42	A43	A44	A45	A46	A47	A48	N39	N40	N41	A49
A01	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,02628011	0,00000000	0,00000000	0,00000000	0,00000000
A02	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00105102	0,00000000	0,00000000	0,00000000	0,00000000
A03	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A04	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,06380748	0,00000000	0,00000000	0,00000000	0,00000000
A05	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,04472043	0,06071794	0,00000000	0,00000000	0,00000000	0,00000000
A06	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00250341	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A07	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,01002942	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A08	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A09	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00087533	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A10	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,02738877	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A11	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00230850	0,00000000	0,00000000	0,00000000	0,00000000
A12	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00280828	0,00000000	0,00000000	0,00000000	0,00000000
A13	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A14	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00126678	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A15	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A16	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A17	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A18	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,02387493	0,03574081	0,00000000	0,00000000	0,00000000	0,00000000
A19	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,03866828	0,04046961	0,00000000	0,00000000	0,00000000	0,00000000
A20	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A21	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A22	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A23	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A24	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A25	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,03935489	0,00000000	0,00000000	0,00000000	0,00000000
A26	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A27	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,02533610	0,00000000	0,00000000	0,00000000	0,00000000
A28	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A29	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,01832946	0,00000000	0,00000000	0,00000000	0,00000000
A30	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00057990	0,00000000	0,00000000	0,00000000	0,00000000
A31	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A32	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A33	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A34	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A35	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A36	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A37	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A38	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A39	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,31968041	0,00000000	0,00000000	0,00000000	0,00000000
E06	0,00000000	0,00000000	0,00000000	1,00000000	1,00000000	1,00000000	1,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A40	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	1,01522843	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A41	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,90839612	0,19769272	0,00000000	0,00000000	0,00000000	0,00000000
A42	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,15336093	0,00000000	0,00000000	0,00000000	0,00000000
A43	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00429672	0,01248183	0,00000000	0,00000000	0,00000000	0,00000000
A44	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A45	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A46	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,09596399	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A47	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A48	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000

Table B.20 – Technical coefficient matrix N_E (Part VII)

	A50	A51	A52	A53	N42	N43	N44	N45	N46	N47	N48	N49	N50	N51	N52	N53
A01	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A02	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A03	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A04	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A05	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A06	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A07	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A08	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A09	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A10	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A11	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A12	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A13	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A14	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A15	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A16	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A17	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A18	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A19	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A20	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A21	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A22	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A23	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A24	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A25	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A26	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A27	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A28	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A29	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A30	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A31	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A32	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A33	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A34	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A35	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A36	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A37	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A38	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A39	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
E06	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A40	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A41	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A42	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A43	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A44	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A45	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A46	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A47	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000
A48	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000	0,00000000

XII. Assumptions for the computation of the GHG emissions from energy combustion (expressions 5.49 to 5.61).

The IPCC *sectoral-based approach* is used to estimate both CO_2 and non-CO_2 emissions from energy combustion in the intermediary sectors and final demand (general government, households and NPISH). Applying a higher *tier* according to the Brazilian reality in this category is not feasible due to data shortage by which the *tier* 1 approach is used. Emission estimates are based on the data of production/transformation and consumption by energy source obtained from the BER and computed in the hybrid IO framework previously referred in the energy consumption section and the IPCC emission factors.

Table B.21 – Energy Industries emission factors - vectors fecele$_w$, fecchp$_w$, fecref$_w$, fecpge$_w$ and fecbio$_w$ - (g/TJ) (adapted from IPCC, 2006).

	CO_2			CH_4			N_2O		
	Default	Lower	Upper	Default	Lower	Upper	Default	Lower	Upper
Wood	112,000,000	95,000,000	132,000,000	30,000	10,000	100,000	4,000	1,500	15,000
Charcoal	112,000,000	95,000,000	132,000,000	200,000	70,000	600,000	4,000	1,500	15,000
Crude Oil	73,300,000	71,110,000	75,500,000	3,000	1,000	10,000	600	200	2,000
Natural Gas Wet	64,200,000	58,300,000	70,400,000	3,000	1,000	10,000	600	200	2,000
Natural Gas Dry	56,100,000	54,300,000	58,300,000	1,000	300	3,000	100	30	300
Steam Coal 3100	107,000,000	95,700,000	119,000,000	1,000	300	3,000	1,500	500	5,000
Steam Coal 3300	107,000,000	95,700,000	119,000,000	1,000	300	3,000	1,500	500	5,000
Steam Coal 3700	107,000,000	95,700,000	119,000,000	1,000	300	3,000	1,500	500	5,000
Steam Coal 4200	107,000,000	95,700,000	119,000,000	1,000	300	3,000	1,500	500	5,000
Steam Coal 4500	107,000,000	95,700,000	119,000,000	1,000	300	3,000	1,500	500	5,000
Steam Coal 4700	107,000,000	95,700,000	119,000,000	1,000	300	3,000	1,500	500	5,000
Steam Coal 5200	107,000,000	95,700,000	119,000,000	1,000	300	3,000	1,500	500	5,000
Steam Coal 5900	107,000,000	95,700,000	119,000,000	1,000	300	3,000	1,500	500	5,000
Steam Coal 6000	107,000,000	95,700,000	119,000,000	1,000	300	3,000	1,500	500	5,000
Steam Coal without specification	107,000,000	95,700,000	119,000,000	1,000	300	3,000	1,500	500	5,000
Metallurgical Coal	107,000,000	95,700,000	119,000,000	1,000	300	3,000	1,500	500	5,000
Automotive gasoline	69,300,000	67,500,000	73,000,000	3,000	1,000	10,000	600	200	2,000
Fuel oil	77,400,000	75,500,000	78,800,000	3,000	1,000	10,000	600	200	2,000
Diesel oil	74,100,000	72,600,000	74,800,000	3,000	1,000	10,000	600	200	2,000
Aviation gasoline	70,000,000	67,500,000	73,000,000	3,000	1,000	10,000	600	200	2,000
Liquefied petroleum gas	63,100,000	61,600,000	65,600,000	1,000	300	3,000	100	30	300
Naphtha	73,300,000	69,300,000	76,300,000	3,000	1,000	10,000	600	200	2,000
Kerosene Illuminated	71,900,000	70,800,000	73,700,000	3,000	1,000	10,000	600	200	2,000
Jet Kerosene	71,500,000	69,700,000	74,400,000	3,000	1,000	10,000	600	200	2,000
Gas coke	107,000,000	95,700,000	119,000,000	1,000	300	3,000	100	30	300
Coke coal	94,600,000	87,300,000	101,000,000	1,000	300	3,000	1,500	500	5,000
Refinery Gas	57,600,000	48,200,000	69,000,000	1,000	300	3,000	100	30	300
Petroleum Coke	97,500,000	82,900,000	115,000,000	3,000	1,000	10,000	600	200	2,000
Other energy petroleum products	73,300,000	72,200,000	74,400,000	3,000	1,000	10,000	600	200	2,000
Tar	107,000,000	90,200,000	125,000,000	1,000	300	3,000	1,500	500	5,000
Asphalt	80,700,000	73,000,000	89,900,000	3,000	1,000	10,000	600	200	2,000
Lubricants	73,300,000	71,900,000	75,200,000	3,000	1,000	10,000	600	200	2,000
Solvents	73,300,000	72,200,000	74,400,000	3,000	1,000	10,000	600	200	2,000
Other non-energy petroleum products	73,300,000	72,200,000	74,400,000	3,000	1,000	10,000	600	200	2,000
Anhydrous bioethanol	70,800,000	59,800,000	84,300,000	3,000	1,000	10,000	600	200	2,000
Hydrous bioethanol	70,800,000	59,800,000	84,300,000	3,000	1,000	10,000	600	200	2,000
Sugarcane Bagasse	100,000,000	84,700,000	117,000,000	30,000	10,000	100,000	4,000	1,500	15,000
Bleach	95,300,000	80,700,000	110,000,000	3,000	1,000	18,000	2,000	1,000	21,000

Table B.22 – Commercial/Institutional emission factors - vectors fecg$_w$ and feccs$_w$ – (g/TJ) (adapted from IPCC, 2006)									
	CO_2			CH_4			N_2O		
	Default	Lower	Upper	Default	Lower	Upper	Default	Lower	Upper
Wood	112,000,000	95,000,000	132,000,000	300,000	100,000	900,000	4,000	1,500	15,000
Charcoal	112,000,000	95,000,000	132,000,000	200,000	70,000	600,000	1,000	300	3,000
Crude Oil	73,300,000	71,100,000	75,500,000	10,000	3,000	30,000	600	200	2,000
Natural Gas Wet	64,200,000	58,300,000	70,400,000	10,000	3,000	30,000	600	200	2,000
Natural Gas Dry	56,100,000	54,300,000	58,300,000	5,000	1,500	15,000	100	30	300
Steam Coal 3100	107,000,000	95,700,000	119,000,000	10,000	3,000	30,000	1,500	500	4,000
Steam Coal 3300	107,000,000	95,700,000	119,000,000	10,000	3,000	30,000	1,500	500	4,000
Steam Coal 3700	107,000,000	95,700,000	119,000,000	10,000	3,000	30,000	1,500	500	4,000
Steam Coal 4200	107,000,000	95,700,000	119,000,000	10,000	3,000	30,000	1,500	500	4,000
Steam Coal 4500	107,000,000	95,700,000	119,000,000	10,000	3,000	30,000	1,500	500	4,000
Steam Coal 4700	107,000,000	95,700,000	119,000,000	10,000	3,000	30,000	1,500	500	4,000
Steam Coal 5200	107,000,000	95,700,000	119,000,000	10,000	3,000	30,000	1,500	500	4,000
Steam Coal 5900	107,000,000	95,700,000	119,000,000	10,000	3,000	30,000	1,500	500	4,000
Steam Coal 6000	107,000,000	95,700,000	119,000,000	10,000	3,000	30,000	1,500	500	4,000
Steam Coal without specification	107,000,000	95,700,000	119,000,000	10,000	3,000	30,000	1,500	500	4,000
Metallurgical Coal	107,000,000	95,700,000	119,000,000	10,000	3,000	30,000	1,500	500	4,000
Automotive gasoline	69,300,000	67,500,000	73,000,000	10,000	3,000	30,000	600	200	2,000
Fuel oil	77,400,000	75,500,000	78,800,000	10,000	3,000	30,000	600	200	2,000
Diesel oil	74,100,000	72,600,000	74,800,000	10,000	3,000	30,000	600	200	2,000
Aviation gasoline	70,000,000	67,500,000	73,000,000	10,000	3,000	30,000	600	200	2,000
Liquefied petroleum gas	63,100,000	61,600,000	65,600,000	5,000	1,500	15,000	100	30	300
Naphtha	73,300,000	69,300,000	76,300,000	10,000	3,000	30,000	600	200	2,000
Kerosene Illuminated	71,900,000	70,800,000	73,700,000	10,000	3,000	30,000	600	200	2,000
Jet Kerosene	71,500,000	69,700,000	74,400,000	10,000	3,000	30,000	600	200	2,000
Gas coke	107,000,000	95,700,000	119,000,000	5,000	1,500	15,000	100	30	300
Coke coal	94,600,000	87,300,000	101,000,000	10,000	3,000	30,000	1,500	500	5,000
Refinery Gas	57,600,000	48,200,000	69,000,000	5,000	1,500	15,000	100	30	300
Petroleum Coke	97,500,000	82,900,000	115,000,000	10,000	3,000	30,000	600	200	2,000
Other energy petroleum products	73,300,000	72,200,000	74,400,000	10,000	3,000	30,000	600	200	2,000
Tar	107,000,000	90,200,000	125,000,000	10,000	3,000	30,000	1,500	500	5,000
Asphalt	80,700,000	73,000,000	89,900,000	10,000	3,000	30,000	600	200	2,000
Lubricants	73,300,000	71,900,000	75,200,000	10,000	3,000	30,000	600	200	2,000
Solvents	73,300,000	72,200,000	74,400,000	10,000	3,000	30,000	600	200	2,000
Other non-energy petroleum products	73,300,000	72,200,000	74,400,000	10,000	3,000	30,000	600	200	2,000
Anhydrous bioethanol	70,800,000	59,800,000	84,300,000	10,000	3,000	30,000	600	200	2,000
Hydrous bioethanol	70,800,000	59,800,000	84,300,000	10,000	3,000	30,000	600	200	2,000
Sugarcane Bagasse	100,000,000	84,700,000	117,000,000	300,000	100,000	900,000	4,000	1,500	15,000
Bleach	95,300,000	80,700,000	110,000,000	3,000	1,000	18,000	2,000	1,000	21,000

The emission factors for *Energy Industries* (see table B.21) are utilized to compute the emissions from electricity and combined heat and power generation, petroleum refining, petroleum and gas extraction and bioethanol production (corresponding to vectors **fecele**$_w$, **fecchp**$_w$, **fecref**$_w$, **fecpge**$_w$ and **fecbio**$_w$). The *Commercial/Institutional* emission factors (see table B.22) are applied for the trade and service sectors, public sectors and the final demand of the general government (corresponding to the vectors **fecg**$_w$ and **feccs**$_w$). The *Residential and Agriculture/Forestry/Fishing/Fishing* farms emission factors (see table B.23) are used to compute the emissions from the agriculture & forestry and fishing & livestock sectors, the final demand of households and NPISH (corresponding to the vectors **fecal**$_w$, **feccf**$_w$ and

fecnpish$_w$). Finally, the *Manufacturing Industries/Construction* emission factors (see table B.24) are used for the other sectors (corresponding to the vector **fecind**$_w$). The corresponding emission factors for road, railway, waterborne and aviation transport are presented in tables B.25 to B.28 (aggregated in the vector **fectr**$_{tw}$).

Table B.23 – Residential and Agriculture/ Forestry/ Fishing/ Fishing farms emission factors - vectors fecal$_w$, feccf$_w$ and **fecnpish$_w$ – (g/TJ) (adapted from IPCC, 2006).**

	CO_2			CH_4			N_2O		
	Default	Lower	Upper	Default	Lower	Upper	Default	Lower	Upper
Wood	112,000,000	95,000,000	132,000,000	300,000	100,000	900,000	4,000	1,500	15,000
Charcoal	112,000,000	95,000,000	132,000,000	200,000	70,000	600,000	1,000	300	3,000
Crude Oil	73,300,000	71,100,000	75,500,000	10,000	3,000	30,000	600	200	2,000
Natural Gas Wet	64,200,000	58,300,000	70,400,000	10,000	3,000	30,000	600	200	2,000
Natural Gas Dry	56,100,000	54,300,000	58,300,000	5,000	1,500	15,000	100	30	300
Steam Coal 3100	107,000,000	95,700,000	119,000,000	300,000	100,000	900,000	1,500	500	5,000
Steam Coal 3300	107,000,000	95,700,000	119,000,000	300,000	100,000	900,000	1,500	500	5,000
Steam Coal 3700	107,000,000	95,700,000	119,000,000	300,000	100,000	900,000	1,500	500	5,000
Steam Coal 4200	107,000,000	95,700,000	119,000,000	300,000	100,000	900,000	1,500	500	5,000
Steam Coal 4500	107,000,000	95,700,000	119,000,000	300,000	100,000	900,000	1,500	500	5,000
Steam Coal 4700	107,000,000	95,700,000	119,000,000	300,000	100,000	900,000	1,500	500	5,000
Steam Coal 5200	107,000,000	95,700,000	119,000,000	300,000	100,000	900,000	1,500	500	5,000
Steam Coal 5900	107,000,000	95,700,000	119,000,000	300,000	100,000	900,000	1,500	500	5,000
Steam Coal 6000	107,000,000	95,700,000	119,000,000	300,000	100,000	900,000	1,500	500	5,000
Steam Coal without specification	107,000,000	95,700,000	119,000,000	300,000	100,000	900,000	1,500	500	5,000
Metallurgical Coal	107,000,000	95,700,000	119,000,000	300,000	100,000	900,000	1,500	500	5,000
Automotive gasoline	69,300,000	67,500,000	73,000,000	10,000	3,000	30,000	600	200	2,000
Fuel oil	77,400,000	75,500,000	78,800,000	10,000	3,000	30,000	600	200	2,000
Diesel oil	74,100,000	72,600,000	74,800,000	10,000	3,000	30,000	600	200	2,000
Aviation gasoline	70,000,000	67,500,000	73,000,000	10,000	3,000	30,000	600	200	2,000
Liquefied petroleum gas	63,100,000	61,600,000	65,600,000	5,000	1,500	15,000	100	30	300
Naphtha	73,300,000	69,300,000	76,300,000	10,000	3,000	30,000	600	200	2,000
Kerosene Illuminated	71,900,000	70,800,000	73,700,000	10,000	3,000	30,000	600	200	2,000
Jet Kerosene	71,500,000	69,700,000	74,400,000	10,000	3,000	30,000	600	200	2,000
Gas coke	107,000,000	95,700,000	119,000,000	5,000	1,500	15,000	100	30	300
Coke coal	94,600,000	87,300,000	101,000,000	300,000	100,000	900,000	1,500	500	5,000
Refinery Gas	57,600,000	48,200,000	69,000,000	5,000	1,500	15,000	100	30	300
Petroleum Coke	97,500,000	82,900,000	115,000,000	10,000	3,000	30,000	600	200	2,000
Other energy petroleum products	73,300,000	72,200,000	74,400,000	10,000	3,000	30,000	600	200	2,000
Tar	107,000,000	90,200,000	125,000,000	300,000	100,000	900,000	1,500	500	5,000
Asphalt	80,700,000	73,000,000	89,900,000	10,000	3,000	30,000	600	200	2,000
Lubricants	73,300,000	71,900,000	75,200,000	10,000	3,000	30,000	600	200	2,000
Solvents	73,300,000	72,200,000	74,400,000	10,000	3,000	30,000	600	200	2,000
Other non-energy petroleum products	73,300,000	72,200,000	74,400,000	10,000	3,000	30,000	600	200	2,000
Anhydrous bioethanol	70,800,000	59,800,000	84,300,000	10,000	3,000	30,000	600	200	2,000
Hydrous bioethanol	70,800,000	59,800,000	84,300,000	10,000	3,000	30,000	600	200	2,000
Sugarcane Bagasse	100,000,000	84,700,000	117,000,000	300,000	100,000	900,000	4,000	1,500	15,000
Bleach	95,300,000	80,700,000	110,000,000	3,000	1,000	18,000	2,000	1,000	21,000

Table B.24 – Manufacturing Industries and Construction emission factors - vector $fecind_w$ – (g/TJ) (adapted from IPCC, 2006).

	CO2			CH4			N2O		
	Default	Lower	Upper	Default	Lower	Upper	Default	Lower	Upper
Wood	112,000,000	95,000,000	132,000,000	30,000	10,000	100,000	4,000	1,500	15,000
Charcoal	112,000,000	95,000,000	132,000,000	200,000	70,000	600,000	4,000	1,500	15,000
Crude Oil	73,300,000	71,100,000	75,500,000	3,000	1,000	10,000	600	200	2,000
Natural Gas Wet	64,200,000	58,300,000	70,400,000	3,000	1,000	10,000	600	200	2,000
Natural Gas Dry	56,100,000	54,300,000	58,300,000	1,000	300	3,000	100	30	300
Steam Coal 3100	107,000,000	95,700,000	119,000,000	10,000	3,000	30,000	1,500	500	5,000
Steam Coal 3300	107,000,000	95,700,000	119,000,000	10,000	3,000	30,000	1,500	500	5,000
Steam Coal 3700	107,000,000	95,700,000	119,000,000	10,000	3,000	30,000	1,500	500	5,000
Steam Coal 4200	107,000,000	95,700,000	119,000,000	10,000	3,000	30,000	1,500	500	5,000
Steam Coal 4500	107,000,000	95,700,000	119,000,000	10,000	3,000	30,000	1,500	500	5,000
Steam Coal 4700	107,000,000	95,700,000	119,000,000	10,000	3,000	30,000	1,500	500	5,000
Steam Coal 5200	107,000,000	95,700,000	119,000,000	10,000	3,000	30,000	1,500	500	5,000
Steam Coal 5900	107,000,000	95,700,000	119,000,000	10,000	3,000	30,000	1,500	500	5,000
Steam Coal 6000	107,000,000	95,700,000	119,000,000	10,000	3,000	30,000	1,500	500	5,000
Steam Coal without specification	107,000,000	95,700,000	119,000,000	10,000	3,000	30,000	1,500	500	5,000
Metallurgical Coal	107,000,000	95,700,000	119,000,000	10,000	3,000	30,000	1,500	500	5,000
Automotive gasoline	69,300,000	67,500,000	73,000,000	3,000	1,000	10,000	600	200	2,000
Fuel oil	77,400,000	75,500,000	78,800,000	3,000	1,000	10,000	600	200	2,000
Diesel oil	74,100,000	72,600,000	74,800,000	3,000	1,000	10,000	600	200	2,000
Aviation gasoline	70,000,000	67,500,000	73,000,000	3,000	1,000	10,000	600	200	2,000
Liquefied petroleum gas	63,100,000	61,600,000	65,600,000	1,000	300	3,000	100	30	300
Naphtha	73,300,000	69,300,000	76,300,000	3,000	1,000	10,000	600	200	2,000
Kerosene Illuminated	71,900,000	70,800,000	73,700,000	3,000	1,000	10,000	600	200	2,000
Jet Kerosene	71,500,000	69,700,000	74,400,000	3,000	1,000	10,000	600	200	2,000
Gas coke	107,000,000	95,700,000	119,000,000	1,000	300	3,000	100	30	300
Coke coal	94,600,000	87,300,000	101,000,000	10,000	3,000	30,000	1,500	500	5,000
Refinery Gas	57,600,000	48,200,000	69,000,000	1,000	300	3,000	100	30	300
Petroleum Coke	97,500,000	82,900,000	115,000,000	3,000	1,000	10,000	600	200	2,000
Other energy petroleum products	73,300,000	72,200,000	74,400,000	3,000	1,000	10,000	600	200	2,000
Tar	107,000,000	90,200,000	125,000,000	10,000	3,000	30,000	1,500	500	5,000
Asphalt	80,700,000	73,000,000	89,900,000	3,000	1,000	10,000	600	200	2,000
Lubricants	73,300,000	71,900,000	75,200,000	3,000	1,000	10,000	600	200	2,000
Solvents	73,300,000	72,200,000	74,400,000	3,000	1,000	10,000	600	200	2,000
Other non-energy petroleum products	73,300,000	72,200,000	74,400,000	3,000	1,000	10,000	600	200	2,000
Anhydrous bioethanol	70,800,000	59,800,000	84,300,000	3,000	1,000	10,000	600	200	2,000
Hydrous bioethanol	70,800,000	59,800,000	84,300,000	3,000	1,000	10,000	600	200	2,000
Sugarcane Bagasse	100,000,000	84,700,000	117,000,000	30,000	10,000	100,000	4,000	1,500	15,000
Bleach	95,300,000	80,700,000	110,000,000	3,000	1,000	18,000	2,000	1,000	21,000

Table B.25 – Road Transport emission factors – (g/TJ) (adapted from IPCC, 2006).

	CO_2			CH_4			N_2O		
	Default	Lower	Upper	Default	Lower	Upper	Default	Lower	Upper
Natural Gas Wet	56,100,000	54,300,000	58,300,000	-	-	-	-	-	-
Natural Gas Dry	56,100,000	54,300,000	58,300,000	92,000	50,000	1,540,000	3,000	1,000	77,000
Automotive gasoline	69,300,000	67,500,000	73,000,000	25,000	7,500	86,000	8,000	2,600	24,000
Diesel oil	74,100,000	72,600,000	74,800,000	3,900	1,600	9,500	3,900	1,300	12,000
Liquefied petroleum gas	63,100,000	61,600,000	65,600,000	62,000	-	-	200	-	-
Kerosene Illuminated	71,900,000	70,800,000	73,700,000	-	-	-	-	-	-
Lubricants	73,300,000	71,900,000	75,200,000	-	-	-	-	-	-
Anhydrous bioethanol	70,800,000	59,800,000	84,300,000	18,000	13,000	84,000	-	-	-
Hydrous bioethanol	70,800,000	59,800,000	84,300,000	18,000	13,000	84,000	-	-	-

Table B.26 – Railways emission factors – (g/TJ) (adapted from IPCC, 2006).

	CO_2			CH_4			N_2O		
	Default	Lower	Upper	Default	Lower	Upper	Default	Lower	Upper
Diesel oil	74,100,000	72,600,000	74,800,000	4,150	1,670	10,400	28,600	14,300	85,800
Coke coal	96,100,000	72,800,000	100,000,000	2,000	600	6,000	1,500	500	5,000

Table B.27 – Aviation emission factors – (g/TJ) (adapted from IPCC, 2006).

	CO_2			CH_4			N_2O		
	Default	Lower	Upper	Default	Lower	Upper	Default	Lower	Upper
Aviation gasoline	69,300,000	67,500,000	73,000,000	500	215	1,000	2,000	600	5,000
Jet Kerosene	71,500,000	69,800,000	74,400,000	500	215	1,000	2,000	600	5,000

Table B.28 – Water-borne Navigation emission factors – (g/TJ) (adapted from IPCC, 2006).

	CO_2			CH_4			N_2O		
	Default	Lower	Upper	Default	Lower	Upper	Default	Lower	Upper
Natural Gas Dry	56,100,000	54,300,000	58,300,000	-	-	-	-	-	-
Automotive gasoline	69,300,000	67,500,000	73,000,000	-	-	-	-	-	-
Fuel oil	77,400,000	75,500,000	78,800,000	7,000	3,500	10,500	2,000	1,200	4,800
Diesel oil	74,100,000	72,600,000	74,800,000	7,000	3,500	10,500	2,000	1,200	4,800
Liquefied petroleum gas	63,100,000	61,600,000	65,600,000	-	-	-	-	-	-
Kerosene Illuminated	71,900,000	70,800,000	73,600,000	-	-	-	-	-	-
Refinery Gas	57,600,000	48,200,000	69,000,000	-	-	-	-	-	-
Other energy petroleum products	73,300,000	72,200,000	74,400,000	-	-	-	-	-	-

XIII. Assumptions for the computation of the fugitive GHG emissions (expressions 5.62 to 5.74).

Fugitive emissions of different sources in Brazil (coal production, gas production, gas transmission, gas storage, gas distribution, transport of Liquefied Petroleum Gas, oil production and oil transport) are computed by using the methodology and emission factors for developing countries from IPCC (2006) in combination with specific data of the Brazilian conditions provided in the Brazilian National GHG Inventory (MCT, 2010).

The total national production of each coal is used to compute the fugitive emissions associated to the coal production. The emission factors considered for underground ($efcpmu_w$) or surface ($efcpms_w$) mining and underground ($efpmmu_w$) or suface ($efpmms_w$) post-mining are presented in table B.29.

Table B.29 – Fugitive emissions – Coal mining and post-mining (Gg/ 10^3t).

	CO_2			CH_4			N_2O		
	Default	Lower	Upper	Default	Lower	Upper	Default	Lower	Upper
$efcpmu_w$	-	-	-	0.00001206	0.00000670	0.00001675	-	-	-
$efcpms_w$	-	-	-	0.00000168	0.00000060	0.00000268	-	-	-
$efpmmu_w$	-	-	-	0.00000080	0.00000020	0.00000134	-	-	-
$efpmms_w$	-	-	-	0.00000007	-	0.00000013	-	-	-

The total national productions of natural gas dry and wet are used to compute the fugitive emissions from flaring and venting. The intermediary and final consumption of natural gas dry and wet are used to compute the fugitive emissions associated with the transportation, storage and distribution, therefore accounting both national and imported natural gas consumed in the country. The intermediary and final consumption of LPG are used to estimate the fugitive emissions associated with LPG distribution. The default fugitive emission factors (and the corresponding uncertainty) from gas operations in developing countries and countries with economies in transition provided by IPCC (2006) is used to define default, lower and upper emission factors associated with each fugitive source, which are outlined in table B.30.

Table B.30 – Fugitive emissions – Gas production, transmission, storage and distribution (Gg/ $10^6 m^3$).

	CO_2			CH_4			N_2O		
	Default	Lower	Upper	Default	Lower	Upper	Default	Lower	Upper
$efgpfl_w$	0.00009700	0.00001400	0.00018000	0.01219000	0.00038000	0.02400000	-	-	-
$efgpv_w$	0.00140000	0.00120000	0.00160000	0.00000088	0.00000076	0.00000100	0.00000003	0.00000002	0.00000003
$efgpf_w$	0.00000144	0.00000088	0.00000200	0.00063300	0.00016600	0.00110000	-	-	-
$efgtf_w$	0.00000520	0.00000310	0.00000730	0.00039200	0.00004400	0.00074000	-	-	-
$efgs_w$	0.00000019	0.00000011	0.00000026	0.00004150	0.00002500	0.00005800	-	-	-
$efgd_w$	0.00009550	0.00005100	0.00014000	0.00180000	0.00110000	0.00250000	-	-	-
$eflpgd_w$	0.43000000	-	0.86000000	-	-	-	0.00000220	0.00000198	0.00002420

The total national production of crude oil is used to estimate venting, flaring and other fugitive emissions associated with petroleum extraction, while the fugitive emissions from oil transportation is computed by using the total crude oil consumed by the refinery sector. The fugitive emissions from venting, flaring, transport and other fugitive releases from oil systems are estimated using the default emission factors for developing countries provided in the *2006 IPCC* Guidelines presented in table B.31.

Table B.31 – Fugitive emissions – Oil production and tranportation (Gg/ $10^6 m^3$)

	CO_2			CH_4			N_2O		
	Default	Lower	Upper	Default	Lower	Upper	Default	Lower	Upper
$efopv_w$	0.00004300	0.00003763	0.00038700	0.00059000	0.00051625	0.00531000	-	-	-
$efopfl_w$	0.11250000	0.09500000	0.13000000	0.85500000	0.72000000	0.99000000	-	-	-
$efopf_w$	48.50000000	41.00000000	56.00000000	0.02950000	0.02500000	0.03400000	-	-	-
$efotp_w$	0.00049000	0.00024500	0.00147000	0.00540000	0.00270000	0.01620000	-	-	-

The conversion factors from toe to tons for each coal product (**cftoet**) and from toe to m^3 for gas and oil products (**cftoem3**) are estimated from the values in the BER and presented in table B.32.

Table B.32 – Conversion factors for coal, gas and oil.		
Coal products		
	BER	**cftoet**
	toe/t	t/toe
Steam Coal 3100	0.295	3.390
Steam Coal 3300	0.310	3.226
Steam Coal 3700	0.350	2.857
Steam Coal 4200	0.400	2.500
Steam Coal 4500	0.425	2.353
Steam Coal 4700	0.445	2.247
Steam Coal 5200	0.490	2.041
Steam Coal 5900	0.560	1.786
Steam Coal 6000	0.570	1.754
Steam Coal without specification	0.285	3.509
Metallurgical Coal	0.740	1.351
Gas and oil		
	BER	**cftoem3**
	toe/m^3	m^3/toe
Natural Gas Wet	0.993	1.007
Natural Gas Dry	0.88	1.136
LPG	0.612	1.634
Crude oil	0.889	1.125

XIV. Assumptions for the computation GHG emissions from industrial process and product use (expressions 5.75 and 5.76).

This category includes the GHG emissions generated by some industries as a byproduct of its production processes. The emissions in the chemical industry (production of ammonia, carbide, petrochemicals, carbon black, nitric acid, adipic acid and caprolactam), the mineral industry (production of cement or clinker, lime and carbonates) and the metal industry (production of aluminum, pig iron and steel) are linked to the total output of the sectors chemicals, cement, other products of nonmetallic minerals, metallurgy of nonferrous metals and manufacture of steel and steel products. Emission factors ($effeipz_w$) estimated by dividing the total national emissions related to each industrial process (allocated in the corresponding sector) provided in the Brazilian National Inventory by the corresponding sector's output in the base year of the study are used and outlined in table B.33.

Table B.33– Emission factor for industrial process and product use (Gg/R$ million).			
	CO_2	CH_4	N_2O
Chemicals	3,532	11	27
Cement	18,829	-	-
Other products of nonmetallic minerals	9,508	-	-
Manufacture of steel and steel products	45,677	-	-
Metallurgy of nonferrous metals	2,871	-	-

The fugitive emissions of CO_2 from lubricants are estimated using a *tier* 1 approach and considering the data of the level of lubricants production, exports and national consumption from the BER. The coefficient a_{elub} is estimated as a relation of the lubricants exported in the total national production of lubricants. The carbon content of lubricants (cc_{lub} – usually given in ton C/TJ is converted to GgC/toe) and an *oxidised during use* factor (odu_{lub}) are obtained from the IPCC (2006) (see table B.34).

Table B.34 – Parameters for the calculation of fugitive emissions from lubricants.			
a_{elub} (toe/toe)	cc_{lub} (t C/TJ)	cc_{lub} (GgC/toe)	odu_{lub}
0.0482	20	0.83736	0.2

XV. Assumptions for the computation GHG emissions from Agriculture, Forestry, Livestock and Fishing Sectors (expressions 5.78 to 5.94).

The vector with the coefficients of number of heads of each livestock species/category (cattle, buffaloes, pigs, chickens, turkeys, ducks, lamb, sheep, horses, mules and asses) by millions of output of the livestock and fishing sector (**aep**) is calculated based on the data for 2009 of animal population in Brazil from FAOSTAT (http://faostat.fao.org/) and the total output of the corresponding species/category from Guilhoto and Sesso Filho (2010). The coefficients of nitrogen (N) excretion by each livestock species/category (**amp**) are obtained from the IPCC (2006). The fraction of total annual N excretion for each livestock species/category *i* that is managed in manure management system *j* (anaerobic lagoon, solid storage, dry lot and anaerobic digester) ($\mathbf{A}_{ma}$) and the fraction of total annual N excretion that is deposited directly in soil by grazing animals of each livestock species/category ($\mathbf{a}_{ga}$) in the country is obtained from specific data according to the major producers States in Brazil available in the Brazilian National GHG Inventory (MCT, 2010) (see table B.35).

Table B.35 – Parameters for livestock population and manure management.							
	aep (10^3 heads/Million R$)	**amp** Gg/10^3 heads	$\mathbf{A}_{ma}$ (%)				$\mathbf{a}_{ga}$ (%)
	-	-	Anaerobic lagoon	Anaerobic digester	Solid Storage	Dry lot	Pasture
Cattle	2.3262	0.0526	0.000500	0.001667	0.027833	-	97.00%
Buffaloes	0.0129	0.0526	0.003000	-	0.009600	-	98.74%
Pigs	0.4311	0.0168	0.040500	0.062100	0.897400	-	0.00%
Chickens	13.9801	0.0005	0.012300	0.001500	0.359660	0.595240	3.13%
Turkeys	0.2923	0.0018	0.012300	0.001500	0.359660	0.595240	3.13%
Ducks	0.0419	0.0008	0.012300	0.001500	0.359660	0.595240	3.13%
Lamb	0.1168	0.0120	0.001000	0.000200	0.042800	-	95.60%
Sheep	0.1905	0.0120	0.001000	0.000400	0.050600	-	94.80%
Horses	0.0623	0.0400	0.002700	0.001100	0.094200	-	90.20%
Mules	0.0145	0.0218	0.000600	0.000500	0.034600	-	96.43%
Asses	0.0117	0.0218	0.000300	0.000100	0.014500	-	98.51%

Default emission factors for direct N_2O emissions from each manure management system ($\mathbf{efdmm}_w$) and percentage of managed manure nitrogen for livestock category *i* that volatilizes as NH3 and NOx in the manure management system *j* ($\mathbf{A}_{fv}$) are obtained from the

IPCC (2006) (see tables B.36 and B.37).

Table B.36 – Emission factors for direct N_2O emissions from each manure management system – **efdmm**$_w$ (GgN2O-N/GgN)

	Cattle	Buffaloes	Pigs	Chickens	Turkeys	Ducks	Lamb	Sheep	Horses	Mules	Asses
Anaerobic lagoon	-	-	-	-	-	-	-	-	-	-	-
Anaerobic digester	-	-	-	-	-	-	-	-	-	-	-
Solid Storage	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005
DryLot	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020

Table B.37 – Percentage of managed manure N that volatilizes as NH_3 and NO_x – **A**$_{fv}$ (%)

	Cattle	Buffaloes	Pigs	Chickens	Turkeys	Ducks	Lamb	Sheep	Horses	Mules	Asses
Anaerobic lagoon	35%	35%	40%	40%	40%	40%	0%	0%	0%	0%	0%
Anaerobic digester	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Solid Storage	30%	30%	45%	0%	0%	0%	12%	12%	12%	12%	12%
DryLot	20%	30%	0%	0%	0%	0%	0%	0%	0%	0%	0%

The default value of 0.01 Gg N_2O-N/ Gg N from IPCC (2006) is used for the emission factor for N_2O emissions from atmospheric deposition of nitrogen on soils and water surfaces ($efadv_w$) and for N_2O emissions from N additions to the soils from organic and synthetic fertilizers ($eofmm_w$) and from crop residues ($efcr_w$).

The CH_4 emission factors of manure management for the defined livestock population ($efmm_{rw}$) and for enteric fermentation ($efentf_{rw}$) are obtained from the Brazilian National GHG Inventory (MCT, 2010). The emission factor for N_2O emissions from urine and dung N deposited on pasture by grazing animals of each livestock species/category is obtained from IPCC (2006) (see table B.38).

Table B.38 – Emission factors for manure management, enteric fermentation and manure from grazing animals deposited on pasture.

	$efmm_{rw}$ Gg/ 10^3 heads/ year			$efentf_{rw}$ Gg/ 10^3 heads/ year			**egm**$_w$ Gg N02-N/ Gg N
	CO2	CH4	N2O	CO2	CH4	N2O	
Cattle	-	0.00100	-	-	0.0560	-	0.02
Buffaloes	-	0.00100	-	-	0.0550	-	0.02
Pigs	-	0.00100	-	-	0.0010	-	0.02
Chickens	-	0.00002	-	-	-	-	0.02
Turkeys	-	0.00002	-	-	-	-	0.02
Ducks	-	0.00002	-	-	-	-	0.02
Lamb	-	0.00015	-	-	0.0050	-	0.01
Sheep	-	0.00015	-	-	0.0050	-	0.01
Horses	-	0.00164	-	-	0.0180	-	0.01
Mules	-	0.00090	-	-	0.0100	-	0.01
Asses	-	0.00090	-	-	0.0100	-	0.01

The coefficient of productivity ($aprod_q$) is estimated by considering the total production and the total area cultivated of each crop in the base year using data from IBGE (2014). The computation of the coefficient of area cultivated by unity of production in monetary terms ($aprodut_q$) is based on data of the cultivated area from IBGE and the corresponding total output of each crop from Guilhoto and Sesso Filho (2010). The computation of the weights of the output of each crop in the total output of the agriculture and forestry sector ($apats_q$) is based on the data from Guilhoto and Sesso Filho (2010). The ratio of dry matter (d.m.) produced by unit of mass of each crop ($admqp_q$), the ratio of above ground ($admag_q$) and bellow ground ($admbg_q$) residues in the total dry matter produced by each crop, the ratio of the burnt area in the total area of each crop ($aburn_q$), the ratio of residues burnt in the total d.m. produced by each crop ($admbdm_q$) and the N content of above-ground residues (nag_q) and of below-ground residues (nbg_q) for each crop are obtained from the MCT (2010) according to the Brazilian reality (see table B.39).

Table B.39 – Parameters for the computation of emissions due to crop residues.

	$aprod_q$	$aprodut_q$	$apats_q$	$admqp_q$	$admag_q$	$admbg_q$	$aburn_q$	$admbdm_q$	nag_q	nbg_q
	$\frac{Gg}{ha}$	$\frac{ha}{10^6 R\$}$	$\frac{R\$}{R\$}$	$\frac{Gg (d.m.)}{Gg}$	$\frac{Gg (d.m.)}{Gg (d.m.)}$	$\frac{Gg (d.m.)}{Gg (d.m.)}$	%	$\frac{Gg (d.m.)}{Gg (d.m.)}$	%	%
Rice	0.0044	364.89	0.05	0.870	1.050	0.160	-	-	0.008	-
Corn	0.0037	849.12	0.11	0.870	1.490	0.220	-	-	0.008	0.007
Soy	0.0026	559.11	0.26	0.870	1.980	0.190	-	-	0.009	0.008
Cassava	0.0139	332.31	0.04	0.350	1.420	0.200	-	-	0.014	-
Bean	0.0009	1179.53	0.02	0.870	1.490	0.190	-	-	0.017	0.008
Sugarcane	0.0790	408.45	0.14	0.169	0.210	-	0.575	0.790	0.006	-

The coefficient of utilization of synthetic fertilizers N in the agriculture sector (afert) is calculated based on the total N fertilizers applied in the soil in the country in the base year from the MCT (2010) and the total output of the agriculture and forestry sector. The fractions of applied organic N fertilizers and manure N deposited by grazing animals (aofgav) and synthetic fertilizer N (asfv) that volatilizes as NH_3 and NO_x, the fraction of all N added to managed soils in regions where leaching/runoff occurs that is lost through leaching and runoff (aflr) and the emission factor for N_2O emissions from N leaching and runoff (eflr) are default values from IPCC (2006) (see table B.40).

Table B.40 – Parameters for the computation of direct and indirect emissions from synthetic fertilizers.

	afert	aofgav	asfv	aflr	eflr
	Gg N/10^6 R$	Gg N/Gg N	Gg N/Gg N	Gg N/Gg N	Gg N_2O–N/ Gg N
Direct deposition	0.014547605				
Atmospheric deposition		0.2	0.1		
Lixiviation				0.3	0.0075

The coefficient of annual harvested area of rice according to each water regime ($arice_T$) is estimated based on the data of cultivated area in the base year from IBGE (2014) and the total output of rice in monetary terms from Guilhoto and Sesso Filho (2010). The annual emission factor for each water regime is computed using the total emission of CH_4 from each water regime provided in the Brazilian National GHG Inventory (MCT, 2010) for

2005 and the total area cultivated of each water regime in the same year (IBGE, 2014) (see table B.41).

Table B.41 – Parameters for the computation of CH_4 emissions from rice cultivation.

	$arice_T$	$Efrice_{Tw}$
	ha/10^6 R$	Gg/ha
Continuously flooded	128.77	0.0003001
Intermittently flooded	4.29	0.0002391
Regular rainfed	231.83	-

Since only the residues of sugarcane are still burned in the field, the emission factor for dry matter burnt ($efburn_{qw}$) is applied just for this commodity. These emission factors are obtained from the MCT (2010) and calculated according to the Brazilian reality, considering the most used varieties of sugarcane in the country. The values for $efburn_{qw}$ are 0.00283067 Gg/ Gg (d.m.) for CH_4 and 0.00013965 Gg/ Gg (d.m.) for N_2O emissions.

The annual direct N_2O emissions from managed organic soils (eos_w) is considered as the same values obtained for 2005 in the Brazilian National Inventory (MCT, 2010), therefore 12.8 Gg of N_2O. The land use change emissions ($eluc_w$) which includes CO_2 emissions from liming is set as the same values obtained for 2000 in the Brazilian National Inventory (MCT, 2010), therefore 1,258,626 Gg of CO2; 3,045 Gg of CH_4 and 20.9 Gg of N_2O.

XVI. Assumptions for the computation of GHG emissions from Solid Waste Disposal (expressions 5.95 to 5.108).

The coefficient of per capita disposal of MSW (amsw) is obtained from the ABRELPE Report (ABRELPE, 2010) considering the MSW generated in 2009 (60,868.08 Gg) and the urban population of the same year (160,879,708 hab). The ratio of urban population on the total human population in the country (a_{up}) is obtained considering the values of the urban population provided by ABRELPE (2010) and the total population in the country in 2009 from IMF (2014). The fractions of MSW disposed to SWDS (fmswswd), carried to composting and anaerobic digestion processes (fmswbt) and incinerated (fmswincin) are obtained from the default values for Brazil in 2000 from IPCC (2006). The prospective Brazilian population for the year of analysis (p) is obtained from IMF (2014). The recovery factor of CH_4 ($rfmsw_w$) is estimated based on data of recovered CH_4 in 2005 from the Brazilian GHG Inventory (MCT, 2010). The coefficient of ISW production by monetary unity of output (ais_w) is obtained by dividing the total ISW estimated by ABRELPE (2008) for 2007 by the sum of the total output of all industrial sectors in monetary terms from the hybrid IO framework. The fraction of non-hazardous waste in the total ISW ($fnhwis_w$), the fraction of ISW to SWD in the total ISW (fiswswd) and the fraction of ISW incinerated (without energy recovery) in the total ISW are obtained from the respective totals available in ABRELPE (2008) for the year 2007. The default values from IPCC (2006) are used for the fraction of organic waste in the industrial waste (fisworgswd). The coefficient of CW incinerated per unit of output of the health sectors (acwincin) are estimated by using a full utilization of the of the incineration capacity in 2009 from ABRELPE (2009) and the total output of the private and public health sectors from the hybrid IO framework. The values for carbon content in MSW (ccmsw), in ISW (ccisw) and the CW (cccw); the fraction of fossil carbon in MSW (ffcmsw), in ISW (ffcisw) and in CW (ffccw), and the combustion efficiency of incinerators (ceinc) are obtained from MCT (2010), which are based on the Good Practice Guidance of IPCC (2000) (see table B.42).

Table B.42 – Parameters and coefficients for the computation of GHG emissions from MSW, ISW and CW.

Parameter/Coefficient	Unity	Value	Data source
amsw	Gg/cap/year	0.000378	ABRELPE (2010)
aup	%	84.36	ABRELPE (2010), IBGE (2013).
fmswswd	%	80	IPCC (2006)
fmswbt	%	3	IPCC (2006)
fmswincin	%	5	IPCC (2006)
p	habitants	204,759,993	IBGE (2008)
$rfmsw_w$	%	5.4	MCT (2010)
ais_w	Gg/ 10^6 R$	0.003208987	ABRELPE (2008), Guilhoto & Sesso Filho (2010)
$fnhwis_w$	%	74.0	ABRELPE (2008)
fiswswd	%	75.4	ABRELPE (2008)
fiswincin	%	1.2	ABRELPE (2008)
fisworgswd	%	1%	IPCC (2010)
acwincin	Gg/ 10^6 R$	0.00000085	ABRELPE (2009), Guilhoto & Sesso Filho (2010)
ccmsw	%	40%	MCT (2010)
ffcmsw	%	40%	MCT (2010)
ccisw	%	50%	MCT (2010)
ffcisw	%	90%	MCT (2010)
cccw	%	60%	MCT (2010)
ffccw	%	40%	MCT (2010)
ceinc	%	95%	MCT (2010)

Regional default values for South America from IPCC (2006) are used in the coefficient of MSW by residue type ($amsw_u$). Values for uncategorized SWDS from IPCC (2006) are used for the CH_4 correction factor for aerobic decomposition in the year of deposition (mfcmsw). Default values from IPCC (2006) are considered for the fraction of degradable organic carbon in the year of deposition ($docmsw_u$), the fraction of DOC that can be decomposed ($docfmsw_u$) and the fraction of CH_4 in generated landfill gas ($fch4glg_w$). The values for tropical (moist and wet) from IPCC (2006) are applied to the reaction constant (k) (see table B.43).

Table B.43 – Parameters and coefficients applied to the computation of GHG emissions from MSW.						
	$amsw_u$	$mcfmsw_u$	$docmsw_u$	$docfmsw_u$	$fch4glg_w$	k
Food waste	45%	60%	15%	50%	50%	0.40
Garden (yard) and park waste	0	60%	20%	50%	50%	0.17
Paper and cardboard	17%	60%	40%	50%	50%	0.07
Wood	5%	60%	43%	50%	50%	0.035
Textiles	3%	60%	24%	50%	50%	0.07
Nappies (disposable diapers)	0	60%	24%	50%	50%	0
Rubber and leather	1%	60%	39%	50%	50%	0
Plastics	11%	60%	0%	50%	50%	0
Metal	3%	60%	0%	50%	50%	0
Glass (and pottery and china)	3%	60%	0%	50%	50%	0
Other (e.g., ash, dirt, dust, soil, electronic waste)	13%	60%	0%	50%	50%	0

The emission factors for biological treatment of MSW ($efmswbt_w$) are set as the default values on a wet weight basis from IPCC (2006). The default value of 0.5 for the fraction of degradable organic carbon decomposed from IPCC (2006) and the molecular weight ratio of CH_4 and C (16/12) are used to compute the emission factor for organic ISW disposed ($efiworgswd_w$). The default N_2O emission factor for all types of incineration from IPCC (2006) is considered for the emission factor for ISW incineration ($efiswincin_w$). Due to a lack o default emission factors for CW incinerated, the default emission factor for sewage sludge incineration (on wet weight basis) from IPCC (2006) are used for the emission factor for CW incinerated ($efcwincin_w$)[8] (see table B.44). The MSW depostid in SWDS by type of residue and the production of CH_4 in SWDS are presented in tables B.45 and B.46, respectively.

Table B.44 – Emission factors for biological treatment of MSW, organic ISW disposed and ISW and CW incinerated (Gg/Gg).			
Parameters	**CO_2**	**CH_4**	**N_2O**
$efmswbt_w$	-	0.0040	0.0003
$efiworgswd_w$	-	0.6667	-
$efiswincin_w$	-	-	0.0001
$efcwincin_w$	-	-	0.0009

[8] Since no detailed information about the performance of the incinerators is available, the CH_4 emissions are set to zero as in the Brazilina National Inventory (MCT, 2010), by which only CO_2 and N_2O emissions from incineration are computed.

Table B.45 – MSW depostid in SWDS by type of residue (t).

	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Food waste	17,206	17,728	18,255	18,748	19,176	19,544	19,866	20,154	20,424	20,687	20,960	21,250	21,556	21,870	22,349	22,532	22,706	22,872	23,031	23,184	23,332
Garden (yard) and park waste	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Paper and cardboard	6,553	6,752	6,953	7,140	7,303	7,443	7,566	7,676	7,778	7,879	7,982	8,093	8,210	8,329	8,512	8,581	8,647	8,711	8,771	8,830	8,886
Wood	1,801	1,856	1,911	1,963	2,007	2,046	2,080	2,110	2,138	2,165	2,194	2,224	2,256	2,289	2,339	2,359	2,377	2,394	2,411	2,427	2,442
Textiles	996	1,027	1,057	1,086	1,110	1,132	1,150	1,167	1,183	1,198	1,214	1,231	1,248	1,266	1,294	1,305	1,315	1,324	1,334	1,343	1,351
Nappies (disposable diapers)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Rubber and leather	268	276	285	292	299	305	310	314	318	323	327	331	336	341	348	351	354	357	359	361	364
Plastics	4,139	4,264	4,391	4,510	4,613	4,701	4,778	4,848	4,913	4,976	5,042	5,111	5,185	5,261	5,376	5,420	5,461	5,501	5,540	5,577	5,612
Metal	1,111	1,145	1,179	1,211	1,239	1,262	1,283	1,302	1,319	1,336	1,354	1,373	1,392	1,413	1,443	1,455	1,467	1,477	1,488	1,497	1,507
Glass (and pottery and china)	1,265	1,303	1,342	1,378	1,409	1,436	1,460	1,481	1,501	1,520	1,540	1,562	1,584	1,607	1,643	1,656	1,669	1,681	1,693	1,704	1,715
Other (e.g., ash, dirt, dust, soil, electronic waste)	4,982	5,133	5,286	5,428	5,552	5,659	5,752	5,835	5,913	5,990	6,068	6,153	6,241	6,332	6,471	6,524	6,574	6,622	6,668	6,713	6,755

Table B.46 – Production of CH_4 in SWDS – First Order Decay (FOD) method (t of CH_4)

	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Food waste	0.1	0.2	0.3	0.5	0.7	1.1	1.6	2.4	3.7	5.6	8.4	12.8	19.3	29.3	44.6	67.1	100.9	151.6	227.8	342.1	513.6
Garden (yard) and park waste	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Paper and cardboard	10.1	11.1	12.3	13.5	14.8	16.2	17.7	19.2	20.9	22.7	24.7	26.8	29.2	31.7	34.8	37.6	40.7	43.9	47.4	51.2	55.3
Wood	2.8	3.0	3.2	3.4	3.6	3.8	4.0	4.2	4.5	4.7	4.9	5.1	5.4	5.7	6.0	6.3	6.6	6.8	7.1	7.4	7.7
Textiles	0.9	1.0	1.1	1.2	1.4	1.5	1.6	1.8	1.9	2.1	2.2	2.4	2.7	2.9	3.2	3.4	3.7	4.0	4.3	4.7	5.0
Nappies (disposable diapers)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Rubber and leather	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Plastics	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Metal	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Glass (and pottery and china)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Other (e.g., ash, dirt, dust, soil, electronic waste)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

XVII. Assumptions for the computation of GHG emissions from wastewater and sludge (expressions 109 to 114).

The biochemical oxygen demand per person (bod) is set as 19.71 kg BOD/habitants/year. This value is obtained from MCT (2010) according to the Brazilian reality. The default value of 0.6 kg CH_4/kg BOD from IPCC (2006) is considered for the maximum CH_4 producing potential for domestic wastewater (b_o). The values for the methane correction factor for the wastewater treatment and discharge system (mcf_j) is obtained from the IPCC (2006). An average value is considered for other treatment and discharge pathway or system not accounted in the Brazilian GHG Inventory (MCT, 2010). The degree of utilization of each treatment/discharge pathway or system ($adwwt_j$) is obtained from MCT (2010) according to the Brazilian reality. The coefficient of CH_4 recovered by CH_4 produced in the inventory year (adwwrec) is defined as a ratio of the total CH_4 recovered in 2005 on the total CH_4 generated by all pathway and systems, obtaining the value of 0.0038%. The emission factor for each domestic wastewater treatment and discharge pathway and system ($efdww_j$) is calculated based on the b_o and mcf_j (see table B.47).

Table B.47 – Parameters considered in the estimation of GHG emissions from domestic wastewater.

Type of treatment and discharge pathway or system	mcf_j	$adwwt_j$	$efdww_j$
Stagnant sewer	0.5	22.5%	0.30
Sea, river and lake discharge	0.1	30.5%	0.06
Anaerobic reactor	0.8	1.8%	0.48
Anaerobic deep lagoon	0.8	5%	0.48
Sea, river and lake discharge	0.1	22.9%	0.06
Others	0.33	17.3%	0.20

The coefficients of physical production of each product per unit of output of the respective sector ($\mathbf{aprod}_p$) is estimated based on the total production of each product in physical terms from MCT (2010) and the total output of the corresponding product in monetary terms from IBGE (2008) for the year 2005. The vector of BOD in the wastewater from each product ($\mathbf{bod}_p$) is obtained from MCT (2010). The default value of 0.6 kg CH_4/kg BOD from IPCC (2006) is considered for the maximum CH_4 producing potential for industrial wastewater (b_{oind}). Weighed values from MCT (2010) are considered for the methane correction factor for industrial wastewater by each product ($\mathbf{mcf}_p$). The vector with the emission factor of CH_4 by BOD produced for each product ($\mathbf{efiww}_p$) is estimated based on the values of b_{oind} and $\mathbf{mcf}_p$. The coefficient of net CH_4 recovery from wastewater ($\mathbf{achnr}_p$) is estimated based on the total CH_4 recovered by anaerobic reactors for each product using the data of MCT (2010) for 2005 (see table B.48).

Table B.48 – Parameters considered in the estimation of GHG emissions from industrial wastewater					
	$aprod_p$	**bod_p**	**mcf_p**	**$efiww_p$**	**$achnr_p$**
Products / Units	t (or m^3)/10^6 R$	kg BOD/t (or m^3)	%	kg Ch_4/ kg BOD	%
Bioethanol	656.3102415	200	0.0	0.000	100.0
Sugar	515.4597085	220	0.0	0.000	100.0
Beer*	341.9096508	62.1	61.5	0.395	53.6
Pasteurized Milk	498.5268972	11	50.0	0.300	38.7
Raw Milk	2393.415562	11	50.0	0.300	38.9
Cotton	199.7029055	155	50.0	0.300	38.9
Paper	1421.982633	8	50.0	0.300	38.9
Swine	451.9107293	30	50.0	0.300	38.7
Poultry	710.9988249	7	50.0	0.300	38.9
Cattle	235.7022249	7	50.0	0.300	39.2

The computation of the fraction of each selected product *p* in the total output of the respective sector *y* (**Asp**$_{yp}$) is based on the data of the corresponding total output from Guilhoto & Sesso Filho (2010) (see table B.49).

Table B.49 – Matrix with the fraction of each selected product *p* in the total output of the respective sector *y* - Asp$_{yp}$ R$/R$										
	Bioethanol	Sugar	Beer	Pasteurized Milk	Raw Milk	Cotton	Paper	Swine	Poultry	Cattle
Alcohol	1.00000	-	-	-	-	-	-	-	-	-
Food and Beverage	-	0.08718	0.12101	0.04646	0.04646	-	-	-	-	-
Agriculture and forestry	-	-	-	-	-	0.02548	-	-	-	-
Pulp and paper products	-	-	-	-	-	-	0.18056	-	-	-
Livestock and fishing	-	-	-	-	-	-	-	0.05883	0.14863	0.36114

The annual per capita protein consumption (pcprot) is estimated by multiplying the daily per capita protein consumption for Brazil (0.0855 kg/ person/day) from FAOSTAT by 365 days. Default values from IPCC (2006) are considered for the fraction of nitrogen in protein (fnprot), the factor for non-consumed protein added to the wastewater (fncprot), the factor for industrial and commercial co-discharged protein into the sewer system (findcom), the coefficient for nitrogen removed with sludge (asludge) and the emission factor for N_2O emissions from discharged to wastewater (efn2oww) (see table B.50).

Table B.50 – Parameters considered in the estimation N_2O emissions from wastewater		
Parameter	Unity	Value
pcprot	kg/person/yr	31.2075
fnprot	kg N/kg protein	0.16
fncprot	%	1.4[9]
findcom	%	1.25
asludge	%	0
efn2oww	kg N2O-N/kg N	0.005

[9] Value for countries with garbage disposals.

APPENDIX C – Construction of the sugarcane sector to be included in the input-output framework – estimation and allocation of the production costs, imports, taxes, distribution and transportation costs, salaries and social contributions – current and future scenarios.

Table C.1 – Agricultural operations – equipment/implement parameters (adapted from Macedo et al, 2004).

Nº	**Equipments**	**Power** (cv)	**Power** (hp)	**Implements**	**Capacity** (ha/h)	**Consumption** (L diesel/h)	**Specific Consumption** (L/ha)
1	MF 290	78	76.93	Lime distributing wagon	1.61	6.0	3.73
2	CAT D-6	165	162.74	Heavy harrow, 18 discs x 34"	1.30	27.6	21.23
3	CAT D-6	165	162.74	5 shanks subsoiler	1.00	26.0	26.00
4	CAT D-6	165	162.74	Heavy harrow, 18 discs x 34"	1.35	27.6	20.44
5	Valmet 1780	165	162.74	Light harrow, 48 discs x 20"	1.60	15.0	9.38
6	MF 680	170	167.67	2 row furrower – fertilizer	1.10	15.0	13.64
7	MF 275	69	68.06	Planting wagon	0.60	4.0	6.67
8	MF 275	69	68.06	2 row furrow coverer	1.80	4.8	2.67
9	MF 275	69	68.06	Herbicide pump	2.50	4.0	1.60
10	MF 292	104	102.58	Cultivator	1.30	8.0	6.15
11	MF 275	69	68.06	Trash rake	1.50	4.0	2.67
12	Valmet 1580	143	141.04	Triple cultivator	1.30	9.2	7.08
13	Valmet 1580	143	141.04	Mechanical ratoon eliminator	1.10	12.2	11.09
14	Case A-7700	330	325.49	Combine sugar cane harvester	45.0 t/h	40.4	74.00
15	MF 290 RA	78	76.93	Sugar cane grab loader	46.0 t/h	7.1	12.70
16	MB 2318	180	177.54	Sugar cane transport (8%)	2.2 km/L	-	-
17	MB 2325	250	246.58	Sugar cane transport (25%)	1.6 km/L	-	-
18	Volvo	360	355.08	Sugar cane transport (67%)	1.2 km/L	-	-
19	MB 2318	180	177.54	Dumpster (skip tipper) truck	2.5 km/L	-	-
20	MB 2213	130	128.22	Flat bed fertilizer transport	2.5 km/L	-	-
21	MB 2318	180	177.54	Vinasse transport	2.2 km/L	-	-
22	MB 2220	200	197.26	Vinasse transport	2.0 km/L	-	-
23	Volvo	360	355.08	Vinasse transport	1.3 km/L	-	-
24	Diesel pump	120	118.36	Vinasse application	120 m3 /h	14.0	-
25	Valtra BH 180	180	177.54	Tractor hauler/transloader	35.0 t/h	9.0	21.2
26	Volvo FH	520	512.89	Sugarcane transport (100%)	1.1 km/L	-	-

1 – The power of each equipment provided by Macedo et al. (2004) in cheval vapeur (cv) is multiplied by the conversion factor 1cv = 0.986321577 hp in order to obtain the corresponding values in horse power (hp).

Table C.2 – Estimates of diesel oil consumed in land preparation, planting and ratoon tillage operations in the base year (2009) – general scenario.					
Agricultural operations	**Equipment**	**Specific Consumption**	**Fraction of area worked**	**Applied area in the base year**	**Total Consumption**
Notation ➔		scd_{α}	faa_{α}	aao_{α}	tcd_{α}
Land preparation and planting operations 🡻 **Units** ➔	Nº	(L diesel oil/ha)	(%)	20% of total area* (ha)	(L diesel oil)
Lime application	1	3.73	100	1,723,511	6,428,696
Mechanical elimination of ratoons	13	11.09	30	1,723,511	5,734,121
Chemical elimination of ratoons	9	1.60	30	1,723,511	827,285
Heavy harrowing I	2	21.23	90	1,723,511	32,931,125
Sub-soiling	3	26.00	70	1,723,511	31,367,900
Heavy harrowing II	4	20.44	70	1,723,511	24,659,995
Heavy harrowing III	4	20.44	30	1,723,511	10,568,569
Light harrowing	5	9.38	90	1,723,511	14,549,880
Furrowing and fertilizing	6	13.64	100	1,723,511	23,508,690
Sugarcane seed distribution	7	6.67	100	1,723,511	11,495,818
Closing furrows and insecticide application	8	2.67	100	1,723,511	4,601,774
Chemical tillage (herbicide application)	9	1.60	100	1,723,511	2,757,618
Mechanical tillage	10	6.15	70	1,723,511	7,419,715
Sub-total					176,851,187
Ratoon tillage operations		(L diesel oil/ha)	(%)	80% of total area* (ha)	(L diesel oil)
Trash raking	11	2.67	25	6,894,044	4,601,774
Triple operation tillage	12	7.08	100	6,894,044	48,809,832
Chemical tillage (herbicide application)	9	1.6	85	6,894,044	9,375,900
Sub-total					62,787,506
Total					**239,638,693**
*The total area cultivated with sugarcane in 2009 was 8,617,555 ha (IBGE, 2014).					

$$cd_{\alpha} = (scd_{\alpha})\,(faa_{\alpha})\,(aao_{\alpha}) \quad \text{(C.1)}$$

tcd_{α} = total consumption of diesel oil in land preparation, planting and ratoon tillage operations in the base year (L).

scd_{α} = specific consumption of diesel oil of each equipment/implement (L/ha).

faa_{α} = fraction of applied area (%).

aao_{α} = applied area in the base year (ha).

α = land preparation, planting and ratoon tillage operations (lime application, mechanical elimination of ratoons, chemical elimination of ratoons, heavy harrowing I, subsoiling, heavy harrowing II, heavy harrowing III, light harrowing, furrowing and fertilizing, sugarcane seed distribution, closing furrows and insecticide application, chemical tillage (herbicide application), mechanical tillage).

Table C.3 – Estimates of costs from diesel oil consumed in land preparation, planting and ratoon tillage operations in the base year – general scenario (R$ of 2009).

	Production costs	Taxes	Distribution cost	Total Cost
(R$/L)	1.202 (pc$)	0.469 (t$)	0.332 (dc$)	2.003(tc$)
Notation ➔	$pclpr_{\alpha}$	$tlpr_{\alpha}$	$dclpr_{\alpha}$	$tclpr_{\alpha}$
Land preparation and planting operations ➔ Units ➔	R$	R$	R$	R$
Lime application	7,727,293	3,015,058	2,134,327	12,876,678
Mechanical elimination of ratoons	6,892,414	2,689,303	1,903,728	11,485,445
Chemical elimination of ratoons	994,397	387,997	274,659	1,657,052
Heavy harrowing I	39,583,212	15,444,697	10,933,133	65,961,043
Sub-soiling	37,704,216	14,711,545	10,414,143	62,829,904
Heavy harrowing II	29,641,314	11,565,538	8,187,118	49,393,971
Heavy harrowing III	12,703,420	4,956,659	3,508,765	21,168,845
Light harrowing	17,488,956	6,823,894	4,830,560	29,143,409
Furrowing and fertilizing	28,257,445	11,025,576	7,804,885	47,087,906
Sugarcane seed distribution	13,817,974	5,391,539	3,816,612	23,026,124
Closing furrows and insecticide application	5,531,333	2,158,232	1,527,789	9,217,354
Chemical tillage (herbicide application)	3,314,656	1,293,323	915,529	5,523,508
Mechanical tillage	8,918,497	3,479,846	2,463,345	14,861,689
Sub-total	212,575,127	82,943,207	58,714,594	354,232,928
Ratoon tillage operations				
Trash raking	5,531,333	2,158,232	1,527,789	9,217,354
Triple operation tillage	58,669,417	22,891,811	16,204,864	97,766,093
Chemical tillage (herbicide application)	11,269,832	4,397,297	3,112,799	18,779,927
Sub-total	75,470,582	29,447,340	20,845,452	125,763,374
Total	**288,045,709**	**112,390,547**	**79,560,046**	**479,996,302**

$$pclpr_{\alpha} = (tcd_{\alpha})\ (pc\$) \quad (C.2)$$

$$lpr_{\alpha} = (tcd_{\alpha})\ (t\$) \quad (C.3)$$

$$dclpr_{\alpha} = (tcd_{\alpha})\ (dc\$) \quad (C.4)$$

$$clpr_{\alpha} = (pclpr_{\alpha}) + (tlpr_{\alpha}) + (dclpr_{\alpha}) \quad (C.5)$$

$pclpr_{\alpha}$ = production costs on diesel oil consumed for land preparation, planting and ratoon tillage operations (R$).

pc$ = production costs on each oil diesel unit (R$/L).

$tlpr_{\alpha}$ = taxes on diesel oil consumed for land preparation, planting and ratoon tillage operations (R$).

t$ = taxes on each oil diesel unit (R$/L)

$dclpr_{\alpha}$ = distribution cost on diesel oil consumed for land preparation, planting and ratoon tillage operations (R$).

dc$ = distribution costs on each oil diesel unit (R$/L).

$tclpr_{\alpha}$ = total cost on diesel oil consumed for land preparation, planting and ratoon tillage operations (R$).

Table C.4 – Estimates of total consumption of diesel oil in harvesting and loading operations – current scenario.

Equipment			**Harvester**	**Sugarcane loader**	**Tractor hauler/transloader**		**Total**
Nº			14	15	25		
Type of harvesting operation			Mechanical	Manual	Mechanical	Manual	
Specific consumption (L/t)			0.898 (scmh)	0.154 (scsl)	0.257 (sct)		
	Sugarcane harvested*		Consumption of diesel oil	Consumption of diesel oil	Consumption of diesel oil	Consumption of diesel oil	Consumption of diesel oil
	Manually	Mechanically					
Notation ➔	$sgman_\gamma$	$sgmec_\gamma$	$mech_\gamma$	$manh_\gamma$	$tmec_\gamma$	$tman_\gamma$	$thlc_\gamma$
States ➔ \ **Units** ➔	(t)	(t)	(L diesel oil)	(L diesel oil)	(L diesel oil)	(L diesel oil)	(L diesel oil)
Minas Gerais	30,651,655	27,732,450	24,903,740	4,731,016	7,131,201	7,881,854	44,647,812
Rio de Janeiro	4,751,097	1,730,618	1,554,095	733,322	445,016	1,221,711	3,954,143
São Paulo	169,098,750	239,352,338	214,938,399	26,100,025	61,547,744	43,482,536	346,068,703
Paraná	39,351,039	14,480,752	13,003,715	6,073,747	3,723,622	10,118,839	32,919,923
Mato Grosso do Sul	9,258,820	15,969,572	14,340,676	1,429,079	4,106,461	2,380,839	22,257,055
Mato Grosso	6,921,495	9,288,094	8,340,709	1,068,318	2,388,367	1,779,813	13,577,207
Goiás	15,436,138	28,230,447	25,350,942	2,382,534	7,259,258	3,969,293	38,962,026
Distrito Federal	66,248	-	-	10,225	-	17,035	27,260
Espírito Santo	4,079,075	1,170,700	1,051,288	629,596	301,037	1,048,905	3,030,827
Santa Catarina	699,068	-	-	107,900	-	179,760	287,660
Rio Grande do Sul	1,254,475	-	-	193,625	-	322,579	516,205
Tocantins	332,142	332,142	298,264	51,265	85,408	85,408	520,345
Pará	349,423	349,423	313,781	53,933	89,852	89,852	547,417
Rondônia	101,311	151,966	136,466	15,637	39,077	26,051	217,231
Acre	38,650	-	-	5,966	-	9,939	15,904
Amazonas	133,602	234,448	210,534	20,621	60,287	34,355	325,797
Roraima	1,376	-	-	212	-	354	566
Amapá	1,395	-	-	215	-	359	574
Maranhão	2,824,701	-	-	435,986	-	726,352	1,162,338
Piauí	859,513	-	-	132,664	-	221,018	353,682
Ceará	1,484,996	838,941	753,369	229,206	215,728	381,856	1,580,159
Rio Grande do Norte	2,892,537	1,367,459	1,227,978	446,457	351,632	743,795	2,769,862
Paraíba	6,302,570	-	-	972,788	-	1,620,661	2,593,449
Pernambuco	19,386,905	58,336	52,385	2,992,327	15,001	4,985,204	8,044,917
Alagoas	25,115,470	1,688,660	1,516,417	3,876,518	434,227	6,458,264	12,285,426
Sergipe	2,607,155	-	-	402,409	-	670,411	1,072,820
Bahia	4,630,196	-	-	714,661	-	1,190,622	1,905,283
Total	**348,629,802**	**342,976,345**	**307.992.758**	**53.810.252**	**88.193.917**	**89.647.663**	**539.644.591**

* Estimated based on the information from CONAB (2012) and IBGE (2014).

$$mech_\gamma = (sgmec_\gamma)\,(scmh) \qquad (C.6)$$

$$manh_\gamma = (sgman_\gamma)\,(scsl) \qquad (C.7)$$

$$mec_\gamma = (sgmec_\gamma)\,(sc\ ) \qquad (C.8)$$

$$man_\gamma = (sgman_\gamma)\,(sc\ ) \qquad (C.9)$$

$$hlc_\gamma = (mech_\gamma) + (manh_\gamma) + (tmec_\gamma) + (tman_\gamma) \qquad (C.10)$$

$sgmec_{\gamma}$ = sugarcane harvested mechanically in each Brazilian State γ (t).

$sgman_{\gamma}$ = sugarcane harvested manually in each Brazilian State γ (t).

scmh = specific consumption of diesel of the harvester (L/t).

scsl = specific consumption of diesel of the sugarcane loader (L/t).

sct = specific consumption of diesel of the tractor hauler/transloader (L/t).

$mech_{\gamma}$ = total consumption of diesel oil by harvester (mechanical harvesting) (L).

$manh_{\gamma}$ = total consumption of diesel oil by sugarcane loader (manual harvesting) (L).

$tmec_{\gamma}$ = total consumption of diesel oil by tractor hauler/transloader in mechanical harvesting operation (L).

$tman_{\gamma}$ = total consumption of diesel oil by tractor hauler/transloader in manual harvesting operation (L).

$thlc_{\gamma}$ = total consumption of diesel oil in harvesting and loading operations (L).

Table C.5 – Estimates of costs from diesel oil consumption in harvesting and loading operations – current scenario (R$ of 2009).				
	Production costs	**Taxes**	**Distribution costs**	**Total Costs**
R$/L	1.202 (pc$)	0.469 (t$)	0.332 (dc$)	2.003(tc$)
Notation ➔	pch_γ	th_γ	dch_γ	tch_γ
States ↓ \ **Units** ➔	R$	R$	R$	R$
Minas Gerais	53,666,670	20,939,824	14,823,074	89,429,567
Rio de Janeiro	4,752,880	1,854,493	1,312,776	7,920,149
São Paulo	415,974,582	162,306,222	114,894,810	693,175,613
Paraná	39,569,747	15,439,444	10,929,414	65,938,606
Mato Grosso do Sul	26,752,980	10,438,559	7,389,342	44,580,882
Mato Grosso	16,319,802	6,367,710	4,507,633	27,195,145
Goiás	46,832,356	18,273,190	12,935,393	78,040,939
Distrito Federal	32,767	12,785	9,050	54,603
Espírito Santo	3,643,054	1,421,458	1,006,235	6,070,746
Santa Catarina	345,767	134,913	95,503	576,183
Rio Grande do Sul	620,478	242,100	171,380	1,033,958
Tocantins	625,454	244,042	172,754	1,042,251
Pará	657,995	256,739	181,742	1,096,476
Rondônia	261,112	101,881	72,121	435,114
Acre	19,117	7,459	5,280	31,856
Amazonas	391,608	152,799	108,165	652,571
Roraima	681	266	188	1,134
Amapá	690	269	191	1,150
Maranhão	1,397,130	545,137	385,896	2,328,163
Piauí	425,125	165,877	117,422	708,424
Ceará	1,899,351	741,095	524,613	3,165,058
Rio Grande do Norte	3,329,374	1,299,065	919,594	5,548,034
Paraíba	3,117,326	1,216,328	861,025	5,194,678
Pernambuco	9,669,990	3,773,066	2,670,912	16,113,969
Alagoas	14,767,082	5,761,865	4,078,761	24,607,707
Sergipe	1,289,530	503,153	356,176	2,148,858
Bahia	2,290,150	893,577	632,554	3,816,281
Total	**648,652,798**	**253,093,313**	**179,162,004**	**1,080,908,115**

$$pch_\gamma = (thlc_\gamma)\ (pc\$) \quad \text{(C.11)}$$

$$th_\gamma = (thlc_\gamma)\ (t\$) \quad \text{(C.12)}$$

$$dch_\gamma = (thlc_\gamma)\ (dc\$) \quad \text{(C.13)}$$

$$ch_\gamma = (pch_\gamma) + (th_\gamma) + (dch_\gamma) \quad \text{(C.14)}$$

pch_γ = production costs of diesel oil consumed for harvesting and loading operations in each Brazilian State (R$).

th_γ = taxes on diesel oil consumed for harvesting and loading operations in each Brazilian State (R$).

dch_γ = distribution costs on diesel oil consumed for harvesting and loading operations in each Brazilian State (R$).

tch_γ = total cost of diesel oil consumed for harvesting and loading operations in each Brazilian State (R$).

Table C.6 – Estimates of total consumption of diesel oil in sugarcane transportation from the field to the mill – current scenario.

Type of truck		**Single**	**Double-wagon**	**Triple-wagon**	**Total**
Share of sugarcane transported		8% (sst)	25% (sdw)	67% (stw)	
Operational capacity (t)		15	28	45	
Specific consumption (L/t.km)		0.0303 (scst)	0.0223 (scdw)	0.0185 (sctw)	
Notation ➔	ad_γ	stc_γ	dwc_γ	twc_γ	ttc_γ
States 🡻 \ **Units** ➔	Average distance from field to the mill (km)	Consumption (L diesel oil)	Consumption (L diesel oil)	Consumption (L diesel oil)	Consumption (L diesel oil)
Minas Gerais	24.93	7,057,046	16,244,595	36,118,353	59,419,995
Rio de Janeiro	23.29	731,923	1,684,812	3,746,023	6,162,758
São Paulo	25.65	50,796,463	116,928,241	259,979,118	427,703,821
Paraná	22.45	5,859,509	13,487,988	29,989,292	49,336,789
Mato Grosso do Sul	24.92	3,048,201	7,016,647	15,600,864	25,665,712
Mato Grosso	23.27	1,828,835	4,209,789	9,360,077	15,398,701
Goiás	22.43	4,748,807	10,931,267	24,304,659	39,984,734
Distrito Federal	24.50	7,869	18,115	40,276	66,260
Espírito Santo	25.29	643,718	1,481,772	3,294,584	5,420,074
Santa Catarina	24.50	83,041	191,151	425,007	699,200
Rio Grande do Sul	18.12	110,211	253,695	564,068	927,974
Tocantins	12.00	38,649	88,967	197,809	325,425
Pará	18.36	62,210	143,201	318,394	523,805
Rondônia	12.00	14,736	33,921	75,420	124,077
Acre	24.50	4,591	10,568	23,498	38,657
Amazonas	12.00	21,414	49,292	109,597	180,303
Roraima	24.50	163	376	837	1,376
Amapá	24.50	166	381	848	1,395
Maranhão	15.10	206,802	476,038	1,058,426	1,741,266
Piauí	25.27	105,309	242,410	538,975	886,693
Ceará	12.00	135,211	311,242	692,017	1,138,469
Rio Grande do Norte	22.53	465,346	1,071,180	2,381,669	3,918,195
Paraíba	21.71	663,412	1,527,107	3,395,381	5,585,901
Pernambuco	20.29	1,912,940	4,403,392	9,790,535	16,106,867
Alagoas	19.02	2,471,828	5,689,895	12,650,954	20,812,676
Sergipe	25.47	321,960	741,119	1,647,809	2,710,888
Bahia	28.86	647,891	1,491,378	3,315,941	5,455,209
Total	**24.50**	**81,988,252**	**188,728,539**	**419,620,431**	**690,337,222**

$$stc_\gamma = \{[(sgmec_\gamma + sgman_\gamma)\ (sst)]\ (ad_\gamma)\ (scs\ )\} \times 2 \quad (C.15)$$

$$dwc_\gamma = \{[(sgmec_\gamma + sgman_\gamma)\ (sdw)]\ (ad_\gamma)\ (scdw)\} \times 2 \quad (C.16)$$

$$wc_\gamma = \{[(sgmec_\gamma + sgman_\gamma)\ (stw)]\ (ad_\gamma)\ (sctw)\} \times 2 \quad (C.17)$$

$$tc_\gamma = (stc_\gamma) + (dwc_\gamma) + (twc_\gamma) \quad (C.18)$$

stc_γ = total consumption of diesel oil in the transportation of sugarcane from the field to the mill by single trucks (L).

dwc_{γ} = total consumption of diesel oil in the transportation of sugarcane from the field to the mill by double-wagon trucks (L).

twc_{γ} = total consumption of diesel oil in the transportation of sugarcane from the field to the mill by triple-wagon trucks (L).

ttc_{γ} = total consumption of diesel oil in the transportation of sugarcane from the field to the mill (L).

ad_{γ} = sverage distance from field to the mill (km).

sst = share of sugarcane transported by single trucks (%).

scst = specific consumption of single trucks (L/t.km).

sdw = share of sugarcane transported by double-wagon trucks (%).

scdw = specific consumption of double-wagon trucks (L/t.km).

stw = share of sugarcane transported by triple-wagon trucks (%).

sctw = specific consumption of triple-wagon trucks (L/t.km).

Table C.7 – Estimates of costs from diesel oil consumed for sugarcane transportation from the field to the mill – current scenario (R$ of 2009).

	Production costs	Taxes	Distribution costs	Total Costs
R$/L	1.202 (pc$)	0.469 (t$)	0.332 (dc$)	2.003(tc$)
Notation ➔	pct_{γ}	tt_{γ}	dct_{γ}	tct_{γ}
States ➔ \ **Units** ➔	R$	R$	R$	R$
Minas Gerais	71,422,834	27,867,978	19,727,438	119,018,250
Rio de Janeiro	7,407,635	2,890,334	2,046,036	12,344,005
São Paulo	514,099,993	200,593,092	141,997,669	856,690,754
Paraná	59,302,820	23,138,954	16,379,814	98,821,588
Mato Grosso do Sul	30,850,186	12,037,219	8,521,016	51,408,421
Mato Grosso	18,509,239	7,221,991	5,112,369	30,843,598
Goiás	48,061,650	18,752,840	13,274,932	80,089,421
Distrito Federal	79,645	31,076	21,998	132,720
Espírito Santo	6,514,929	2,542,015	1,799,465	10,856,408
Santa Catarina	840,438	327,925	232,134	1,400,497
Rio Grande do Sul	1,115,425	435,220	308,087	1,858,732
Tocantins	391,161	152,624	108,041	651,826
Pará	629,613	245,664	173,903	1,049,180
Rondônia	149,141	58,192	41,194	248,527
Acre	46,466	18,130	12,834	77,431
Amazonas	216,725	84,562	59,861	361,148
Roraima	1,654	645	457	2,757
Amapá	1,677	654	463	2,795
Maranhão	2,093,002	816,654	578,100	3,487,756
Piauí	1,065,805	415,859	294,382	1,776,047
Ceará	1,368,440	533,942	377,972	2,280,354
Rio Grande do Norte	4,709,671	1,837,634	1,300,841	7,848,145
Paraíba	6,714,253	2,619,787	1,854,519	11,188,559
Pernambuco	19,360,455	7,554,121	5,347,480	32,262,055
Alagoas	25,016,837	9,761,145	6,909,809	41,687,791
Sergipe	3,258,487	1,271,406	900,015	5,429,908
Bahia	6,557,161	2,558,493	1,811,129	10,926,784
Total	**829,785,340**	**323,768,157**	**229,191,958**	**1,382,745,455**

$$pct_{\gamma} = (ttc_{\gamma})\ (pc\$) \quad \text{(C.19)}$$

$$_{\gamma} = (ttc_{\gamma})\ (\ \$) \quad \text{(C.20)}$$

$$dct_{\gamma} = (ttc_{\gamma})\ (dc\$) \quad \text{(C.21)}$$

$$ct_{\gamma} = (pc\ _{\gamma}) + (tt_{\gamma}) + (dct_{\gamma}) \quad \text{(C.22)}$$

pct_{γ} = production costs of diesel oil consumed for sugarcane transportation from the field to the mill in each Brazilian State (R$).

tt_{γ} = taxes on diesel oil consumed for sugarcane transportation from the field to the mill in each Brazilian State (R$).

dct_{γ} = distribution costs on diesel oil consumed for sugarcane transportation from the field to the mill in each Brazilian State (R$).
tct_{γ} = total cost of diesel oil consumed for sugarcane transportation from the field to the mill in each Brazilian State (R$).

Table C.8 – Estimates of diesel oil consumed in transportation/application of agricultural inputs in the base year – general scenario.

		Sugarcane seed	Filter mud cake	Vinasse	Fertilizers	Total
Equipment Nº		19	20	21+22+23+24 (weighed value)	20	
Area of application		20% total area	30% planted area[1]	30% ratoon area[2]	70% total area	
Diesel oil consumption		17.4 L/ha (see)	9.6 L/ha (fmc)	24.7 L/ha (vin)	1.60 L/ha (fer)	
Notation ➔	(ac_γ)	see_γ	fmc_γ	vin_γ	fer_γ	$ttac_\gamma$
States ➔ \ **Units** ➔	Area cultivated (ha)	Consumption (L diesel oil)	Consumption (L diesel oil)	Consumption (L diesel oil)	Consumption (L diesel oil)	Consumption (L diesel oil)
Minas Gerais	715,628	2,489,141	412,202	4,239,480	801,503	7,942,326
Rio de Janeiro	135,130	470,017	77,835	800,529	151,346	1,499,727
São Paulo	4,781,465	16,631,183	2,754,124	28,326,067	5,355,241	53,066,615
Paraná	595,371	2,070,856	342,934	3,527,061	666,816	6,607,666
Mato Grosso do Sul	285,993	994,758	164,732	1,694,263	320,312	3,174,065
Mato Grosso	213,164	741,440	122,782	1,262,813	238,744	2,365,779
Goiás	523,808	1,821,941	301,713	3,103,112	586,665	5,813,431
Distrito Federal	783	2,723	451	4,639	877	8,690
Espírito Santo	80,162	278,824	46,173	474,891	89,781	889,670
Santa Catarina	17,177	59,746	9,894	101,759	19,238	190,637
Rio Grande do Sul	36,567	127,190	21,063	216,628	40,955	405,835
Tocantins	8,651	30,090	4,983	51,250	9,689	96,012
Pará	9,773	33,993	5,629	57,897	10,946	108,465
Rondônia	4,220	14,678	2,431	25,000	4,726	46,835
Acre	773	2,689	445	4,579	866	8,579
Amazonas	6,050	21,043	3,485	35,841	6,776	67,145
Roraima	399	1,388	230	2,364	447	4,428
Amapá	70	243	40	415	78	777
Maranhão	46,072	160,250	26,537	272,937	51,601	511,326
Piauí	12,866	44,751	7,411	76,220	14,410	142,792
Ceará	42,706	148,543	24,599	252,996	47,831	473,968
Rio Grande do Norte	67,582	235,068	38,927	400,365	75,692	750,052
Paraíba	122,888	427,437	70,783	728,006	137,635	1,363,860
Pernambuco	352,276	1,225,308	202,911	2,086,932	394,549	3,909,700
Alagoas	434,005	1,509,583	249,987	2,571,106	486,086	4,816,761
Sergipe	41,931	145,847	24,152	248,405	46,963	465,367
Bahia	82,045	285,374	47,258	486,046	91,890	910,568
Total	**8,617,555**	**29,974,104**	**4,963,712**	**51,051,601**	**9,651,662**	**95,641,079**

1 – The planted area represents 20% of the total area cultivated.
2 – The ratoon area represents 80% of the total cultivated area.

$$see_\gamma = [(ac_\gamma) \times 20\%]\ (see) \quad (C.23)$$

$$fmc_\gamma = [(ac_\gamma) \times 20\% \times 30\%]\ (fmc) \quad (C.24)$$

$$vin_\gamma = [(ac_\gamma) \times 80\% \times 30\%]\ (vin) \quad (C.25)$$

$$fer_\gamma = [(ac_\gamma) \times 70\%]\ (fer) \quad (C.26)$$

$$tac_\gamma = see_\gamma + fmc_\gamma + vin_\gamma + fer_\gamma \quad (C.27)$$

see = consumption of diesel oil in the transportation/application of sugarcane seed by unit of area cultivated (L/ha)

fmc = consumption of diesel oil in the transportation/application of filter mud cake by unit of area cultivated (L/ha)

vin = consumption of diesel oil in the transportation/application of vinasse by unit of area cultivated (L/ha)

fer = consumption of diesel oil in the transportation/application of fertilizers by unit of area cultivated (L/ha)

ac_γ = total area cultivated with sugarcane in each Brazilian State (ha).

see_γ = total consumption of diesel oil in the transportation/application of sugarcane seed (L).

fmc_γ = total consumption of diesel oil in the transportation/application of filter mud cake (L).

vin_γ = total consumption of diesel oil in the transportation/application of vinasse (L).

fer_γ = total consumption of diesel oil the transportation/application of fertilizers (L).

$ttac_\gamma$ = total consumption of diesel oil in transportation/application of agricultural inputs (L).

Table C.9 – Estimates of costs from diesel oil consumed in transportation/application of agricultural inputs in the base year – general scenario (R$ of 2009).				
	Production costs	**Taxes**	**Distribution cost**	**Total Cost**
(R$/L)	1.202 (pc$)	0.469 (t$)	0.332 (dc$)	2.003(tc$)
Notation ➔	$pcta_\gamma$	tta_γ	$dcta_\gamma$	$tcta_\gamma$
States 🡻 \ **Units** ➔	R$	R$	R$	R$
Minas Gerais	9,546,676	3,724,951	2,636,852	15,908,480
Rio de Janeiro	1,802,672	703,372	497,909	3,003,953
São Paulo	63,786,071	24,888,242	17,618,116	106,292,429
Paraná	7,942,414	3,098,995	2,193,745	13,235,155
Mato Grosso do Sul	3,815,226	1,488,636	1,053,790	6,357,652
Mato Grosso	2,843,667	1,109,551	785,439	4,738,656
Goiás	6,987,744	2,726,499	1,930,059	11,644,302
Distrito Federal	10,445	4,076	2,885	17,406
Espírito Santo	1,069,383	417,255	295,370	1,782,009
Santa Catarina	229,146	89,409	63,292	381,846
Rio Grande do Sul	487,814	190,337	134,737	812,888
Tocantins	115,407	45,030	31,876	192,313
Pará	130,375	50,870	36,010	217,255
Rondônia	56,296	21,966	15,549	93,811
Acre	10,312	4,024	2,848	17,184
Amazonas	80,709	31,491	22,292	134,492
Roraima	5,323	2,077	1,470	8,870
Amapá	934	364	258	1,556
Maranhão	614,613	239,812	169,760	1,024,185
Piauí	171,636	66,969	47,407	286,012
Ceará	569,710	222,291	157,357	949,359
Rio Grande do Norte	901,563	351,774	249,017	1,502,354
Paraíba	1,639,360	639,650	452,802	2,731,812
Pernambuco	4,699,460	1,833,649	1,298,020	7,831,130
Alagoas	5,789,747	2,259,061	1,599,165	9,647,973
Sergipe	559,371	218,257	154,502	932,130
Bahia	1,094,503	427,057	302,309	1,823,868
Total	**114,960,577**	**44,855,666**	**31,752,838**	**191,569,081**

$$pcta_\gamma = (ttac_\gamma)\ (pc\$) \qquad (C.28)$$

$$ta_\gamma = (ttac_\gamma)\ (t\$) \qquad (C.29)$$

$$dcta_\gamma = (ttac_\gamma)\ (dc\$) \qquad (C.30)$$

$$cta_\gamma = (pcta_\gamma) + (tta_\gamma) + (dcta_\gamma) \qquad (C.31)$$

$pcta_\gamma$ = production costs of diesel oil consumed for transportation/application of agricultural inputs in each Brazilian State (R$).

tta_γ = taxes on diesel oil consumed for transportation/application of agricultural inputs in each Brazilian State (R$).

$dcta_{\gamma}$ = distribution costs on diesel oil consumed for transportation/application of agricultural inputs in each Brazilian State (R$).

$tcta_{\gamma}$ = total cost of diesel oil consumed for transportation/application of agricultural inputs in each Brazilian State (R$).

Table C.10 – Estimates of costs from diesel oil consumption in mechanized harvesting and loading operations in a scenario with 100% of mechanical harvesting.

	Consumption of diesel oil			**Costs on diesel oil consumption**			
	Equipment		Total	Production costs	Taxes	Distribution costs	Total Costs
	Harvester	Tractor hauler/ transloader					
Specific consumpt. (L/t.km)	0.898 (scmh)	0.257 (sct)					
R$/L				1.202 (pc$)	0.469 (t$)	0.332 (dc$)	2.003(tc$)
Notation ➔	$mechf_\gamma$	$tmecf_\gamma$	$thlcf_\gamma$	$pchf_\gamma$	thf_γ	$dchf_\gamma$	$tchf_\gamma$
States 🡻 \ **Units** ➔	(L diesel oil)	(L diesel oil)	(L diesel oil)	(R$)	(R$)	(R$)	(R$)
Minas Gerais	52,428,926	15,013,056	67,441,982	81,065,262	31,630,289	22,390,738	135,086,290
Rio de Janeiro	5,820,580	1,666,727	7,487,307	8,999,743	3,511,547	2,485,786	14,997,075
São Paulo	366,789,077	105,030,280	471,819,357	567,126,867	221,283,278	156,644,026	945,054,172
Paraná	48,340,948	13,842,461	62,183,409	74,744,457	29,164,019	20,644,892	124,553,368
Mato Grosso do Sul	22,655,096	6,487,301	29,142,397	35,029,161	13,667,784	9,675,276	58,372,221
Mato Grosso	14,556,211	4,168,180	18,724,391	22,506,718	8,781,739	6,216,498	37,504,955
Goiás	39,212,593	11,228,550	50,441,144	60,630,255	23,656,896	16,746,460	101,033,611
Distrito Federal	59,491	17,035	76,526	91,984	35,891	25,407	153,281
Espírito Santo	4,714,298	1,349,942	6,064,240	7,289,217	2,844,129	2,013,328	12,146,673
Santa Catarina	627,763	179,760	807,523	970,643	378,728	268,098	1,617,469
Rio Grande do Sul	1,126,519	322,579	1,449,098	1,741,816	679,627	481,100	2,902,543
Tocantins	596,527	170,816	767,343	922,346	359,884	254,758	1,536,988
Pará	627,563	179,703	807,266	970,334	378,608	268,012	1,616,953
Rondônia	227,443	65,128	292,571	351,670	137,216	97,134	586,020
Acre	34,708	9,939	44,646	53,665	20,939	14,823	89,426
Amazonas	330,509	94,641	425,150	511,031	199,396	141,150	851,576
Roraima	1,236	354	1,589	1,911	745	528	3,184
Amapá	1,253	359	1,611	1,937	756	535	3,228
Maranhão	2,536,581	726,352	3,262,933	3,922,046	1,530,316	1,083,294	6,535,655
Piauí	771,843	221,018	992,860	1,193,418	465,651	329,630	1,988,699
Ceará	2,086,895	597,584	2,684,479	3,226,744	1,259,021	891,247	5,377,012
Rio Grande do Norte	3,825,476	1,095,428	4,920,904	5,914,927	2,307,904	1,633,740	9,856,571
Paraíba	5,659,708	1,620,661	7,280,369	8,751,003	3,414,493	2,417,082	14,582,579
Pernambuco	17,461,826	5,000,205	22,462,031	26,999,362	10,534,693	7,457,394	44,991,449
Alagoas	24,070,109	6,892,491	30,962,599	37,217,044	14,521,459	10,279,583	62,018,086
Sergipe	2,341,225	670,411	3,011,636	3,619,987	1,412,458	999,863	6,032,308
Bahia	4,157,916	1,190,622	5,348,538	6,428,942	2,508,464	1,775,715	10,713,121
Total	**621,062,320**	**177,841,581**	**798,903,901**	**960,282,489**	**374,685,929**	**265,236,095**	**1,600,204,513**

$$mechf_\gamma = [(sgmec_\gamma) + (sgman_\gamma)]\ (scmh) \quad (C.32)$$

$$mecf_\gamma = [(sgmec_\gamma) + (sgman_\gamma)]\ (sc\ ) \quad (C.33)$$

$$hlcf_\gamma = (mechf_\gamma) + (tmecf_\gamma) \quad (C.34)$$

$$pchf_\gamma = (thlcf_\gamma)\ (pc\$) \quad (C.35)$$

$$hf_\gamma = (thlcf_\gamma)\ (t\$) \quad (C.36)$$

$dchf_\gamma = (thlcf_\gamma)\ (dc\$)$ (C.37)

$chf_\gamma = (pchf_\gamma) + (thf_\gamma) + (dchf_\gamma)$ (C.38)

$mechf_\gamma$ = total consumption of diesel oil by harvesters in a scenario with 100% of mechanical harvesting (L).

$tmecf_\gamma$ = total consumption of diesel oil by tractor haulers/transloaders operations in a scenario with 100% of mechanical harvesting (L).

$thlcf_\gamma$ = total consumption of diesel oil in harvesting and loading operations in a scenario with 100% of mechanical harvesting (L).

$pchf_\gamma$ = production costs of diesel oil consumed for harvesting and loading operations in each Brazilian State in a scenario with 100% of mechanical harvesting (R$).

thf_γ = taxes on diesel oil consumed for harvesting and loading operations in each Brazilian State in a scenario with 100% of mechanical harvesting (R$).

$dchf_\gamma$ = distribution costs on diesel oil consumed for harvesting and loading operations in each Brazilian State in a scenario with 100% of mechanical harvesting (R$).

$tchf_\gamma$ = total cost of diesel oil consumed for harvesting and loading operations in each Brazilian State in a scenario with 100% of mechanical harvesting (R$).

Table C.11 – Estimates of costs from diesel oil consumed for sugarcane transportation from the field to the mill – future scenario.					
	Consumption of diesel oil	**Costs on diesel oil consumption**			
Equipment	Road train truck	Production cost	Taxes	Distribution costs	Total Costs
Nº	26				
Share of sugarcane transported	100% (srt)				
Specific consumption (L/t.km)	0.0157 (scrt)				
Operational capacity (t)	58				
R$/L	-	1.202 (pc$)	0.469 (t$)	0.332 (dc$)	2.003(tc$)
Notation ➔	$trtc_\gamma$	$pcrt_\gamma$	trt_γ	$dcrt_\gamma$	$tcrt_\gamma$
States ↓ \ **Units** ➔	(L diesel oil)	(R$)	(R$)	(R$)	(R$)
Minas Gerais	45,627,453	54,844,198	21,399,275	15,148,314	91,391,788
Rio de Janeiro	4,732,262	5,688,178	2,219,431	1,571,111	9,478,720
São Paulo	328,425,405	394,767,336	154,031,515	109,037,234	657,836,085
Paraná	37,884,756	45,537,476	17,767,950	12,577,739	75,883,166
Mato Grosso do Sul	19,708,198	23,689,254	9,243,145	6,543,122	39,475,521
Mato Grosso	11,824,362	14,212,883	5,545,626	3,925,688	23,684,196
Goiás	30,703,495	36,905,601	14,399,939	10,193,560	61,499,101
Distrito Federal	50,880	61,158	23,863	16,892	101,913
Espírito Santo	4,161,969	5,002,687	1,951,963	1,381,774	8,336,424
Santa Catarina	536,902	645,356	251,807	178,251	1,075,414
Rio Grande do Sul	712,573	856,513	334,197	236,574	1,427,284
Tocantins	249,887	300,365	117,197	82,963	500,524
Pará	402,219	483,468	188,641	133,537	805,645
Rondônia	95,277	114,522	44,685	31,632	190,839
Acre	29,684	35,680	13,922	9,855	59,457
Amazonas	138,451	166,419	64,934	45,966	277,318
Roraima	1,057	1,270	496	351	2,117
Amapá	1,071	1,288	502	356	2,146
Maranhão	1,337,084	1,607,175	627,092	443,912	2,678,180
Piauí	680,874	818,411	319,330	226,050	1,363,791
Ceará	874,208	1,050,798	410,004	290,237	1,751,039
Rio Grande do Norte	3,008,706	3,616,464	1,411,083	998,890	6,026,437
Paraíba	4,289,304	5,155,743	2,011,684	1,424,049	8,591,476
Pernambuco	12,368,149	14,866,515	5,800,662	4,106,225	24,773,402
Alagoas	15,981,647	19,209,940	7,495,393	5,305,907	32,011,240
Sergipe	2,081,638	2,502,128	976,288	691,104	4,169,520
Bahia	4,188,948	5,035,116	1,964,617	1,390,731	8,390,464
Total	**530,096,459**	**637,175,945**	**248,615,240**	**175,992,025**	**1,061,783,210**

$$rtc_\gamma = \{[(sgmec_\gamma + sgman_\gamma)\ (sr\ )]\ (ad_\gamma)\ (scrt)\} \times 2 \qquad (C.39)$$

$$pcr_{\ \gamma} = (trtc_\gamma)\ (pc\$) \qquad (C.40)$$

$$rt_\gamma = (trtc_\gamma)\ (t\$) \qquad (C.41)$$

$$dcr_{\ \gamma} = (trtc_\gamma)\ (dc\$) \qquad (C.42)$$

$$cr_{\ \gamma} = (pcr_{\ \gamma}) + (trt_\gamma) + (dcr_{\ \gamma}) \qquad (C.43)$$

$trtc_\gamma$ = total consumption of diesel oil in the transportation of sugarcane from the field to the mill in a scenario with 100% of transport by road train trucks (L).

srt = share of sugarcane transported by road train trucks (%).

scrt = specific consumption of road train trucks (L/t.km).

$pcrt_\gamma$ = production costs of diesel oil consumed for sugarcane transportation from the field to the mill in each Brazilian State in a scenario with 100% of transport by road train trucks (R$).

trt_γ = taxes on diesel oil consumed for sugarcane transportation from the field to the mill in each Brazilian State in a scenario with 100% of transport by road train trucks (R$).

$dcrt_\gamma$ = distribution costs on diesel oil consumed for sugarcane transportation from the field to the mill in each Brazilian State in a scenario with 100% of transport by road train trucks (R$).

$tcrt_\gamma$ = total cost of diesel oil consumed for sugarcane transportation from the field to the mill in each Brazilian State in a scenario with 100% of transport by road train trucks (R$).

Table C.12 – Estimates of costs with salaries and labor and social security liabilities in land preparation, planting and ratoon tillage mechanical operations in the base year (R$ of 2009) – general scenario.

	Operational capacity	**Total hours worked**	**Gross salary**	**Social security contribution - employees**	**Net salary**	**Labor and social security liabilities - employers**
Parameters	-	-	3.487 R$/h[1] (hw)	11% (ssc)	89% (ns)	70.03%[2] (lssl)
Notation ➔	$ocap_\alpha$	thw_α	$gslpr_\alpha$	$sclpr_\alpha$	$nslpr_\alpha$	$lslpr_\alpha$
Land preparation and planting operations 🡻 **Units** ➔	ha/h	h	R$	R$	R$	R$
Lime application	1.61	1,070,504	3,733,138	410,645	3,322,493	2,614,424
Mechanical elimination of ratoons	1.10	5,222,761	18,213,191	2,003,451	16,209,740	12,755,220
Chemical elimination of ratoons	2.50	2,298,015	8,013,804	881,518	7,132,285	5,612,297
Heavy harrowing I	1.30	1,473,086	5,137,054	565,076	4,571,978	3,597,626
Subsoiling	1.00	2,462,159	8,586,218	944,484	7,641,734	6,013,175
Heavy harrowing II	1.35	1,823,821	6,360,162	699,618	5,660,544	4,454,204
Heavy harrowing III	1.35	4,255,583	14,840,378	1,632,442	13,207,936	10,393,142
Light harrowing	1.60	1,196,883	4,173,856	459,124	3,714,732	2,923,071
Furrowing and fertilizing	1.10	1,566,828	5,463,957	601,035	4,862,922	3,826,566
Sugarcane seed distribution	0.60	2,872,518	10,017,255	1,101,898	8,915,357	7,015,371
Closing furrows and insecticide application	1.80	957,506	3,339,085	367,299	2,971,786	2,338,457
Chemical tillage (herbicide application)	2.50	689,404	2,404,141	264,456	2,139,686	1,683,689
Mechanical tillage	1.30	1,893,968	6,604,783	726,526	5,878,257	4,625,519
Sub-total		27,783,036	96,887,022	10,657,572	86,229,450	67,852,763
Ratoon tillage operations						
Trash raking	1.50	18,384,117	64,110,431	7,052,147	57,058,284	44,898,376
Triple operation tillage	1.30	5,303,111	18,493,394	2,034,273	16,459,120	12,951,454
Chemical tillage (herbicide application)	2.50	3,244,256	11,313,605	1,244,497	10,069,109	7,923,243
Sub-total		26,931,484	93,917,430	10,330,917	83,586,513	65,773,073
Total		**54,714,520**	**190,804,452**	**20,988,490**	**169,815,963**	**133,625,836**

1- The average monthly wage of tractor drivers in the São Paulo State in 2009 (obtained from the Institute of Agricultural Economics of the São Paulo State, 2013) of R$767.20 was divided by the number of monthly working hours (220h) to obtain the hourly wage paid for harvester/tractor drivers in land preparation, planting and ratoon tillage operations (R$3.487).
2 - The labor and social security liabilities for employers includes: Christmas bonus (8.33%), holydays allowance (8.33%), holydays bonus (2.78%), other labor liabilities (1.72%), social contributions for the *Instituto Nacional do Seguro Social* - INSS (20.00%), social contributions for the *Fundo de Garantia por Tempo de Serviço* - FGTS (8,00 %), other social contributions (8.80%)[1], FGTS/provision for penalization on contract extinction (50% of FGTS = 4,00 %), social security contibutions on Christmas bonus, holydays allowance and holydays bonus and other labor obligations (8,07%). Other labor and social obligations paid by employers will not be included in this estimate due to methodological constraints, data shortage and incidence variability which does not allow determines them accordingly to the Brazilian reality.

$$hw_\alpha = (ocap_\alpha)\,(faa_\alpha)\,(aao_\alpha) \quad \text{(C.44)}$$

$$gslpr_\alpha = (thw_\alpha)\,(hw) \quad \text{(C.45)}$$

$$sclpr_\alpha = (gslpr_\alpha)\,(ssc) \quad \text{(C.46)}$$

[1]This item includes: *Seguro de Acidente do Trabalho/Risco Ambiental do Trabalho* – SAT/RAT (1,00 to 3,00 %, but 3,00% was considered); educational salary (2,50 %); *Instituto Nacional de Colonização e Reforma Agrária* - INCRA (0,2%); *Serviço Social da Indústria* or *Serviço Social do Comércio* – SESI or SESC (1,5%); *Serviço Brasileiro de Apoio às Micro e Pequenas Empresas* – SEBRAE (0,6%); *Serviço Nacional de Aprendizagem Industrial* or *Serviço Nacional de Aprendizagem Comercial* – SENAI or SENAC) (1,0%).

$$nslpr_{\alpha} = (gslpr_{\alpha})\,(ns) \tag{C.47}$$

$$lslpr_{\alpha} = (gslpr_{\alpha})\,(lssl) \tag{C.48}$$

$ocap_{\alpha}$ = operational capacity of each equipment/operation (ha/h)

thw_{α} = total hours worked (or expended) by each equipment/operation in the base year (h)

$gslpr_{\alpha}$ = total costs with salaries from in land preparation, planting and ratoon tillage mechanical operations in the base year (R$)

hw = hourly wage paid for harvester/tractor drivers in land preparation, planting and ratoon tillage mechanical operations in the base year (R$)

$sclpr_{\alpha}$ = social security contributions (SSC) on the gross salary paid by harvester/tractor drivers in land preparation, planting and ratoon tillage operations in the base year (R$)

ssc = coefficient of social security contributions on the gross salary paid by harvester/tractor drivers in land preparation, planting and ratoon tillage operations in the base year (%)

$nslpr_{\alpha}$ = total net salary earned by harvester/tractor drivers in land preparation, planting and ratoon tillage operations in the base year (R$)

ns = coefficient of net salary on the gross salary paid to harvester/tractor drivers in land preparation, planting and ratoon tillage operations in the base year %

$lslpr_{\alpha}$ = labor and social security liabilities (LSSL) on the gross salary of harvester/tractor drivers in land preparation, planting and ratoon tillage operations paid by employers in the base year (R$)

lssl = coefficient of labor and social security liabilities on the gross salary of harvester/tractor drivers in land preparation, planting and ratoon tillage operations paid by employers in the base year (%).

Table C.13 – Estimates of hours worked (or expended) in harvesting and loading operations – current scenario.

Equipment	Harvester	Sugarcane loader	Tractor hauler/transloader		Total
Nº	14	15	25		
Type of harvesting operation	Mechanical	Manual	Mechanical	Manual	
Operational Capacity (t/h)	45	46	35		
Operational Capacity (h/t)	1/45 = 0.02222 (ocmh)	1/46 = 0.02174 (ocsl)	1/35 = 0.02857 (oct)		
Notation ➔	$hmec_\gamma$	$hman_\gamma$	$htmec_\gamma$	$htman_\gamma$	$thlh_\gamma$
States ➔ \ **Units** ➔	(h)	(h)	(h)	(h)	(h)
Minas Gerais	616,277	666,340	792,356	875,762	2,950,734
Rio de Janeiro	38,458	103,285	49,446	135,746	326,935
São Paulo	5,318,941	3,676,060	6,838,638	4,831,393	20,665,032
Paraná	321,794	855,457	413,736	1,124,315	2,715,303
Mato Grosso do Sul	354,879	201,279	456,273	264,538	1,276,969
Mato Grosso	206,402	150,467	265,374	197,757	820,000
Goiás	627,343	335,568	806,584	441,033	2,210,528
Distrito Federal	-	1,440	-	1,893	3,333
Espírito Santo	26,016	88,676	33,449	116,545	264,685
Santa Catarina	-	15,197	-	19,973	35,171
Rio Grande do Sul	-	27,271	-	35,842	63,113
Tocantins	7,381	7,220	9,490	9,490	33,581
Pará	7,765	7,596	9,984	9,984	35,328
Rondônia	3,377	2,202	4,342	2,895	12,816
Acre	-	840	-	1,104	1,945
Amazonas	5,210	2,904	6,699	3,817	18,630
Roraima	-	30	-	39	69
Amapá	-	30	-	40	70
Maranhão	-	61,407	-	80,706	142,112
Piauí	-	18,685	-	24,558	43,243
Ceará	18,643	32,283	23,970	42,428	117,324
Rio Grande do Norte	30,388	62,881	39,070	82,644	214,983
Paraíba	-	137,012	-	180,073	317,086
Pernambuco	1,296	421,454	1,667	553,912	978,329
Alagoas	37,526	545,988	48,247	717,585	1,349,347
Sergipe	-	56,677	-	74,490	131,167
Bahia	-	100,656	-	132,291	232,948
Total	**7,621,697**	**7,578,909**	**9,799,324**	**9,960,851**	**34,960,781**

$$hmec_\gamma = (sgmec_\gamma)\ (ocmh) \quad (C.49)$$

$$hman_\gamma = (sgman_\gamma)\ (ocsl) \quad (C.50)$$

$$htmec_\gamma = (sgmec_\gamma)\ (oct) \quad (C.51)$$

$$htman_\gamma = (sgman_\gamma)\ (oct) \quad (C.52)$$

$$hlh_\gamma = hmec_\gamma + hman_\gamma + htmec_\gamma + htman_\gamma \quad (C.53)$$

$sgmec_\gamma$ = sugarcane harvested mechanically in each Brazilian State γ (t).

$sgman_\gamma$ = sugarcane harvested manually in each Brazilian State γ (t).

ocmh = operational capacity of the harvester (h/t).

ocsl = operational capacity of the sugarcane loader (h/t).

oct = operational capacity of the tractor hauler/transloader (h/t).

$hmec_\gamma$ = total hours expended by harvesters (mechanical harvesting) in each State in the base year (h).

$hman_\gamma$ = total hours expended by sugarcane loader (manual harvesting) in each State in the base year (h).

$htmec_\gamma$ = total hours expended by tractor hauler/transloader in mechanical harvesting operations in each State in the base year (h).

$htman_\gamma$ = total hours expended by tractor hauler/transloader in manual harvesting in each State in the base year (h).

$thlh_\gamma$ = total hours worked (expended) in harvesting and loading operations in each State in the base year (h).

Table C.14 – Estimates of costs with salaries and labor and social security liabilities in harvesting and loading operations – current scenario (R$ of 2009).				
	Gross salary	**Social security contribution - employees**	**Net salary**	**Labor and social security liabilities - employers**
Parameters	3.487 R$/h (hw)	11% (ssc)	89% (ns)	70.03% (lssl)
Notation ➔	$gshl_\gamma$	$schl_\gamma$	$nshl_\gamma$	$lshl_\gamma$
States 🡻 \ **Units** ➔	R$	R$	R$	R$
Minas Gerais	10.290.015	1.131.902	9.158.114	7.206.393
Rio de Janeiro	1.140.111	125.412	1.014.698	798.452
São Paulo	72.064.601	7.927.106	64.137.495	50.468.909
Paraná	9.469.002	1.041.590	8.427.412	6.631.414
Mato Grosso do Sul	4.453.140	489.845	3.963.295	3.118.662
Mato Grosso	2.859.565	314.552	2.545.013	2.002.636
Goiás	7.708.715	847.959	6.860.756	5.398.634
Distrito Federal	11.623	1.279	10.344	8.140
Espírito Santo	923.028	101.533	821.495	646.423
Santa Catarina	122.649	13.491	109.158	85.895
Rio Grande do Sul	220.093	24.210	195.883	154.138
Tocantins	117.106	12.882	104.224	82.013
Pará	123.199	13.552	109.647	86.280
Rondônia	44.693	4.916	39.776	31.300
Acre	6.781	746	6.035	4.749
Amazonas	64.968	7.146	57.822	45.499
Roraima	241	27	215	169
Amapá	245	27	218	171
Maranhão	495.584	54.514	441.070	347.072
Piauí	150.799	16.588	134.211	105.609
Ceará	409.140	45.005	364.135	286.533
Rio Grande do Norte	749.706	82.468	667.238	525.040
Paraíba	1.105.765	121.634	984.131	774.399
Pernambuco	3.411.700	375.287	3.036.413	2.389.312
Alagoas	4.705.539	517.609	4.187.930	3.295.424
Sergipe	457.417	50.316	407.101	320.342
Bahia	812.352	89.359	722.994	568.914
Total	**121.917.778**	**13.410.956**	**108.506.822**	**85.382.520**

$$gshl_\gamma = (thlh_\gamma)\,(hw) \quad (C.54)$$

$$schl_\gamma = (gshl_\gamma)\,(ssc) \quad (C.55)$$

$$nshl_\gamma = (gshl_\gamma)\,(ns) \quad (C.56)$$

$$lshl_\gamma = (gshl_\gamma)\,(lssl) \quad (C.57)$$

$gshl_\gamma$ = total costs with salaries from harvesting and loading operations in the base year (R$).

$schl_\gamma$ = social security contributions on the gross salary paid by harvester/tractor drivers in harvesting and loading operations in the base year (R$).

$nshl_\gamma$ = total net salary earned by harvester/tractor drivers in harvesting and loading operations in the base year (R$).

$lshl_\gamma$ = labor and social security liabilities on the gross salary of harvester/tractor drivers in harvesting and loading operations paid by employers in the base year (R$).

Table C.15 – Estimates of hours expended in sugarcane transportation from the field to the mill – current scenario.

	Roundtrips for transportation of sugarcane manually harvested			**Roundtrips for transportation of sugarcane mechanically harvested**			**Hours expended with sugarcane transportation**	
	Single truck	Double-wagon truck	Triple-wagon truck	Single truck	Double-wagon truck	Triple-wagon truck	Semi-mechanical load	Mechanical load
Share of sugarcane transported	8% (sst)	25% (sdw)	67% (stw)	8% (sst)	25% (sdw)	67% (stw)		
Operational capacity (t)	15	28	45	15	28	45		
Roundtrip time (h)							2.333 (rtsml)	1.833 (rtml)
Notation ➔	$rtst_{\gamma}$	$rtdw_{\gamma}$	$rttw_{\gamma}$	$rtstm_{\gamma}$	$rtdwm_{\gamma}$	$rttwm_{\gamma}$	$hsml_{\gamma}$	hml_{γ}
States 🡻 \ **Units** ➔	roundtrip	roundtrip	roundtrip	roundtrip	roundtrip	roundtrip	h	h
Minas Gerais	163,475	273,675	456,369	147,906	247,611	412,905	2,084,880	1,482,109
Rio de Janeiro	25,339	42,421	70,739	9,230	15,452	25,767	323,163	92,490
São Paulo	901,860	1,509,810	2,517,693	1,276,546	2,137,074	3,563,690	11,501,846	12,791,736
Paraná	209,872	351,349	585,893	77,231	129,292	215,602	2,676,599	773,897
Mato Grosso do Sul	49,380	82,668	137,854	85,171	142,585	237,769	629,771	853,464
Mato Grosso	36,915	61,799	103,053	49,537	82,929	138,289	470,790	496,385
Goiás	82,326	137,823	229,827	150,562	252,058	420,320	1,049,943	1,508,723
Distrito Federal	353	592	986	-	-	-	4,506	-
Espírito Santo	21,755	36,420	60,733	6,244	10,453	17,430	277,453	62,566
Santa Catarina	3,728	6,242	10,408	-	-	-	47,550	-
Rio Grande do Sul	6,691	11,201	18,678	-	-	-	85,328	-
Tocantins	1,771	2,966	4,945	1,771	2,966	4,945	22,592	17,751
Pará	1,864	3,120	5,203	1,864	3,120	5,203	23,767	18,674
Rondônia	540	905	1,508	810	1,357	2,263	6,891	8,122
Acre	206	345	575	-	-	-	2,629	-
Amazonas	713	1,193	1,989	1,250	2,093	3,491	9,087	12,530
Roraima	7	12	20	-	-	-	94	-
Amapá	7	12	21	-	-	-	95	-
Maranhão	15,065	25,221	42,057	-	-	-	192,132	-
Piauí	4,584	7,674	12,797	-	-	-	58,463	-
Ceará	7,920	13,259	22,110	4,474	7,491	12,491	101,007	44,836
Rio Grande do Norte	15,427	25,826	43,067	7,293	12,209	20,360	196,746	73,081
Paraíba	33,614	56,273	93,838	-	-	-	428,691	-
Pernambuco	103,397	173,097	288,649	311	521	869	1,318,669	3,118
Alagoas	133,949	224,245	373,941	9,006	15,077	25,142	1,708,317	90,247
Sergipe	13,905	23,278	38,818	-	-	-	177,335	-
Bahia	24,694	41,341	68,938	-	-	-	314,939	-
Total	**1,859,359**	**3,112,766**	**5,190,710**	**1,829,207**	**3,062,289**	**5,106,537**	**23,713,283**	**18,329,727**

$$rtst_{\gamma} = (sgman_{\gamma})\ (sst)\ \left(\frac{1}{15}\right) \qquad (C.58)$$

$$rtdw_{\gamma} = (sgman_{\gamma})\ (sdw)\ \left(\frac{1}{28}\right) \qquad (C.59)$$

$$rt\ w_{\gamma} = (sgman_{\gamma})\ (stw)\ \left(\frac{1}{45}\right) \qquad (C.60)$$

$$rtstm_{\gamma} = (sgmec_{\gamma})\ (sst)\ (\tfrac{1}{15}) \qquad \text{(C.61)}$$

$$rtdwm_{\gamma} = (sgmec_{\gamma})\ (sdw)\ (\tfrac{1}{28}) \qquad \text{(C.62)}$$

$$rt\ wm_{\gamma} = (sgmec_{\gamma})\ (stw)\ (\tfrac{1}{45}) \qquad \text{(C.63)}$$

$$hsml_{\gamma} = (rtst_{\gamma} + rtdw_{\gamma} + r\ \ w_{\gamma})\ (rtsml) \qquad \text{(C.64)}$$

$$hml_{\gamma} = (rtstm_{\gamma} + rtdwm_{\gamma} + rttwm_{\gamma})\ (rtml) \qquad \text{(C.65)}$$

$rtst_{\gamma}$ = amount of roundtrips for transportation of sugarcane harvested manually by single trucks in each State (units).

$rtdw_{\gamma}$ = amount of roundtrips for transportation of sugarcane harvested manually by double-wagon trucks in each State (units).

$rttw_{\gamma}$ = amount of roundtrips for transportation of sugarcane harvested manually by triple-wagon trucks in each State (units).

$rtstm_{\gamma}$ = amount of roundtrips for transportation of sugarcane harvested mechanically by single trucks in each State (units).

$rtdwm_{\gamma}$ = amount of roundtrips for transportation of sugarcane harvested mechanically by double-wagon trucks in each State (units).

$rttwm_{\gamma}$ = amount of roundtrips for transportation of sugarcane harvested manually by triple-wagon trucks in each State (units).

$hsml_{\gamma}$ = number of hours expended in sugarcane transportation from the field to the mill with semi-mechanical load operations (h).

hml_{γ} = number of hours expended in sugarcane transportation from the field to the mill with mechanical load operations (h).

rtsml = time of each roundtrip (field-mill-field) with semi-mechanical load operations (h).

rtml = time of each roundtrip (field-mill-field) with mechanical load operations (h).

Table C.16 – Estimates of costs with salaries and labor and social security liabilities in sugarcane transportation from the field to the mill – current scenario (R$ of 2009).

		Gross salary	Social security contribution - employees	Net salary	Labor and social security liabilities - employers
Parameters		3.487 R$/h[1] (hw)	11% (ssc)	89% (ns)	70.03% (lssl)
Notation ➔	$thst_\gamma$	$gsst_\gamma$	$scst_\gamma$	$nsst_\gamma$	$lsst_\gamma$
States ➔ \ **Units** ➔	h	R$	R$	R$	R$
Minas Gerais	3,566,989	12,439,063	1,368,297	11,070,766	8,711,433
Rio de Janeiro	415,652	1,449,493	159,444	1,290,048	1,015,121
São Paulo	24,293,583	84,718,348	9,319,018	75,399,330	59,330,691
Paraná	3,450,496	12,032,820	1,323,610	10,709,210	8,426,930
Mato Grosso do Sul	1,483,235	5,172,445	568,969	4,603,476	3,622,412
Mato Grosso	967,175	3,372,801	371,008	3,001,793	2,362,070
Goiás	2,558,666	8,922,768	981,504	7,941,263	6,248,870
Distrito Federal	4,506	15,714	1,729	13,985	11,005
Espírito Santo	340,019	1,185,737	130,431	1,055,306	830,406
Santa Catarina	47,550	165,818	18,240	147,578	116,127
Rio Grande do Sul	85,328	297,560	32,732	264,829	208,390
Tocantins	40,343	140,685	15,475	125,210	98,526
Pará	42,441	148,005	16,281	131,724	103,652
Rondônia	15,013	52,353	5,759	46,594	36,664
Acre	2,629	9,168	1,008	8,159	6,420
Amazonas	21,617	75,385	8,292	67,092	52,794
Roraima	94	326	36	290	229
Amapá	95	331	36	294	232
Maranhão	192,132	670,017	73,702	596,315	469,232
Piauí	58,463	203,876	22,426	181,449	142,780
Ceará	145,843	508,594	55,945	452,648	356,183
Rio Grande do Norte	269,827	940,962	103,506	837,456	658,982
Paraíba	428,691	1,494,964	164,446	1,330,518	1,046,966
Pernambuco	1,321,786	4,609,429	507,037	4,102,392	3,228,115
Alagoas	1,798,564	6,272,084	689,929	5,582,155	4,392,521
Sergipe	177,335	618,415	68,026	550,389	433,094
Bahia	314,939	1,098,278	120,811	977,468	769,156
Total	**42,043,009**	**146,615,439**	**16,127,698**	**130,487,741**	**102,679,002**

1 – The average value for the wage paid for tractor drivers in the State of São Paulo is also used due to data shortages.

$$hs_\gamma = (hsml_\gamma)\,(hml_\gamma) \tag{C.66}$$

$$gss_\gamma = (thst_\gamma)\,(hw) \tag{C.67}$$

$$scst_\gamma = (gss_\gamma)\,(ssc) \tag{C.68}$$

$$nsst_\gamma = (gsst_\gamma)\,(ns) \tag{C.69}$$

$$lsst_\gamma = (gsst_\gamma)\,(lssl) \tag{C.70}$$

$thst_{\gamma}$ = total number of hours expended in sugarcane transportation from the field to the mill in each State (h).

$gsst_{\gamma}$ = total costs of salaries for truck drivers in sugarcane transportation from the field to the mill in each State in the base year (R$).

$scst_{\gamma}$ = social security contributions on the gross salary paid by truck drivers in sugarcane transportation from the field to the mill in each State in the base year (R$).

$nsst_{\gamma}$ = total net salary earned by truck drivers in sugarcane transportation from the field to the mill in each State in the base year (R$).

$lsst_{\gamma}$ = labor and social security liabilities on the gross salary of truck drivers in sugarcane transportation from the field to the mill in each State in the base year (R$).

Table C.17 – Estimates of hours worked in transportation/application of agricultural inputs in the base year – general scenario.					
	Sugarcane seed	**Filter mud cake**	**Vinasse**	**Fertilizers**	**Total**
Equipment Nº	19	20	21+22+23+24 (weighed value)	20	
Operational Capacity ha/h	0.6 (ocst)	1.1 (ocfc)	1.667 (ocvi)	1.1(ocfe)	
Area of application	20% total area	30% planted area	30% ratoon area[1]	70% total area	
Notation ➔	$hsee_\gamma$	$hfmc_\gamma$	$hvin_\gamma$	$hfer_\gamma$	$thta_\gamma$
States 🡇 \ **Units** ➔	h	h	h	h	h
Minas Gerais	238,543	39,034	38,129	455,400	771,105
Rio de Janeiro	45,043	7,371	7,200	85,992	145,606
São Paulo	1,593,822	260,807	254,756	3,042,750	5,152,136
Paraná	198,457	32,475	31,721	378,872	641,526
Mato Grosso do Sul	95,331	15,600	15,238	181,996	308,164
Mato Grosso	71,055	11,627	11,357	135,650	229,689
Goiás	174,603	28,571	27,908	333,332	564,415
Distrito Federal	261	43	42	498	844
Espírito Santo	26,721	4,372	4,271	51,012	86,376
Santa Catarina	5,726	937	915	10,931	18,509
Rio Grande do Sul	12,189	1,995	1,948	23,270	39,402
Tocantins	2,884	472	461	5,505	9,322
Pará	3,258	533	521	6,219	10,531
Rondônia	1,407	230	225	2,685	4,547
Acre	258	42	41	492	833
Amazonas	2,017	330	322	3,850	6,519
Roraima	133	22	21	254	430
Amapá	23	4	4	45	75
Maranhão	15,357	2,513	2,455	29,319	49,644
Piauí	4,289	702	686	8,187	13,863
Ceará	14,235	2,329	2,275	27,177	46,017
Rio Grande do Norte	22,527	3,686	3,601	43,007	72,821
Paraíba	40,963	6,703	6,547	78,201	132,415
Pernambuco	117,425	19,215	18,769	224,176	379,585
Alagoas	144,668	23,673	23,124	276,185	467,650
Sergipe	13,977	2,287	2,234	26,683	45,182
Bahia	27,348	4,475	4,371	52,210	88,405
Total	**2,872,518**	**470,048**	**459,143**	**5,483,899**	**9,285,609**
1 – This value is multiplied by a factor of 37% in order to obtain the net area applied by trucks, since direct application with tanker trucks represents 6% of the area and trucks combined with cannons 31 % of the area (while the sprinkler system - water cannons - is used in 63% of the area).					

$$hsee_\gamma = [(ac_\gamma) \times 20\%] \left(\frac{1}{ocst}\right) \quad (C.71)$$

$$hfmc_\gamma = [(ac_\gamma) \times 20\% \times 30\%] \left(\frac{1}{ocfc}\right) \quad (C.72)$$

$$hvin_\gamma = [(ac_\gamma) \times 80\% \times 30\% \times 37\%] \left(\frac{1}{ocvi}\right) \quad (C.73)$$

$$hfer_\gamma = [(ac_\gamma) \times 70\%] \left(\frac{1}{ocfe}\right) \quad (C.74)$$

$$hta_{\gamma} = hsee_{\gamma} + hfmc_{\gamma} + hvin_{\gamma} + hfer_{\gamma} \quad \text{(C.75)}$$

ac_{γ} = total area cultivated with sugarcane in each Brazilian State (ha).

ocst = operational capacity for the transportation/application of sugarcane seed (ha/h).

ocfc = operational capacity for the transportation/application of filter mud cake (ha/h).

ocvi = operational capacity for the transportation/application of vinasse (ha/h).

ocfe = operational capacity for the transportation/application of fertilizers (ha/h).

$hsee_{\gamma}$ = total number of hours in the transportation of sugarcane seed in each State (h).

$hfmc_{\gamma}$ = total number of hours in the in the transportation of filter mud cake in each State (h).

$hvin_{\gamma}$ = total number of hours in the transportation of vinasse in each State (h).

$hfer_{\gamma}$ = total number of hours in the transportation of fertilizers in each State (h).

$thta_{\gamma}$ = total number of hours expended in transportation of agricultural inputs in each State (h).

Table C.18 – Estimates of costs with salaries and labor and social security liabilities in transportation/application of agricultural inputs in the base year – general scenario (R$ of 2009).				
	Gross salary	**Social security contribution - employees**	**Net salary**	**Labor and social security liabilities - employers**
Parameters	3.487 R$/h[1] (hw)	11% (ssc)	89% (ns)	70.03% (lssl)
Notation ➔	$gsta_\gamma$	$scta_\gamma$	$nsta_\gamma$	$lsta_\gamma$
States ➔ \ **Units** ➔	R$	R$	R$	R$
Minas Gerais	2,689,054	295,796	2,393,258	1,883,222
Rio de Janeiro	507,766	55,854	451,912	355,603
São Paulo	17,966,903	1,976,359	15,990,543	12,582,738
Paraná	2,237,175	246,089	1,991,086	1,566,758
Mato Grosso do Sul	1,074,651	118,212	956,440	752,609
Mato Grosso	800,988	88,109	712,879	560,955
Goiás	1,968,269	216,510	1,751,759	1,378,435
Distrito Federal	2,942	324	2,619	2,061
Espírito Santo	301,218	33,134	268,084	210,952
Santa Catarina	64,545	7,100	57,445	45,202
Rio Grande do Sul	137,405	15,115	122,290	96,228
Tocantins	32,507	3,576	28,931	22,766
Pará	36,723	4,040	32,684	25,718
Rondônia	15,857	1,744	14,113	11,105
Acre	2,905	320	2,585	2,034
Amazonas	22,734	2,501	20,233	15,921
Roraima	1,499	165	1,334	1,050
Amapá	263	29	234	184
Maranhão	173,121	19,043	154,078	121,241
Piauí	48,345	5,318	43,027	33,858
Ceará	160,473	17,652	142,821	112,384
Rio Grande do Norte	253,947	27,934	226,013	177,846
Paraíba	461,766	50,794	410,972	323,388
Pernambuco	1,323,717	145,609	1,178,109	927,037
Alagoas	1,630,824	179,391	1,451,433	1,142,113
Sergipe	157,561	17,332	140,229	110,344
Bahia	308,293	33,912	274,381	215,907
Total	**32,381,450**	**3,561,960**	**28,819,491**	**22,677,659**
1 – The average value for the wage paid for tractor drivers in the State of São Paulo is also used due to data shortages.				

$$gsta_\gamma = (thta_\gamma)\ (hw) \qquad (C.76)$$

$$sc\ a_\gamma = (gs\ a_\gamma)\ (ssc) \qquad (C.77)$$

$$ns\ a_\gamma = (gsta_\gamma)\ (ns) \qquad (C.78)$$

$$ls\ a_\gamma = (gsta_\gamma)\ (lssl) \qquad (C.79)$$

$gsta_\gamma$ = total costs of salaries for truck drivers in transportation of agricultural inputs in each State in the base year (R$).

$scta_{\gamma}$ = social security contributions on the gross salary paid by truck drivers in transportation of agricultural inputs in each State in the base year (R$).

$nsta_{\gamma}$ = total net salary earned by truck drivers in transportation of agricultural inputs in each State in the base year (R$).

$lsta_{\gamma}$ = labor and social security liabilities on the gross salary of truck drivers in transportation of agricultural inputs in each State in the base year (R$).

Table C.19 – Estimates of costs with salaries and labor and social security liabilities in manual harvesting in the base year – current scenario (R$ of 2009).

	Daily rate of manual harvesting	Total daily wage to pay for workers.	Gross salary	Social security contribution - employees	Net salary	Labor and social security liabilities - employers
Parameters	-	-	28.73 R$/day[1] (dw)	11% (ssc)	89% (ns)	70.03% (lssl)
Notation ➔	dr_γ	tdi_γ	$gsmh_\gamma$	$scmh_\gamma$	$nsmh_\gamma$	$lsmh_\gamma$
States ⬇ \ **Units** ➔	t/day[2]	unit	R$	R$	R$	R$
Minas Gerais	7.993	3,834,812	110,174,159	12,119,157	98,055,001	77,158,127
Rio de Janeiro	6.976	681,093	19,567,788	2,152,457	17,415,331	13,703,884
São Paulo	7.993	21,154,797	607,777,304	66,855,503	540,921,800	425,643,896
Paraná	8.012	4,911,513	141,107,758	15,521,853	125,585,905	98,821,814
Mato Grosso do Sul	7.980	1,160,253	33,334,072	3,666,748	29,667,324	23,344,808
Mato Grosso	8.023	862,716	24,785,837	2,726,442	22,059,395	17,358,233
Goiás	8.024	1,923,674	55,267,156	6,079,387	49,187,769	38,705,176
Distrito Federal	7.741	8,558	245,859	27,044	218,814	172,182
Espírito Santo	7.022	580,899	16,689,238	1,835,816	14,853,422	11,687,953
Santa Catarina	7.741	90,302	2,594,375	285,381	2,308,994	1,816,915
Rio Grande do Sul	6.977	179,808	5,165,886	568,247	4,597,639	3,617,818
Tocantins	6.986	47,542	1,365,879	150,247	1,215,632	956,564
Pará	7.018	49,793	1,430,544	157,360	1,273,185	1,001,851
Rondônia	6.977	14,521	417,194	45,891	371,303	292,173
Acre	7.741	4,993	143,438	15,778	127,659	100,453
Amazonas	7.042	18,972	545,051	59,956	485,096	381,715
Roraima	7.741	178	5,107	562	4,545	3,576
Amapá	7.741	180	5,177	569	4,608	3,626
Maranhão	6.989	404,185	11,612,231	1,277,345	10,334,886	8,132,379
Piauí	7.026	122,336	3,514,702	386,617	3,128,084	2,461,446
Ceará	6.027	246,389	7,078,768	778,665	6,300,104	4,957,465
Rio Grande do Norte	7.016	412,270	11,844,508	1,302,896	10,541,612	8,295,049
Paraíba	6.978	903,152	25,947,551	2,854,231	23,093,320	18,171,815
Pernambuco	6.991	2,773,064	79,670,119	8,763,713	70,906,406	55,795,272
Alagoas	7.008	3,583,728	102,960,501	11,325,655	91,634,846	72,106,195
Sergipe	7.017	371,554	10,674,737	1,174,221	9,500,516	7,475,825
Bahia	7.023	659,290	18,941,411	2,083,555	16,857,856	13,265,214
Total	**7.741**	**45,000,569**	**1,292,866,350**	**142,215,299**	**1,150,651,052**	**905,431,425**

1 – The average value for the diary wage paid for agricultural workers in the State of São Paulo is used.
2 – In the States which data are not available, the average value for the whole Brazil is used and highlighted with subscript. This data is provided by CONAB (2012).

$$di_\gamma = (sgman_\gamma)\left(\frac{1}{dr_\gamma}\right) \quad (C.80)$$

$$gsmh_\gamma = (tdi_\gamma)\,(dw) \quad (C.81)$$

$$scmh_\gamma = (gsmh_\gamma)\,(ssc) \quad (C.82)$$

$$ns\ a_\gamma = (gsmh_\gamma)\,(ns) \quad (C.83)$$

$$ls\,a_{\gamma} = (gsmh_{\gamma})\,(lssl) \quad (C.84)$$

dr_{γ} = daily rate of manual harvesting of sugarcane per worker in each State (t/day).

tdi_{γ} = total amount of diary incomes paid for workers in manual harvesting of sugarcane in each State in the base year (unit).

dw = daily wage paid for workers in manual harvesting of sugarcane in each State in the base year (R$).

$gsmh_{\gamma}$ = total costs of salaries for workers in manual harvesting of sugarcane in each State in the base year (R$).

$scmh_{\gamma}$ = social security contributions on the gross salary paid by workers in manual harvesting of sugarcane in each State in the base year (R$).

$nsmh_{\gamma}$ = total net salary earned by workers in manual harvesting of sugarcane in each State in the base year (R$).

$lsmh_{\gamma}$ = labor and social security liabilities on the gross salary of workers in manual harvesting of sugarcane in each State in the base year (R$).

Table C.20 – Estimates of costs with salaries and labor and social security liabilities in harvesting and loading operations 100% mechanical – future scenario (R$ of 2009).

	Number of hours expended			Costs			
	Harvester	Tractor hauler/ transloader	Total	Gross salary	Social security contribution - employees	Net salary	Labor and social security liabilities - employers
Equipment Nº	14	25					
Type of harvesting operation	Mechanical	Mechanical					
Operational Capacity (t/h)	45	35					
Operational Capacity (h/t)	1/45 = 0.02222 (ocmh)	1/35 = 0.02857 (oct)					
Parameters	100% of cultivated area	100% of cultivated area	100% of cultivated area	3.487 R$/h[1] (hw)	11% (ssc)	89% (ns)	70.03% (lssl)
Notation ➔	$hmecf_{\gamma}$	$htmecf_{\gamma}$	$thlhf_{\gamma}$	$gshlf_{\gamma}$	$schlf_{\gamma}$	$nshlf_{\gamma}$	$lshlf_{\gamma}$
States ➔ \ Units ➔	h	h	h	R$	R$	R$	R$
Minas Gerais	1,297,425	1,668,117	2,965,542	10,341,653	1,137,582	9,204,071	7,242,557
Rio de Janeiro	144,038	185,192	329,230	1,148,115	126,293	1,021,822	804,058
São Paulo	9,076,691	11,670,031	20,746,722	72,349,478	7,958,443	64,391,035	50,668,416
Paraná	1,196,262	1,538,051	2,734,313	9,535,296	1,048,883	8,486,413	6,677,841
Mato Grosso do Sul	560,631	720,811	1,281,442	4,468,738	491,561	3,977,177	3,129,586
Mato Grosso	360,213	463,131	823,344	2,871,226	315,835	2,555,391	2,010,802
Goiás	970,369	1,247,617	2,217,985	7,734,720	850,819	6,883,900	5,416,846
Distrito Federal	1,472	1,893	3,365	11,735	1,291	10,444	8,218
Espírito Santo	116,662	149,994	266,655	929,900	102,289	827,611	651,235
Santa Catarina	15,535	19,973	35,508	123,827	13,621	110,206	86,719
Rio Grande do Sul	27,877	35,842	63,719	222,207	24,443	197,764	155,618
Tocantins	14,762	18,980	33,741	117,665	12,943	104,722	82,405
Pará	15,530	19,967	35,497	123,787	13,617	110,171	86,692
Rondônia	5,628	7,236	12,865	44,863	4,935	39,928	31,419
Acre	859	1,104	1,963	6,846	753	6,093	4,795
Amazonas	8,179	10,516	18,695	65,193	7,171	58,022	45,657
Roraima	31	39	70	244	27	217	171
Amapá	31	40	71	247	27	220	173
Maranhão	62,771	80,706	143,477	500,343	55,038	445,305	350,405
Piauí	19,100	24,558	43,658	152,247	16,747	135,500	106,623
Ceará	51,643	66,398	118,041	411,642	45,281	366,361	288,285
Rio Grande do Norte	94,667	121,714	216,381	754,579	83,004	671,575	528,453
Paraíba	140,057	180,073	320,131	1,116,383	122,802	993,580	781,835
Pernambuco	432,116	555,578	987,695	3,444,361	378,880	3,065,481	2,412,185
Alagoas	595,647	765,832	1,361,480	4,747,851	522,264	4,225,587	3,325,056
Sergipe	57,937	74,490	132,427	461,809	50,799	411,010	323,418
Bahia	102,893	132,291	235,185	820,153	90,217	729,936	574,376
Total	**15,369,025**	**19,760,176**	**35,129,201**	**122,505,105**	**13,475,562**	**109,029,543**	**85,793,842**

1 – The average value for the wage paid for tractor drivers in the State of São Paulo is also used due to data shortages.

$$hmecf_{\gamma} = [(sgmec_{\gamma}) + (sgman_{\gamma})] (ocmh) \quad (C.85)$$

$$htmecf_{\gamma} = [(sgmec_{\gamma}) + (sgman_{\gamma})] (oct) \quad (C.86)$$

$$hlhf_\gamma = hmecf_\gamma + htmecf_\gamma \quad (C.87)$$

$$gshlf_\gamma = (thlhf_\gamma)\ (hw) \quad (C.88)$$

$$schlf_\gamma = (gshlf_\gamma)\ (ssc) \quad (C.89)$$

$$nshlf_\gamma = (gshlf_\gamma)\ (ns) \quad (C.90)$$

$$lshl_\gamma = (gshlf_\gamma)\ (lssl) \quad (C.91)$$

$sgmec_\gamma$ = sugarcane harvested mechanically in each Brazilian State γ in the base year (t).

$sgman_\gamma$ = sugarcane harvested manually in each Brazilian State γ in the base year (t).

ocmh = operational capacity of the harvester (h/t).

oct = operational capacity of the tractor hauler/transloader (h/t).

$hmecf_\gamma$ = total hours expended in harvesting operations considering a scenario with 100% of mechanical harvesting in the total area cultivated in each State in the base year (h).

$htmecf_\gamma$ = total hours expended by tractor hauler/transloader operations considering a scenario with 100% of mechanical harvesting in the total area cultivated in each State in the base year (h).

$thlh_\gamma$ = total hours worked (expended) in harvesting and loading operations considering a scenario with 100% of mechanical harvesting in the total area cultivated in each State in the base year (h).

$gshlf_\gamma$ = total costs with salaries from harvesting and loading operations in a scenario with 100% of mechanical harvesting in the base year (R$).

$schlf_\gamma$ = social security contributions on the gross salary paid by harvester/tractor drivers in harvesting and loading operations in a scenario with 100% of mechanical harvesting in the base year (R$).

$nshlf_\gamma$ = total net salary earned by harvester/tractor drivers in a scenario with 100% of mechanical harvesting in the base year (R$).

$lshlf_\gamma$ = labor and social security liabilities on the gross salary of harvester/tractor drivers in harvesting and loading operations paid by employers harvester/tractor drivers in a scenario with 100% of mechanical harvesting in the base year (R$).

Table C.21 – Estimates of costs with salaries and labor and social security liabilities in sugarcane transportation from the field to the mill – future scenario (R$ of 2009).

	Roundtrips and hours expended		Costs			
	Roundtrips for transportation of sugarcane mechanically harvested	Hours expended with sugarcane transportation	Gross salary	Social security contribution - employees	Net salary	Labor and social security liabilities - employers
Equipment Nº	26	-	-	-	-	-
Share of sugarcane transported	100% (srt)					
Operational capacity (t)	58					
Roundtrip time (h)	-	1.833 (rtml)				
Parameters	-	-	3.487 R$/h[1] (hw)	11% (ssc)	89% (ns)	70.03% (lssl)
Notation ➔	$rtrt_\gamma$	$hmlf_\gamma$	$gsstf_\gamma$	$scstf_\gamma$	$nsstf_\gamma$	$lsstf_\gamma$
States 🡻 \ **Units** ➔	roundtrip	h	R$	R$	R$	R$
Minas Gerais	1,006,623	1,845,475	6,435,673	707,924	5,727,749	4,507,087
Rio de Janeiro	111,754	204,882	714,479	78,593	635,886	500,370
São Paulo	7,042,260	12,910,810	45,023,516	4,952,587	40,070,930	31,531,261
Paraná	928,134	1,701,580	5,933,872	652,726	5,281,146	4,155,661
Mato Grosso do Sul	434,972	797,449	2,780,923	305,902	2,475,021	1,947,560
Mato Grosso	279,476	512,372	1,786,781	196,546	1,590,235	1,251,334
Goiás	752,872	1,380,266	4,813,363	529,470	4,283,893	3,370,936
Distrito Federal	1,142	2,094	7,303	803	6,499	5,114
Espírito Santo	90,513	165,941	578,682	63,655	515,027	405,268
Santa Catarina	12,053	22,097	77,058	8,476	68,582	53,966
Rio Grande do Sul	21,629	39,653	138,281	15,211	123,070	96,842
Tocantins	11,453	20,997	73,224	8,055	65,169	51,281
Pará	12,049	22,090	77,034	8,474	68,560	53,949
Rondônia	4,367	8,006	27,919	3,071	24,848	19,552
Acre	666	1,222	4,260	469	3,792	2,984
Amazonas	6,346	11,634	40,570	4,463	36,107	28,412
Roraima	24	43	152	17	135	106
Amapá	24	44	154	17	137	108
Maranhão	48,702	89,287	311,366	34,250	277,116	218,059
Piauí	14,819	27,169	94,744	10,422	84,322	66,352
Ceará	40,068	73,458	256,167	28,178	227,989	179,401
Rio Grande do Norte	73,448	134,655	469,579	51,654	417,925	328,860
Paraíba	108,665	199,219	694,732	76,420	618,311	486,540
Pernambuco	335,263	614,648	2,143,447	235,779	1,907,668	1,501,117
Alagoas	462,140	847,257	2,954,616	325,008	2,629,608	2,069,203
Sergipe	44,951	82,410	287,386	31,613	255,774	201,265
Bahia	79,831	146,357	510,386	56,142	454,244	357,438
Total	**11,924,244**	**21,861,114**	**76,235,666**	**8,385,923**	**67,849,743**	**53,390,026**

1 – The average value for the wage paid for tractor drivers in the State of São Paulo is also used due to data shortages.

$$rtrt_\gamma = [(sgmec_\gamma) + (sgman_\gamma)]\ (sr\ )\ (\frac{1}{58}) \qquad (C.92)$$

$$hmlf_\gamma = (rtrt_\gamma)\ (rtml) \qquad (C.93)$$

$$gss\ f_{\gamma} = (hmlf_{\gamma})\ (hw) \tag{C.94}$$

$$scstf_{\gamma} = (gss\ f_{\gamma})\ (ssc) \tag{C.95}$$

$$nsstf_{\gamma} = (gss\ f_{\gamma})\ (ns) \tag{C.96}$$

$$lsstf_{\gamma} = (gss\ f_{\gamma})\ (lssl) \tag{C.97}$$

$rtrt_{\gamma}$ = amount of roundtrips for transportation of sugarcane by road train trucks in a scenario with 100% of mechanical loading in each State in the base year (units).

$hmlf_{\gamma}$ = number of hours expended in transportation of sugarcane from the field to the mill by road train trucks in a scenario with 100% of mechanical load operations (h).

rtml = time of each roundtrip (field-mill-field) with mechanical load operations (h).

$gshlf_{\gamma}$ = total costs with salaries from transportation of sugarcane from the field to the mill by road train trucks in a scenario with 100% of mechanical load operations (R$).

$scstf_{\gamma}$ = social security contributions on the gross salary paid by truck drivers in the transportation of sugarcane from the field to the mill by road train trucks in a scenario with 100% of mechanical load operations (R$).

$nsstf_{\gamma}$ = total net salary earned by truck drivers in the transportation of sugarcane from the field to the mill by road train trucks in a scenario with 100% of mechanical load operations (R$).

$lsstf_{\gamma}$ = labor and social security liabilities on the gross salary of truck drivers in the transportation of sugarcane from the field to the mill by road train trucks paid by employers in a scenario with 100% of mechanical load operations (R$).

Table C.22 – Estimates of costs with salaries for agriculture workers in land preparation, planting, ratoon tillage and harvesting operations in the base year (2009) – current scenario (R$ of 2009).

	Description	Unitary cost	Work force	Cost/ ha	Area	Gross salary	SSC - employees	Net salary	LSSL - employers
	Notation ➔	uc_{λ}	whd_{λ}	cha_{λ}	aac_{λ}	$gslprh_{\lambda}$	$sclprh_{\lambda}$	$nslprh_{\lambda}$	$lslprh_{\lambda}$
	Operations ➔ **Units** ➔	R$/day	Worker/ ha/day	R$/ha	(ha)	(R$)	(R$)	(R$)	(R$)
Area with new plantation	**1 - Land preparation**	-	-	**33.62**	**1,723,511**	**57,952,575**	-	-	-
	Terraces location	29.04	1.10	31.94	1,723,511	55,055,835	-	-	-
	Soil sampling	33.61	0.05	1.68	1,723,511	2,896,740	-	-	-
	2 - Planting	-	-	**398.87**	**1,723,511**	**687,456,833**	**75,620,252**	**611,836,581**	**481,445,757**
	Detrash and harvest of sapling	-	-	-	-	-	-	-	-
	Sapling distribution	33.61	11.80	396.65	1,723,511	683,630,638	75,199,370	608,431,268	478,766,164
	Preparation of sugarcane setts	-	-	-	-	-	-	-	-
	Soil cover operations	-	-	-	-	-	-	-	-
	Audit - planting	67.23	0.033	2.22	1,723,511	3,826,194	420,881	3,405,313	2,679,594
	3 – Tillage operations	-	-	**129.86**	**1,723,511**	**223,820,616**	**24,620,268**	**199,200,348**	**156,748,003**
	Tillage - chemical	33.61	0.63	21.18	1,723,511	36,498,924	4,014,882	32,484,042	25,561,244
	Tillage - manual	33.61	2.70	90.76	1,723,511	156,423,960	17,206,636	139,217,324	109,548,190
	Ant control	33.61	0.50	16.81	1,723,511	28,967,400	3,186,414	25,780,986	20,286,702
	Irrigation operation	-	-	-	-	-	-	-	-
	Herbicide application	-	-	-	-	-	-	-	-
	Fertilizer application	-	-	-	-	-	-	-	-
	Field supervisor	67.23	0.017	1.12	1,723,511	1,930,332	212,337	1,717,996	1,351,867
Area with sugarcane ratoon	**1 - Land preparation**	-	-	-	-	-	-	-	-
	2 - Planting	-	-	-	-	-	-	-	-
	3 – Tillage operations	-	-	**34.87**	**6,894,044**	**240,387,485**	**26,442,623**	**213,944,862**	**168,350,258**
	Tillage – chemical	33.61	0.504	16.94	6,894,044	116,796,556	12,847,621	103,948,935	81,795,982
	Tillage – manual	-	-	-	-	-	-	-	-
	Ant control	33.61	0.50	16.81	6,894,044	115,869,600	12,745,656	103,123,944	81,146,807
	Irrigation operation	-	-	-	-	-	-	-	-
	Herbicide application	-	-	-	-	-	-	-	-
	Fertilizer application	-	-	-	-	-	-	-	-
	Field supervisor	67.23	0.017	1.12	6,894,044	7,721,329	849,346	6,871,983	5,407,469
Total cultivated area	**4 - Harvesting**	-	-	**20.07**	**8,617,555**	**172,935,890**	**19,022,948**	**153,912,942**	**121,111,969**
	Pre-analysis of sugarcane	50.42	0.008	0.40	8,617,555	3,475,977	382,357	3,093,620	2,434,326
	Audit - harvest	67.23	0.028	1.88	8,617,555	16,222,030	1,784,423	14,437,607	11,360,754
	Audit - cultivation	67.23	0.033	2.22	8,617,555	19,118,821	2,103,070	17,015,751	13,389,460
	Firebreak	33.61	0.30	10.08	8,617,555	86,902,200	9,559,242	77,342,958	60,860,106
	Sugarcane burn	33.61	0.063	2.12	8,617,555	18,249,462	2,007,441	16,242,021	12,780,622
	Straw burn	33.61	0.02	0.67	8,617,555	5,793,480	637,283	5,156,197	4,057,340
	Gathering of field residues	33.61	0.08	2.69	8,617,555	23,173,920	2,549,131	20,624,789	16,229,361
TOTAL				**617.29**	-	**1,382,553,399**	**145,706,091**	**1,178,894,733**	**927,655,988**

$cha_\lambda = (uc_\lambda)\ (whd_\lambda)$ (C.98)

$gslprh_\lambda = (aac_\lambda)\ (cha_\lambda)$ (C.99)

$sclprh_\lambda = (gslprh_\lambda)\ (ssc)$ (C.100)

$nslprh_\lambda = (gslprh_\lambda)\ (ns)$ (C.101)

$lslprh_\lambda = (gslprh_\lambda)\ (lssl)$ (C.102)

uc_λ = unitary cost of each manual operation λ (R$/day).
whd_λ = technical coefficient for work force necessary in each manual operation λ (workers/ha/day).
cha_λ = cost of each manual operation per unit of area (R$/ha).
aac_λ = area worked in each operation – 20% of total area for area with new plantation, 80% for area with sugarcane ratoon and 100% of total area for harvesting operations (ha).
$gslprh_\lambda$ = total costs with salaries for agriculture workers in land preparation, planting, ratoon tillage and harvesting operations in the base year (R$).
$sclprh_\lambda$ = social security contributions on the gross salary paid by agriculture workers in land preparation, planting, ratoon tillage and harvesting operations in the base year (R$).
$nslprh_\lambda$ = total net salary earned by agriculture workers in land preparation, planting, ratoon tillage and harvesting operations in the base year (R$).
$lslprh_\lambda$ = labor and social security liabilities on the gross salary of agriculture workers in land preparation, planting, ratoon tillage and harvesting operations paid by employers in the base year (R$).
λ = terraces location, soil sampling, detrash and harvest of sapling, sapling distribution, preparation of sugarcane setts, soil cover operations, audit (planting, cultivation and harvesting), tillage (chemical and manual – planted and ratoon areas), ant control (planted and ratoon areas), irrigation operation (planted and ratoon areas), herbicide application (planted and ratoon areas), fertilizer application (planted and ratoon areas), field supervisor (planted and ratoon areas), pre-analysis of sugarcane, firebreak, sugarcane burn, straw burn and gathering of field residues.

Table C.23 – Estimates of costs with salaries for agriculture workers in land preparation, planting, ratoon tillage and harvesting operations in a scenario with 100% of mechanical harvesting – future scenario (R$ of 2009).

	Description	Unitary cost	Work force	Cost/ Area	Area	Gross salary	SSC - employees	Net salary	LSSL - employers
	Notation ➔	uc_λ	whd_λ	chf_λ	aac_λ	$gslprhf_\lambda$	$sclprhf_\lambda$	$nslprhf_\lambda$	$lslprhf_\lambda$
	Operations ➔ **Units** ➔	R$/day	Worker/ ha/day	R$/ha	(ha)	(R$)	(R$)	(R$)	(R$)
Area with new plantation	**1 - Land preparation**	-	-	**33.62**	**1,723,511**	**57,952,575**	-	-	-
	Terraces location	29.04	1.10	31.94	1,723,511	55,055,835	-	-	-
	Soil sampling	33.61	0.05	1.68	1,723,511	2,896,740	-	-	-
	2 - Planting	-	-	**398.87**	**1,723,511**	**687,456,833**	**75,620,252**	**611,836,581**	**481,445,757**
	Detrash and harvest of sapling	-	-	-	-	-	-	-	-
	Sapling distribution	33.61	11.80	396.65	1,723,511	683,630,638	75,199,370	608,431,268	478,766,164
	Preparation of sugarcane setts	-	-	-	-	-	-	-	-
	Soil cover operations	-	-	-	-	-	-	-	-
	Audit - planting	67.23	0.033	2.22	1,723,511	3,826,194	420,881	3,405,313	2,679,594
	3 – Tillage operations	-	-	**129.86**	**1,723,511**	**223,820,616**	**24,620,268**	**199,200,348**	**156,748,003**
	Tillage - chemical	33.61	0.63	21.18	1,723,511	36,498,924	4,014,882	32,484,042	25,561,244
	Tillage - manual	33.61	2.70	90.76	1,723,511	156,423,960	17,206,636	139,217,324	109,548,190
	Ant control	33.61	0.50	16.81	1,723,511	28,967,400	3,186,414	25,780,986	20,286,702
	Irrigation operation	-	-	-	-	-	-	-	-
	Herbicide application	-	-	-	-	-	-	-	-
	Fertilizer application	-	-	-	-	-	-	-	-
	Field supervisor	67.23	0.017	1.12	1,723,511	1,930,332	212,337	1,717,996	1,351,867
Area with sugarcane ratoon	**1 - Land preparation**	-	-	-	-	-	-	-	-
	2 - Planting	-	-	-	-	-	-	-	-
	3 – Tillage operations	-	-	**34.87**	**6,894,044**	**240,387,485**	**26,442,623**	**213,944,862**	**168,350,258**
	Tillage – chemical	33.61	0.504	16.94	6,894,044	116,796,556	12,847,621	103,948,935	81,795,982
	Tillage – manual	-	-	-	-	-	-	-	-
	Ant control	33.61	0.50	16.81	6,894,044	115,869,600	12,745,656	103,123,944	81,146,807
	Irrigation operation	-	-	-	-	-	-	-	-
	Herbicide application	-	-	-	-	-	-	-	-
	Fertilizer application	-	-	-	-	-	-	-	-
	Field supervisor	67.23	0.017	1.12	6,894,044	7,721,329	849,346	6,871,983	5,407,469
Total cultivated area	**4 - Harvesting**	-	-	**17.28**	**8,617,555**	**148,892,948**	**16,378,224**	**132,514,724**	**104,274,007**
	Pre-analysis of sugarcane	50.42	0.008	0.40	8,617,555	3,475,977	382,357	3,093,620	2,434,326
	Audit - harvest	67.23	0.028	1.88	8,617,555	16,222,030	1,784,423	14,437,607	11,360,754
	Audit - cultivation	67.23	0.033	2.22	8,617,555	19,118,821	2,103,070	17,015,751	13,389,460
	Firebreak	33.61	0.30	10.08	8,617,555	86,902,200	9,559,242	77,342,958	60,860,106
	Sugarcane burn	33.61	-	-	-	-	-	-	-
	Straw burn	33.61	-	-	-	-	-	-	-
	Gathering of field residues	33.61	0.08	2.69	8,617,555	23,173,920	2,549,131	20,624,789	16,229,361
TOTAL				**614.50**	-	**1,358,510,457**	**143,061,367**	**1,157,496,515**	**910,818,025**

$$chf_{\lambda} = (uc_{\lambda})\ (whd_{\lambda}) \quad (C.103)$$

$$gslprhf_{\lambda} = (aac_{\lambda})\ (chf_{\lambda}) \quad (C.104)$$

$$sclprhf_{\lambda} = (gslprhf_{\lambda})\ (ssc) \quad (C.105)$$

$$nslprhf_{\lambda} = (gslprhf_{\lambda})\ (ns) \quad (C.106)$$

$$lslprhf_{\lambda} = (gslprhf_{\lambda})\ (lssl) \quad (C.107)$$

chf_{λ} = cost of each manual operation per unit of area in a scenario without sugarcane burn (R$/ha).
aac_{λ} = area worked in each operation – 20% of total area for area with new plantation, 80% for area with sugarcane ratoon and 100% of total area for harvesting operations (ha).
$gslprhf_{\lambda}$ = total costs with salaries for agriculture workers in land preparation, planting, ratoon tillage and harvesting operations in the base year in a scenario without sugarcane burn (R$).
$sclprhf_{\lambda}$ = social security contributions on the gross salary paid by agriculture workers in land preparation, planting, ratoon tillage and harvesting operations in the base year in a scenario without sugarcane burn (R$).
$nslprhf_{\lambda}$ = total net salary earned by agriculture workers in land preparation, planting, ratoon tillage and harvesting operations in the base year in a scenario without sugarcane burn (R$).
$lslprhf_{\lambda}$ = labor and social security liabilities on the gross salary of agriculture workers in land preparation, planting, ratoon tillage and harvesting operations paid by employers in the base year in a scenario without sugarcane burn (R$).

Table C.24 – Estimates of lubricants consumed in land preparation, planting and ratoon tillage operations in the base year (2009) – general scenario.

	Equip.	Power	Specific[2] consumption	**Operational capacity**	Specific consumption	Fraction of area worked	**Applied area in the base year**	**Total consumption**
Notation ➔	-	hp_α	scl_α	$ocap_\alpha$	$sclf_\alpha$	faa_α	aao_α	tcl_α
Land preparation and planting operations ➔ **Units** ➔	Nº	hp	L/h	ha/h	L/ha	%	20% of total area (ha)	L
Lime application	1	76.93	0.056	1.61	0.0345	100%	1,723,511	59,456
Mechanical elimination of ratoons	13	141.04	0.084	1.10	0.0761	30%	1,723,511	39,366
Chemical elimination of ratoons	9	68.06	0.052	2.50	0.0207	30%	1,723,511	10,679
Heavy harrowing I	2	162.74	0.093	1.30	0.0718	90%	1,723,511	111,322
Sub-soiling	3	162.74	0.093	1.00	0.0933	70%	1,723,511	112,559
Heavy harrowing II	4	162.74	0.093	1.35	0.0691	70%	1,723,511	83,377
Heavy harrowing III	4	162.74	0.093	1.35	0.0691	30%	1,723,511	35,733
Light harrowing	5	162.74	0.093	1.60	0.0583	90%	1,723,511	90,449
Furrowing and fertilizing	6	167.67	0.095	1.10	0.0868	100%	1,723,511	149,580
Sugarcane seed distribution	7	68.06	0.052	0.60	0.0861	100%	1,723,511	148,322
Closing furrows and insecticide application	8	68.06	0.052	1.80	0.0287	100%	1,723,511	49,441
Chemical tillage (herbicide application)	9	68.06	0.052	2.50	0.0207	100%	1,723,511	35,597
Mechanical tillage	10	102.58	0.067	1.30	0.0514	70%	1,723,511	62,016
Subtotal								987,897
Ratoon tillage operations	Nº	hp	L/h	ha/h	L/ha	%	80% of total area (ha)	L
Trash raking	11	68.06	0.052	1.50	0.0344	25%	6,894,044	59,329
Triple operation tillage	12	141.04	0.084	1.30	0.0644	100%	6,894,044	444,132
Chemical tillage (herbicide application)	9	68.06	0.052	2.50	0.0207	85%	6,894,044	121,030
Subtotal								624,491
Total								**1,612,388**

$$scl_\alpha = 0.00044\,(hp_\alpha) + 0.02169 \quad (C.108)$$

$$sclf_\alpha = (scl_\alpha)\left(\frac{1}{ocap_\alpha}\right) \quad (C.109)$$

$$cl_\alpha = (sclf_\alpha)\,(faa_\alpha)\,(aao_\alpha) \quad (C.110)$$

scl_α = specific consumption of lubricants of each equipment/implement (L/h).

hp_α = power of each equipment/implement (hp).

$sclf_\alpha$ = specific consumption of lubricants by unit of area worked of each equipment/implement (L/ha).

$ocap_\alpha$ = operational capacity of each equipment/implement (ha/h).

tcl_α = total consumption of lubricants in land preparation, planting and ratoon tillage operations (L).

[2] This estimate is based on the methodology provided in the AGRAFNP (2010).

Table C.25 – Estimates of costs on lubricants consumed in land preparation, planting and ratoon tillage operations in the base year (2009) – general scenario.

	Production costs	Taxes	Distribution costs	Total Costs
Parameters	60.01% (pc%)	23.41% (ts%)	16.58% (dc%)	10.24 R$/L (tcl$)
Notation ➔	$pclprl_\alpha$	$tlprl_\alpha$	$dclprl_\alpha$	$tclprl_\alpha$
Land preparation and planting operations ➔ **Units** ➔	R$	R$	R$	R$
Lime application	365,361	142,558	100,915	608,833
Mechanical elimination of ratoons	241,907	94,388	66,816	403,110
Chemical elimination of ratoons	65,624	25,605	18,126	109,355
Heavy harrowing I	684,076	266,915	188,946	1,139,936
Sub-soiling	691,676	269,880	191,045	1,152,602
Heavy harrowing II	512,353	199,911	141,515	853,779
Heavy harrowing III	219,580	85,676	60,649	365,905
Light harrowing	555,811	216,868	153,519	926,198
Furrowing and fertilizing	919,173	358,646	253,882	1,531,701
Sugarcane seed distribution	911,440	355,628	251,746	1,518,814
Closing furrows and insecticide application	303,813	118,543	83,915	506,271
Chemical tillage (herbicide application)	218,746	85,351	60,419	364,515
Mechanical tillage	381,088	148,694	105,259	635,041
Subtotal	6,070,648	2,368,664	1,676,751	10,116,063
Ratoon tillage operations				
Trash raking	364,576	142,251	100,698	607,526
Triple operation tillage	2,729,202	1,064,888	753,823	4,547,913
Chemical tillage (herbicide application)	743,735	290,193	205,424	1,239,352
Subtotal	3,837,513	1,497,332	1,059,945	6,394,791
Total	**9,908,161**	**3,865,996**	**2,736,697**	**16,510,853**

$$clprl_\alpha = (tcl_\alpha)\ (tcl\$) \quad (C.111)$$

$$pclprl_\alpha = (tclprl_\alpha)\ (pc\%) \quad (C.112)$$

$$lprl_\alpha = (tclprl_\alpha)\ (t\%) \quad (C.113)$$

$$dclprl_\alpha = (tclprl_\alpha)\ (dc\%) \quad (C.114)$$

$tclprl_\alpha$ = total cost of lubricants consumed for land preparation, planting and ratoon tillage operations (R$).

(tcl$) = total unit cost of lubricants (R$/L).

$pclprl_\alpha$ = production costs on lubricants consumed for land preparation, planting and ratoon tillage operations (R$).

pc% = fraction of production costs on the total unit cost of lubricants (%).

$tlprl_{\alpha}$ = taxes on lubricants consumed for land preparation, planting and ratoon tillage operations (R$).

t% = fraction of taxes on the total unit cost of lubricants (%).

$dclpr_{\alpha}$ = distribution cost on lubricants consumed for land preparation, planting and ratoon tillage operations (R$).

dc% = fraction of distribution costs on the total unit cost of lubricants (%).

Table C.26 – Estimates of total consumption of lubricants in harvesting and loading operations – current scenario.

Equipment	Harvester	Sugarcane loader	Tractor hauler/transloader		Total
Nº	14	15	25		
Type of harvesting operation	Mechanical	Manual	Mechanical	Manual	
Operational Capacity (t/h)	45	46	35		
Operational Capacity (h/t)	1/45 = 0.02222 (ocmh)	1/46 = 0.02174 (ocsl)	1/35 = 0.02857 (oct)		
Power (hp)	325.49 (hhp)	76.93 (slhp)	177.54 (thhp)		
Specific Consumption (L/h)	0.1649 (sclh)	0.0555 (sclsl)	0.0998 (sclth)		
Notation ➔	lch_γ	$lcsl_\gamma$	$lctmec_\gamma$	$lctman_\gamma$	$lchl_\gamma$
States ➔ \ **Units** ➔	L	L	L	L	L
Minas Gerais	101,626	37,009	79,082	87,407	305,125
Rio de Janeiro	6,342	5,736	4,935	13,548	30,562
São Paulo	877,114	204,170	682,542	482,205	2,246,031
Paraná	53,065	47,513	41,294	112,214	254,086
Mato Grosso do Sul	58,521	11,179	45,539	26,403	141,642
Mato Grosso	34,037	8,357	26,486	19,737	88,617
Goiás	103,451	18,638	80,502	44,018	246,609
Distrito Federal	-	80	-	189	269
Espírito Santo	4,290	4,925	3,338	11,632	24,186
Santa Catarina	-	844	-	1,993	2,838
Rio Grande do Sul	-	1,515	-	3,577	5,092
Tocantins	1,217	401	947	947	3,512
Pará	1,280	422	996	996	3,695
Rondônia	557	122	433	289	1,401
Acre	-	47	-	110	157
Amazonas	859	161	669	381	2,070
Roraima	-	1.7	-	3.9	5.6
Amapá	-	1.7	-	4	5.7
Maranhão	-	3,411	-	8,055	11,466
Piauí	-	1,038	-	2,451	3,489
Ceará	3,074	1,793	2,392	4,235	11,494
Rio Grande do Norte	5,011	3,492	3,899	8,248	20,651
Paraíba	-	7,610	-	17,973	25,582
Pernambuco	214	23,408	166	55,284	79,072
Alagoas	6,188	30,325	4,815	71,620	112,948
Sergipe	-	3,148	-	7,435	10,583
Bahia	-	5,591	-	13,204	18,794
Total	**1,256,847**	**420,937**	**978,038**	**994,159**	**3,649,982**

$$sclh = 0.00044\,(hhp) + 0.02169 \quad (C.115)$$

$$sclsl = 0.00044\,(slhp) + 0.02169 \quad (C.116)$$

$$sclth = 0.00044\,(thhp) + 0.02169 \quad (C.117)$$

$$lch_\gamma = (hmec_\gamma)(sclh) \quad (C.118)$$

$lcsl_\gamma = (hman_\gamma)\ (sclsl)$ (C.119)

$lc\ mec_\gamma = (htmec_\gamma)\ (sclth)$ (C.120)

$lc\ man_\gamma = (htman_\gamma)\ (sclth)$ (C.121)

$lchl_\gamma = lch_\gamma + lcsl_\gamma + lc\ mec_\gamma + lc\ man_\gamma$ (C.122)

hhp = power of harvesters (hp).

slhp = power of sugarcane loader (hp).

thhp = power of tractor hauler/transloader (hp).

sclh = specific consumption of lubricants of harvester (L/h).

sclsl = specific consumption of lubricants of sugarcane loader (L/h).

sclth = specific consumption of lubricants of tractor hauler/transloader (L/h).

lch_γ = total consumption of lubricants by harvesters (mechanical harvesting) in each State in the base year (L).

$lcsl_\gamma$ = total consumption of lubricants by sugarcane loader (manual harvesting) in each State in the base year (L).

$lctmec_\gamma$ = total consumption of lubricants by tractor hauler/transloader (mechanical harvesting) operation in each State in the base year (L).

$lctman_\gamma$ = total consumption of lubricants by tractor hauler/transloader (manual harvesting) operation in each State in the base year (L).

$lchl_\gamma$ = total consumption of lubricants in harvesting and loading operations in each State in the base year (L).

Table C.27 – Estimates of costs on lubricants consumed in harvesting and loading operations in the base year (2009) – current scenario.				
	Production costs	**Taxes**	**Distribution costs**	**Total Costs**
Parameters	60.01% (pc%)	23.41% (ts%)	16.58% (dc%)	10.24 R$/L (tcl$)
Notation ➔	$pchll_\gamma$	$thll_\gamma$	$dchll_\gamma$	$tchll_\gamma$
States ↓ \ **Units** ➔	R$	R$	R$	R$
Minas Gerais	1,874,997	731,592	517,886	3,124,476
Rio de Janeiro	187,803	73,277	51,872	312,953
São Paulo	13,801,913	5,385,272	3,812,176	22,999,361
Paraná	1,561,361	609,217	431,258	2,601,836
Mato Grosso do Sul	870,393	339,612	240,408	1,450,413
Mato Grosso	544,554	212,476	150,409	907,439
Goiás	1,515,421	591,291	418,569	2,525,281
Distrito Federal	1,652	645	456	2,754
Espírito Santo	148,621	57,989	41,050	247,660
Santa Catarina	17,437	6,804	4,816	29,056
Rio Grande do Sul	31,290	12,209	8,643	52,141
Tocantins	21,584	8,422	5,962	35,968
Pará	22,707	8,860	6,272	37,839
Rondônia	8,612	3,360	2,379	14,351
Acre	964	376	266	1,606
Amazonas	12,720	4,963	3,513	21,197
Roraima	34	13	9	57
Amapá	35	14	10	58
Maranhão	70,456	27,491	19,460	117,407
Piauí	21,439	8,365	5,921	35,725
Ceará	70,633	27,560	19,509	117,702
Rio Grande do Norte	126,904	49,516	35,052	211,471
Paraíba	157,204	61,338	43,421	261,962
Pernambuco	485,899	189,590	134,208	809,697
Alagoas	694,067	270,813	191,706	1,156,586
Sergipe	65,030	25,373	17,962	108,365
Bahia	115,490	45,062	31,899	192,451
Total	**22,429,219**	**8,751,500**	**6,195,092**	**37,375,811**

$$chll_\gamma = (lchl_\gamma)\ (tcl\$) \qquad (C.123)$$

$$pchll_\gamma = (tchll_\gamma)\ (pc\%) \qquad (C.124)$$

$$hll_\gamma = (tchll_\gamma)\ (t\%) \qquad (C.125)$$

$$dchll_\gamma = (tchll_\gamma)\ (dc\%) \qquad (C.126)$$

$tchll_\gamma$ = total cost of lubricants consumed in harvesting and loading operations in each State in the base year (R$).

$pchll_\gamma$ = production cost on lubricants consumed in harvesting and loading operations in each State in the base year (R$).

$thll_\gamma$ = taxes on lubricants consumed in harvesting and loading operations in each State in the base year (R$).

$dchll_\gamma$ = distribution cost on lubricants consumed in harvesting and loading operations in each State in the base year (R$).

Table C.28 – Estimates of total lubricants consumed in the transportation of sugarcane from the field to the mill in the base year (2009) – current scenario.							
	Hours expended in the transportation of sugarcane from the field to the mill			**Lubricants consumption**			
	Single truck	Double-wagon	Triple-wagon	Single truck	Double-wagon	Triple-wagon	Total
Power (hp)	177.54 (sthp)	246.58 (dwhp)	355.08 (twhp)	-	-	-	
Specific Consumption (L/h)	0.0998 (sclst)	0.13019 (scldw)	0.17792 (scltw)				
Notation ➔	$hest_\gamma$	$hedw_\gamma$	$hetw_\gamma$	$stlc_\gamma$	$dwlc_\gamma$	$twlc_\gamma$	$tclst_\gamma$
States ➔ \ **Units** ➔	h	h	h	L	L	L	L
Minas Gerais	652,605	1,092,530	1,821,854	65,134	142,231	324,150	531,516
Rio de Janeiro	76,046	127,310	212,296	7,590	16,574	37,772	61,936
São Paulo	4,444,674	7,440,860	12,408,048	443,608	968,691	2,207,681	3,619,981
Paraná	631,291	1,056,849	1,762,355	63,007	137,586	313,564	514,158
Mato Grosso do Sul	271,368	454,299	757,568	27,084	59,143	134,789	221,016
Mato Grosso	176,951	296,235	493,988	17,661	38,565	87,892	144,118
Goiás	468,125	783,692	1,306,850	46,722	102,025	232,519	381,266
Distrito Federal	824	1,380	2,302	82	180	409	671
Espírito Santo	62,209	104,144	173,666	6,209	13,558	30,899	50,666
Santa Catarina	8,700	14,564	24,286	868	1,896	4,321	7,085
Rio Grande do Sul	15,611	26,135	43,581	1,558	3,402	7,754	12,715
Tocantins	7,381	12,356	20,605	737	1,609	3,666	6,011
Pará	7,765	12,999	21,677	775	1,692	3,857	6,324
Rondônia	2,747	4,598	7,668	274	599	1,364	2,237
Acre	481	805	1,343	48	105	239	392
Amazonas	3,955	6,621	11,041	395	862	1,964	3,221
Roraima	17.1	28.7	47.8	1.7	3.7	8.5	13.9
Amapá	17.4	29.1	48.5	1.7	3.8	8.6	14.1
Maranhão	35,152	58,848	98,132	3,508	7,661	17,460	28,630
Piauí	10,696	17,907	29,860	1,068	2,331	5,313	8,712
Ceará	26,683	44,670	74,490	2,663	5,815	13,253	21,732
Rio Grande do Norte	49,367	82,645	137,815	4,927	10,759	24,521	40,207
Paraíba	78,432	131,304	218,956	7,828	17,094	38,957	63,879
Pernambuco	241,830	404,849	675,108	24,136	52,705	120,117	196,959
Alagoas	329,059	550,881	918,624	32,842	71,717	163,445	268,004
Sergipe	32,445	54,316	90,574	3,238	7,071	16,115	26,425
Bahia	57,620	96,462	160,856	5,751	12,558	28,620	46,929
Total	**7,692,051**	**12,877,317**	**21,473,641**	**767,718**	**1,676,438**	**3,820,662**	**6,264,818**

$$sclst = 0.00044\ (sthp) + 0.02169 \quad (C.127)$$

$$scldw = 0.00044\ (dwhp) + 0.02169 \quad (C.128)$$

$$scltw = 0.00044\ (twhp) + 0.02169 \quad (C.129)$$

$$hest_\gamma = (rts_\gamma)\ (rtsml) + (rtstm_\gamma)\ (rtml) \quad (C.130)$$

$$hedw_\gamma = (rtdw_\gamma)\ (rtsml) + (rtdwm_\gamma)\ (rtml) \quad (C.131)$$

$he\ w_\gamma = (rttw_\gamma)\ (rtsml) + (rttwm_\gamma)\ (rtml)$ (C.132)

$stlc_\gamma = (hest_\gamma)\ (scls\ )$ (C.133)

$dwlc_\gamma = (hedw_\gamma)\ (scldw)$ (C.134)

$wlc_\gamma = (he\ w_\gamma)\ (scl\ w)$ (C.135)

$clst_\gamma = stlc_\gamma + dwlc_\gamma + twlc_\gamma$ (C.136)

sthp = power of single trucks (hp).

dwhp = power of double-wagon trucks (hp).

twhp = power of triple-wagon trucks (hp).

sclst = specific consumption of lubricants of single trucks (L/h).

scldw = specific consumption of lubricants of double-wagon trucks (L/h).

scltw = specific consumption of lubricants of triple-wagon trucks (L/h).

$hest_\gamma$ = number of hours expended in sugarcane transportation from the field to the mill by single trucks in each State in the base year (h).

$hedw_\gamma$ = number of hours expended in sugarcane transportation from the field to the mill by double-wagon trucks in each State in the base year (h).

$hetw_\gamma$ = number of hours expended in sugarcane transportation from the field to the mill by triple-wagon trucks in each State in the base year (h).

$stlc_\gamma$ = total consumption of lubricants by single trucks for sugarcane transport in each State in the base year (L).

$dwlc_\gamma$ = total consumption of lubricants by double-wagon trucks for sugarcane transport in each State in the base year (L).

$twlc_\gamma$ = total consumption of lubricants by triple-wagon trucks for sugarcane transport in each State in the base year (L).

$tclst_\gamma$ = total consumption of lubricants in sugarcane transport in each State in the base year (L).

Table C.29 – Estimates of costs on lubricants consumed in the transportation of sugarcane from the field to the mill in the base year (2009) – current scenario.				
	Production costs	**Taxes**	**Distribution costs**	**Total Costs**
Parameters	60.01% (pc%)	23.41% (ts%)	16.58% (dc%)	10.24 R$/L (tcl$)
Notation ➔	$pctl_γ$	$ttl_γ$	$dctl_γ$	$tctl_γ$
States 🡻 \ **Units** ➔	R$	R$	R$	R$
Minas Gerais	3,266,178	1,274,407	902,139	5,442,725
Rio de Janeiro	380,600	148,503	105,124	634,227
São Paulo	22,244,862	8,679,568	6,144,172	37,068,602
Paraná	3,159,510	1,232,787	872,677	5,264,973
Mato Grosso do Sul	1,358,151	529,928	375,130	2,263,209
Mato Grosso	885,611	345,550	244,611	1,475,773
Goiás	2,342,890	914,156	647,121	3,904,166
Distrito Federal	4,126	1,610	1,140	6,876
Espírito Santo	311,344	121,481	85,995	518,821
Santa Catarina	43,540	16,988	12,026	72,554
Rio Grande do Sul	78,132	30,486	21,580	130,198
Tocantins	36,940	14,414	10,203	61,557
Pará	38,862	15,163	10,734	64,760
Rondônia	13,747	5,364	3,797	22,907
Acre	2,407	939	665	4,011
Amazonas	19,794	7,723	5,467	32,985
Roraima	86	33	24	143
Amapá	87	34	24	145
Maranhão	175,929	68,645	48,593	293,166
Piauí	53,533	20,887	14,786	89,206
Ceará	133,544	52,106	36,886	222,536
Rio Grande do Norte	247,072	96,403	68,243	411,719
Paraíba	392,539	153,162	108,422	654,123
Pernambuco	1,210,318	472,245	334,297	2,016,860
Alagoas	1,646,888	642,588	454,881	2,744,357
Sergipe	162,380	63,358	44,850	270,588
Bahia	288,380	112,521	79,652	480,553
Total	**38,497,449**	**15,021,051**	**10,633,239**	**64,151,739**

$$ctl_γ = (tclst_γ)\ (tcl\$) \tag{C.137}$$

$$pctl_γ = (tctl_γ)\ (pc\%) \tag{C.138}$$

$$tl_γ = (tctl_γ)\ (t\%) \tag{C.139}$$

$$dctl_γ = (tctl_γ)\ (dc\%) \tag{C.140}$$

$tctl_γ$ = total cost of lubricants consumed in the transportation of sugarcane from the field to the mill in each State in the base year (R$).

$pctl_\gamma$ = production cost on lubricants consumed in the transportation of sugarcane from the field to the mill in each State in the base year (R$).

ttl_γ = taxes on lubricants consumed in the transportation of sugarcane from the field to the mill in each State in the base year (R$).

$dctl_\gamma$ = distribution cost on lubricants consumed in the transportation of sugarcane from the field to the mill in each State in the base year (R$).

Table C.30 – Estimates of total lubricants consumed in the transportation of agriculture inputs in the base year (2009) – general scenario.

	Sugarcane seed	Filter mud cake	Vinasse		Fertilizers	Total
Equipment Nº	19	20	21	23	20	
Operational Capacity (ha/h)	0.6 (ocst)	1.1 (ocfc)	1.667 (ocvi)		1.1(ocfe)	
Area of application	20% total area	30% planted area	30% ratoon area[1]		70% total area	
Power (hp)	177.54	128.22	177.54	355.08	128.22	
Specific Consumption (L/h)	0.09981 (sclss)	0.07811 (sclffc)	0.09981 (sclvs)	0.17792 (sclvr)	0.07811 (sclffc)	
Notation ➔	$lcst_{\gamma}$	$lcfct_{\gamma}$	$lcvst_{\gamma}$	$lcvrt_{\gamma}$	$lcft_{\gamma}$	$tclai_{\gamma}$
States ➔ \ **Units** ➔	L	L	L	L	L	L
Minas Gerais	23,808	3,049	617	5,684	35,570	68,728
Rio de Janeiro	4,496	576	117	1,073	6,717	12,978
São Paulo	159,074	20,371	4,123	37,977	237,662	459,207
Paraná	19,807	2,537	513	4,729	29,593	57,179
Mato Grosso do Sul	9,515	1,218	247	2,271	14,215	27,466
Mato Grosso	7,092	908	184	1,693	10,595	20,472
Goiás	17,427	2,232	452	4,160	26,036	50,306
Distrito Federal	26	3.3	0.7	6.2	39	75
Espírito Santo	2,667	342	69	637	3,984	7,699
Santa Catarina	571	73	15	136	854	1,650
Rio Grande do Sul	1,217	156	32	290	1,818	3,512
Tocantins	288	37	7.5	69	430	831
Pará	325	42	8.4	78	486	939
Rondônia	140	18	3.6	34	210	405
Acre	26	3.3	0.7	6.1	38	74
Amazonas	201	26	5.2	48	301	581
Roraima	13	1.7	0.3	3.2	19,8	38
Amapá	2.3	0.3	0.1	0.6	3.5	6.7
Maranhão	1,533	196	40	366	2,290	4,425
Piauí	428	55	11	102	640	1,236
Ceará	1,421	182	37	339	2,123	4,101
Rio Grande do Norte	2,248	288	58	537	3,359	6,491
Paraíba	4,088	524	106	976	6,108	11,802
Pernambuco	11,720	1,501	304	2,798	17,510	33,832
Alagoas	14,439	1,849	374	3,447	21,572	41,681
Sergipe	1,395	179	36	333	2,084	4,027
Bahia	2,730	350	71	652	4,078	7,880
Total	**286,696**	**36,714**	**7,431**	**68,445**	**428,334**	**827,621**

$$lcst_{\gamma} = (hsee_{\gamma})\ (sclss) \tag{C.141}$$

$$lcfct_{\gamma} = (hfmc_{\gamma})\ (sclffc) \tag{C.142}$$

$$lcvst_{\gamma} = (hvinst_{\gamma})\ (sclvs) \tag{C.143}$$

$$lcvrt_{\gamma} = (hvinrt_{\gamma})\ (sclvr) \tag{C.144}$$

$lcft_{\gamma} = (hfer_{\gamma})\ (sclffc)$ (C.145)

$clai_{\gamma} = lcst_{\gamma} + lcfct_{\gamma} + lcvst_{\gamma} + lcvrt_{\gamma} + lcft_{\gamma}$ (C.146)

$hvinst_{\gamma} = [(ac_{\gamma}) \times 80\% \times 30\% \times 6\%]\ (\frac{1}{ocvi})$ (C.147)

$hvinrt_{\gamma} = [(ac_{\gamma}) \times 80\% \times 30\% \times 31\%]\ (\frac{1}{ocvi})$ (C.148)

$lcst_{\gamma}$ = total consumption of lubricants in the transportation of sugarcane seed in each State (L).

$hsee_{\gamma}$ = total number of hours in the transportation of sugarcane seed in each State (h).

sclss = specific consumption of lubricants by trucks in the transportation of sugarcane seed (L/h).

$lcfct_{\gamma}$ = total consumption of lubricants in the transportation of filter mud cake in each State (L).

$hfmc_{\gamma}$ = total number of hours in the in the transportation of filter mud cake in each State (h).

sclffc = specific consumption of lubricants by trucks in the transportation of filter mud cake (L/h).

$lcvst_{\gamma}$ = total consumption of lubricants in the transportation of vinasse by single trucks in each State (L).

$hvinst_{\gamma}$ = total number of hours in the transportation of vinasse by single trucks in each State (h).

sclvs = specific consumption of lubricants by single trucks in the transportation of vinasse (L/h).

$lcvrt_{\gamma}$ = total consumption of lubricants in the transportation of vinasse by road train trucks in each State (L).

$hvinrt_{\gamma}$ = total number of hours in the transportation of vinasse by road train trucks in each State (h).

sclvr = specific consumption of lubricants by road train trucks in the transportation of vinasse (L/h).

$lcft_{\gamma}$ = total consumption of lubricants in the transportation of fertilizers in each State (L).

$hfer_{\gamma}$ = total number of hours in the transportation of fertilizers in each State (h).

sclffc = specific consumption of lubricants by trucks in the transportation of fertilizers (L/h).

$tclai_{\gamma}$ = total consumption of lubricants in the transportation of agricultural inputs in each State (h).

ac_{γ} = total area cultivated with sugarcane in each Brazilian State (ha).

ocvi = operational capacity for the transportation of vinasse (ha/h).

Table C.31 – Estimates of costs on lubricants consumed in the transportation of agriculture inputs in the base year (2009) – general scenario.				
	Production costs	**Taxes**	**Distribution costs**	**Total Costs**
Parameters	60.01% (pc%)	23.41% (ts%)	16.58% (dc%)	10.24 R$/L (tcl$)
Notation ➔	$pctai_\gamma$	$ttai_\gamma$	$dctai_\gamma$	$tctai_\gamma$
States 🡻 \ **Units** ➔	R$	R$	R$	R$
Minas Gerais	422,336	164,788	116,652	703,776
Rio de Janeiro	79,749	31,117	22,027	132,892
São Paulo	2,821,837	1,101,033	779,409	4,702,279
Paraná	351,365	137,097	97,049	585,511
Mato Grosso do Sul	168,782	65,856	46,619	281,257
Mato Grosso	125,801	49,085	34,747	209,634
Goiás	309,131	120,618	85,384	515,133
Distrito Federal	462	180	128	770
Espírito Santo	47,309	18,459	13,067	78,834
Santa Catarina	10,137	3,955	2,800	16,893
Rio Grande do Sul	21,580	8,420	5,961	35,961
Tocantins	5,105	1,992	1,410	8,508
Pará	5,768	2,250	1,593	9,611
Rondônia	2,490	972	688	4,150
Acre	456	178	126	760
Amazonas	3,570	1,393	986	5,950
Roraima	235	92	65	392
Amapá	41	16	11	69
Maranhão	27,190	10,609	7,510	45,309
Piauí	7,593	2,963	2,097	12,653
Ceará	25,203	9,834	6,961	41,999
Rio Grande do Norte	39,884	15,562	11,016	66,463
Paraíba	72,524	28,298	20,032	120,853
Pernambuco	207,900	81,119	57,423	346,442
Alagoas	256,133	99,939	70,746	426,817
Sergipe	24,746	9,655	6,835	41,237
Bahia	48,420	18,893	13,374	80,686
Total	**5,085,750**	**1,984,373**	**1,404,716**	**8,474,840**

$ctai_\gamma = (tclai_\gamma)\ (tcl\$)$ (C.149)

$pctai_\gamma = (tctai_\gamma)\ (pc\%)$ (C.150)

$tai_\gamma = (tctai_\gamma)\ (t\%)$ (C.151)

$dctai_\gamma = (tctai_\gamma)\ (dc\%)$ (C.152)

$tctai_\gamma$ = total cost of lubricants consumed in the transportation of agriculture inputs in each State in the base year (R$).

$pctai_{\gamma}$ = production cost on lubricants consumed in the transportation of agriculture inputs in each State in the base year (R$).

$ttai_{\gamma}$ = taxes on lubricants consumed in the transportation of agriculture inputs in each State in the base year (R$).

$dctai_{\gamma}$ = distribution cost on lubricants consumed in the transportation of agriculture inputs in each State in the base year (R$).

Table C.32 – Estimates of costs on lubricants consumed in mechanized harvesting and loading operations in a scenario with 100% of mechanical harvesting – future scenario.

	Lubricants consumption			Costs			
	Harvester	**Tractor hauler/ transloader**	**Total**	**Production costs**	**Taxes**	**Distribution costs**	**Total Costs**
Equipment Nº	14	25		-	-	-	
Operational Capacity (t/h)	45	35					
Operational Capacity (h/t)	1/45 = 0.02222 (ocmh)	1/35 = 0.02857 (oct)					
Power (hp)	325.49 (hhp)	177.54 (thhp)					
Specific Consumption (L/h)	0.1649 (sclh)	0.0998 (sclth)					
Parameters	-	-	-	60.01% (pc%)	23.41% (ts%)	16.58% (dc%)	10.24 R$/L (tcl$)
Notation ➔	$lchf_\gamma$	$lctmecf_\gamma$	$lchlf_\gamma$	$pchllf_\gamma$	$thllf_\gamma$	$dchllf_\gamma$	$tchllf_\gamma$
States 🡻 \ **Units** ➔	L	L	L	R$	R$	R$	R$
Minas Gerais	213,950	166,489	380,440	2,337,810	912,174	645,718	3,895,701
Rio de Janeiro	23,752	18,483	42,236	259,540	101,268	71,687	432,495
São Paulo	1,496,782	1,164,747	2,661,529	16,355,153	6,381,503	4,517,397	27,254,053
Paraná	197,268	153,508	350,776	2,155,527	841,050	595,370	3,591,947
Mato Grosso do Sul	92,450	71,942	164,392	1,010,192	394,160	279,022	1,683,374
Mato Grosso	59,401	46,224	105,624	649,063	253,253	179,275	1,081,591
Goiás	160,018	124,520	284,538	1,748,493	682,232	482,945	2,913,669
Distrito Federal	243	189	432	2,653	1,035	733	4,420
Espírito Santo	19,238	14,970	34,208	210,211	82,021	58,062	350,293
Santa Catarina	2,562	1,993	4,555	27,992	10,922	7,732	46,646
Rio Grande do Sul	4,597	3,577	8,174	50,232	19,599	13,874	83,705
Tocantins	2,434	1,894	4,329	26,599	10,379	7,347	44,325
Pará	2,561	1,993	4,554	27,983	10,919	7,729	46,631
Rondônia	928	722	1,650	10,142	3,957	2,801	16,900
Acre	142	110	252	1,548	604	427	2,579
Amazonas	1,349	1,050	2,398	14,737	5,750	4,071	24,558
Roraima	5	3.9	9	55	21	15	92
Amapá	5	4.0	9	56	22	15	93
Maranhão	10,351	8,055	18,406	113,106	44,132	31,241	188,479
Piauí	3,150	2,451	5,601	34,417	13,429	9,506	57,351
Ceará	8,516	6,627	15,143	93,055	36,308	25,702	155,066
Rio Grande do Norte	15,611	12,148	27,759	170,578	66,557	47,115	284,250
Paraíba	23,096	17,973	41,068	252,367	98,469	69,705	420,541
Pernambuco	71,258	55,450	126,708	778,624	303,806	215,061	1,297,491
Alagoas	98,225	76,435	174,660	1,073,288	418,779	296,449	1,788,516
Sergipe	9,554	7,435	16,989	104,395	40,733	28,835	173,963
Bahia	16,967	13,204	30,171	185,402	72,341	51,209	308,952
Total	**2,534,412**	**1,972,197**	**4,506,609**	**27,693,216**	**10,805,423**	**7,649,041**	**46,147,681**

$$lchf_\gamma = [(hmec_\gamma) + (htman_\gamma)](sclh) \quad (C.153)$$

$$lc\ mecf_\gamma = [(hmec_\gamma) + (htman_\gamma)]\ (sclth) \quad (C.154)$$

$$lchlf_\gamma = lchf_\gamma + lc\ mecf_\gamma \quad (C.155)$$

$$chllf_\gamma = (lchlf_\gamma)\ (tcl\$) \quad (C.156)$$

$pchllf_\gamma = (tchllf_\gamma)\ (pc\%)$ (C.157)

$hllf_\gamma = (tchllf_\gamma)\ (t\%)$ (C.158)

$dchllf_\gamma = (tchllf_\gamma)\ (dc\%)$ (C.159)

$lchf_\gamma$ = total consumption of lubricants by harvesters in each State in a scenario with 100% of mechanical harvesting (L).

$lctmecf_\gamma$ = total consumption of lubricants by tractor hauler/transloader in each State in a scenario with 100% of mechanical harvesting (L).

$lchlf_\gamma$ = total consumption of lubricants in harvesting and loading operations in each State in a scenario with 100% of mechanical harvesting (L).

$tchllf_\gamma$ = total cost of lubricants consumed in harvesting and loading operations in each State in a scenario with 100% of mechanical harvesting (R$).

$pchllf_\gamma$ = production cost on lubricants consumed in harvesting and loading operations in each State in a scenario with 100% of mechanical harvesting (R$).

$thllf_\gamma$ = taxes on lubricants consumed in harvesting and loading operations in each State in a scenario with 100% of mechanical harvesting (R$).

$dchllf_\gamma$ = distribution cost on lubricants consumed in harvesting and loading operations in a scenario with 100% of mechanical harvesting (R$).

Table C.33 – Estimates of costs on lubricants consumed in the transportation of sugarcane from the field to the mill in a scenario with 100 % of transport by road train trucks (2009) – future scenario.

	Lubricants consumption	**Production costs**	**Taxes**	**Distribution costs**	**Total Costs**
Power (hp)	512.89 (rthp)				
Specific Consumption (L/h)	0.24736 (sclrt)				
Parameters	-	60.01% (pc%)	23.41% (ts%)	16.58% (dc%)	10.24 R$/L (tcl$)
Notation ➔	$rtlc_\gamma$	$pcrtl_\gamma$	$trtl_\gamma$	$dcrtl_\gamma$	$tcrtl_\gamma$
States ➔ \ **Units** ➔	L	R$	R$	R$	R$
Minas Gerais	456,497	2,805,186	1,094,536	774,810	4,674,532
Rio de Janeiro	50,680	311,428	121,514	86,018	518,959
São Paulo	3,193,623	19,624,884	7,657,297	5,420,517	32,702,698
Paraná	420,903	2,586,461	1,009,193	714,397	4,310,051
Mato Grosso do Sul	197,257	1,212,151	472,961	334,804	2,019,915
Mato Grosso	126,741	778,824	303,884	215,116	1,297,823
Goiás	341,423	2,098,052	818,624	579,495	3,496,172
Distrito Federal	518	3,183	1,242	879	5,304
Espírito Santo	41,047	252,236	98,418	69,669	420,324
Santa Catarina	5,466	33,588	13,106	9,277	55,971
Rio Grande do Sul	9,809	60,274	23,518	16,648	100,440
Tocantins	5,194	31,917	12,453	8,816	53,186
Pará	5,464	33,577	13,101	9,274	55,953
Rondônia	1,980	12,169	4,748	3,361	20,279
Acre	302	1,857	725	513	3,095
Amazonas	2,878	17,684	6,900	4,884	29,468
Roraima	11	66	26	18	110
Amapá	11	67	26	19	112
Maranhão	22,086	135,719	52,955	37,486	226,160
Piauí	6,720	41,297	16,113	11,407	68,817
Ceará	18,171	111,658	43,567	30,841	186,066
Rio Grande do Norte	33,308	204,680	79,863	56,534	341,077
Paraíba	49,279	302,820	118,155	83,641	504,616
Pernambuco	152,040	934,287	364,543	258,056	1,556,886
Alagoas	209,578	1,287,860	502,501	355,715	2,146,077
Sergipe	20,385	125,266	48,877	34,599	208,742
Bahia	36,203	222,467	86,803	61,447	370,717
Total	**5,407,573**	**33,229,660**	**12,965,649**	**9,178,242**	**55,373,551**

$$sclrt = 0.00044\ (rthp) + 0.02169 \quad (C.160)$$

$$rtlc_\gamma = (hmlf_\gamma)\ (sclr\ ) \quad (C.161)$$

$$crtl_\gamma = (rtlc_\gamma)\ (tcl\$) \quad (C.162)$$

$$pcr\ l_\gamma = (tcrtl_\gamma)\ (pc\%) \quad (C.163)$$

$$rtl_\gamma = (tcrtl_\gamma)\ (t\%) \quad (C.164)$$

$$dcr\ l_{\gamma} = (tcrtl_{\gamma})\ (dc\%) \tag{C.165}$$

rthp = power of road train trucks (hp).

sclrt = specific consumption of lubricants by road train trucks (L/h).

$hmlf_{\gamma}$ = number of hours expended in the transportation of sugarcane from the field to the mill in each State in a scenario with 100% of transport by road train trucks (h).

$rtlc_{\gamma}$ = total consumption of lubricants in the transportation of sugarcane from the field to the mill in each State in a scenario with 100% of transport by road train trucks (L).

$tcrtl_{\gamma}$ = total cost of lubricants consumed in the transportation of sugarcane from the field to the mill in each State in a scenario with 100% of transport by road train trucks (R$).

$pcrtl_{\gamma}$ = production cost on lubricants consumed in the transportation of sugarcane from the field to the mill in each State in a scenario with 100% of transport by road train trucks (R$).

$trtl_{\gamma}$ = taxes on lubricants consumed in the transportation of sugarcane from the field to the mill in each State in a scenario with 100% of transport by road train trucks (R$).

$dcrtl_{\gamma}$ = distribution cost on lubricants consumed in the transportation of sugarcane from the field to the mill in each State in a scenario with 100% of transport by road train trucks (R$).

Table C.34 – Estimates of costs with agriculture inputs for land preparation, planting and ratoon tillage operations in the base year – general scenario (R$ of 2009)[1].								
	Category/Product	**Unitary cost**	**Unit**	**Quantity**	**Unit**	**Cost/area (R$/ha)**	**Area (ha)**	**Total cost (R$)**
	Notation ➔	uci_{β}	-	qi_{β}	-	$chai_{\beta}$	aa_{β}	cai_{β}
New plantation	Fertilizer – sugarcane plant	900.00	R$/t	0.60	t/ha	540.00	1,723,511	930,695,940
	Herbicide – sugarcane plant	25.52	R$/L	2.00	L/ha	51.04	1,723,511	87,968,001
	Herbicide – chemical tillage	38.21	R$/L	1.50	L/ha	57.32	1,723,511	98,783,033
	Insecticide	700.00	R$/kg	0.25	kg/ha	175.00	1,723,511	301,614,425
	Nematicide	23.50	R$/kg	6.00	kg/ha	141.00	1,723,511	243,015,051
	Limestone/Gypsum	60.00	R$/t	1.50	t/ha	90.00	1,723,511	155,115,990
	Sugarcane seeds	67.31	R$/t	14.00	t/ha	942.34	1,723,511	1,624,133,356
	Ripener	2744.00	R$/L	0.02	L/ha	54.88	1,723,511	94,586,284
	Desiccants	15.75	R$/L	2.00	L/ha	31.50	1,723,511	54,290,597
Sugarcane ratoon	Fertilizer - ratoon	1130.00	R$/t	0.50	t/ha	565.00	6,894,044	3,895,134,860
	Herbicide – ratoon	240.30	R$/L	0.37	L/ha	87.96	6,894,044	606,412,623
	Herbicide – chemical tillage	38.21	R$/L	1.50	L/ha	57.32	6,894,044	395,132,132
	Limestone/Gypsum	44.00	R$/t	0.30	t/ha	13.20	6,894,044	91,001,381
	Ripener	2744.00	R$/L	0.02	L/ha	54.88	6,894,044	378,345,135
Total						**2861.43**	**-**	**8,956,228,807**

1 – Costs and technical coefficients are provided by the AGRAFNP (2010). Furthermore, since the imported fert the agriculture inputs are considered as commercialized internally in each State. This assumption are based on the nationally produced without , the taxes on agriculture inputs are considered null as due to
2 - The main tax on agricultural inputs is the VAT system. The sector do not pay taxes on production (IPI) nor social contributions (PIS/PASEP and COFINS) since law No. 10.925 of July 23, 2004, which reduced to zero the rates of social contributions on imports and gross revenue from domestic sales of fertilizers. Thus, there is no VAT charge if the importer is in the same consumer state. The import duty was reduced to 0% by the mechanism of Exception List MCET - Mercosur Common External Tariff. The imported product is exempt from VAT. The national product is taxed in interstate operations between 4.95% to 8.40%.

$$chai_{\beta} = (uci_{\beta})\ (qi_{\beta}) \qquad (C.166)$$

$$cai_{\beta} = (chai_{\beta})\ (aa_{\beta}) \qquad (C.167)$$

uci_{β} = unitary cost of each agriculture input (R$/t, R$/L or R$/kg).

qi_{β} = technical coefficient of utilization of each agriculture input per area of application (t/ha, L/ha or kg/ha).

$chai_{\beta}$ = cost of each agriculture input per unit of area of application (R$/ha).

aa_{β} = area of application of each agriculture input (ha).

cai_{β} = total costs with agriculture inputs for land preparation, planting and ratoon tillage operations in the base year – general scenario (R$).

Table C.35 – Estimates of administrative costs in the base year – general scenario (R$ of 2009)[1].

Description	Coefficients		Total cost	
	Notation	R$/ha	Notation	R$
Total cost with administrative employees	ctcea	180.64	tcea	1,556,675,135
Gross Salary	-	-	gsa	915,514,233
SSC – employees – (11%)	-	-	ssca	100,706,566
Net salary - (89%)	-	-	nsa	814,807,667
LSS liabilities - employers - (70.03%)	-	-	lssa	641,160,903
Maintenance	ctmca	39.06	mca	336,601,698
Energy and telecommunication costs	ctetca	34.2	etca	294,720,381
Depreciation	ctdca	9.71	dca	83,676,459
Other taxes	ctota	86.88	ota	748,693,178
Total	-	**350.49**	tca	**3,020,366,852**

1 – If the coefficients for other costs (e.g. travel and accounting services costs) provided by the AGRAFNP (2010) are applied to the total area, they will overestimate those expenses such that they become not compatible with the expenses of these respective services by the agriculture sector in the input-output table. Hence, due to a shortage of better approximation for these costs, they will not be computed in this study.

$$cea = (ctcea)\,(ac) \tag{C.168}$$

$$ac = \sum_{\gamma} (ac_{\gamma}) \tag{C.169}$$

$$gsa = (tcea)\left(\frac{1}{1 + lssl}\right) \tag{C.170}$$

$$ssca = (gsa)\,(ssc) \tag{C.171}$$

$$nsa = (gsa)\,(ns) \tag{C.172}$$

$$lssa = (gsa)\,(lssl) \tag{C.173}$$

$$mca = (ctmca)\,(ac) \tag{C.174}$$

$$etca = (ctetca)\,(ac) \tag{C.175}$$

$$dca = (ctdca)\,(ac) \tag{C.176}$$

$$ota = (ctota)\,(ac) \tag{C.177}$$

$$ca = tcea + mca + etca + dca + ota \tag{C.178}$$

tcea = total cost with salary and labor and social security liabilities for administrative employees (R$).

ctcea = technical coefficient for the total cost with salary and labor and social security liabilities for administrative employees per area cultivated in the base year (R$/ha).

ac = total area cultivated in the base year (ha).

gsa = total gross salary of administrative employees in the base year (R$).

ssca = social security contributions (SSC) on the gross salary paid by administrative employees in the base year (R$).

nsa = total net salary earned by administrative employees in the base year (R$).

lssa = total labor and social security liabilities (LSSL) on the gross salary of administrative employees paid by employers in the base year (R$).

mca = total cost with maintenance in the base year (R$).

ctmca = technical coefficient for the total cost with maintenance per area cultivated in the base year (R$/ha).

etca = total cost with energy and telecommunication in the base year (R$).

ctetca = technical coefficient for the total cost with energy and telecommunication per area cultivated in the base year (R$/ha).

dca = depreciation cost in the base year (R$).

ctdca = technical coefficient for the depreciation cost per area cultivated in the base year (R$/ha).

ota = cost with other taxes in the base year (R$).

ctota = technical coefficient for the cost with other taxes per area cultivated in the base year (R$/ha).

tca = total administrative costs in the base year (R$).

Table C.36 – Sum up of the costs of sugarcane production and transport for the current and future scenarios (R$ of 2009).

Description	Current		Future	
	Notation	L	Notation	L
L diesel	tcdoc	1,565,261,584	tcdof	1,664,280,132
L Lubricants	tclubc	12,354,809	tclubf	12,354,192
	Notation	R$	Notation	R$
Diesel oil – production cost	pcdoc	1,881,444,424	pcdof	2,000,464,718
Diesel oil – taxes	tdoc	734,107,683	tdof	780,547,382
Diesel oil – distribution cost	dcdoc	519,666,846	dcdof	552,541,004
Lubricants – production cost	pclubc	75,920,578	pclubf	75,916,787
Lubricants – taxes	tlubc	29,622,921	tlubf	29,621,442
Lubricants – distribution cost	dclubc	20,969,744	dclubf	20,968,696
Gross salary total	gsc	4,024,700,526	gsf	2,622,745,241
Social security contributions total	sscc	442,717,058	sscf	288,501,977
Social security contributions total – final	sscfc	2,409,524,883	sscff	1,570,196,311
Net salary total	nsc	3,581,983,468	nsf	2,334,243,264
Net salary total – final	nscf	4,433,788,975	nsff	2,889,332,724
Labor and social security liabilities – employers (70.03%)	lsslc	2,818,613,332	lsslf	1,836,783,794
Labor and social security liabilities – employers (21.16%)	$lsslc_s$	851,805,507	$lsslf_s$	555,089,459
Labor and social security liabilities – employers (48.87%)	$lsslc_{sc}$	1,966,807,825	$lsslf_{sc}$	1,281,694,335
Sugarcane seed	cai_s	1,624,133,356	cai_s	1,624,133,356
Fertilizers	cai_f	4,825,830,800	cai_f	4,825,830,800
Fertilizers – national	cai_{fn}	1,831,402,789	cai_{fn}	1,831,402,789
Fertilizers – imported	cai_{fi}	2,994,428,011	cai_{fi}	2,994,428,011
Limestone	cai_l	155,115,990	cai_l	155,115,990
Gypsum	cai_g	91,001,381	cai_g	91,001,381
Other agrochemicals	cai_o	2,260,147,280	cai_o	2,260,147,280
Other agrochemicals – national	cai_{on}	857,725,893	cai_{on}	857,725,893
Other agrochemicals – imported	cai_{oi}	1,402,421,387	cai_{oi}	1,402,421,387
Maintenance	mca	336,601,698	mca	336,601,698
Electricity and telecommunication	etca	294,720,381	etca	294,720,381
Other taxes	ota	748,693,178	ota	748,693,178
Differences	d_c	234,709,882	d_f	2,420,166,872
Total output	tc_c	**20,676,000,000**	tc_f	**20,676,000,000**

$$cdoc = \sum_{\alpha} cd_{\alpha} + {}_{\gamma} hlc_{\gamma} + {}_{\gamma} tc_{\gamma} + \sum_{\gamma} tac_{\gamma} \quad (C.179)$$

$$cdocf = {}_{\alpha} tcd_{\alpha} + {}_{\gamma} hlcf_{\gamma} + {}_{\gamma} rtc_{\gamma} + \sum_{\gamma} tac_{\gamma} \quad (C.180)$$

$$clubc = {}_{\alpha} cl_{\alpha} + {}_{\gamma} lchl_{\gamma} + {}_{\gamma} clst_{\gamma} + {}_{\gamma} clai_{\gamma} \quad (C.181)$$

$$clubf = {}_{\alpha} cl_{\alpha} + {}_{\gamma} lchlf_{\gamma} + {}_{\gamma} rtlc_{\gamma} + {}_{\gamma} clai_{\gamma} \quad (C.182)$$

$$pcdoc = \sum_{\alpha} pclpr_{\alpha} + {}_{\gamma} pch_{\gamma} + {}_{\gamma} pct_{\gamma} + \sum_{\gamma} pcta_{\gamma} \quad (C.183)$$

$$pcdof = {}_{\alpha} pclpr_{\alpha} + {}_{\gamma} pchf_{\gamma} + {}_{\gamma} pcr_{\gamma} + {}_{\gamma} pcta_{\gamma} \quad (C.184)$$

$$doc = \sum_{\alpha} lpr_{\alpha} + {}_{\gamma} th_{\gamma} + {}_{\gamma} tt_{\gamma} + \sum_{\gamma} ta_{\gamma} \quad (C.185)$$

$$dof = {}_{\alpha}\ lpr_{\alpha} + {}_{\gamma}\ hf_{\gamma} + {}_{\gamma}\ rt_{\gamma} + {}_{\gamma}\ ta_{\gamma} \quad (C.186)$$

$$dcdoc = \sum_{\alpha} dclpr_{\alpha} + {}_{\gamma}\, dch_{\gamma} + {}_{\gamma}\, dct_{\gamma} + \sum_{\gamma} dcta_{\gamma} \quad (C.187)$$

$$dcdof = {}_{\alpha}\, dclpr_{\alpha} + {}_{\gamma}\, dchf_{\gamma} + {}_{\gamma}\, dcr\ {}_{\gamma} + {}_{\gamma}\, dcta_{\gamma} \quad (C.188)$$

$$pclubc = {}_{\alpha}\, pclprl_{\alpha} + {}_{\gamma}\, pchll_{\gamma} + {}_{\gamma}\, pctl_{\gamma} + {}_{\gamma}\, pctai_{\gamma} \quad (C.189)$$

$$pclubf = {}_{\alpha}\, pclprl_{\alpha} + {}_{\gamma}\, pchllf_{\gamma} + {}_{\gamma}\, pcrtl_{\gamma} + {}_{\gamma}\, pctai_{\gamma} \quad (C.190)$$

$$lubc = {}_{\alpha}\, tlprl_{\alpha} + {}_{\gamma}\ hll_{\gamma} + {}_{\gamma}\, ttl_{\gamma} + \sum_{\gamma} ttai_{\gamma} \quad (C.191)$$

$$lubf = {}_{\alpha}\ lprl_{\alpha} + {}_{\gamma}\ hllf_{\gamma} + {}_{\gamma}\ rtl_{\gamma} + \sum_{\gamma} ttai_{\gamma} \quad (C.192)$$

$$dclubc = {}_{\alpha}\, dclprl_{\alpha} + {}_{\gamma}\, dchll_{\gamma} + {}_{\gamma}\, dctl_{\gamma} + {}_{\gamma}\, dctai_{\gamma} \quad (C.193)$$

$$dclubf = {}_{\alpha}\, dclprl_{\alpha} + {}_{\gamma}\, dchllf_{\gamma} + {}_{\gamma}\, dcrtl_{\gamma} + {}_{\gamma}\, dctai_{\gamma} \quad (C.194)$$

$$gsc = {}_{\alpha}\, gslpr_{\alpha} + {}_{\gamma}\, gshl_{\gamma} + {}_{\gamma}\, gss\ {}_{\gamma} + {}_{\gamma}\, gsta_{\gamma} + {}_{\gamma}\, gsmh_{\gamma} + {}_{\lambda}\, gslprh_{\lambda} + gsa \quad (C.195)$$

$$gsf = {}_{\alpha}\, gslpr_{\alpha} + {}_{\gamma}\, gshlf_{\gamma} + {}_{\gamma}\, gss\ f_{\gamma} + {}_{\gamma}\, gsta_{\gamma} + {}_{\lambda}\, gslprhf_{\lambda} + gsa \quad (C.196)$$

$$sscc = {}_{\alpha}\, sclpr_{\alpha} + {}_{\gamma}\, schl_{\gamma} + {}_{\gamma}\, scst_{\gamma} + {}_{\gamma}\, sc\ a_{\gamma} + {}_{\gamma}\, scmh_{\gamma} + {}_{\lambda}\, sclprh_{\lambda} + ssca \quad (C.197)$$

$$sscf = {}_{\alpha}\, sclpr_{\alpha} + {}_{\gamma}\, schlf_{\gamma} + {}_{\gamma}\, scstf_{\gamma} + {}_{\gamma}\, sc\ a_{\gamma} + {}_{\lambda}\, sclprhf_{\lambda} + ssca \quad (C.198)$$

$$sscfc = sscc + lsslc_{sc} \quad (C.199)$$

$$sscff = sscf + lsslf_{sc} \quad (C.200)$$

$$nsc = {}_{\alpha}\, nslpr_{\alpha} + {}_{\gamma}\, nshl_{\gamma} + {}_{\gamma}\, nsst_{\gamma} + {}_{\gamma}\, ns\ a_{\gamma} + {}_{\gamma}\, nsmh_{\gamma} + {}_{\lambda}\, nslprh_{\lambda} + nsa \quad (C.201)$$

$$nsf = {}_{\alpha}\, nslpr_{\alpha} + {}_{\gamma}\, nshlf_{\gamma} + {}_{\gamma}\, nsstf_{\gamma} + {}_{\gamma}\, ns\ a_{\gamma} + {}_{\lambda}\, nslprhf_{\lambda} + nsa \quad (C.202)$$

$$nscf = nsc + lsslc_{s} \quad (C.203)$$

$$nsff = nsf + lsslf_{s} \quad (C.204)$$

$$lsslc = {}_{\alpha}\, lslpr_{\alpha} + {}_{\gamma}\, lshl_{\gamma} + {}_{\gamma}\, lsst_{\gamma} + {}_{\gamma}\, ls\ a_{\gamma} + {}_{\gamma}\, lsmh_{\gamma} + {}_{\lambda}\, lslprh_{\lambda} + lssa \quad (C.205)$$

$$lsslf = {}_{\alpha}\, lslpr_{\alpha} + {}_{\gamma}\, lshlf_{\gamma} + {}_{\gamma}\, lsstf_{\gamma} + {}_{\gamma}\, ls\ a_{\gamma} + {}_{\lambda}\, lslprhf_{\lambda} + lssa \quad (C.206)$$

$$lsslc_{s} = (gsc) \times 21.16\% \quad (C.207)$$

$$lsslf_{s} = (gsf) \times 21.16\% \quad (C.208)$$

$$lsslc_{sc} = (gsc) \times 48.87\% \quad (C.209)$$

$$lsslf_{sc} = (gsf) \times 48.87\% \quad (C.210)$$

$cai_{s} = \sum_{\beta} cai_{\beta}$ β = sugarcane seeds. (C.211)

$cai_{f} = \sum_{\beta} cai_{\beta}$ β = fertilizers (sugarcane plant and ratoon). (C.212)

$$cai_{fn} = (cai_{f}) \times 0.3795 \quad (C.213)$$

$$cai_{fi} = (cai_{f}) \times 0.6205 \quad (C.214)$$

$cai_{l} = \sum_{\beta} cai_{\beta}$ β = limestone/gypsum (sugarcane plant). (C.215)

$cai_{g} = \sum_{\beta} cai_{\beta}$ β = limestone/gypsum (sugarcane ratoon). (C.216)

$cai_{o} = \sum_{\beta} cai_{\beta}$ β = herbicide (sugarcane plant and ratoon), herbicide – chemical tillage (sugarcane plant and ratoon), insecticide, nematicide, ripener (sugarcane plant and ratoon) and desiccants. (C.217)

$$cai_{on} = (cai_{o}) \times 0.3795 \quad (C.218)$$

$$cai_{oi} = (cai_{o}) \times 0.6205 \quad (C.219)$$

$$tc_{c} = pcdoc + tdoc + dcdoc + pclubc + tlubc + dclubc + sscfc + nscf + cai_{s} + cai_{fn} + cai_{fi} + {} + cai_{l} + cai_{g} + cai_{on} + cai_{oi} + mca + etca + ota + d_{c} \quad (C.220)$$

$$tc_{f} = pcdof + tdof + dcdof + pclubf + tlubf + dclubf + sscff + nsff + cai_{s} + cai_{fn} + cai_{fi} + {} + cai_{l} + cai_{g} + cai_{on} + cai_{oi} + mca + etca + ota + d_{f} \quad (C.221)$$

tcdoc = total consumption of diesel oil in the base year – current scenario (L).

tcdof = total consumption of diesel oil in the base year – future scenario (L).

tclubc = total consumption of lubricants in the base year – current scenario (L).

tclubf = total consumption of lubricants in the base year – future scenario (L).

pcdoc = production cost on the total consumption of diesel oil in the base year – current scenario (R$).

pcdof = production cost on the total consumption of diesel oil in the base year – future scenario (R$).

tdoc = taxes on the total consumption of diesel oil in the base year – current scenario (R$).

tdof = taxes on the total consumption of diesel oil in the base year – future scenario (R$).

dcdoc = distribution cost on the total consumption of diesel oil in the base year – current scenario (R$).

dcdof = distribution cost on the total consumption of diesel oil in the base year – future scenario (R$).

pclubc = production cost on the total consumption of lubricants in the base year – current scenario (R$).

pclubf = production cost on the total consumption of lubricants in the base year – future scenario (R$).

tlubc = taxes on the total consumption of lubricants in the base year – current scenario (R$).

tlubf = taxes on the total consumption of lubricants in the base year – future scenario (R$).

dclubc = distribution cost on the total consumption of lubricants in the base year – current scenario (R$).

dclubf = distribution cost on the total consumption of lubricants in the base year – future scenario (R$).

gsc = total amount of gross salary in the base year – current scenario (R$).

gsf = total amount of gross salary in the base year – future scenario (R$).

sscc = total amount of social security contributions paid by employees in the base year – current scenario (R$).

sscf = total amount of social security contributions paid by employees in the base year – future scenario (R$).

sscfc = total final amount of social security contributions paid by employees in the base year – current scenario (R$).

sscff = total final amount of social security contributions paid by employees in the base year – future scenario (R$).

nsc = total amount of net salary in the base year – current scenario (R$).

nsf = total amount of net salary in the base year – future scenario (R$).

nscf = total final amount of net salary in the base year – current scenario (R$).

nsff = total final amount of net salary in the base year – future scenario (R$).

lsslc = total labor and social security liabilities on the gross salary paid by employers in the base year (70.03%) – current scenario (R$).

lsslf = total labor and social security liabilities on the gross salary paid by employers in the base year (70.03%) – future scenario (R$).

$lsslc_s$ = total labor liabilities paid by employers in the base year (48.87%) – current scenario (R$).

$lsslf_s$ = total labor liabilities paid by employers in the base year (48.87%) – future scenario (R$).

$lsslc_{sc}$ = total social security liabilities paid by employers in the base year (21.16%) – current scenario (R$).

$lsslf_{sc}$ = total social security liabilities paid by employers in the base year (21.16%) – future scenario (R$).

cai_s = total costs with agriculture inputs – sugarcane seed (R$).

cai_f = total costs with agriculture inputs – fertilizers (R$).

cai_{fn} = total costs with agriculture inputs –fertilizers (national production) (R$).

cai_{fi} = total costs with agriculture inputs – fertilizers (imported) (R$).

cai_l = total costs with agriculture inputs – limestone (R$).

cai_g = total costs with agriculture inputs – gypsum (R$).

cai_o = total costs with agriculture inputs – other agrochemicals (R$).

cai_{on} = total costs with agriculture inputs – other agrochemicals (national production) (R$).

cai_{oi} = total costs with agriculture inputs – other agrochemicals (imported) (R$).

d_c = differences – current scenario (R$).

d_f = differences – future scenario (R$).

Table C.37 – Schematic representation of the allocation of production costs, imports, taxes, distribution and transportation margins, salaries and social contributions of the sugarcane production and transport in the IO framework – current scenario.

	National Production	Imports	Taxes	Dist. and transp. Margins
Forestry and logging products	cai_s			
Nonmetallic minerals	cai_l			
Diesel oil	pcdoc		tdoc	dcdoc
Other petroleum products	pclubc		tlubc	dclubc
Inorganic chemicals	cai_{fn}	cai_{fi}		
Agrochemicals	cai_{on}	cai_{oi}		
Other products of nonmetallic minerals	cai_g			
Metal products - except machinery and equipment	(mca) (%)[1]			
Machinery, equipment and electric material	(mca) (%)			
Parts and accessories for motor vehicles	(mca) (%)			
Electricity distribution	(etca) (%)[2]			
Trade	(dcdoc + dclubc)			- (dcdoc + dclubc)
Information services	(etca) (%)			
Salary	nscf			
Social contributions	sscfc			
Gross operating surplus	d_c			
Other taxes on production	ota			
Total output	tc_c			

1 – The total maintenance costs in the sugarcane production are allocated proportionally to the total consumed of the respective commodities/sectors (metal products - except machinery and equipment; machinery, equipment and electric material; and parts and accessories for motor vehicles) in the agriculture sector.
2 – The total costs with electricity and telecommunication in the sugarcane production are allocated proportionally to the total consumed of the respective commodities/sectors (electricity distribution and information services) in the agriculture sector.

Table C.38 – Schematic representation of the allocation of production costs, imports, taxes, distribution and transportation margins, salaries and social contributions of the sugarcane production and transport in the IO framework – future scenario.

	National Production	Imports	Taxes	Transp. and Dist. Margins
Forestry and logging products	cai_s			
Nonmetallic minerals	cai_l			
Diesel oil	pcdocf		tdocf	dcdocf
Other petroleum products	pclubcf		tlubcf	dclubcf
Inorganic chemicals	cai_{fn}	cai_{fi}		
Agrochemicals	cai_{on}	cai_{oi}		
Other products of nonmetallic minerals	cai_g			
Metal products - except machinery and equipment	(mca) (%)[1]			
Machinery, equipment and electric material	(mca) (%)			
Parts and accessories for motor vehicles	(mca) (%)			
Electricity distribution	(etca) (%)[2]			
Trade	(dcdocf + dclubcf)			- (dcdocf + dclubcf)
Information services	(etca) (%)			
Salary	nsff			
Social contributions	sscfcf			
Gross operating surplus	d_f			
Other taxes on t production	ota			
Total output	tc_f			

1 – The total maintenance costs in the sugarcane production are allocated proportionally to the total consumed of the respective commodities/sectors (metal products - except machinery and equipment; machinery, equipment and electric material; and parts and accessories for motor vehicles) in the agriculture sector.
2 – The total costs with electricity and telecommunication in the sugarcane production are allocated proportionally to the total consumed of the respective commodities/sectors (electricity distribution and information services) in the agriculture sector.

APPENDIX D – Computation of the technological coefficients of 1G+2G bioethanol scenarios.

The estimates of Macrelli *et al.* (2012) for eight different configurations of combined first generation (1G) and second generation (2G) bioethanol production plants (2G-A to 2G-H) were used to compute eight different sets of technical coefficients for the Brazilian bioethanol sector weighted by the total bioethanol produced in the combined (1G+2G) plants for each scenario.

The authors have modeled a full-scale plant and the following four main processes were simulated: 1G bioethanol production from sugarcane juice, 2G bioethanol production from lignocellulosic residues of the sugarcane (bagasse and leaves), combined heat and power (CHP) plant and waste water treatment by anaerobic digestion (AD). The 1G process (autonomous distillery) comprises the traditional Melle-Boinot steps, while the 2G bioethanol production is based on separate hydrolysis and fermentation of H_3PO_4-catalysed steam pre-treated bagasse and leaves (Macrelli *et al*., 2012). The scenarios 2G-A to 2G-H represent the values for combined 1G+2G plants without mixing the material streams. In addition, process variables found to have significant impact on the plant design and capital cost – mainly parameters associated with the enzymatic hydrolysis step (i.e. the residence time, enzyme dosage, concentration of water-insoluble solid material (WIS) in the pretreated material, addition of sugar cane leaves to raw material for 2G ethanol production) – were investigated. The main premises and conditions of each 1G and 2G plant are presented in Table D.1.

Table D.1 – Summary of the conditions for the 1G+2G scenarios investigated (adapted from Macrelli et al., 2012).

Parameter/Scenario	1G	2G-A	2G-B	2G-C	2G-D	2G-E	2G-F	2G-G	2G-H
1G heat integration	-	-	-	-	-	-	-	YES	YES
Leaves	-	-	-	-	-	-	YES	-	YES
Enzymatic hydrolysis									
Water insoluble solids (%)[a]	-	7	7	7	7	7	7|7	7	7|14
Enzyme dosage	-	low	low	low	high[b]	high[b]	high[b]	high[b]	high[b]
Hydrolysis time (h)	-	72	72	48	72	48	72	72	72
Glucose yield from EH, (%)	-	47	47	42	73	66	73|96	73	73|76
2G bioethanol, L/ dry ton sugarcane	-	45	57	53	76	76	151	95	136
1G + 2G bioethanol, L/dry ton sugarcane	284[c]	329	341	337	360	360	435	379	420

[a] When two values are given the first is for bagasse and the second for leaves.
[b] The high enzyme loading is twice the low enzyme loading.
[c] Represent the production of the 1G bioethanol plant.

Summarily, the methodology used by Macrelli et al. (2012) for the technical and economic assessment of the 1G and 2G bioethanol processes includes flowsheet design and simulations, capital cost evaluation and investment cost analysis. The flowsheets for the various process configurations were designed and simulated using the commercial software *AspenPlus v7.1* (*AspenTechnology Inc.*) to perform thermodynamic calculations for mass and energy balances. The output data from the simulations were then used as input for the Aspen Process Economic Analyzer (*AspenTechnology Inc.*) for equipment sizing and for the estimates of both direct and indirect capital costs (whereas the cost for some specific equipment was obtained from vendor quotations). Finally, the overall bioethanol production cost was calculated in a *Microsoft® Excel* spreadsheet starting from the capital cost and the operating costs, in order to obtain the minimum ethanol[1] selling price (MESP) of each process configuration (see Table D.2). Further details about the methodology and parameters used in the simulations can be consulted in Macrelli et al. (2012).

Table D.2 – Summary of costs for each individual 1G and 2G bioethanol plant (adapted from Macrelli et al., 2012) (US$/L).

Cost items	**1G**	**2G-A**	**2G-B**	**2G-C**	**2G-D**	**2G-E**	**2G-F**	**2G-G**	**2G-H**
Sugarcane[a]	0.23	-	-	-	-	-	-	-	-
Enzymes	-	0.34	0.33	0.36	0.42	0.47	0.38	0.42	0.41
Acid	-	0.08	0.08	0.09	0.05	0.06	0.05	0.05	0.05
Base	0.00	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.02
Leaves	-	-	-	-	-	-	0.05	-	0.05
Other costs	0.04	1.11	0.93	0.98	0.71	0.71	0.49	0.69	0.51
Total (MESP)	**0.27**	**1.55**	**1.36**	**1.45**	**1.19**	**1.25**	**0.97**	**1.16**	**1.05**

[a] Since the raw material for the 2G bioethanol is the bagasse derived from the 1G bioethanol plant, the cost of sugarcane is considered only for the 1G bioethanol plant. The cost of leaves which is used as a supplementary raw material in scenarios F and H are computed separately.

In the first step, the cost of each item *i* in each combined 1G+2G bioethanol plant (US$ cost $1G+2G_i$, see Table D.3) is obtained by the weighed sum of the cost of the respective item *i* in the 1G and 2G plants from Table D.2 and the ratio of the 1G and 2G bioethanol on the total bioethanol produced (L/ dry ton sugarcane, see Table D.1) in the corresponding combined 1G+2G bioethanol plant considering the following formula:

$$\text{US\\$ cost } 1G{+}2G_i = \left[\text{cost } 1G_i \times \frac{\text{1G bioethanol}}{\text{1G+2G bioethanol}}\right] + \left[\text{cost } 2G_i \times \frac{\text{2G bioethanol}}{\text{1G+2G bioethanol}}\right] \qquad (D.1)$$

where:

US$ cost $1G+2G_i$ = the weighed cost of item *i* in the respective combined 1G+2G bioethanol plant (US$);

cost $1G_i$ = the cost of item *i* in the 1G plant (US$);

[1] Here the term ethanol originally presented in the study of Macrelli et al. (2012) is maintained, although the term bioethanol has been used in this thesis to refer to the same product.

1G bioethanol = the total amount of bioethanol produced in the 1G plant (L/dry ton sugarcane);

cost $2G_i$ = the cost of item *i* in the 2G plant (US$);

2G bioethanol = total amount of bioethanol produced in the respective 2G plant (L/dry ton sugarcane);

1G+2G bioethanol = total amount of bioethanol produced in the respective combined 1G+2G bioethanol plant (L/dry ton sugarcane).

Table D.3 – Summary of the cost per litre of bioethanol produced in each combined 1G+2G bioethanol plant investigated (US$/L).

Cost items	2G-A	2G-B	2G-C	2G-D	2G-E	2G-F	2G-G	2G-H
Sugarcane	0.1985	0.1916	0.1938	0.1814	0.1814	0.1502	0.1723	0.1555
Enzymes	0.0466	0.0552	0.0566	0.0887	0.0992	0.1319	0.1053	0.1328
Acid	0.0109	0.0134	0.0142	0.0106	0.0127	0.0174	0.0125	0.0162
Base	0.0053	0.0042	0.0041	0.0045	0.0045	0.0054	0.0048	0.0085
Leaves	0.0000	0.0000	0.0000	0.0000	0.0000	0.0174	0.0000	0.0162
Other costs	0.1816	0.1846	0.1836	0.1775	0.1775	0.1929	0.1992	0.1888
Total	**0.4431**	**0.4489**	**0.4523**	**0.4626**	**0.4753**	**0.5152**	**0.4941**	**0.5180**

The cost per litre of each item *i* in Brazilian Real (see Table D.4) is obtained by multiplying the cost per litre in US dollars by a exchange rate R$/US$ as follows:

$$\text{R\$ cost 1G+2G} = \text{US\$ cost 1G+2G} \times (\text{R\$/US\$}) \quad \text{(D.2)}$$

Table D.4 – Summary of total costs for 1G+2G scenarios investigated (R$/L).[1]

Cost items	2G-A	2G-B	2G-C	2G-D	2G-E	2G-F	2G-G	2G-H
Sugarcane	0.3965	0.3826	0.3871	0.3624	0.3624	0.2999	0.3442	0.3106
Enzymes	0.0932	0.1102	0.1131	0.1771	0.1982	0.2634	0.2103	0.2651
Acid	0.0219	0.0267	0.0283	0.0211	0.0253	0.0347	0.0250	0.0323
Base	0.0106	0.0083	0.0082	0.0089	0.0089	0.0108	0.0095	0.0170
Leaves	0.0000	0.0000	0.0000	0.0000	0.0000	0.0347	0.0000	0.0323
Other costs	0.3627	0.3687	0.3667	0.3545	0.3545	0.3853	0.3978	0.3771
Total 1G+2G cost	**0.8849**	**0.8965**	**0.9034**	**0.9240**	**0.9493**	**1.0289**	**0.9868**	**1.0345**

1- It is considered the 2009 annual average exchange rate of 1.9972 (R$/US$) from the Brazilian Central Bank.

Thus, the cost of each item *i* by monetary unit of the total 1G+2G bioethanol produced in each scenario (see Table D.5) are computed by dividing the cost of each item *i* by the total cost in the respective 1G+2G plant as follows:

$$\text{R\$/R\$} = \frac{\text{R\$ cost 1G+2G}_i}{\text{total 1G+2G cost}} \quad \text{(D.3)}$$

Table D.5 – Costs of each item by monetary unit for 1G+2G scenarios investigated (R$/R$).								
Cost items	**2G-A**	**2G-B**	**2G-C**	**2G-D**	**2G-E**	**2G-F**	**2G-G**	**2G-H**
Sugarcane	0.4481	0.4268	0.4285	0.3922	0.3817	0.2915	0.3488	0.3003
Enzymes	0.1053	0.1229	0.1252	0.1917	0.2088	0.2561	0.2131	0.2563
Acid	0.0247	0.0298	0.0313	0.0228	0.0266	0.0337	0.0254	0.0313
Base	0.0120	0.0093	0.0091	0.0097	0.0094	0.0105	0.0096	0.0164
Leaves	0.0000	0.0000	0.0000	0.0000	0.0000	0.0337	0.0000	0.0313
Other costs	0.4099	0.4113	0.4060	0.3837	0.3734	0.3745	0.4031	0.3645
Total	**1.0000**	**1.0000**	**1.0000**	**1.0000**	**1.0000**	**1.0000**	**1.0000**	**1.0000**

In the next step, a technical coefficient vector of the 1G bioethanol sector is estimated. For this purpose each element of the column vector corresponding to the bioethanol sector in the original sector by sector IO framework is divided by the total output of this sector (R$/R$ – production prices), thus obtaining the participation in monetary terms of each sector to produce a monetary unity of 1G bioethanol. Next, each element of this vector is multiplied by a ratio representing the bioethanol produced in the 1G plant over the total bioethanol produced in the respective 1G+2G scenario, in order to obtain 10 different (normalized) technical coefficients vectors corresponding to each 1G+2G scenarios. After that, the element of each vector corresponding to the technical coefficient of the sugarcane sector (in row) is replaced by the cost (or the technical coefficient) of sugarcane by monetary unit of 1G+2G bioethanol which was estimated previously (values presented in Table D.5). It is noteworthy that the cost of leaves is summed to the cost of sugarcane in scenarios F and H in which leaves are used to produce bioethanol. Moreover, the costs (or the technical coefficients) of enzymes and acid by monetary unit of 1G+2G bioethanol from Table D.5 are summed to the element corresponding to the inorganic chemical sector (in row), whereas the cost (or the technical coefficient) of base by monetary unit of 1G+2G bioethanol is summed to the element corresponding to the organic chemical sector (in row) in the normalized technical coefficient vectors corresponding to each 1G+2G scenarios. As a simplification the other costs computed for the 1G+2G scenarios are not considered or allocated in the technical coefficient vectors by which they keep the same. In addition, the costs of sugarcane, leaves, enzymes, acid and base from Macrelli et al. (2012) are considered as equivalent to the national production cost of each item, by which the imports, taxes and commercial and trade margins are considered as null, thus the original technical coefficients are not modified. Finally, each vector of coefficients is multiplied by the total output of the bioethanol sector (at production prices) to obtain new IO vectors in monetary terms for the bioethanol sector. These vectors are used in the hybrid IO framework to subsequently generates technical coefficients by the total output of the bioethanol sector in energy terms, i.e. in R$/toe or toe/toe unities (see Table D.6). Every vector is used to substitute the technical coefficient of the bioethanol sector into the 2009 Brazilian technical coefficient matrix according of the respective 1G+2G scenario to be optimized.

Table D.6 – Technical coefficients for the 1G and 2G scenarios investigated (R$/toe or toe/toe).

	1G	2G-A	2G-B	2G-C	2G-D	2G-E	2G-F	2G-G	2G-H
N01	0.00012531	0.00010817	0.00010436	0.00010560	0.00009885	0.00009885	0.00008181	0.00009390	0.00008473
N02	0.17934350	0.17229684	0.16409073	0.16476892	0.15080008	0.14678138	0.12503387	0.13412254	0.12746704
E01	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
A01	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
A02	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
N03	0.00366046	0.00000003	0.00000003	0.00000003	0.00000003	0.00000003	0.00000002	0.00000002	0.00000002
E02	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
A03	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
A04	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
A05	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
N04	0.00000083	0.00000072	0.00000069	0.00000070	0.00000066	0.00000066	0.00000054	0.00000062	0.00000056
N05	0.00000151	0.00000134	0.00000130	0.00000131	0.00000123	0.00000123	0.00000102	0.00000117	0.00000105
E03	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
A06	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
A07	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
A08	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
A09	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
A10	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
A11	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
A12	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
A13	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
A14	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
A15	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
A16	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
N06	0.01037657	0.00895729	0.00864207	0.00874465	0.00818596	0.00818596	0.00677459	0.00777559	0.00701654
N07	0.00000002	0.00000002	0.00000002	0.00000002	0.00000002	0.00000002	0.00000002	0.00000002	0.00000002
N08	0.00060517	0.00052240	0.00050402	0.00051000	0.00047741	0.00047741	0.00039510	0.00045348	0.00040921
N09	0.00000244	0.00000211	0.00000203	0.00000206	0.00000193	0.00000193	0.00000159	0.00000183	0.00000165
N10	0.00000098	0.00000084	0.00000081	0.00000082	0.00000077	0.00000077	0.00000064	0.00000073	0.00000066
N11	0.00000258	0.00000223	0.00000215	0.00000217	0.00000203	0.00000203	0.00000168	0.00000193	0.00000174
N12	0.00068549	0.00059173	0.00057090	0.00057768	0.00054077	0.00054077	0.00044754	0.00051366	0.00046352
N13	0.00000197	0.00000146	0.00000140	0.00000142	0.00000133	0.00000133	0.00000110	0.00000126	0.00000114
E04	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
A17	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
A18	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
A19	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
A20	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
A21	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
A22	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
A23	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
A24	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
A25	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
A26	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
A27	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
A28	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
A29	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
A30	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
A31	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
A32	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
A33	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
A34	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
E05	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
A35	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
A36	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
A37	0.18429477	0.18429477	0.18429477	0.18429477	0.18429477	0.18429477	0.18429477	0.18429477	0.18429477
A38	0.05141612	0.05141612	0.05141612	0.05141612	0.05141612	0.05141612	0.05141612	0.05141612	0.05141612

A39	0.21000209	0.21000209	0.21000209	0.21000209	0.21000209	0.21000209	0.21000209	0.21000209	0.21000209
N14	0.00042538	0.05274093	0.06053489	0.06189334	0.08461411	0.09261657	0.11439605	0.09402625	0.11577290
N15	0.00000052	0.00000045	0.00000043	0.00000044	0.00000041	0.00000041	0.00000034	0.00000039	0.00000035
N16	0.00000259	0.00000223	0.00000216	0.00000218	0.00000204	0.00000204	0.00000169	0.00000194	0.00000175
N17	0.00002671	0.00002306	0.00002225	0.00002251	0.00002107	0.00002107	0.00001744	0.00002002	0.00001806
N18	0.00000233	0.00000201	0.00000194	0.00000197	0.00000184	0.00000184	0.00000152	0.00000175	0.00000158
N19	0.00000212	0.00000183	0.00000177	0.00000179	0.00000167	0.00000167	0.00000138	0.00000159	0.00000143
N20	0.00022850	0.00019725	0.00019031	0.00019256	0.00018026	0.00018026	0.00014918	0.00017122	0.00015451
N21	0.00341800	0.00295050	0.00284667	0.00288045	0.00269643	0.00269643	0.00223152	0.00256125	0.00231122
N22	0.00000755	0.00000652	0.00000629	0.00000636	0.00000595	0.00000595	0.00000493	0.00000566	0.00000510
N23	0.00082011	0.00070794	0.00068303	0.00069113	0.00064698	0.00064698	0.00053543	0.00061454	0.00055455
N24	0.00004896	0.00004227	0.00004078	0.00004126	0.00003863	0.00003863	0.00003197	0.00003669	0.00003311
N25	0.00006440	0.00005559	0.00005363	0.00005427	0.00005080	0.00005080	0.00004204	0.00004825	0.00004354
N26	0.00425346	0.00367168	0.00354247	0.00358452	0.00335551	0.00335551	0.00277697	0.00318729	0.00287615
N27	0.00394162	0.00340249	0.00328276	0.00332172	0.00310950	0.00310950	0.00257338	0.00295361	0.00266529
N28	0.00000794	0.00000685	0.00000661	0.00000669	0.00000626	0.00000626	0.00000518	0.00000595	0.00000537
N29	0.00000985	0.00000850	0.00000820	0.00000830	0.00000777	0.00000777	0.00000643	0.00000738	0.00000666
N30	0.00019839	0.00017125	0.00016523	0.00016719	0.00015651	0.00015651	0.00012952	0.00014866	0.00013415
N31	0.00001908	0.00001647	0.00001589	0.00001608	0.00001505	0.00001505	0.00001246	0.00001430	0.00001290
N32	0.00000550	0.00000474	0.00000458	0.00000463	0.00000434	0.00000434	0.00000359	0.00000412	0.00000372
N33	0.00000047	0.00000041	0.00000039	0.00000040	0.00000037	0.00000037	0.00000031	0.00000035	0.00000032
N34	0.00000927	0.00000800	0.00000772	0.00000781	0.00000731	0.00000731	0.00000605	0.00000695	0.00000627
N35	0.00018460	0.00015935	0.00015375	0.00015557	0.00014563	0.00014563	0.00012052	0.00013833	0.00012483
N36	0.00000275	0.00000238	0.00000229	0.00000232	0.00000217	0.00000217	0.00000180	0.00000206	0.00000186
N37	0.00000777	0.00000670	0.00000646	0.00000654	0.00000612	0.00000612	0.00000506	0.00000581	0.00000525
N38	0.00098510	0.00036686	0.00035395	0.00035815	0.00033527	0.00033527	0.00027747	0.00031846	0.00028738
E06	0.00641254	0.00641254	0.00641254	0.00641254	0.00641254	0.00641254	0.00641254	0.00641254	0.00641254
A40	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
A41	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
A42	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
A43	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
A44	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
A45	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
A46	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
A47	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
A48	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
N39	0.00005561	0.00004801	0.00004632	0.00004687	0.00004387	0.00004387	0.00003631	0.00004167	0.00003761
N40	0.00470288	0.00406650	0.00392340	0.00396997	0.00371633	0.00371633	0.00307558	0.00353002	0.00318542
N41	0.00760046	0.00656088	0.00633000	0.00640513	0.00599592	0.00599592	0.00496214	0.00569533	0.00513936
A49	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
A50	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
A51	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
A52	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
A53	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
N42	0.00068096	0.00058121	0.00056076	0.00056741	0.00053116	0.00053116	0.00043958	0.00050453	0.00045528
N43	0.00719549	0.00621130	0.00599272	0.00606385	0.00567644	0.00567644	0.00469774	0.00539187	0.00486552
N44	0.00096477	0.00083281	0.00080351	0.00081304	0.00076110	0.00076110	0.00062988	0.00072294	0.00065237
N45	0.00015882	0.00013710	0.00013227	0.00013384	0.00012529	0.00012529	0.00010369	0.00011901	0.00010739
N46	0.00047220	0.00040761	0.00039327	0.00039794	0.00037251	0.00037251	0.00030829	0.00035384	0.00031930
N47	0.00387139	0.00334187	0.00322427	0.00326254	0.00305410	0.00305410	0.00252753	0.00290099	0.00261780
N48	0.00003501	0.00003022	0.00002916	0.00002950	0.00002762	0.00002762	0.00002286	0.00002623	0.00002367
N49	0.00007377	0.00006368	0.00006144	0.00006217	0.00005819	0.00005819	0.00004816	0.00005528	0.00004988
N50	0.00059180	0.00051086	0.00049288	0.00049873	0.00046687	0.00046687	0.00038637	0.00044346	0.00040017
N51	0.00000759	0.00000655	0.00000632	0.00000640	0.00000599	0.00000599	0.00000496	0.00000569	0.00000513
N52	0.00000008	0.00000007	0.00000007	0.00000007	0.00000007	0.00000007	0.00000005	0.00000006	0.00000006
N53	0.00031084	0.00026833	0.00025888	0.00026196	0.00024522	0.00024522	0.00020294	0.00023293	0.00021019

APPENDIX E – Results of the model

Table E.1 - Results of the main variables in the deterministic model

Objetive Functions ➔ Variables ➔		Max gdp	Max emp	Min cf	Min ghg	Sol.5	Sol.6	Sol.7	Sol.8	Sol.9	Sol.10	Sol.11
Output of Sectors	N01	188 026	194 932	176 980	177 819	184 188	183 001	187 576	183 368	180 991	185 259	182 506
	N02	26 612	26 703	24 569	25 050	26 073	25 874	26 550	25 935	25 536	25 246	25 791
	E01	37 868	37 939	35 507	35 465	37 237	37 001	37 795	37 074	36 602	36 675	36 903
	A01	32 588	32 417	30 500	30 508	32 029	31 811	32 524	31 878	31 443	31 368	31 720
	A02	5 280	5 523	5 007	4 957	5 208	5 190	5 271	5 196	5 160	5 308	5 183
	N03	130 610	131 221	122 360	122 560	128 245	127 375	130 338	127 644	125 902	126 368	127 012
	E02	226 969	240 772	215 380	215 093	222 822	221 536	226 483	221 933	219 602	228 601	220 999
	A03	162 200	173 809	154 116	154 073	159 092	158 147	161 835	158 439	156 758	164 312	157 753
	A04	34 003	35 884	32 252	32 176	33 405	33 219	33 933	33 276	32 935	34 162	33 141
	A05	26 791	27 130	25 286	25 127	26 413	26 283	26 748	26 323	26 063	26 293	26 229
	N04	30 225	37 307	29 516	29 516	29 516	29 516	30 134	29 516	29 516	33 761	29 516
	N05	23 521	25 046	22 424	22 178	23 214	23 155	23 484	23 173	23 055	23 972	23 130
	E03	2 379	2 865	2 248	2 242	2 345	2 333	2 375	2 336	2 309	2 277	2 328
	A06	147	144	139	139	145	144	147	145	143	141	144
	A07	495	478	467	467	487	485	494	486	480	471	484
	A08	-	-	-	-	-	0	-	0	-	-	-
	A09	56	55	53	53	55	55	56	55	54	53	55
	A10	1 432	1 388	1 353	1 350	1 411	1 404	1 430	1 406	1 389	1 366	1 401
	A11	-	204	-	-	-	-	-	-	-	-	-
	A12	232	237	220	218	229	228	232	228	226	229	227
	A13	17	17	16	16	17	17	17	17	17	17	17
	A14	-	92	-	-	-	-	-	-	-	-	-
	A15	-	-	-	-	-	-	-	-	-	-	-
	A16	-	250	-	-	-	-	-	-	-	-	-
	N06	459 514	462 517	430 067	432 975	450 110	446 673	458 430	447 735	440 856	443 076	445 241
	N07	14 078	14 570	13 213	13 308	13 768	13 670	14 041	13 700	13 503	13 811	13 629
	N08	52 974	52 551	49 473	49 728	51 949	51 546	52 857	51 670	50 863	50 660	51 378
	N09	55 667	53 847	51 644	52 022	54 551	54 061	55 542	54 212	53 231	52 203	53 857
	N10	30 931	31 158	28 892	29 090	30 279	30 041	30 856	30 115	29 639	29 805	29 942
	N11	25 432	26 301	24 154	23 812	25 159	25 089	25 400	25 111	24 970	25 500	25 060
	N12	56 328	58 723	53 380	53 491	55 307	55 012	56 207	55 103	54 512	55 984	54 889
	N13	51 497	51 143	48 683	48 828	50 696	50 380	51 406	50 477	49 845	49 675	50 248
	E04	148 135	152 757	139 813	139 667	145 505	144 454	147 836	144 779	142 909	146 337	144 016
	A17	20 481	20 281	19 050	19 214	20 040	19 865	20 431	19 919	19 570	19 473	19 793
	A18	16 757	18 961	16 110	16 099	16 420	16 376	16 715	16 390	16 302	17 635	16 358
	A19	51 015	51 741	48 010	48 064	50 116	49 806	50 911	49 902	49 278	49 757	49 676
	A20	55	56	52	52	54	53	55	53	53	54	53

	A21	9 691	9 408	9 030	9 079	9 512	9 433	9 671	9 457	9 300	9 140	9 400
	A22	13 414	13 893	12 695	12 641	13 207	13 147	13 389	13 166	13 046	13 337	13 122
	A23	24	25	23	23	24	24	24	24	24	24	24
	A24	5 505	5 974	5 241	5 248	5 396	5 373	5 492	5 380	5 333	5 617	5 363
	A25	1 992	2 082	1 894	1 872	1 967	1 962	1 989	1 963	1 952	2 007	1 959
	A26	6 792	7 218	6 471	6 381	6 710	6 695	6 782	6 700	6 670	6 928	6 689
	A27	6 080	6 258	5 739	5 731	5 974	5 932	6 068	5 945	5 870	6 002	5 915
	A28	7 484	7 765	7 123	6 985	7 421	7 407	7 476	7 411	7 384	7 555	7 401
	A29	2 770	2 876	2 622	2 619	2 724	2 711	2 764	2 715	2 688	2 752	2 705
	A30	257	263	243	240	254	253	256	253	252	255	253
	A31	2 887	2 944	2 730	2 696	2 854	2 844	2 883	2 847	2 826	2 861	2 839
	A32	1 249	1 278	1 182	1 167	1 161	904	1 247	983	694	1 241	796
	A33	994	1 101	952	946	977	975	991	975	971	1 035	974
	A34	3 577	3 628	3 380	3 337	3 537	3 524	3 572	3 528	3 502	3 534	3 518
	E05	75 576	75 540	68 838	71 067	74 057	73 489	75 402	73 664	72 520	70 517	73 252
	A35	4 719	4 764	3 745	4 446	4 611	4 572	4 706	4 584	4 507	3 745	4 556
	A36	12 714	12 563	11 486	11 912	12 453	12 349	12 684	12 381	12 172	11 748	12 305
	A37	13 928	13 922	12 686	13 097	13 648	13 544	13 896	13 576	13 365	12 996	13 500
	A38	3 886	3 884	3 539	3 654	3 808	3 779	3 877	3 788	3 729	3 626	3 766
	A39	40 330	40 407	37 381	37 958	39 537	39 246	40 238	39 336	38 748	38 402	39 124
	N14	81 453	85 070	77 130	77 090	80 052	79 656	81 287	79 778	78 989	81 172	79 490
	N15	27 269	28 569	25 868	25 763	26 835	26 721	27 217	26 756	26 527	27 318	26 673
	N16	52 348	51 438	49 378	49 656	51 493	51 136	52 251	51 246	50 532	50 032	50 987
	N17	21 095	21 775	19 877	19 937	20 701	20 578	21 049	20 616	20 370	20 774	20 527
	N18	35 899	35 016	33 389	33 605	35 192	34 892	35 820	34 985	34 384	33 892	34 767
	N19	17 101	17 142	16 236	15 971	16 970	16 922	17 086	16 937	16 841	16 871	16 902
	N20	18 995	19 621	18 035	18 011	18 699	18 610	18 960	18 638	18 460	18 841	18 573
	N21	79 429	80 688	74 984	74 584	78 293	77 911	79 297	78 029	77 265	78 052	77 752
	N22	17 118	17 199	16 246	15 818	17 048	17 023	17 110	17 031	16 983	17 036	17 013
	N23	56 396	57 129	53 586	52 372	56 070	55 974	56 358	56 004	55 812	56 263	55 934
	N24	90 200	95 831	85 932	84 733	89 113	88 913	90 067	88 975	88 577	91 979	88 830
	N25	39 952	43 554	38 235	37 836	39 381	39 301	39 881	39 326	39 167	41 338	39 268
	N26	91 558	93 503	86 786	85 298	90 725	90 477	91 460	90 554	90 064	91 257	90 374
	N27	117 158	120 308	111 230	108 378	116 471	116 327	117 075	116 371	116 086	117 987	116 267
	N28	19 848	19 317	18 437	18 532	19 463	19 298	19 804	19 349	19 018	18 721	19 229
	N29	29 662	29 681	28 051	27 270	29 537	29 491	29 647	29 505	29 412	29 430	29 472
	N30	60 523	61 864	57 370	56 539	59 889	59 705	60 448	59 762	59 389	60 226	59 629
	N31	38 979	39 615	36 831	36 223	38 593	38 472	38 934	38 509	38 266	38 664	38 421
	N32	21 046	21 073	19 838	19 520	20 843	20 768	21 023	20 791	20 640	20 666	20 736
	N33	120 422	119 620	112 861	111 753	118 869	118 252	120 245	118 443	117 208	116 807	117 995
	N34	30 940	31 687	29 388	28 501	30 822	30 805	30 925	30 810	30 777	31 228	30 798
	N35	86 044	88 335	81 253	80 580	84 845	84 478	85 903	84 591	83 858	85 277	84 325
	N36	41 696	44 710	39 685	39 337	41 070	40 947	41 620	40 985	40 740	42 562	40 896
	N37	60 195	59 308	56 489	56 292	59 329	58 969	60 097	59 080	58 359	57 874	58 819

	N38	61 027	60 335	57 524	57 594	60 063	59 693	60 916	59 807	59 045	58 691	59 538
	E06	119 111	115 218	112 520	112 344	117 351	116 741	118 907	116 929	115 501	113 385	116 486
	A40	4 868	4 709	4 550	4 592	4 796	4 771	4 860	4 779	4 606	2 833	4 761
	A41	47 702	46 187	45 063	44 983	47 001	46 758	47 621	46 833	46 265	45 443	46 657
	A42	7 212	7 418	6 830	6 830	7 090	7 054	7 198	7 065	6 990	7 119	7 038
	A43	1 434	1 468	1 358	1 357	1 411	1 403	1 431	1 406	1 391	1 412	1 400
	A44	-	-	-	-	-	-	-	-	-	-	-
	A45	-	-	-	-	-	-	-	-	-	-	-
	A46	4 795	4 639	4 530	4 523	4 724	4 700	4 787	4 707	4 650	4 565	4 690
	A47	49 969	48 336	47 204	47 131	49 231	48 975	49 884	49 054	48 455	47 567	48 868
	A48	11 687	11 525	11 041	10 974	11 532	11 479	11 669	11 495	11 377	11 294	11 457
	N39	415 093	415 383	394 543	381 884	414 593	414 411	415 035	414 468	414 108	414 316	414 336
	N40	654 214	654 869	614 502	613 205	643 876	639 994	653 027	641 193	633 427	634 315	638 376
	N41	357 648	358 599	335 867	335 988	351 597	349 327	356 953	350 028	345 505	346 384	348 381
	A49	39 099	39 203	36 717	36 731	38 437	38 189	39 023	38 266	37 771	37 867	38 086
	A50	-	-	-	-	-	-	-	-	-	-	-
	A51	1 024	1 027	962	962	1 007	1 001	1 022	1 003	990	992	998
	A52	1 809	1 814	1 699	1 700	1 779	1 767	1 806	1 771	1 748	1 752	1 762
	A53	3 827	3 837	3 594	3 595	3 762	3 738	3 820	3 746	3 697	3 707	3 728
	N42	276 467	274 219	262 308	262 905	272 523	270 946	276 017	271 433	268 279	267 150	270 288
	N43	413 848	409 639	390 151	390 957	407 376	404 776	413 111	405 579	400 371	398 164	403 692
	N44	342 016	333 424	318 650	320 279	335 611	332 857	341 294	333 708	328 207	323 439	331 709
	N45	52 561	51 433	49 146	49 378	51 618	51 219	52 454	51 342	50 544	49 921	51 053
	N46	151 625	147 487	141 453	142 356	148 790	147 562	151 306	147 941	145 485	143 164	147 051
	N47	305 488	310 707	291 171	291 095	301 218	299 794	304 991	300 234	297 393	300 738	299 201
	N48	67 066	64 853	62 297	62 739	65 749	65 168	66 918	65 348	64 185	62 934	64 926
	N49	134 265	130 569	126 184	126 920	132 035	131 053	134 015	131 356	129 391	127 303	130 644
	N50	230 661	226 474	219 101	219 927	227 480	226 119	230 302	226 540	223 818	221 489	225 552
	N51	197 615	197 616	197 566	197 568	197 601	197 596	197 614	197 597	197 587	197 588	197 593
	N52	130 853	130 754	130 650	130 670	130 797	130 772	130 847	130 780	130 730	130 673	130 761
	N53	592 545	592 538	591 122	591 154	592 142	591 990	592 499	592 037	591 732	591 750	591 927
Competitive Imports	A01	-	-	-	-	-	-	-	-	-	-	-
	A02	2	2	2	2	2	2	2	2	2	2	2
	A03	-	-	-	-	-	-	-	-	-	-	-
	A04	-	-	-	-	-	-	-	-	-	-	-
	A05	-	-	-	-	-	-	-	-	-	-	-
	A06	-	-	-	-	-	-	-	-	-	-	-
	A07	-	-	-	-	-	-	-	-	-	-	-
	A08	-	-	-	-	-	-	-	-	-	-	-
	A09	-	-	-	-	-	-	-	-	-	-	-
	A10	-	-	-	-	-	-	-	-	-	-	-
	A11	201	-	189	189	197	196	200	197	195	197	196
	A12	-	-	-	-	-	-	-	-	-	-	-
	A13	-	-	-	-	-	-	-	-	-	-	-

	A14	93	-	88	88	92	92	93	92	91	90	92
	A15	-	-	-	-	-	-	-	-	-	-	-
	A16	11 832	12 400	11 287	11 158	11 677	11 649	11 813	11 658	11 602	12 094	11 638
	A17	-	-	-	-	-	-	-	-	-	-	-
	A18	-	-	-	-	-	-	-	-	-	-	-
	A19	-	-	-	-	-	-	-	-	-	-	-
	A20	-	-	-	-	-	-	-	-	-	-	-
	A21	-	-	-	-	-	-	-	-	-	-	-
	A22	-	-	-	-	-	-	-	-	-	-	-
	A23	-	-	-	-	-	-	-	-	-	-	-
	A24	-	-	-	-	-	-	-	-	-	-	-
	A25	-	-	-	-	-	-	-	-	-	-	-
	A26	-	-	-	-	-	-	-	-	-	-	-
	A27	-	-	-	-	-	-	-	-	-	-	-
	A28	-	-	-	-	-	-	-	-	-	-	-
	A29	-	-	-	-	-	-	-	-	-	-	-
	A30	-	-	-	-	-	-	-	-	-	-	-
	A31	-	-	-	-	-	-	-	-	-	-	-
	A32	-	-	-	-	74	327	-	248	528	-	432
	A33	-	-	-	-	-	-	-	-	-	-	-
	A34	-	-	-	-	-	-	-	-	-	-	-
	A35	-	-	656	-	-	-	-	-	-	794	-
	A36	-	-	347	-	-	-	-	-	-	347	-
	A37	-	-	-	-	-	-	-	-	-	-	-
	A38	-	-	-	-	-	-	-	-	-	-	-
	A39	-	-	-	-	-	-	-	-	-	-	-
	E06	-	2 961	-	-	-	-	-	-	-	-	-
	A40	-	-	49	-	-	-	-	-	115	1 802	-
	A41	-	-	-	-	-	-	-	-	-	-	-
	A42	-	-	-	-	-	-	-	-	-	-	-
	A43	-	-	-	-	-	-	-	-	-	-	-
	A44	-	-	-	-	-	-	-	-	-	-	-
	A45	-	-	-	-	-	-	-	-	-	-	-
	A46	-	-	-	-	-	-	-	-	-	-	-
	A47	-	-	-	-	-	-	-	-	-	-	-
	A48	-	-	-	-	-	-	-	-	-	-	-
Exports (basic prices or toe)	N01	26 686	34 210	26 231	26 343	25 969	25 983	26 593	25 979	26 006	30 514	25 989
	N02	-	-	-	-	-	-	-	-	-	-	-
	E01	-	-	-	-	-	-	-	-	-	-	-
	A01	-	-	-	-	-	-	-	-	-	-	-
	A02	-	-	-	-	-	-	-	-	-	-	-
	N03	3 911	5 013	3 844	3 860	3 806	3 808	3 897	3 807	3 811	4 472	3 809
	E02	-	-	-	-	-	-	-	-	-	-	-
	A03	26 231	33 626	25 783	25 893	25 526	25 539	26 139	25 535	25 562	29 993	25 545

	A04	-	-	-	-	-	-	-	-	-	-	-
	A05	-	-	-	-	-	-	-	-	-	-	-
	N04	21 861	28 024	21 488	21 579	21 273	21 285	21 785	21 281	21 304	24 996	21 289
	N05	2 702	3 464	2 656	2 667	2 630	2 631	2 693	2 631	2 633	3 090	2 632
	E03	-	-	-	-	-	-	-	-	-	-	-
	A06	-	-	-	-	-	-	-	-	-	-	-
	A07	-	-	-	-	-	-	-	-	-	-	-
	A08	-	-	-	-	-	-	-	-	-	-	-
	A09	-	-	-	-	-	-	-	-	-	-	-
	A10	-	-	-	-	-	-	-	-	-	-	-
	A11	-	-	-	-	-	-	-	-	-	-	-
	A12	-	-	-	-	-	-	-	-	-	-	-
	A13	-	-	-	-	-	-	-	-	-	-	-
	A14	-	-	-	-	-	-	-	-	-	-	-
	A15	-	-	-	-	-	-	-	-	-	-	-
	A16	-	-	-	-	-	-	-	-	-	-	-
	N06	45 129	57 852	44 359	44 548	43 916	43 939	44 971	43 932	43 979	51 602	43 949
	N07	3 098	3 971	3 045	3 058	3 014	3 016	3 087	3 016	3 019	3 542	3 017
	N08	2 399	3 076	2 359	2 369	2 335	2 336	2 391	2 336	2 338	2 744	2 337
	N09	233	298	229	230	226	227	232	227	227	266	227
	N10	3 469	4 447	3 410	3 424	3 376	3 378	3 457	3 377	3 381	3 967	3 378
	N11	2 579	3 306	2 535	2 546	2 510	2 511	2 570	2 511	2 513	2 949	2 512
	N12	8 567	10 982	8 421	8 457	8 337	8 341	8 537	8 340	8 349	9 796	8 343
	N13	135	173	132	133	131	131	134	131	131	154	131
	E04	-	-	-	-	-	-	-	-	-	-	-
	A17	1 875	2 404	1 843	1 851	1 825	1 826	1 869	1 826	1 827	2 144	1 826
	A18	6 945	8 902	6 826	6 855	6 758	6 761	6 920	6 760	6 768	7 941	6 763
	A19	1 651	2 117	1 623	1 630	1 607	1 608	1 646	1 608	1 609	1 888	1 608
	A20	4	6	4	4	4	4	4	4	4	5	4
	A21	12	15	12	12	12	12	12	12	12	14	12
	A22	37	48	37	37	36	36	37	36	36	43	36
	A23	-	-	-	-	-	-	-	-	-	-	-
	A24	1 621	2 079	1 594	1 601	1 578	1 579	1 616	1 578	1 580	1 854	1 579
	A25	-	-	-	-	-	-	-	-	-	-	-
	A26	-	-	-	-	-	-	-	-	-	-	-
	A27	-	-	-	-	-	-	-	-	-	-	-
	A28	210	269	206	207	204	204	209	204	204	240	204
	A29	-	-	-	-	-	-	-	-	-	-	-
	A30	0	1	0	0	0	0	0	0	0	0	0
	A31	63	81	62	62	61	61	63	61	61	72	61
	A32	44	56	43	43	43	43	44	43	43	50	43
	A33	348	446	342	344	339	339	347	339	339	398	339
	A34	8	11	8	8	8	8	8	8	8	10	8
	E05	-	-	-	-	-	-	-	-	-	-	-

A35	777	996	763	767	756	756	774	756	757	888	756
A36	885	1 135	870	874	862	862	882	862	863	1 012	862
A37	-	-	-	-	-	-	-	-	-	-	-
A38	-	-	-	-	-	-	-	-	-	-	-
A39	-	-	-	-	-	-	-	-	-	-	-
N14	5 877	7 534	5 777	5 801	5 719	5 722	5 857	5 721	5 727	6 720	5 723
N15	3 387	4 342	3 329	3 343	3 296	3 297	3 375	3 297	3 300	3 873	3 298
N16	1 402	1 798	1 378	1 384	1 365	1 365	1 397	1 365	1 366	1 603	1 366
N17	768	985	755	758	748	748	765	748	749	878	748
N18	685	878	673	676	667	667	683	667	668	783	667
N19	309	397	304	305	301	301	308	301	302	354	301
N20	1 559	1 999	1 533	1 539	1 518	1 518	1 554	1 518	1 520	1 783	1 519
N21	3 459	4 434	3 400	3 414	3 366	3 368	3 447	3 367	3 371	3 955	3 368
N22	55	71	54	55	54	54	55	54	54	63	54
N23	2 189	2 806	2 151	2 161	2 130	2 131	2 181	2 131	2 133	2 503	2 132
N24	13 787	17 673	13 552	13 609	13 416	13 423	13 739	13 421	13 435	15 764	13 426
N25	9 546	12 237	9 383	9 423	9 290	9 295	9 513	9 293	9 303	10 915	9 297
N26	2 720	3 487	2 673	2 685	2 647	2 648	2 710	2 648	2 651	3 110	2 649
N27	8 973	11 503	8 820	8 857	8 732	8 737	8 942	8 735	8 744	10 260	8 738
N28	351	449	345	346	341	341	349	341	342	401	341
N29	530	679	521	523	515	516	528	516	516	606	516
N30	4 402	5 643	4 327	4 345	4 284	4 286	4 386	4 285	4 290	5 033	4 287
N31	3 052	3 913	3 000	3 013	2 970	2 972	3 041	2 971	2 974	3 490	2 972
N32	959	1 229	942	946	933	934	955	933	934	1 096	934
N33	5 399	6 921	5 307	5 330	5 254	5 257	5 380	5 256	5 261	6 173	5 258
N34	2 494	3 197	2 452	2 462	2 427	2 428	2 485	2 428	2 431	2 852	2 429
N35	6 380	8 179	6 272	6 298	6 209	6 212	6 358	6 211	6 218	7 295	6 214
N36	9 368	12 009	9 208	9 247	9 116	9 121	9 335	9 119	9 129	10 711	9 123
N37	1 351	1 732	1 328	1 334	1 315	1 316	1 347	1 315	1 317	1 545	1 316
N38	409	524	402	403	398	398	407	398	398	467	398
E06	90	115	88	89	88	88	90	88	88	103	88
A40	-	-	-	-	-	-	-	-	-	-	-
A41	-	-	-	-	-	-	-	-	-	-	-
A42	-	-	-	-	-	-	-	-	-	-	-
A43	-	-	-	-	-	-	-	-	-	-	-
A44	-	-	-	-	-	-	-	-	-	-	-
A45	-	-	-	-	-	-	-	-	-	-	-
A46	-	-	-	-	-	-	-	-	-	-	-
A47	-	-	-	-	-	-	-	-	-	-	-
A48	-	-	-	-	-	-	-	-	-	-	-
N39	1 467	1 880	1 442	1 448	1 427	1 428	1 461	1 428	1 429	1 677	1 428
N40	33 476	42 913	32 905	33 044	32 576	32 593	33 359	32 588	32 622	38 277	32 600
N41	9 149	11 729	8 993	9 031	8 903	8 908	9 117	8 907	8 916	10 462	8 910
A49	-	-	-	-	-	-	-	-	-	-	-

	A50	-	-	-	-	-	-	-	-	-	-	-
	A51	-	-	-	-	-	-	-	-	-	-	-
	A52	-	-	-	-	-	-	-	-	-	-	-
	A53	-	-	-	-	-	-	-	-	-	-	-
	N42	1 051	1 347	1 033	1 038	1 023	1 023	1 047	1 023	1 024	1 202	1 024
	N43	2 611	3 347	2 566	2 577	2 541	2 542	2 602	2 542	2 544	2 985	2 543
	N44	2 055	2 634	2 019	2 028	1 999	2 000	2 047	2 000	2 002	2 349	2 001
	N45	59	75	58	58	57	57	59	57	57	67	57
	N46	1 211	1 553	1 191	1 196	1 179	1 179	1 207	1 179	1 180	1 385	1 180
	N47	21 320	27 331	20 956	21 045	20 747	20 758	21 246	20 755	20 777	24 378	20 763
	N48	92	118	91	91	90	90	92	90	90	106	90
	N49	321	411	316	317	312	313	320	312	313	367	313
	N50	1 935	2 480	1 902	1 910	1 883	1 884	1 928	1 884	1 885	2 212	1 884
	N51	40	51	39	40	39	39	40	39	39	46	39
	N52	2	3	2	2	2	2	2	2	2	3	2
	N53	875	1 122	860	864	851	852	872	852	853	1 001	852
Exports at consumer prices	N01	34 120	43 740	33 538	33 681	33 203	33 221	34 001	33 215	33 251	39 014	33 228
	N02	-	-	-	-	-	-	-	-	-	-	-
	E01	-	-	-	-	-	-	-	-	-	-	-
	A01	-	-	-	-	-	-	-	-	-	-	-
	A02	-	-	-	-	-	-	-	-	-	-	-
	N03	4 762	6 104	4 680	4 700	4 634	4 636	4 745	4 635	4 640	5 444	4 637
	E02	-	-	-	-	-	-	-	-	-	-	-
	A03	17 203	22 053	16 910	16 982	16 741	16 750	17 143	16 747	16 765	19 671	16 753
	A04	-	-	-	-	-	-	-	-	-	-	-
	A05	-	-	-	-	-	-	-	-	-	-	-
	N04	25 622	32 845	25 185	25 292	24 933	24 946	25 532	24 942	24 969	29 297	24 952
	N05	3 110	3 987	3 057	3 070	3 026	3 028	3 099	3 028	3 031	3 556	3 029
	E03	-	-	-	-	-	-	-	-	-	-	-
	A06	-	-	-	-	-	-	-	-	-	-	-
	A07	-	-	-	-	-	-	-	-	-	-	-
	A08	-	-	-	-	-	-	-	-	-	-	-
	A09	-	-	-	-	-	-	-	-	-	-	-
	A10	-	-	-	-	-	-	-	-	-	-	-
	A11	-	-	-	-	-	-	-	-	-	-	-
	A12	-	-	-	-	-	-	-	-	-	-	-
	A13	-	-	-	-	-	-	-	-	-	-	-
	A14	-	-	-	-	-	-	-	-	-	-	-
	A15	-	-	-	-	-	-	-	-	-	-	-
	A16	-	-	-	-	-	-	-	-	-	-	-
	N06	56 764	72 767	55 796	56 033	55 238	55 268	56 566	55 258	55 317	64 905	55 280
	N07	5 587	7 162	5 492	5 515	5 437	5 440	5 567	5 439	5 444	6 388	5 441
	N08	3 038	3 894	2 986	2 999	2 956	2 958	3 027	2 957	2 960	3 473	2 958
	N09	361	462	355	356	351	351	359	351	352	412	351

	N10	4 888	6 267	4 805	4 825	4 757	4 760	4 871	4 759	4 764	5 590	4 761
	N11	3 223	4 132	3 168	3 181	3 136	3 138	3 212	3 138	3 141	3 685	3 139
	N12	9 571	12 270	9 408	9 448	9 314	9 319	9 538	9 318	9 328	10 944	9 321
	N13	185	237	182	182	180	180	184	180	180	211	180
	E04	-	-	-	-	-	-	-	-	-	-	-
	A17	1 611	2 065	1 583	1 590	1 567	1 568	1 605	1 568	1 570	1 842	1 568
	A18	5 964	7 646	5 863	5 887	5 804	5 807	5 943	5 806	5 812	6 820	5 808
	A19	1 418	1 818	1 394	1 400	1 380	1 381	1 413	1 381	1 382	1 622	1 381
	A20	4	5	4	4	4	4	4	4	4	4	4
	A21	10	13	10	10	10	10	10	10	10	12	10
	A22	32	41	32	32	31	31	32	31	31	37	31
	A23	-	-	-	-	-	-	-	-	-	-	-
	A24	1 393	1 785	1 369	1 375	1 355	1 356	1 388	1 356	1 357	1 592	1 356
	A25	-	-	-	-	-	-	-	-	-	-	-
	A26	-	-	-	-	-	-	-	-	-	-	-
	A27	-	-	-	-	-	-	-	-	-	-	-
	A28	180	231	177	178	175	175	179	175	175	206	175
	A29	-	-	-	-	-	-	-	-	-	-	-
	A30	-	-	-	-	-	-	-	-	-	-	-
	A31	54	69	53	53	53	53	54	53	53	62	53
	A32	38	48	37	37	37	37	38	37	37	43	37
	A33	299	383	294	295	291	291	298	291	291	342	291
	A34	7	9	7	7	7	7	7	7	7	8	7
	E05	-	-	-	-	-	-	-	-	-	-	-
	A35	1 208	1 548	1 187	1 192	1 175	1 176	1 204	1 176	1 177	1 381	1 176
	A36	1 377	1 766	1 354	1 360	1 340	1 341	1 373	1 341	1 342	1 575	1 341
	A37	-	-	-	-	-	-	-	-	-	-	-
	A38	-	-	-	-	-	-	-	-	-	-	-
	A39	-	-	-	-	-	-	-	-	-	-	-
	N14	6 630	8 500	6 517	6 545	6 452	6 456	6 607	6 454	6 461	7 581	6 457
	N15	3 699	4 741	3 636	3 651	3 599	3 601	3 686	3 601	3 604	4 229	3 602
	N16	2 351	3 014	2 311	2 321	2 288	2 289	2 343	2 289	2 291	2 688	2 290
	N17	900	1 154	885	889	876	877	897	877	878	1 030	877
	N18	1 202	1 541	1 181	1 186	1 170	1 170	1 198	1 170	1 171	1 374	1 170
	N19	417	535	410	412	406	406	416	406	407	477	406
	N20	1 842	2 361	1 810	1 818	1 792	1 793	1 835	1 793	1 795	2 106	1 793
	N21	4 618	5 920	4 539	4 558	4 494	4 496	4 602	4 495	4 500	5 280	4 497
	N22	79	102	78	78	77	77	79	77	77	91	77
	N23	2 996	3 841	2 945	2 958	2 916	2 917	2 986	2 917	2 920	3 426	2 918
	N24	15 462	19 821	15 198	15 262	15 046	15 054	15 408	15 052	15 067	17 679	15 057
	N25	10 408	13 343	10 231	10 274	10 128	10 134	10 372	10 132	10 143	11 901	10 136
	N26	3 268	4 189	3 212	3 226	3 180	3 181	3 256	3 181	3 184	3 736	3 182
	N27	11 915	15 275	11 712	11 762	11 595	11 601	11 874	11 600	11 612	13 625	11 604
	N28	718	921	706	709	699	699	716	699	700	821	699

N29	832	1 067	818	822	810	810	829	810	811	952	811
N30	5 516	7 071	5 422	5 445	5 367	5 370	5 496	5 369	5 375	6 307	5 372
N31	4 011	5 141	3 942	3 959	3 903	3 905	3 997	3 904	3 908	4 586	3 906
N32	1 365	1 750	1 342	1 348	1 329	1 329	1 361	1 329	1 330	1 561	1 330
N33	7 950	10 192	7 815	7 848	7 737	7 741	7 922	7 739	7 748	9 091	7 742
N34	3 047	3 907	2 995	3 008	2 965	2 967	3 037	2 967	2 970	3 484	2 968
N35	7 694	9 863	7 563	7 595	7 487	7 491	7 667	7 490	7 498	8 797	7 493
N36	10 552	13 526	10 372	10 416	10 268	10 273	10 515	10 272	10 283	12 065	10 276
N37	2 222	2 848	2 184	2 193	2 162	2 163	2 214	2 163	2 165	2 541	2 164
N38	496	635	487	489	482	483	494	483	483	567	483
E06	1 375	1 763	1 352	1 357	1 338	1 339	1 370	1 339	1 340	1 572	1 339
A40	-	-	-	-	-	-	-	-	-	-	-
A41	-	-	-	-	-	-	-	-	-	-	-
A42	-	-	-	-	-	-	-	-	-	-	-
A43	-	-	-	-	-	-	-	-	-	-	-
A44	-	-	-	-	-	-	-	-	-	-	-
A45	-	-	-	-	-	-	-	-	-	-	-
A46	-	-	-	-	-	-	-	-	-	-	-
A47	-	-	-	-	-	-	-	-	-	-	-
A48	-	-	-	-	-	-	-	-	-	-	-
N39	1 507	1 931	1 481	1 487	1 466	1 467	1 501	1 467	1 468	1 723	1 467
N40	385	494	379	380	375	375	384	375	376	441	375
N41	6 327	8 111	6 219	6 245	6 157	6 160	6 305	6 159	6 166	7 234	6 162
A49	-	-	-	-	-	-	-	-	-	-	-
A50	-	-	-	-	-	-	-	-	-	-	-
A51	-	-	-	-	-	-	-	-	-	-	-
A52	-	-	-	-	-	-	-	-	-	-	-
A53	-	-	-	-	-	-	-	-	-	-	-
N42	1 243	1 594	1 222	1 227	1 210	1 211	1 239	1 210	1 212	1 422	1 211
N43	2 821	3 616	2 773	2 784	2 745	2 746	2 811	2 746	2 749	3 225	2 747
N44	2 097	2 689	2 062	2 070	2 041	2 042	2 090	2 042	2 044	2 398	2 043
N45	1	2	1	1	1	1	1	1	1	2	1
N46	2 148	2 753	2 111	2 120	2 090	2 091	2 140	2 091	2 093	2 456	2 092
N47	22 090	28 317	21 713	21 805	21 496	21 507	22 013	21 504	21 527	25 258	21 512
N48	92	118	90	91	89	89	91	89	89	105	89
N49	184	236	181	181	179	179	183	179	179	210	179
N50	1 152	1 477	1 132	1 137	1 121	1 121	1 148	1 121	1 122	1 317	1 122
N51	42	54	41	41	41	41	42	41	41	48	41
N52	2	3	2	2	2	2	2	2	2	3	2
N53	847	1 086	833	836	824	825	844	825	826	969	825

Economic Variables	cf	2 585 212	2 491 328	2 393 625	2 412 456	2 532 227	2 508 682	2 579 264	2 515 956	2 468 823	2 415 592	2 498 870
	cnpish	68 769	68 769	68 769	68 769	68 769	68 769	68 769	68 769	68 769	68 769	68 769
	cpr	2 668 603	2 574 038	2 475 401	2 494 412	2 615 111	2 591 341	2 662 598	2 598 684	2 551 100	2 497 578	2 581 435
	g	922 816	922 816	922 816	922 816	922 816	922 816	922 816	922 816	922 816	922 816	922 816
	cfr	2 574 558	2 480 889	2 383 186	2 402 017	2 521 573	2 498 028	2 568 610	2 505 301	2 458 169	2 405 153	2 488 216
	cpe	10 654	10 439	10 439	10 439	10 654	10 654	10 654	10 654	10 654	10 439	10 654
	cpm	25 276	24 380	23 446	23 626	24 769	24 544	25 219	24 614	24 163	23 656	24 451
	sc	- 10 082	- 10 221	- 9 527	- 9 405	- 9 970	- 9 933	- 10 069	- 9 945	- 9 870	- 9 958	- 9 918
	gfcf	861 608	861 608	816 599	786 297	861 608	861 608	861 608	861 608	861 608	861 608	861 608
	impwtcif	425 900	426 201	401 552	398 089	420 719	418 792	425 304	419 387	415 525	415 971	417 989
	impwtfob	411 517	411 808	387 991	384 645	406 511	404 650	410 941	405 225	401 493	401 923	403 874
	impfob	436 793	436 188	411 438	408 272	431 280	429 194	436 160	429 838	425 656	425 580	428 324
	expcpt	345 186	439 284	339 267	340 663	336 194	336 368	344 019	336 315	336 660	392 953	336 441
	expcpwt	334 531	428 845	328 827	330 224	325 540	325 714	333 365	325 660	326 006	382 514	325 786
	cfm	90 528	87 241	83 819	84 479	88 673	87 848	90 320	88 103	86 453	84 589	87 505
	cnpishm	253	253	253	253	253	253	253	253	253	253	253
	gm	1 205	1 205	1 205	1 205	1 205	1 205	1 205	1 205	1 205	1 205	1 205
	gfcfm	81 263	81 263	77 018	74 160	81 263	81 263	81 263	81 263	81 263	81 263	81 263
	scm	932	945	881	870	922	919	931	920	913	921	917
	expm	-	-	-	-	-	-	-	-	-	-	-
	gav	3 757 340	3 758 636	3 574 262	3 568 728	3 709 550	3 691 554	3 751 854	3 697 113	3 661 086	3 664 141	3 684 053
	emp	55 200 246	55 318 774	52 883 124	52 766 488	54 611 137	54 392 926	55 132 475	54 460 334	54 023 755	54 115 728	54 301 985
	gdpinc	4 351 337	4 351 337	4 133 118	4 126 511	4 294 478	4 273 006	4 344 811	4 279 639	4 236 658	4 239 417	4 264 057
	gdppro	4 351 337	4 351 337	4 133 118	4 126 511	4 294 478	4 273 006	4 344 811	4 279 639	4 236 658	4 239 417	4 264 057
	gdpcurr	6 735 909	6 776 766	6 447 358	6 486 833	6 641 188	6 605 418	6 725 038	6 616 467	6 544 865	6 549 462	6 590 510
	gts	2 479	2 479	2 479	2 479	2 479	2 479	2 479	2 479	2 479	2 479	2 479
	expts	20 127	25 801	19 783	19 867	19 586	19 596	20 056	19 593	19 614	23 013	19 600
	cnpishts	1 343	1 343	1 343	1 343	1 343	1 343	1 343	1 343	1 343	1 343	1 343
	cfts	235 178	226 637	217 749	219 462	230 358	228 216	234 637	228 878	224 590	219 748	227 323
	gfcfts	59 134	59 134	56 045	53 965	59 134	59 134	59 134	59 134	59 134	59 134	59 134
	scts	- 85	- 86	- 81	- 80	- 84	- 84	- 85	- 84	- 84	- 84	- 84
	ts	593 996	592 700	558 856	557 783	584 929	581 453	592 958	582 526	575 572	575 276	580 004
	gcurr	1 368 743	1 368 743	1 368 743	1 368 743	1 368 743	1 368 743	1 368 743	1 368 743	1 368 743	1 368 743	1 368 743
	gfcfcurr	1 090 940	1 131 798	1 090 940	1 090 940	1 090 940	1 090 940	1 090 940	1 090 940	1 090 940	1 090 940	1 090 940
	wagcurr	3 166 312	3 170 583	3 036 883	3 031 572	3 133 002	3 120 558	3 162 484	3 124 402	3 099 518	3 103 428	3 115 372
	gfcfg	107 013	107 013	107 013	107 013	107 013	107 013	107 013	107 013	107 013	107 013	107 013
	pig	-	-	-	-	-	-	-	-	-	-	-
	pig	204 064	205 302	195 323	196 519	201 195	200 111	203 735	200 446	198 277	198 416	199 659
	tk	11 964	12 037	11 452	11 522	11 796	11 732	11 945	11 752	11 625	11 633	11 706
	itsub	1 089 802	1 088 193	1 025 554	1 023 573	1 073 192	1 066 851	1 087 899	1 068 810	1 056 126	1 056 012	1 064 208
	itsubg	1 089 802	1 088 193	1 025 554	1 023 573	1 073 192	1 066 851	1 087 899	1 068 810	1 056 126	1 056 012	1 064 208
	ssc	591 901	592 699	567 706	566 713	585 674	583 348	591 185	584 066	579 415	580 146	582 378
	dt	274 669	264 936	254 783	256 740	269 163	266 717	274 051	267 472	262 575	257 066	265 697
	dtc	362 687	364 887	347 150	349 276	357 587	355 661	362 102	356 256	352 401	352 648	354 858
	trgh	890 704	890 704	890 704	890 704	917 858	894 235	890 704	901 532	890 704	890 704	890 704
	pi	257 300	64 077	64 077	64 077	64 077	64 077	257 300	64 077	64 077	64 077	197 699
	pi	-	-	-	-	-	-	-	-	-	-	-

	ctr	- 37 120	- 55 717	- 55 717	- 55 717	84 219	84 219	- 42 000	84 219	47 768	- 55 717	- 55 717
	yd	2 837 059	2 736 525	2 631 661	2 651 873	2 780 191	2 754 921	2 830 676	2 762 727	2 712 140	2 655 239	2 744 389
	ydcurr	4 726 263	4 558 783	4 384 091	4 417 761	4 631 526	4 589 428	4 715 629	4 602 433	4 518 159	4 423 368	4 571 883
	ctrg	93 407	93 407	93 407	93 407	93 407	93 407	93 407	93 407	93 407	93 407	93 407
	trkg	15 975	15 975	15 975	15 975	15 975	15 975	15 975	15 975	15 975	15 975	15 975
	gbg	-	-	-	-	-	-	-	-	-	-	-
	gbg	130 120	139 629	245 756	245 774	188 015	176 412	133 632	179 996	193 215	197 990	177 890
	dat	- 33 370	- 33 370	- 33 370	- 4 768	- 33 370	105 724	- 33 370	110 151	- 33 370	- 33 370	- 33 370
	debt	4 558 698	4 568 207	4 674 334	4 702 954	4 616 594	4 788 928	4 562 211	4 796 939	4 621 794	4 626 569	4 606 469
	debt-1	4 461 948	4 461 948	4 461 948	4 461 948	4 461 948	4 506 792	4 461 948	4 506 792	4 461 948	4 461 948	4 461 948
	jurg	710 503	711 252	719 611	721 865	715 063	732 169	710 779	732 800	715 472	715 848	714 265

Table E.2 - Results of the main variables in the deterministic model - Analysis of the bioethanol system

	Objetive Functions →	Max gdp	Max emp	Min cf	Min ghg	Sol.5	Sol.6	Sol.7	Sol.8	Sol.9	Sol.10	Sol.11	Sol.12	Sol.13	Sol.14	Sol.15	Sol.16	Sol.17	Sol.18	Sol.19	Sol.20	Sol.21	Sol.22	Sol.23	Sol.24
	Variables ↓					Curr.	Opt.	A	B	C	D	E	F	G	H	Curr.	Opt.	A	B	C	D	E	F	G	H
Output of Sectors	N01	188,026	194,932	176,980	177,819	180,991	180,991	181,154	181,078	181,069	180,870	180,862	180,750	180,788	180,770	204,041	204,041	204,142	204,101	204,118	204,094	204,101	203,976	203,988	204,013
	N02	26,612	26,703	24,569	25,050	25,536	25,536	25,021	24,423	24,473	23,455	23,152	21,565	22,238	21,739	28,143	28,143	27,554	26,902	26,955	25,840	25,519	23,790	24,518	23,983
	E01	37,868	37,939	35,507	35,465	36,602	36,602	36,601	36,599	36,600	36,598	36,586	36,574	36,590	36,572	39,582	39,582	39,563	39,563	39,562	39,560	39,559	39,557	39,561	39,557
	A01	32,588	32,417	30,500	30,508	31,443	31,443	31,434	31,434	31,435	31,438	31,431	31,422	31,432	31,421	33,955	33,955	33,939	33,939	33,939	33,937	33,936	33,935	33,938	33,934
	A02	5,280	5,523	5,007	4,957	5,160	5,160	5,166	5,165	5,165	5,160	5,155	5,152	5,158	5,151	5,627	5,627	5,624	5,624	5,624	5,623	5,623	5,623	5,623	5,622
	N03	130,610	131,221	122,360	122,560	125,902	125,902	125,631	125,619	125,621	125,599	125,585	125,544	125,575	125,547	137,599	137,599	137,282	137,275	137,279	137,274	137,277	137,249	137,260	137,256
	E02	226,969	240,772	215,380	215,093	219,602	219,607	218,578	218,765	218,573	218,214	217,988	218,679	218,987	218,316	243,166	243,167	242,271	242,420	242,329	242,286	242,195	242,668	242,745	242,477
	A03	162,200	173,809	154,116	154,073	156,758	156,763	155,707	155,842	155,674	155,298	155,555	156,365	156,134	156,209	176,690	176,691	176,522	176,611	176,579	176,647	176,640	176,915	176,870	176,842
	A04	34,003	35,884	32,252	32,176	32,935	32,936	32,797	32,821	32,796	32,746	32,595	32,614	32,797	32,525	35,855	35,855	35,535	35,556	35,531	35,477	35,440	35,515	35,573	35,465
	A05	26,791	27,130	25,286	25,127	26,063	26,063	26,229	26,256	26,258	26,324	26,059	25,962	26,239	25,865	26,741	26,741	26,443	26,479	26,452	26,421	26,388	26,506	26,544	26,450
	N04	30,225	37,307	29,516	29,516	29,516	29,516	29,715	29,678	29,661	29,516	29,516	29,516	29,516	29,516	37,579	37,579	37,690	37,689	37,696	37,723	37,737	37,731	37,705	37,744
	N05	23,521	25,046	22,424	22,178	23,055	23,055	23,349	23,373	23,376	23,445	23,488	23,578	23,479	23,590	25,300	25,300	25,611	25,645	25,656	25,774	25,819	25,912	25,803	25,927
	E03	2,379	2,865	2,248	2,242	2,309	2,309	2,298	2,297	2,297	2,295	2,293	2,289	2,293	2,289	2,391	2,391	2,370	2,371	2,369	2,365	2,363	2,365	2,369	2,362
	A06	147	144	139	139	143	143	142	142	142	142	141	141	142	140	145	145	143	143	143	142	142	142	143	142
	A07	495	478	467	467	480	480	477	477	477	476	476	476	476	476	497	497	493	493	493	492	491	492	493	491
	A08	-	-	-	-	-	-	-	-	-	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	A09	56	55	53	53	54	54	54	54	54	54	55	55	54	55	59	59	60	60	60	60	60	60	60	60
	A10	1,432	1,388	1,353	1,350	1,389	1,389	1,382	1,381	1,381	1,380	1,378	1,375	1,378	1,375	1,431	1,431	1,417	1,417	1,416	1,413	1,411	1,413	1,416	1,411
	A11	-	204	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	A12	232	237	220	218	226	226	226	226	226	226	226	226	226	226	241	241	241	241	241	241	241	241	241	241
	A13	17	17	16	16	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17
	A14	-	92	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	A15	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	A16	-	250	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	N06	459,514	462,517	430,067	432,975	440,856	440,856	440,845	440,792	440,800	440,695	440,796	440,704	440,667	440,769	487,789	487,789	487,951	487,918	487,952	487,987	488,034	487,878	487,888	487,945
	N07	14,078	14,570	13,213	13,308	13,503	13,503	13,520	13,517	13,516	13,506	13,503	13,500	13,503	13,499	15,415	15,415	15,422	15,422	15,422	15,424	15,425	15,424	15,423	15,425
	N08	52,974	52,551	49,473	49,728	50,863	50,863	50,866	50,866	50,869	50,880	50,876	50,866	50,873	50,867	55,327	55,327	55,333	55,333	55,334	55,337	55,339	55,335	55,336	55,337

N09	55,667	53,847	51,644	52,022	53,231	53,231	53,195	53,203	53,208	53,246	53,247	53,243	53,241	53,245	57,641	57,641	57,636	57,636	57,636	57,635	57,635	57,636	57,637	57,635
N10	30,931	31,158	28,892	29,090	29,639	29,639	29,652	29,650	29,650	29,646	29,625	29,610	29,634	29,604	33,078	33,078	33,058	33,059	33,057	33,053	33,050	33,051	33,056	33,049
N11	25,432	26,301	24,154	23,812	24,970	24,970	25,000	24,996	24,994	24,978	24,996	25,007	24,986	25,013	26,576	26,576	26,624	26,625	26,628	26,640	26,647	26,645	26,634	26,651
N12	56,328	58,723	53,380	53,491	54,512	54,512	54,598	54,585	54,581	54,538	54,509	54,485	54,522	54,477	59,758	59,758	59,767	59,768	59,769	59,775	59,778	59,776	59,776	59,779
N13	51,497	51,143	48,683	48,828	49,845	49,845	49,847	49,851	49,852	49,865	49,907	49,935	49,884	49,949	51,249	51,249	51,329	51,331	51,336	51,359	51,371	51,373	51,352	51,381
E04	148,135	152,757	139,813	139,667	142,909	142,914	141,520	141,711	141,546	141,299	141,731	142,717	142,286	142,593	156,172	156,172	156,103	156,201	156,173	156,276	156,284	156,579	156,502	156,514
A17	20,481	20,281	19,050	19,214	19,570	19,570	19,570	19,570	19,571	19,576	19,614	19,635	19,590	19,649	21,897	21,897	21,965	21,964	21,969	21,985	21,994	21,990	21,974	21,998
A18	16,757	18,961	16,110	16,099	16,302	16,302	16,371	16,364	16,358	16,321	16,284	16,274	16,314	16,259	19,097	19,097	19,075	19,081	19,079	19,081	19,079	19,097	19,097	19,091
A19	51,015	51,741	48,010	48,064	49,278	49,278	48,983	49,300	49,298	49,290	49,348	49,392	49,320	49,410	53,766	53,766	53,876	53,880	53,886	53,921	53,937	53,945	53,913	53,956
A20	55	56	52	52	53	53	41	41	53	53	53	54	53	54	60	60	60	60	60	61	61	61	61	61
A21	9,691	9,408	9,030	9,079	9,300	9,300	9,294	9,295	9,296	9,302	9,310	9,314	9,305	9,316	9,940	9,940	9,951	9,951	9,952	9,955	9,956	9,955	9,953	9,957
A22	13,414	13,893	12,695	12,641	13,046	13,046	13,547	13,611	13,259	13,074	13,691	13,813	13,821	13,774	13,625	13,625	13,904	13,979	13,977	14,138	14,184	14,404	14,263	14,390
A23	24	25	23	23	24	24	24	24	24	24	24	25	24	25	26	26	26	26	27	27	27	27	27	27
A24	5,505	5,974	5,241	5,248	5,333	5,333	5,348	5,346	5,344	5,336	5,327	5,323	5,333	5,319	6,093	6,093	6,088	6,088	6,088	6,087	6,086	6,088	6,089	6,087
A25	1,992	2,082	1,894	1,872	1,952	1,952	1,956	1,955	1,955	1,954	1,948	1,945	1,951	1,943	2,092	2,092	2,084	2,084	2,084	2,082	2,081	2,083	2,084	2,082
A26	6,792	7,218	6,471	6,381	6,670	6,670	6,682	6,490	6,679	6,670	6,675	6,678	6,672	6,679	7,320	7,320	7,335	7,335	7,336	7,340	7,342	7,341	7,338	7,343
A27	6,080	6,258	5,739	5,731	5,870	5,870	5,829	5,837	5,831	5,826	5,837	5,874	5,862	5,868	6,376	6,376	6,374	6,379	6,378	6,384	6,384	6,401	6,396	6,397
A28	7,484	7,765	7,123	6,985	7,384	7,384	7,398	7,398	7,397	7,394	7,385	7,382	7,392	7,379	7,744	7,744	7,739	7,741	7,740	7,740	7,740	7,744	7,744	7,743
A29	2,770	2,876	2,622	2,619	2,688	2,688	2,812	2,828	2,831	2,880	2,893	2,937	2,896	2,939	2,925	2,925	3,052	3,071	3,074	3,128	3,147	3,198	3,149	3,202
A30	257	263	243	240	252	252	251	252	252	252	244	239	248	237	241	241	229	229	228	225	223	224	227	223
A31	2,887	2,944	2,730	2,696	2,826	2,826	2,828	2,828	2,827	2,826	2,716	2,649	2,778	2,612	2,610	2,610	2,431	2,433	2,421	2,378	2,355	2,366	2,408	2,344
A32	1,249	1,278	1,182	1,167	694	699	-	-	-	-	-	-	-	-	1,136	1,136	1,059	1,060	1,055	1,037	1,027	1,031	1,049	1,022
A33	994	1,101	952	946	971	971	-	-	-	-	-	929	277	920	1,024	1,024	983	984	981	971	966	968	978	963
A34	3,577	3,628	3,380	3,337	3,502	3,502	3,503	3,503	3,503	3,501	3,363	3,278	3,441	3,232	3,207	3,207	2,981	2,983	2,968	2,914	2,885	2,898	2,952	2,871
E05	75,576	75,540	68,838	71,067	72,520	72,520	72,499	72,493	72,493	72,479	72,381	72,303	72,428	72,273	79,581	79,581	79,395	79,395	79,385	79,341	79,320	79,322	79,369	79,303
A35	4,719	4,764	3,745	4,446	4,507	4,507	4,510	4,509	4,509	4,509	4,531	4,540	4,518	4,547	5,181	5,181	5,221	5,221	5,223	5,233	5,238	5,236	5,226	5,241
A36	12,714	12,563	11,486	11,912	12,172	12,172	12,169	12,170	12,170	12,170	12,149	12,140	12,161	12,133	13,353	13,353	13,320	13,320	13,318	13,310	13,306	13,308	13,316	13,304
A37	13,928	13,922	12,686	13,097	13,365	13,365	13,361	13,360	13,360	13,358	13,339	13,325	13,348	13,320	14,666	14,666	14,632	14,632	14,630	14,622	14,618	14,619	14,627	14,615
A38	3,886	3,884	3,539	3,654	3,729	3,729	3,728	3,727	3,727	3,727	3,722	3,718	3,724	3,716	4,092	4,092	4,082	4,082	4,082	4,079	4,078	4,078	4,081	4,077
A39	40,330	40,407	37,381	37,958	38,748	38,748	38,731	38,726	38,727	38,716	38,640	38,580	38,676	38,557	42,289	42,289	42,140	42,140	42,132	42,096	42,079	42,080	42,118	42,065
N14	81,453	85,070	77,130	77,090	78,989	78,989	83,363	83,929	84,038	85,741	86,336	87,948	86,382	88,066	86,928	86,928	91,633	92,273	92,404	94,354	95,049	96,841	95,070	96,988
N15	27,269	28,569	25,868	25,763	26,527	26,527	26,573	26,567	26,565	26,542	26,534	26,526	26,537	26,524	29,099	29,099	29,115	29,116	29,117	29,123	29,127	29,126	29,123	29,128

N16	52,348	51,438	49,378	49,656	50,532	50,532	50,512	50,515	50,518	50,537	50,535	50,530	50,532	50,531	51,653	51,653	51,647	51,647	51,647	51,646	51,646	51,646	51,646	51,646
N17	21,095	21,775	19,877	19,937	20,370	20,370	20,370	20,336	20,338	20,275	20,229	20,130	20,199	20,129	22,451	22,451	22,390	22,358	22,359	22,297	22,277	22,192	22,236	22,199
N18	35,899	35,016	33,389	33,605	34,384	34,384	34,384	34,390	34,393	34,419	34,410	34,407	34,413	34,405	37,189	37,189	37,190	37,192	37,192	37,195	37,195	37,203	37,201	37,202
N19	17,101	17,142	16,236	15,971	16,841	16,841	16,844	16,844	16,844	16,844	16,848	16,850	16,846	16,852	16,987	16,987	16,997	16,997	16,998	17,001	17,002	17,002	17,000	17,003
N20	18,995	19,621	18,035	18,011	18,460	18,460	18,546	18,552	18,553	18,569	18,575	18,596	18,577	18,597	19,715	19,715	19,796	19,806	19,809	19,841	19,854	19,880	19,851	19,884
N21	79,429	80,688	74,984	74,584	77,265	77,265	77,289	77,277	77,278	77,247	77,258	77,230	77,240	77,241	82,439	82,439	82,467	82,461	82,467	82,473	82,483	82,448	82,457	82,461
N22	17,118	17,199	16,246	15,818	16,983	16,983	16,983	16,983	16,983	16,982	16,977	16,977	16,983	16,974	17,080	17,080	17,073	17,074	17,074	17,073	17,072	17,075	17,076	17,074
N23	56,396	57,129	53,586	52,372	55,812	55,812	55,834	55,829	55,828	55,812	55,821	55,820	55,813	55,825	56,771	56,771	56,804	56,801	56,804	56,811	56,815	56,805	56,802	56,811
N24	90,200	95,831	85,932	84,733	88,577	88,577	88,730	88,701	88,688	88,573	88,648	88,689	88,607	88,714	97,260	97,260	97,471	97,469	97,484	97,536	97,565	97,547	97,501	97,575
N25	39,952	43,554	38,235	37,836	39,167	39,167	39,262	39,243	39,235	39,160	39,093	39,052	39,134	39,030	43,724	43,725	43,666	43,667	43,664	43,651	43,645	43,648	43,663	43,642
N26	91,558	93,503	86,786	85,298	90,064	90,064	90,080	90,064	90,061	90,008	90,026	90,005	90,013	90,015	94,320	94,320	94,356	94,346	94,354	94,357	94,367	94,320	94,333	94,337
N27	117,158	120,308	111,230	108,378	116,086	116,086	116,170	116,156	116,151	116,093	116,002	115,934	116,060	115,905	120,778	120,778	120,672	120,675	120,671	120,653	120,648	120,641	120,676	120,635
N28	19,848	19,317	18,437	18,532	19,018	19,018	19,008	19,010	19,012	19,023	19,001	18,985	19,012	18,979	20,568	20,568	20,530	20,531	20,528	20,519	20,515	20,517	20,526	20,512
N29	29,662	29,681	28,051	27,270	29,412	29,412	29,416	29,417	29,417	29,417	29,411	29,407	29,415	29,405	29,923	29,923	29,917	29,917	29,917	29,916	29,915	29,917	29,918	29,916
N30	60,523	61,864	57,370	56,539	59,389	59,389	59,398	59,391	59,387	59,353	59,308	59,282	59,338	59,266	62,432	62,432	62,343	62,347	62,341	62,324	62,314	62,326	62,345	62,315
N31	38,979	39,615	36,831	36,223	38,266	38,266	38,288	38,285	38,284	38,272	38,287	38,295	38,277	38,301	40,497	40,497	40,537	40,537	40,540	40,550	40,556	40,554	40,545	40,559
N32	21,046	21,073	19,838	19,520	20,640	20,640	20,642	20,642	20,642	20,642	20,645	20,646	20,642	20,647	21,551	21,551	21,560	21,560	21,560	21,562	21,563	21,563	21,561	21,564
N33	120,422	119,620	112,861	111,753	117,208	117,208	117,204	117,206	117,209	117,226	117,118	117,044	117,172	117,010	124,381	124,381	124,218	124,219	124,209	124,170	124,149	124,158	124,197	124,139
N34	30,940	31,687	29,388	28,501	30,777	30,777	30,799	30,795	30,793	30,778	30,755	30,741	30,768	30,733	31,749	31,749	31,723	31,724	31,722	31,716	31,713	31,715	31,721	31,711
N35	86,044	88,335	81,253	80,580	83,858	83,858	83,935	83,922	83,918	83,872	83,902	83,916	83,881	83,928	90,956	90,956	91,061	91,060	91,067	91,093	91,106	91,099	91,075	91,112
N36	41,696	44,710	39,685	39,337	40,740	40,740	40,829	40,813	40,806	40,745	40,634	40,565	40,696	40,528	45,308	45,308	45,179	45,180	45,172	45,141	45,125	45,133	45,163	45,117
N37	60,195	59,308	56,489	56,292	58,359	58,359	58,346	58,350	58,353	58,373	58,403	58,418	58,382	58,429	61,167	61,167	61,219	61,219	61,223	61,236	61,243	61,241	61,228	61,247
N38	61,027	60,335	57,524	57,594	59,045	59,045	58,971	58,971	58,973	58,983	58,976	58,966	58,972	58,967	61,424	61,424	61,307	61,315	61,309	61,302	61,295	61,319	61,331	61,307
E06	119,111	115,218	112,520	112,344	115,501	115,501	114,856	114,795	114,800	114,681	114,581	114,401	114,543	114,400	119,142	119,142	118,007	118,036	117,960	117,714	117,575	117,694	117,946	117,549
A40	4,868	4,709	4,550	4,592	4,606	4,721	4,140	4,692	4,102	4,022	4,387	4,676	4,682	4,666	4,870	4,870	4,823	4,824	4,821	4,811	4,806	4,810	4,821	4,804
A41	47,702	46,187	45,063	44,983	46,265	46,265	46,013	45,989	45,990	45,943	45,868	45,775	45,873	45,763	47,617	47,617	47,112	47,124	47,091	46,980	46,918	46,968	47,081	46,904
A42	7,212	7,418	6,830	6,830	6,990	6,990	6,993	6,991	6,990	6,985	6,953	6,932	6,970	6,922	7,467	7,467	7,412	7,412	7,409	7,396	7,389	7,393	7,406	7,386
A43	1,434	1,468	1,358	1,357	1,391	1,391	1,391	1,390	1,390	1,389	1,386	1,384	1,388	1,383	1,489	1,489	1,483	1,483	1,483	1,481	1,481	1,481	1,483	1,480
A44	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A45	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A46	4,795	4,639	4,530	4,523	4,650	4,650	4,624	4,622	4,622	4,617	4,613	4,606	4,611	4,606	4,796	4,797	4,751	4,752	4,749	4,739	4,733	4,738	4,748	4,732
A47	49,969	48,336	47,204	47,131	48,455	48,455	48,185	48,159	48,161	48,111	48,069	47,993	48,053	47,993	49,982	49,983	49,506	49,519	49,487	49,383	49,325	49,375	49,481	49,314

	A48	11,687	11,525	11,041	10,974	11,377	11,377	11,341	11,337	11,337	11,328	11,140	11,016	11,241	10,955	11,196	11,197	10,830	10,835	10,811	10,725	10,678	10,702	10,788	10,658
	N39	415,093	415,383	394,543	381,884	414,108	414,108	414,098	414,101	414,098	414,093	414,086	414,096	414,105	414,089	409,638	409,638	409,626	409,630	409,628	409,630	409,630	409,640	409,640	409,637
	N40	654,214	654,869	614,502	613,205	633,427	633,429	633,707	633,711	633,726	633,788	633,798	633,778	633,755	633,798	678,051	678,051	678,379	678,395	678,417	678,529	678,585	678,604	678,520	678,641
	N41	357,648	358,599	335,867	335,988	345,505	345,506	345,572	345,593	345,593	345,624	345,637	345,671	345,678	345,668	371,341	371,341	371,471	371,495	371,506	371,583	371,622	371,651	371,619	371,669
	A49	39,099	39,203	36,717	36,731	37,771	37,771	37,787	37,791	37,791	37,797	37,799	37,811	37,806	37,809	40,595	40,595	40,619	40,624	40,624	40,636	40,640	40,653	40,643	40,653
	A50	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	A51	1,024	1,027	962	962	990	990	990	990	990	990	990	991	991	991	1,064	1,064	1,064	1,064	1,064	1,065	1,065	1,065	1,065	1,065
	A52	1,809	1,814	1,699	1,700	1,748	1,748	1,748	1,749	1,749	1,749	1,749	1,750	1,749	1,749	1,878	1,878	1,879	1,880	1,880	1,880	1,880	1,881	1,881	1,881
	A53	3,827	3,837	3,594	3,595	3,697	3,697	3,699	3,699	3,699	3,700	3,700	3,701	3,701	3,701	3,974	3,974	3,976	3,976	3,976	3,978	3,978	3,979	3,978	3,979
	N42	276,467	274,219	262,308	262,905	268,279	268,279	268,255	268,274	268,281	268,346	268,344	268,350	268,353	268,349	269,395	269,395	269,421	269,432	269,433	269,457	269,466	269,490	269,478	269,490
	N43	413,848	409,639	390,151	390,957	400,371	400,372	400,559	400,603	400,633	400,831	400,867	400,882	400,831	400,910	414,441	414,441	414,722	414,755	414,773	414,898	414,956	415,011	414,935	415,039
	N44	342,016	333,424	318,650	320,279	328,207	328,207	327,994	328,046	328,065	328,253	328,266	328,289	328,272	328,290	352,050	352,050	352,038	352,049	352,047	352,059	352,061	352,088	352,084	352,083
	N45	52,561	51,433	49,146	49,378	50,544	50,544	50,528	50,534	50,538	50,565	50,570	50,572	50,566	50,574	53,534	53,534	53,545	53,547	53,547	53,553	53,555	53,559	53,555	53,560
	N46	151,625	147,487	141,453	142,356	145,485	145,485	145,399	145,418	145,430	145,518	145,526	145,519	145,510	145,526	154,613	154,613	154,615	154,615	154,615	154,617	154,619	154,617	154,618	154,618
	N47	305,488	310,707	291,171	291,095	297,393	297,393	297,473	297,461	297,445	297,346	297,285	297,273	297,366	297,242	303,732	303,732	303,681	303,698	303,696	303,713	303,720	303,749	303,760	303,744
	N48	67,066	64,853	62,297	62,739	64,185	64,185	64,139	64,149	64,156	64,203	64,208	64,207	64,200	64,211	69,107	69,107	69,108	69,109	69,109	69,110	69,110	69,112	69,111	69,112
	N49	134,265	130,569	126,184	126,920	129,391	129,391	129,313	129,331	129,341	129,419	129,428	129,426	129,414	129,431	131,730	131,730	131,731	131,732	131,732	131,733	131,733	131,735	131,734	131,735
	N50	230,661	226,474	219,101	219,927	223,818	223,818	223,730	223,751	223,763	223,854	223,861	223,859	223,850	223,864	209,228	209,228	209,231	209,233	209,234	209,239	209,241	209,245	209,244	209,245
	N51	197,615	197,616	197,566	197,568	197,587	197,587	197,587	197,587	197,587	197,587	197,587	197,587	197,587	197,586	147,352	147,352	147,351	147,352	147,352	147,352	147,352	147,352	147,352	147,352
	N52	130,853	130,754	130,650	130,670	130,730	130,730	130,727	130,728	130,728	130,730	130,731	130,730	130,730	130,731	98,205	98,205	98,205	98,205	98,205	98,205	98,205	98,205	98,205	98,205
	N53	592,545	592,538	591,122	591,154	591,732	591,732	591,731	591,731	591,731	591,732	591,732	591,731	591,733	591,731	447,915	447,915	447,912	447,913	447,913	447,915	447,915	447,918	447,919	447,918
Competitive Imports	A01	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	A02	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
	A03	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	A04	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	A05	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	A06	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	A07	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	A08	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	A09	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	A10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

A11	201	-	189	189	195	195	197	197	197	198	197	198	198	198	208	208	209	210	210	210	211	211	211	211
A12	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A13	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A14	93	-	88	88	91	91	91	90	90	90	90	90	90	90	93	93	92	92	92	92	92	92	92	92
A15	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A16	11,832	12,400	11,287	11,158	11,602	11,602	11,718	11,725	11,726	11,746	11,766	11,802	11,761	11,808	12,799	12,799	12,926	12,938	12,943	12,989	13,007	13,041	12,998	13,048
A17	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A18	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A19	-	-	-	-	-	-	318	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A20	-	-	-	-	-	-	12	12	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A21	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A22	-	-	-	-	-	-	-	-	365	742	35	-	-	-	-	-	-	-	-	-	-	-	-	-
A23	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A24	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A25	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A26	-	-	-	-	-	-	-	190	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A27	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A28	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A29	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A30	-	-	-	-	-	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A31	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A32	-	-	-	-	528	524	1,223	1,223	1,223	1,222	1,176	1,147	1,202	1,131	-	-	-	-	-	-	-	-	-	-
A33	-	-	-	-	-	-	974	974	973	971	945	-	683	-	-	-	-	-	-	-	-	-	-	-
A34	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A35	-	-	656	-	-	-	-	-	-	-	-	4	-	4	-	-	-	-	-	-	-	-	-	-
A36	-	-	347	-	-	-	3	3	4	7	6	-	5	-	-	-	-	-	-	-	-	-	-	-
A37	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A38	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A39	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
E06	-	2,961	-	-	-	115	-	593	-	-	-	151	564	-	-	-	-	-	-	-	-	-	-	-
A40	-	-	49	-	115	-	554	-	590	665	296	-	-	9	-	-	-	-	-	-	-	-	-	-
A41	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

	A42	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	A43	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	A44	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	A45	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	A46	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	A47	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	A48	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Exports (basic prices or toe)	N01	26,686	34,210	26,231	26,343	26,006	26,006	26,217	26,178	26,160	26,006	25,934	25,890	25,974	25,867	34,193	34,193	34,193	34,193	34,193	34,193	34,193	34,193	34,193	34,193
	N02	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	E01	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	A01	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	A02	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	N03	3,911	5,013	3,844	3,860	3,811	3,811	3,842	3,836	3,834	3,811	3,801	3,794	3,806	3,791	5,011	5,011	5,011	5,011	5,011	5,011	5,011	5,011	5,011	5,011
	E02	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	A03	26,231	33,626	25,783	25,893	25,562	25,562	25,770	25,731	25,713	25,562	25,491	25,448	25,531	25,425	33,609	33,609	33,609	33,609	33,609	33,609	33,609	33,609	33,609	33,609
	A04	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	A05	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	N04	21,861	28,024	21,488	21,579	21,304	21,304	21,477	21,444	21,430	21,303	21,245	21,209	21,278	21,189	28,010	28,010	28,010	28,010	28,010	28,010	28,010	28,010	28,010	28,010
	N05	2,702	3,464	2,656	2,667	2,633	2,633	2,655	2,651	2,649	2,633	2,626	2,622	2,630	2,619	3,462	3,462	3,462	3,462	3,462	3,462	3,462	3,462	3,462	3,462
	E03	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	A06	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	A07	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	A08	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	A09	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	A10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	A11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	A12	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	A13	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	A14	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	A15	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	A16	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	N06	45,129	57,852	44,359	44,548	43,979	43,979	44,336	44,269	44,239	43,978	43,857	43,783	43,925	43,743	57,823	57,823	57,823	57,823	57,823	57,823	57,823	57,823	57,823	57,823

N07	3,098	3,971	3,045	3,058	3,019	3,019	3,043	3,039	3,037	3,019	3,010	3,005	3,015	3,003	3,969	3,969	3,969	3,969	3,969	3,969	3,969	3,969	3,969	3,969
N08	2,399	3,076	2,359	2,369	2,338	2,338	2,357	2,354	2,352	2,338	2,332	2,328	2,335	2,326	3,074	3,074	3,074	3,074	3,074	3,074	3,074	3,074	3,074	3,074
N09	233	298	229	230	227	227	229	228	228	227	226	226	226	226	298	298	298	298	298	298	298	298	298	298
N10	3,469	4,447	3,410	3,424	3,381	3,381	3,408	3,403	3,401	3,381	3,371	3,366	3,377	3,362	4,445	4,445	4,445	4,445	4,445	4,445	4,445	4,445	4,445	4,445
N11	2,579	3,306	2,535	2,546	2,513	2,513	2,534	2,530	2,528	2,513	2,506	2,502	2,510	2,500	3,305	3,305	3,305	3,305	3,305	3,305	3,305	3,305	3,305	3,305
N12	8,567	10,982	8,421	8,457	8,349	8,349	8,416	8,404	8,398	8,348	8,325	8,311	8,338	8,304	10,977	10,977	10,977	10,977	10,977	10,977	10,977	10,977	10,977	10,977
N13	135	173	132	133	131	131	132	132	132	131	131	131	131	131	173	173	173	173	173	173	173	173	173	173
E04	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A17	1,875	2,404	1,843	1,851	1,827	1,827	1,842	1,840	1,838	1,827	1,822	1,819	1,825	1,818	2,403	2,403	2,403	2,403	2,403	2,403	2,403	2,403	2,403	2,403
A18	6,945	8,902	6,826	6,855	6,768	6,768	6,822	6,812	6,808	6,767	6,749	6,737	6,759	6,731	8,898	8,898	8,898	8,898	8,898	8,898	8,898	8,898	8,898	8,898
A19	1,651	2,117	1,623	1,630	1,609	1,609	1,622	1,620	1,619	1,609	1,605	1,602	1,607	1,601	2,116	2,116	2,116	2,116	2,116	2,116	2,116	2,116	2,116	2,116
A20	4	6	4	4	4	4	4	4	4	4	4	4	4	4	6	6	6	6	6	6	6	6	6	6
A21	12	15	12	12	12	12	12	12	12	12	12	12	12	12	15	15	15	15	15	15	15	15	15	15
A22	37	48	37	37	36	36	37	37	37	36	36	36	36	36	48	48	48	48	48	48	48	48	48	48
A23	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A24	1,621	2,079	1,594	1,601	1,580	1,580	1,593	1,591	1,590	1,580	1,576	1,573	1,578	1,572	2,078	2,078	2,078	2,078	2,078	2,078	2,078	2,078	2,078	2,078
A25	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A26	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A27	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A28	210	269	206	207	204	204	206	206	205	204	204	203	204	203	268	268	268	268	268	268	268	268	268	268
A29	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A30	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1
A31	63	81	62	62	61	61	62	62	62	61	61	61	61	61	81	81	81	81	81	81	81	81	81	81
A32	44	56	43	43	43	43	43	43	43	43	43	43	43	43	56	56	56	56	56	56	56	56	56	56
A33	348	446	342	344	339	339	342	341	341	339	338	338	339	337	446	446	446	446	446	446	446	446	446	446
A34	8	11	8	8	8	8	8	8	8	8	8	8	8	8	11	11	11	11	11	11	11	11	11	11
E05	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A35	777	996	763	767	757	757	763	762	761	757	755	753	756	753	995	995	995	995	995	995	995	995	995	995
A36	885	1,135	870	874	863	863	870	869	868	863	861	859	862	858	1,135	1,135	1,135	1,135	1,135	1,135	1,135	1,135	1,135	1,135
A37	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A38	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A39	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

N14	5,877	7,534	5,777	5,801	5,727	5,727	5,774	5,765	5,761	5,727	5,711	5,702	5,720	5,696	7,530	7,530	7,530	7,530	7,530	7,530	7,530	7,530	7,530	7,530
N15	3,387	4,342	3,329	3,343	3,300	3,300	3,327	3,322	3,320	3,300	3,291	3,286	3,296	3,283	4,339	4,339	4,339	4,339	4,339	4,339	4,339	4,339	4,339	4,339
N16	1,402	1,798	1,378	1,384	1,366	1,366	1,378	1,376	1,375	1,366	1,363	1,360	1,365	1,359	1,797	1,797	1,797	1,797	1,797	1,797	1,797	1,797	1,797	1,797
N17	768	985	755	758	749	749	755	754	753	749	747	745	748	745	984	984	984	984	984	984	984	984	984	984
N18	685	878	673	676	668	668	673	672	672	668	666	665	667	664	878	878	878	878	878	878	878	878	878	878
N19	309	397	304	305	302	302	304	303	303	302	301	300	301	300	396	396	396	396	396	396	396	396	396	396
N20	1,559	1,999	1,533	1,539	1,520	1,520	1,532	1,530	1,529	1,520	1,515	1,513	1,518	1,512	1,998	1,998	1,998	1,998	1,998	1,998	1,998	1,998	1,998	1,998
N21	3,459	4,434	3,400	3,414	3,371	3,371	3,398	3,393	3,391	3,371	3,361	3,356	3,367	3,353	4,432	4,432	4,432	4,432	4,432	4,432	4,432	4,432	4,432	4,432
N22	55	71	54	55	54	54	54	54	54	54	54	54	54	54	71	71	71	71	71	71	71	71	71	71
N23	2,189	2,806	2,151	2,161	2,133	2,133	2,150	2,147	2,146	2,133	2,127	2,124	2,130	2,122	2,804	2,804	2,804	2,804	2,804	2,804	2,804	2,804	2,804	2,804
N24	13,787	17,673	13,552	13,609	13,435	13,435	13,544	13,524	13,515	13,435	13,398	13,375	13,419	13,363	17,665	17,665	17,665	17,665	17,665	17,665	17,665	17,665	17,665	17,665
N25	9,546	12,237	9,383	9,423	9,303	9,303	9,378	9,364	9,358	9,303	9,277	9,261	9,291	9,253	12,231	12,231	12,231	12,231	12,231	12,231	12,231	12,231	12,231	12,231
N26	2,720	3,487	2,673	2,685	2,651	2,651	2,672	2,668	2,666	2,650	2,643	2,639	2,647	2,636	3,485	3,485	3,485	3,485	3,485	3,485	3,485	3,485	3,485	3,485
N27	8,973	11,503	8,820	8,857	8,744	8,744	8,815	8,802	8,796	8,744	8,720	8,705	8,734	8,697	11,497	11,497	11,497	11,497	11,497	11,497	11,497	11,497	11,497	11,497
N28	351	449	345	346	342	342	344	344	344	342	341	340	341	340	449	449	449	449	449	449	449	449	449	449
N29	530	679	521	523	516	516	520	520	519	516	515	514	516	513	679	679	679	679	679	679	679	679	679	679
N30	4,402	5,643	4,327	4,345	4,290	4,290	4,324	4,318	4,315	4,290	4,278	4,271	4,284	4,267	5,640	5,640	5,640	5,640	5,640	5,640	5,640	5,640	5,640	5,640
N31	3,052	3,913	3,000	3,013	2,974	2,974	2,998	2,994	2,992	2,974	2,966	2,961	2,971	2,958	3,911	3,911	3,911	3,911	3,911	3,911	3,911	3,911	3,911	3,911
N32	959	1,229	942	946	934	934	942	941	940	934	932	930	933	929	1,228	1,228	1,228	1,228	1,228	1,228	1,228	1,228	1,228	1,228
N33	5,399	6,921	5,307	5,330	5,261	5,261	5,304	5,296	5,293	5,261	5,247	5,238	5,255	5,233	6,918	6,918	6,918	6,918	6,918	6,918	6,918	6,918	6,918	6,918
N34	2,494	3,197	2,452	2,462	2,431	2,431	2,450	2,447	2,445	2,431	2,424	2,420	2,428	2,418	3,196	3,196	3,196	3,196	3,196	3,196	3,196	3,196	3,196	3,196
N35	6,380	8,179	6,272	6,298	6,218	6,218	6,268	6,259	6,255	6,218	6,201	6,190	6,210	6,184	8,175	8,175	8,175	8,175	8,175	8,175	8,175	8,175	8,175	8,175
N36	9,368	12,009	9,208	9,247	9,129	9,129	9,203	9,189	9,183	9,129	9,104	9,088	9,118	9,080	12,003	12,003	12,003	12,003	12,003	12,003	12,003	12,003	12,003	12,003
N37	1,351	1,732	1,328	1,334	1,317	1,317	1,328	1,326	1,325	1,317	1,313	1,311	1,315	1,310	1,731	1,731	1,731	1,731	1,731	1,731	1,731	1,731	1,731	1,731
N38	409	524	402	403	398	398	402	401	401	398	397	397	398	396	524	524	524	524	524	524	524	524	524	524
E06	90	115	88	89	88	88	88	88	88	88	87	87	88	87	115	115	115	115	115	115	115	115	115	115
A40	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A41	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A42	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A43	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A44	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A45	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

	A46	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	A47	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	A48	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	N39	1,467	1,880	1,442	1,448	1,429	1,429	1,441	1,439	1,438	1,429	1,425	1,423	1,427	1,421	1,879	1,879	1,879	1,879	1,879	1,879	1,879	1,879	1,879	1,879
	N40	33,476	42,913	32,905	33,044	32,622	32,622	32,887	32,838	32,815	32,622	32,532	32,477	32,583	32,447	42,892	42,892	42,892	42,892	42,892	42,892	42,892	42,892	42,892	42,892
	N41	9,149	11,729	8,993	9,031	8,916	8,916	8,988	8,975	8,969	8,916	8,891	8,876	8,905	8,868	11,723	11,723	11,723	11,723	11,723	11,723	11,723	11,723	11,723	11,723
	A49	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	A50	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	A51	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	A52	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	A53	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	N42	1,051	1,347	1,033	1,038	1,024	1,024	1,033	1,031	1,030	1,024	1,021	1,020	1,023	1,019	1,347	1,347	1,347	1,347	1,347	1,347	1,347	1,347	1,347	1,347
	N43	2,611	3,347	2,566	2,577	2,544	2,544	2,565	2,561	2,559	2,544	2,537	2,533	2,541	2,531	3,345	3,345	3,345	3,345	3,345	3,345	3,345	3,345	3,345	3,345
	N44	2,055	2,634	2,019	2,028	2,002	2,002	2,018	2,015	2,014	2,002	1,997	1,993	2,000	1,991	2,632	2,632	2,632	2,632	2,632	2,632	2,632	2,632	2,632	2,632
	N45	59	75	58	58	57	57	58	58	58	57	57	57	57	57	75	75	75	75	75	75	75	75	75	75
	N46	1,211	1,553	1,191	1,196	1,180	1,180	1,190	1,188	1,187	1,180	1,177	1,175	1,179	1,174	1,552	1,552	1,552	1,552	1,552	1,552	1,552	1,552	1,552	1,552
	N47	21,320	27,331	20,956	21,045	20,777	20,777	20,945	20,914	20,899	20,776	20,719	20,684	20,751	20,665	27,317	27,317	27,317	27,317	27,317	27,317	27,317	27,317	27,317	27,317
	N48	92	118	91	91	90	90	91	91	90	90	90	90	90	89	118	118	118	118	118	118	118	118	118	118
	N49	321	411	316	317	313	313	315	315	315	313	312	311	312	311	411	411	411	411	411	411	411	411	411	411
	N50	1,935	2,480	1,902	1,910	1,885	1,885	1,901	1,898	1,897	1,885	1,880	1,877	1,883	1,875	2,479	2,479	2,479	2,479	2,479	2,479	2,479	2,479	2,479	2,479
	N51	40	51	39	40	39	39	39	39	39	39	39	39	39	39	51	51	51	51	51	51	51	51	51	51
	N52	2	3	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3	3	3	3	3
	N53	875	1,122	860	864	853	853	860	858	858	853	850	849	852	848	1,121	1,121	1,121	1,121	1,121	1,121	1,121	1,121	1,121	1,121
Exports at consumer prices	N01	34,120	43,740	33,538	33,681	33,251	33,251	33,520	33,470	33,447	33,250	33,159	33,103	33,210	33,072	43,718	43,718	43,718	43,718	43,718	43,718	43,718	43,718	43,718	43,718
	N02	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	E01	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	A01	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	A02	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	N03	4,762	6,104	4,680	4,700	4,640	4,640	4,678	4,671	4,668	4,640	4,627	4,620	4,634	4,615	6,101	6,101	6,101	6,101	6,101	6,101	6,101	6,101	6,101	6,101
	E02	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	A03	17,203	22,053	16,910	16,982	16,765	16,765	16,901	16,875	16,864	16,764	16,718	16,690	16,744	16,675	22,042	22,042	22,042	22,042	22,042	22,042	22,042	22,042	22,042	22,042
	A04	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

A05	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
N04	25,622	32,845	25,185	25,292	24,969	24,969	25,171	25,134	25,117	24,968	24,900	24,858	24,938	24,835	32,829	32,829	32,829	32,829	32,829	32,829	32,829	32,829	32,829	32,829
N05	3,110	3,987	3,057	3,070	3,031	3,031	3,055	3,051	3,049	3,031	3,022	3,017	3,027	3,014	3,985	3,985	3,985	3,985	3,985	3,985	3,985	3,985	3,985	3,985
E03	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A06	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A07	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A08	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A09	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A12	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A13	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A14	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A15	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A16	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
N06	56,764	72,767	55,796	56,033	55,317	55,317	55,766	55,682	55,644	55,316	55,164	55,071	55,250	55,020	72,731	72,731	72,731	72,731	72,731	72,731	72,731	72,731	72,731	72,731
N07	5,587	7,162	5,492	5,515	5,444	5,444	5,489	5,480	5,477	5,444	5,429	5,420	5,438	5,415	7,158	7,158	7,158	7,158	7,158	7,158	7,158	7,158	7,158	7,158
N08	3,038	3,894	2,986	2,999	2,960	2,960	2,984	2,980	2,978	2,960	2,952	2,947	2,957	2,944	3,892	3,892	3,892	3,892	3,892	3,892	3,892	3,892	3,892	3,892
N09	361	462	355	356	352	352	354	354	354	351	351	350	351	350	462	462	462	462	462	462	462	462	462	462
N10	4,888	6,267	4,805	4,825	4,764	4,764	4,802	4,795	4,792	4,764	4,751	4,743	4,758	4,738	6,263	6,263	6,263	6,263	6,263	6,263	6,263	6,263	6,263	6,263
N11	3,223	4,132	3,168	3,181	3,141	3,141	3,166	3,162	3,159	3,141	3,132	3,127	3,137	3,124	4,130	4,130	4,130	4,130	4,130	4,130	4,130	4,130	4,130	4,130
N12	9,571	12,270	9,408	9,448	9,328	9,327	9,403	9,389	9,383	9,327	9,302	9,286	9,316	9,277	12,264	12,264	12,264	12,264	12,264	12,264	12,264	12,264	12,264	12,264
N13	185	237	182	182	180	180	181	181	181	180	179	179	180	179	237	237	237	237	237	237	237	237	237	237
E04	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A17	1,611	2,065	1,583	1,590	1,570	1,570	1,582	1,580	1,579	1,569	1,565	1,563	1,568	1,561	2,064	2,064	2,064	2,064	2,064	2,064	2,064	2,064	2,064	2,064
A18	5,964	7,646	5,863	5,887	5,812	5,812	5,859	5,851	5,847	5,812	5,796	5,786	5,805	5,781	7,642	7,642	7,642	7,642	7,642	7,642	7,642	7,642	7,642	7,642
A19	1,418	1,818	1,394	1,400	1,382	1,382	1,393	1,391	1,390	1,382	1,378	1,376	1,380	1,375	1,817	1,817	1,817	1,817	1,817	1,817	1,817	1,817	1,817	1,817
A20	4	5	4	4	4	4	4	4	4	4	4	4	4	4	5	5	5	5	5	5	5	5	5	5
A21	10	13	10	10	10	10	10	10	10	10	10	10	10	10	13	13	13	13	13	13	13	13	13	13
A22	32	41	32	32	31	31	32	31	31	31	31	31	31	31	41	41	41	41	41	41	41	41	41	41
A23	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A24	1,393	1,785	1,369	1,375	1,357	1,357	1,368	1,366	1,365	1,357	1,353	1,351	1,355	1,350	1,784	1,784	1,784	1,784	1,784	1,784	1,784	1,784	1,784	1,784

A25	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A26	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A27	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A28	180	231	177	178	175	175	177	177	176	175	175	175	175	174	231	231	231	231	231	231	231	231	231	231
A29	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A30	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A31	54	69	53	53	53	53	53	53	53	53	52	52	53	52	69	69	69	69	69	69	69	69	69	69
A32	38	48	37	37	37	37	37	37	37	37	37	37	37	37	48	48	48	48	48	48	48	48	48	48
A33	299	383	294	295	291	291	294	293	293	291	291	290	291	290	383	383	383	383	383	383	383	383	383	383
A34	7	9	7	7	7	7	7	7	7	7	7	7	7	7	9	9	9	9	9	9	9	9	9	9
E05	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A35	1,208	1,548	1,187	1,192	1,177	1,177	1,187	1,185	1,184	1,177	1,174	1,172	1,176	1,171	1,548	1,548	1,548	1,548	1,548	1,548	1,548	1,548	1,548	1,548
A36	1,377	1,766	1,354	1,360	1,342	1,342	1,353	1,351	1,350	1,342	1,338	1,336	1,341	1,335	1,765	1,765	1,765	1,765	1,765	1,765	1,765	1,765	1,765	1,765
A37	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A38	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A39	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
N14	6,630	8,500	6,517	6,545	6,461	6,461	6,514	6,504	6,500	6,461	6,443	6,433	6,453	6,427	8,495	8,495	8,495	8,495	8,495	8,495	8,495	8,495	8,495	8,495
N15	3,699	4,741	3,636	3,651	3,604	3,604	3,634	3,628	3,626	3,604	3,594	3,588	3,600	3,585	4,739	4,739	4,739	4,739	4,739	4,739	4,739	4,739	4,739	4,739
N16	2,351	3,014	2,311	2,321	2,291	2,291	2,310	2,306	2,305	2,291	2,285	2,281	2,288	2,279	3,012	3,012	3,012	3,012	3,012	3,012	3,012	3,012	3,012	3,012
N17	900	1,154	885	889	878	878	885	883	883	878	875	874	876	873	1,154	1,154	1,154	1,154	1,154	1,154	1,154	1,154	1,154	1,154
N18	1,202	1,541	1,181	1,186	1,171	1,171	1,181	1,179	1,178	1,171	1,168	1,166	1,170	1,165	1,540	1,540	1,540	1,540	1,540	1,540	1,540	1,540	1,540	1,540
N19	417	535	410	412	407	407	410	409	409	407	406	405	406	405	535	535	535	535	535	535	535	535	535	535
N20	1,842	2,361	1,810	1,818	1,795	1,795	1,809	1,807	1,805	1,795	1,790	1,787	1,792	1,785	2,360	2,360	2,360	2,360	2,360	2,360	2,360	2,360	2,360	2,360
N21	4,618	5,920	4,539	4,558	4,500	4,500	4,537	4,530	4,527	4,500	4,488	4,480	4,495	4,476	5,917	5,917	5,917	5,917	5,917	5,917	5,917	5,917	5,917	5,917
N22	79	102	78	78	77	77	78	78	78	77	77	77	77	77	102	102	102	102	102	102	102	102	102	102
N23	2,996	3,841	2,945	2,958	2,920	2,920	2,943	2,939	2,937	2,920	2,912	2,907	2,916	2,904	3,839	3,839	3,839	3,839	3,839	3,839	3,839	3,839	3,839	3,839
N24	15,462	19,821	15,198	15,262	15,067	15,067	15,190	15,167	15,157	15,067	15,026	15,000	15,049	14,987	19,811	19,811	19,811	19,811	19,811	19,811	19,811	19,811	19,811	19,811
N25	10,408	13,343	10,231	10,274	10,143	10,143	10,225	10,210	10,203	10,143	10,115	10,098	10,131	10,088	13,336	13,336	13,336	13,336	13,336	13,336	13,336	13,336	13,336	13,336
N26	3,268	4,189	3,212	3,226	3,184	3,184	3,210	3,205	3,203	3,184	3,176	3,170	3,180	3,167	4,187	4,187	4,187	4,187	4,187	4,187	4,187	4,187	4,187	4,187
N27	11,915	15,275	11,712	11,762	11,612	11,612	11,706	11,688	11,681	11,612	11,580	11,560	11,598	11,550	15,267	15,267	15,267	15,267	15,267	15,267	15,267	15,267	15,267	15,267
N28	718	921	706	709	700	700	706	705	704	700	698	697	699	696	920	920	920	920	920	920	920	920	920	920
N29	832	1,067	818	822	811	811	818	817	816	811	809	808	810	807	1,067	1,067	1,067	1,067	1,067	1,067	1,067	1,067	1,067	1,067

N30	5,516	7,071	5,422	5,445	5,375	5,375	5,419	5,411	5,407	5,375	5,360	5,351	5,369	5,346	7,067	7,067	7,067	7,067	7,067	7,067	7,067	7,067	7,067	7,067
N31	4,011	5,141	3,942	3,959	3,908	3,908	3,940	3,934	3,931	3,908	3,898	3,891	3,904	3,887	5,139	5,139	5,139	5,139	5,139	5,139	5,139	5,139	5,139	5,139
N32	1,365	1,750	1,342	1,348	1,330	1,330	1,341	1,339	1,338	1,330	1,327	1,325	1,329	1,323	1,749	1,749	1,749	1,749	1,749	1,749	1,749	1,749	1,749	1,749
N33	7,950	10,192	7,815	7,848	7,748	7,748	7,810	7,799	7,793	7,747	7,726	7,713	7,738	7,706	10,187	10,187	10,187	10,187	10,187	10,187	10,187	10,187	10,187	10,187
N34	3,047	3,907	2,995	3,008	2,970	2,970	2,994	2,989	2,987	2,970	2,962	2,957	2,966	2,954	3,905	3,905	3,905	3,905	3,905	3,905	3,905	3,905	3,905	3,905
N35	7,694	9,863	7,563	7,595	7,498	7,498	7,559	7,547	7,542	7,497	7,477	7,464	7,489	7,457	9,858	9,858	9,858	9,858	9,858	9,858	9,858	9,858	9,858	9,858
N36	10,552	13,526	10,372	10,416	10,283	10,283	10,366	10,350	10,343	10,282	10,254	10,237	10,270	10,227	13,519	13,519	13,519	13,519	13,519	13,519	13,519	13,519	13,519	13,519
N37	2,222	2,848	2,184	2,193	2,165	2,165	2,183	2,180	2,178	2,165	2,159	2,156	2,163	2,154	2,847	2,847	2,847	2,847	2,847	2,847	2,847	2,847	2,847	2,847
N38	496	635	487	489	483	483	487	486	486	483	482	481	482	480	635	635	635	635	635	635	635	635	635	635
E06	1,375	1,763	1,352	1,357	1,340	1,340	1,351	1,349	1,348	1,340	1,336	1,334	1,338	1,333	1,762	1,762	1,762	1,762	1,762	1,762	1,762	1,762	1,762	1,762
A40	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A41	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A42	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A43	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A44	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A45	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A46	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A47	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A48	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
N39	1,507	1,931	1,481	1,487	1,468	1,468	1,480	1,478	1,477	1,468	1,464	1,462	1,466	1,460	1,930	1,930	1,930	1,930	1,930	1,930	1,930	1,930	1,930	1,930
N40	385	494	379	380	376	376	379	378	378	375	374	374	375	373	494	494	494	494	494	494	494	494	494	494
N41	6,327	8,111	6,219	6,245	6,166	6,166	6,216	6,206	6,202	6,166	6,149	6,138	6,158	6,133	8,107	8,107	8,107	8,107	8,107	8,107	8,107	8,107	8,107	8,107
A49	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A50	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A51	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A52	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A53	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
N42	1,243	1,594	1,222	1,227	1,212	1,212	1,221	1,220	1,219	1,212	1,208	1,206	1,210	1,205	1,593	1,593	1,593	1,593	1,593	1,593	1,593	1,593	1,593	1,593
N43	2,821	3,616	2,773	2,784	2,749	2,749	2,771	2,767	2,765	2,749	2,741	2,737	2,745	2,734	3,614	3,614	3,614	3,614	3,614	3,614	3,614	3,614	3,614	3,614
N44	2,097	2,689	2,062	2,070	2,044	2,044	2,061	2,057	2,056	2,044	2,038	2,035	2,042	2,033	2,687	2,687	2,687	2,687	2,687	2,687	2,687	2,687	2,687	2,687
N45	1	2	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	2
N46	2,148	2,753	2,111	2,120	2,093	2,093	2,110	2,107	2,106	2,093	2,087	2,084	2,091	2,082	2,752	2,752	2,752	2,752	2,752	2,752	2,752	2,752	2,752	2,752

	N47	22,090	28,317	21,713	21,805	21,527	21,527	21,701	21,669	21,654	21,526	21,467	21,431	21,500	21,411	28,303	28,303	28,303	28,303	28,303	28,303	28,303	28,303	28,303	28,303
	N48	92	118	90	91	89	89	90	90	90	89	89	89	89	89	118	118	118	118	118	118	118	118	118	118
	N49	184	236	181	181	179	179	181	180	180	179	179	178	179	178	236	236	236	236	236	236	236	236	236	236
	N50	1,152	1,477	1,132	1,137	1,122	1,122	1,132	1,130	1,129	1,122	1,119	1,117	1,121	1,116	1,476	1,476	1,476	1,476	1,476	1,476	1,476	1,476	1,476	1,476
	N51	42	54	41	41	41	41	41	41	41	41	41	41	41	41	54	54	54	54	54	54	54	54	54	54
	N52	2	3	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3	3	3	3	3
	N53	847	1,086	833	836	826	826	832	831	830	826	823	822	825	821	1,085	1,085	1,085	1,085	1,085	1,085	1,085	1,085	1,085	1,085
Economic Variables	cf	2,585,212	2,491,328	2,393,625	2,412,456	2,468,823	2,468,823	2,466,877	2,467,294	2,467,562	2,469,529	2,469,762	2,469,666	2,469,354	2,469,826	2,687,409	2,687,409	2,687,409	2,687,409	2,687,409	2,687,409	2,687,409	2,687,409	2,687,409	2,687,409
	cnpish	68,769	68,769	68,769	68,769	68,769	68,769	68,769	68,769	68,769	68,769	68,769	68,769	68,769	68,769	39,229	39,229	39,229	39,229	39,229	39,229	39,229	39,229	39,229	39,229
	cpr	2,668,603	2,574,038	2,475,401	2,494,412	2,551,100	2,551,101	2,549,135	2,549,557	2,549,827	2,551,814	2,552,048	2,551,951	2,551,637	2,552,113	2,741,955	2,741,955	2,741,955	2,741,955	2,741,955	2,741,955	2,741,955	2,741,955	2,741,955	2,741,955
	g	922,816	922,816	922,816	922,816	922,816	922,816	922,816	922,816	922,816	922,816	922,816	922,816	922,816	922,816	687,001	687,001	687,001	687,001	687,001	687,001	687,001	687,001	687,001	687,001
	cfr	2,574,558	2,480,889	2,383,186	2,402,017	2,458,169	2,458,169	2,456,222	2,456,640	2,456,907	2,458,875	2,459,108	2,459,011	2,458,700	2,459,171	2,676,755	2,676,755	2,676,755	2,676,755	2,676,755	2,676,755	2,676,755	2,676,755	2,676,755	2,676,755
	cpe	10,654	10,439	10,439	10,439	10,654	10,654	10,654	10,654	10,654	10,654	10,654	10,654	10,654	10,654	10,654	10,654	10,654	10,654	10,654	10,654	10,654	10,654	10,654	10,654
	cpm	25,276	24,380	23,446	23,626	24,163	24,163	24,145	24,149	24,151	24,170	24,172	24,171	24,168	24,173	25,971	25,971	25,971	25,971	25,971	25,971	25,971	25,971	25,971	25,971
	sc	-10,082	-10,221	-9,527	-9,405	-9,870	-9,870	-9,875	-9,874	-9,874	-9,869	-9,479	-9,238	-9,700	-9,108	-9,031	-9,032	-8,392	-8,397	-8,356	-8,202	-8,121	-8,157	-8,309	-8,081
	gfcf	861,608	861,608	816,599	786,297	861,608	861,608	861,608	861,608	861,608	861,608	861,608	861,608	861,608	861,608	861,608	861,608	861,608	861,608	861,608	861,608	861,608	861,608	861,608	861,608
	impwtcif	425,900	426,201	401,552	398,089	415,525	415,525	416,245	416,165	416,213	416,250	415,968	415,551	415,839	415,542	433,266	433,266	433,517	433,447	433,467	433,412	433,407	433,227	433,227	433,273
	impwtfob	411,517	411,808	387,991	384,645	401,493	401,492	402,188	402,111	402,158	402,193	401,921	401,518	401,796	401,509	418,635	418,635	418,877	418,810	418,829	418,776	418,771	418,597	418,597	418,642
	impfob	436,793	436,188	411,438	408,272	425,656	425,656	426,333	426,260	426,309	426,363	426,093	425,689	425,965	425,681	444,605	444,606	444,848	444,781	444,800	444,746	444,741	444,568	444,568	444,612
	expcpt	345,186	439,284	339,267	340,663	336,660	336,660	339,306	338,811	338,589	336,653	335,758	335,209	336,262	334,911	439,284	439,284	439,284	439,284	439,284	439,284	439,284	439,284	439,284	439,284
	expcpwt	334,531	428,845	328,827	330,224	326,006	326,006	328,651	328,156	327,935	325,998	325,103	324,555	325,608	324,256	428,630	428,630	428,630	428,630	428,630	428,630	428,630	428,630	428,630	428,630
	cfm	90,528	87,241	83,819	84,479	86,453	86,453	86,384	86,399	86,408	86,477	86,485	86,482	86,471	86,488	94,107	94,107	94,107	94,107	94,107	94,107	94,107	94,107	94,107	94,107
	cnpishm	253	253	253	253	253	253	253	253	253	253	253	253	253	253	145	145	145	145	145	145	145	145	145	145
	gm	1,205	1,205	1,205	1,205	1,205	1,205	1,205	1,205	1,205	1,205	1,205	1,205	1,205	1,205	897	897	897	897	897	897	897	897	897	897
	gfcfm	81,263	81,263	77,018	74,160	81,263	81,263	81,263	81,263	81,263	81,263	81,263	81,263	81,263	81,263	81,263	81,263	81,263	81,263	81,263	81,263	81,263	81,263	81,263	81,263
	scm	932	945	881	870	913	913	913	913	913	913	877	854	897	842	835	835	776	777	773	759	751	754	768	747
	expm	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	gav	3,757,340	3,758,636	3,574,262	3,568,728	3,661,086	3,661,083	3,661,022	3,660,997	3,660,994	3,660,926	3,660,929	3,660,882	3,660,904	3,660,890	3,668,287	3,668,286	3,668,548	3,668,582	3,668,602	3,668,740	3,668,804	3,668,860	3,668,769	3,668,893

emp	55,200,246	55,318,774	52,883,124	52,766,488	54,023,755	54,023,803	54,028,941	54,023,779	54,024,485	54,016,310	54,012,728	53,997,958	54,005,100	53,999,559	52,251,914	52,251,926	52,255,893	52,251,446	52,252,659	52,247,889	52,247,462	52,234,241	52,237,622	52,237,140
gdpinc	4,351,337	4,351,337	4,133,118	4,126,511	4,236,658	4,236,658	4,236,658	4,236,658	4,236,658	4,236,658	4,236,658	4,236,658	4,236,658	4,236,658	4,276,212	4,276,211	4,276,609	4,276,671	4,276,693	4,276,899	4,276,986	4,277,124	4,276,972	4,277,155
gdppro	4,351,337	4,351,337	4,133,118	4,126,511	4,236,658	4,236,658	4,236,658	4,236,658	4,236,658	4,236,658	4,236,658	4,236,658	4,236,658	4,236,658	4,276,212	4,276,211	4,276,609	4,276,671	4,276,693	4,276,899	4,276,986	4,277,124	4,276,972	4,277,155
gdpcurr	6,735,909	6,776,766	6,447,358	6,486,833	6,544,865	6,544,865	6,544,865	6,544,865	6,544,865	6,544,865	6,544,865	6,544,865	6,544,865	6,544,865	7,145,234	7,145,224	7,145,641	7,145,657	7,145,676	7,145,793	7,145,844	7,145,885	7,145,768	7,145,918
gts	2,479	2,479	2,479	2,479	2,479	2,479	2,479	2,479	2,479	2,479	2,479	2,479	2,479	2,479	1,846	1,846	1,846	1,846	1,846	1,846	1,846	1,846	1,846	1,846
expts	20,127	25,801	19,783	19,867	19,614	19,614	19,773	19,743	19,730	19,613	19,559	19,526	19,590	19,508	25,788	25,788	25,788	25,788	25,788	25,788	25,788	25,788	25,788	25,788
cnpishts	1,343	1,343	1,343	1,343	1,343	1,343	1,343	1,343	1,343	1,343	1,343	1,343	1,343	1,343	766	766	766	766	766	766	766	766	766	766
cfts	235,178	226,637	217,749	219,462	224,590	224,590	224,413	224,451	224,475	224,654	224,675	224,667	224,638	224,681	244,475	244,475	244,475	244,475	244,475	244,475	244,475	244,475	244,475	244,475
gfcfts	59,134	59,134	56,045	53,965	59,134	59,134	59,134	59,134	59,134	59,134	59,134	59,134	59,134	59,134	59,134	59,134	59,134	59,134	59,134	59,134	59,134	59,134	59,134	59,134
scts	-85	-86	-81	-80	-84	-84	-84	-84	-84	-84	-80	-78	-82	-77	-76	-76	-71	-71	-71	-69	-69	-69	-70	-68
ts	593,996	592,700	558,856	557,783	575,572	575,574	575,636	575,661	575,664	575,732	575,729	575,776	575,754	575,768	607,924	607,925	608,061	608,089	608,091	608,160	608,182	608,264	608,203	608,262
gcurr	1,368,743	1,368,743	1,368,743	1,368,743	1,368,743	1,368,743	1,368,743	1,368,743	1,368,743	1,368,743	1,368,743	1,368,743	1,368,743	1,368,743	1,510,375	1,510,366	1,510,120	1,510,032	1,510,016	1,509,788	1,509,695	1,509,506	1,509,642	1,509,487
gfcfcurr	1,090,940	1,131,798	1,090,940	1,090,940	1,090,940	1,090,940	1,090,940	1,090,940	1,090,940	1,090,940	1,090,940	1,090,940	1,090,940	1,090,940	1,090,940	1,090,940	1,090,940	1,090,940	1,090,940	1,090,940	1,090,940	1,090,940	1,090,940	1,090,940
wagcurr	3,166,312	3,170,583	3,036,883	3,031,572	3,099,518	3,099,366	3,099,807	3,099,714	3,099,736	3,099,628	3,099,520	3,099,220	3,099,376	3,099,246	2,972,693	2,972,643	2,973,128	2,973,075	2,973,122	2,973,187	2,973,249	2,973,061	2,972,997	2,973,156
gfcfg	107,013	107,013	107,013	107,013	107,013	107,013	107,013	107,013	107,013	107,013	107,013	107,013	107,013	107,013	107,013	107,013	107,013	107,013	107,013	107,013	107,013	107,013	107,013	107,013
pig	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
pig	204,064	205,302	195,323	196,519	198,277	198,277	198,277	198,277	198,277	198,277	198,277	198,277	198,277	198,277	216,465	216,465	216,477	216,478	216,478	216,482	216,483	216,485	216,481	216,486
tk	11,964	12,037	11,452	11,522	11,625	11,625	11,625	11,625	11,625	11,625	11,625	11,625	11,625	11,625	12,691	12,691	12,692	12,692	12,692	12,692	12,692	12,692	12,692	12,692
itsub	1,089,802	1,088,193	1,025,554	1,023,573	1,056,126	1,056,130	1,056,256	1,056,272	1,056,279	1,056,347	1,056,331	1,056,347	1,056,331	1,056,341	1,115,297	1,115,299	1,115,553	1,115,576	1,115,583	1,115,667	1,115,698	1,115,767	1,115,682	1,115,777
itsubg	1,089,802	1,088,193	1,025,554	1,023,573	1,056,126	1,056,130	1,056,256	1,056,272	1,056,279	1,056,347	1,056,331	1,056,347	1,056,331	1,056,341	1,115,297	1,115,299	1,115,553	1,115,576	1,115,583	1,115,667	1,115,698	1,115,767	1,115,682	1,115,777
ssc	591,901	592,699	567,706	566,713	579,415	579,386	579,469	579,451	579,455	579,435	579,415	579,359	579,388	579,364	555,706	555,697	555,788	555,778	555,786	555,799	555,810	555,775	555,763	555,793
dt	274,669	264,936	254,783	256,740	262,575	262,575	262,372	262,416	262,444	262,648	262,672	262,662	262,630	262,679	282,219	282,219	282,219	282,219	282,219	282,219	282,219	282,219	282,219	282,219
dtc	362,687	364,887	347,150	349,276	352,401	352,401	352,401	352,401	352,401	352,401	352,401	352,401	352,401	352,401	384,727	384,726	384,749	384,750	384,751	384,757	384,760	384,762	384,755	384,764
trgh	890,704	890,704	890,704	890,704	890,704	890,704	890,704	890,704	890,704	890,704	890,704	890,704	890,704	890,704	890,704	890,704	890,704	890,704	890,704	890,704	890,704	890,704	890,704	890,704
pi	257,300	64,077	64,077	64,077	64,077	64,077	64,077	64,077	64,077	64,077	64,077	64,077	64,077	64,077	64,077	64,077	64,077	64,077	64,077	64,077	64,077	64,077	64,077	64,077
pi	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ctr	-37,120	-55,717	-55,717	-55,717	47,768	47,744	44,271	45,059	45,576	49,347	49,750	49,528	48,953	49,830	-55,717	-55,717	-55,717	-55,717	-55,717	-55,717	-55,717	-55,717	-55,717	-55,717

yd	2,837,059	2,736,525	2,631,661	2,651,873	2,712,140	2,712,140	2,710,051	2,710,499	2,710,786	2,712,898	2,713,148	2,713,044	2,712,710	2,713,216	2,915,042	2,915,042	2,915,042	2,915,042	2,915,042	2,915,042	2,915,042	2,915,042	2,915,042	2,915,042
ydcurr	4,726,263	4,558,783	4,384,091	4,417,761	4,518,159	4,518,160	4,514,679	4,515,426	4,515,904	4,519,422	4,519,838	4,519,666	4,519,110	4,519,952	4,856,175	4,856,175	4,856,175	4,856,175	4,856,175	4,856,175	4,856,175	4,856,175	4,856,175	4,856,175
ctrg	93,407	93,407	93,407	93,407	93,407	93,407	93,407	93,407	93,407	93,407	93,407	93,407	93,407	93,407	93,407	93,407	93,407	93,407	93,407	93,407	93,407	93,407	93,407	93,407
trkg	15,975	15,975	15,975	15,975	15,975	15,975	15,975	15,975	15,975	15,975	15,975	15,975	15,975	15,975	15,975	15,975	15,975	15,975	15,975	15,975	15,975	15,975	15,975	15,975
gbg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
gbg	130,120	139,629	245,756	245,774	193,215	193,239	193,232	193,190	193,152	192,900	192,912	192,962	192,980	192,946	264,535	264,535	263,934	263,833	263,799	263,472	263,336	263,112	263,348	263,064
dat	-33,370	-33,370	-33,370	-4,768	-33,370	-33,370	-33,370	-33,370	-33,370	-33,370	-33,370	-33,370	-33,370	-33,370	63,560	63,561	64,161	64,263	64,296	64,624	64,760	64,983	64,748	65,031
debt	4,558,698	4,568,207	4,674,334	4,702,954	4,621,794	4,621,818	4,621,811	4,621,769	4,621,731	4,621,478	4,621,490	4,621,540	4,621,559	4,621,525	4,834,887	4,834,887	4,834,887	4,834,887	4,834,887	4,834,887	4,834,887	4,834,887	4,834,887	4,834,887
debt-1	4,461,948	4,461,948	4,461,948	4,461,948	4,461,948	4,461,948	4,461,948	4,461,948	4,461,948	4,461,948	4,461,948	4,461,948	4,461,948	4,461,948	4,506,792	4,506,792	4,506,792	4,506,792	4,506,792	4,506,792	4,506,792	4,506,792	4,506,792	4,506,792
jurg	710,503	711,252	719,611	721,865	715,472	715,474	715,474	715,470	715,467	715,447	715,448	715,452	715,454	715,451	735,789	735,789	735,789	735,789	735,789	735,789	735,789	735,789	735,789	735,789

Table E.3 - Results of the main variables in the interval model

	Solutions → / Variables ↓	X01	X11	X02	X12	X03	X13	X04	X14	X1U"	X2U"	X3U"	X4U"	X1U'	X2U'	X3U'	X4U'
Output of Sectors	N01	191,846	190,494	194,169	192,091	178,437	178,990	178,234	178,865	186,261	185,900	185,539	184,817	183,872	183,570	183,268	182,664
	N02	26,682	26,426	26,693	26,425	24,456	24,484	24,946	24,978	25,296	25,265	25,234	25,171	25,030	25,005	24,981	24,932
	E01	37,913	37,542	37,931	37,553	35,518	35,667	35,513	35,663	36,803	36,784	36,765	36,727	36,495	36,483	36,472	36,450
	A01	32,500	32,164	32,436	32,117	30,473	30,575	30,479	30,580	31,497	31,483	31,469	31,441	31,243	31,235	31,227	31,212
	A02	5,413	5,378	5,496	5,436	5,045	5,092	5,034	5,084	5,306	5,301	5,296	5,286	5,252	5,249	5,245	5,238
	N03	130,955	129,702	131,154	129,836	122,517	122,913	122,509	122,911	126,944	126,838	126,732	126,519	125,762	125,685	125,608	125,453
	E02	230,950	229,236	239,243	236,570	217,979	219,288	215,736	216,440	229,218	228,763	228,309	227,399	226,172	225,792	225,413	224,654
	A03	165,526	164,373	172,523	170,561	156,327	157,268	154,419	154,831	164,807	164,420	164,034	163,261	162,427	162,100	161,772	161,117
	A04	34,564	34,302	35,675	35,280	32,601	32,803	32,300	32,424	34,243	34,183	34,123	34,002	33,812	33,763	33,713	33,614
	A05	26,975	26,733	27,092	26,815	25,331	25,482	25,296	25,450	26,324	26,316	26,309	26,294	26,116	26,113	26,111	26,106
	N04	34,128	34,357	36,523	36,009	30,859	31,212	30,607	31,038	33,826	33,622	33,417	33,008	32,923	32,741	32,558	32,194
	N05	24,355	24,234	24,877	24,597	22,669	22,898	22,613	22,856	23,939	23,910	23,881	23,823	23,671	23,648	23,626	23,581
	E03	2,397	2,376	2,871	2,846	2,241	2,241	2,253	2,263	2,287	2,288	2,289	2,291	2,274	2,276	2,277	2,280
	A06	148	147	144	143	139	139	139	140	142	142	142	142	141	141	141	141
	A07	498	494	480	476	466	465	469	470	473	473	474	474	471	471	471	472
	A08	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	A09	56	56	55	54	53	53	53	53	54	54	54	54	53	53	53	54
	A10	1,442	1,429	1,393	1,380	1,348	1,347	1,356	1,362	1,372	1,373	1,373	1,375	1,365	1,366	1,367	1,369
	A11	-	-	204	202	-	-	-	-	-	-	-	-	-	-	-	-
	A12	235	233	237	234	220	222	220	222	229	229	229	229	228	227	227	227
	A13	17	17	17	17	16	17	16	16	17	17	17	17	17	17	17	17
	A14	-	-	92	91	-	-	-	-	-	-	-	-	-	-	-	-
	A15	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	A16	-	-	250	250	-	-	-	-	-	-	-	-	-	-	-	-
	N06	461,194	456,851	462,188	457,527	431,172	431,626	431,129	431,620	445,954	445,370	444,786	443,617	441,208	440,741	440,274	439,341
	N07	14,350	14,247	14,515	14,360	13,324	13,356	13,308	13,345	13,905	13,875	13,844	13,783	13,718	13,692	13,666	13,614
	N08	52,743	52,185	52,598	52,084	49,442	49,501	49,461	49,516	50,967	50,927	50,887	50,806	50,509	50,480	50,452	50,394
	N09	54,669	53,980	54,049	53,550	51,372	51,355	51,440	51,404	52,597	52,578	52,559	52,521	52,207	52,198	52,188	52,169
	N10	31,059	30,769	31,133	30,818	28,972	29,015	28,967	29,013	30,015	29,971	29,928	29,841	29,684	29,649	29,614	29,544
	N11	25,909	25,721	26,205	25,926	24,262	24,510	24,222	24,478	25,440	25,437	25,433	25,425	25,241	25,242	25,243	25,245
	N12	57,650	57,269	58,458	57,826	53,857	54,037	53,774	53,980	56,174	56,081	55,989	55,803	55,494	55,418	55,342	55,191
	N13	51,301	50,762	51,182	50,681	48,647	48,633	48,655	48,637	49,817	49,811	49,805	49,794	49,461	49,464	49,467	49,473
	E04	147,291	145,712	152,246	150,633	140,684	141,368	138,866	138,877	146,783	146,600	146,416	146,050	145,192	145,048	144,904	144,616
	A17	18,358	17,693	20,303	20,106	19,043	19,047	19,053	19,055	19,629	19,606	19,584	19,538	19,433	19,415	19,397	19,362
	A18	17,973	17,971	18,717	18,484	16,530	16,660	16,442	16,597	17,678	17,612	17,546	17,414	17,341	17,283	17,226	17,110
	A19	51,432	50,981	51,660	51,131	48,166	48,317	48,134	48,296	49,953	49,905	49,857	49,762	49,464	49,429	49,393	49,322
	A20	55	55	56	55	52	52	52	40	54	54	54	54	53	53	53	53
	A21	9,535	9,417	9,439	9,351	8,986	8,985	8,996	8,992	9,196	9,195	9,193	9,190	9,132	9,133	9,133	9,133
	A22	13,671	13,573	13,840	13,692	12,775	12,855	12,759	12,843	13,353	13,340	13,326	13,299	13,216	13,206	13,196	13,176
	A23	25	24	25	24	23	23	23	23	24	24	24	24	24	24	24	24
	A24	5,760	5,740	5,922	5,853	5,332	5,363	5,314	5,349	5,636	5,621	5,605	5,573	5,547	5,533	5,520	5,493

A25	2,048	2,036	2,072	2,049	1,908	1,926	1,906	1,926	2,005	2,003	2,002	1,999	1,986	1,985	1,984	1,982
A26	7,024	6,988	7,171	7,090	6,537	6,612	6,519	6,598	6,913	6,906	6,900	6,886	6,840	6,835	6,830	6,820
A27	6,056	5,993	6,238	6,173	5,773	5,801	5,706	5,710	6,019	6,012	6,005	5,991	5,956	5,950	5,945	5,934
A28	7,635	7,581	7,734	7,651	7,153	7,242	7,138	7,229	7,523	7,525	7,526	7,528	7,471	7,473	7,476	7,481
A29	2,830	2,810	2,864	2,833	2,642	2,655	2,639	2,654	2,758	2,755	2,751	2,744	2,728	2,725	2,722	2,717
A30	260	258	262	260	244	246	244	246	255	255	255	255	253	253	253	253
A31	2,918	2,894	2,937	2,907	2,736	2,761	2,733	2,668	2,858	2,858	2,858	2,858	2,837	2,838	2,838	2,840
A32	-	-	1,275	1,262	1,185	1,196	-	-	1,239	1,239	1,239	1,239	1,230	1,230	1,230	1,230
A33	1,053	1,051	1,089	1,076	971	981	579	-	1,036	1,033	1,030	1,025	1,019	1,017	1,015	1,010
A34	3,605	3,573	3,623	3,586	3,383	3,414	3,380	3,411	3,529	3,530	3,531	3,532	3,506	3,507	3,508	3,511
E05	75,661	74,920	75,544	74,793	68,023	68,100	70,759	70,859	70,341	70,261	70,181	70,021	69,614	69,552	69,490	69,366
A35	4,744	4,701	4,759	4,711	3,264	3,266	4,418	4,420	3,423	3,414	3,406	3,390	3,367	3,361	3,354	3,340
A36	12,632	12,494	12,580	12,458	11,473	11,483	11,826	11,835	11,835	11,824	11,813	11,791	11,722	11,714	11,705	11,689
A37	13,944	13,807	13,922	13,784	12,536	12,551	13,041	13,059	12,963	12,949	12,934	12,904	12,830	12,818	12,807	12,784
A38	3,890	3,852	3,884	3,846	3,497	3,501	3,638	3,643	3,617	3,613	3,608	3,600	3,579	3,576	3,573	3,567
A39	40,450	40,065	40,398	39,995	37,252	37,300	37,837	37,902	38,502	38,461	38,419	38,336	38,116	38,084	38,052	37,987
N14	83,390	82,842	84,670	83,751	77,790	78,182	77,684	78,103	81,367	81,244	81,120	80,873	80,409	80,309	80,209	80,010
N15	27,983	27,809	28,425	28,115	26,097	26,267	26,049	26,232	27,357	27,320	27,283	27,209	27,046	27,017	26,987	26,929
N16	51,850	51,262	51,539	51,046	49,259	49,166	49,295	49,192	50,223	50,222	50,221	50,219	49,885	49,893	49,900	49,915
N17	21,471	21,312	21,700	21,470	20,007	20,079	20,008	20,087	20,855	20,823	20,791	20,727	20,612	20,586	20,560	20,508
N18	35,415	34,992	35,114	34,784	33,263	33,268	33,297	33,293	34,127	34,111	34,095	34,062	33,859	33,849	33,840	33,820
N19	17,121	16,954	17,137	16,966	16,200	16,346	16,191	16,337	16,805	16,824	16,842	16,879	16,739	16,759	16,779	16,820
N20	19,328	19,184	19,552	19,345	18,149	18,219	18,123	18,199	18,871	18,853	18,834	18,797	18,680	18,667	18,653	18,625
N21	80,110	79,412	80,551	79,723	75,154	75,592	75,103	75,552	78,135	78,105	78,075	78,014	77,492	77,478	77,464	77,435
N22	17,148	16,982	17,190	17,017	16,189	16,420	16,170	16,397	16,920	16,948	16,976	17,033	16,879	16,909	16,938	16,997
N23	56,782	56,274	57,048	56,465	53,519	54,203	53,461	54,146	55,940	56,007	56,074	56,208	55,726	55,798	55,870	56,015
N24	93,275	92,795	95,208	94,141	86,798	87,795	86,558	87,608	91,791	91,701	91,610	91,430	90,822	90,756	90,690	90,557
N25	41,934	41,805	43,155	42,649	38,853	39,270	38,710	39,165	41,296	41,216	41,136	40,976	40,736	40,670	40,604	40,472
N26	92,533	91,754	93,289	92,319	86,897	87,869	86,766	87,736	90,953	90,991	91,030	91,107	90,400	90,453	90,505	90,610
N27	118,833	117,894	119,961	118,700	111,339	113,057	111,146	112,878	117,279	117,381	117,482	117,686	116,700	116,817	116,933	117,165
N28	19,557	19,320	19,375	19,194	18,355	18,372	18,375	18,385	18,848	18,841	18,834	18,820	18,705	18,702	18,699	18,692
N29	29,671	29,378	29,679	29,383	27,923	28,354	27,904	28,333	29,234	29,285	29,337	29,440	29,173	29,226	29,279	29,384
N30	61,342	60,851	61,715	61,072	57,498	58,061	57,436	58,028	60,102	60,111	60,121	60,139	59,691	59,711	59,730	59,768
N31	39,332	38,992	39,545	39,138	36,851	37,263	36,814	37,230	38,567	38,582	38,597	38,627	38,332	38,352	38,373	38,415
N32	21,061	20,853	21,070	20,860	19,790	19,995	19,781	19,985	20,619	20,635	20,651	20,683	20,519	20,538	20,556	20,593
N33	119,987	118,730	119,709	118,535	112,531	113,422	112,530	113,409	116,878	116,920	116,963	117,048	116,197	116,256	116,316	116,435
N34	31,351	31,099	31,604	31,274	29,380	29,890	29,333	29,849	30,993	31,033	31,073	31,152	30,877	30,920	30,962	31,048
N35	87,300	86,615	88,082	87,157	81,578	82,231	81,476	82,150	85,317	85,269	85,222	85,126	84,560	84,531	84,502	84,444
N36	43,358	43,169	44,377	43,871	40,200	40,597	40,084	40,513	42,564	42,491	42,418	42,273	42,024	41,964	41,905	41,786
N37	59,709	59,044	59,407	58,834	56,294	56,513	56,317	56,526	57,995	58,011	58,027	58,060	57,651	57,675	57,700	57,749
N38	60,925	60,304	60,409	59,822	57,441	57,475	57,517	57,604	58,897	58,893	58,889	58,881	58,489	58,495	58,501	58,513
E06	119,896	118,818	115,615	114,548	112,086	111,933	112,790	113,231	113,941	114,003	114,064	114,187	113,385	113,460	113,536	113,686
A40	4,900	4,856	2,073	4,682	4,581	4,575	4,610	4,628	3,065	4,660	4,662	3,313	4,634	3,322	4,640	4,647
A41	48,018	47,586	46,341	45,913	44,893	44,841	45,169	45,350	45,660	45,684	45,709	45,757	45,435	45,465	45,495	45,555
A42	7,352	7,299	7,395	7,317	6,872	6,894	6,870	6,900	7,141	7,133	7,125	7,108	7,066	7,060	7,053	7,041
A43	1,460	1,450	1,464	1,449	1,365	1,370	1,366	1,372	1,417	1,415	1,414	1,411	1,403	1,402	1,400	1,398

	A44	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	A45	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	A46	4,827	4,783	4,655	4,612	4,512	4,506	4,541	4,559	4,587	4,590	4,592	4,597	4,565	4,568	4,571	4,577
	A47	50,299	49,846	48,503	48,055	47,022	46,958	47,318	47,502	47,801	47,827	47,852	47,904	47,567	47,599	47,631	47,694
	A48	11,769	11,664	11,541	11,429	11,019	11,051	11,056	11,124	11,320	11,325	11,329	11,339	11,257	11,263	11,270	11,282
	N39	415,186	411,068	415,351	411,212	392,455	398,925	392,128	398,550	410,576	411,515	412,453	414,330	410,315	411,260	412,204	414,094
	N40	654,542	648,078	654,800	648,272	614,463	617,050	614,360	616,934	636,075	635,862	635,648	635,222	631,069	630,979	630,890	630,711
	N41	357,870	354,342	358,499	354,913	336,092	337,155	335,913	336,920	347,643	347,445	347,246	346,849	344,673	344,548	344,423	344,173
	A49	39,123	38,737	39,192	38,800	36,742	36,858	36,722	36,833	38,005	37,983	37,961	37,918	37,680	37,666	37,653	37,626
	A50	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	A51	1,025	1,015	1,027	1,017	963	966	962	965	996	995	995	993	987	987	987	986
	A52	1,810	1,792	1,813	1,795	1,700	1,705	1,699	1,704	1,759	1,758	1,757	1,754	1,743	1,743	1,742	1,741
	A53	3,829	3,792	3,836	3,798	3,596	3,608	3,595	3,605	3,720	3,718	3,716	3,712	3,688	3,687	3,686	3,683
	N42	275,188	272,264	274,469	271,786	262,013	261,804	262,054	261,810	267,629	267,669	267,710	267,790	265,919	266,002	266,084	266,249
	N43	411,565	407,138	410,108	406,118	389,526	389,731	389,689	389,853	399,356	399,334	399,312	399,268	396,590	396,637	396,683	396,777
	N44	337,131	333,066	334,378	331,234	317,344	317,476	317,578	317,582	325,417	325,324	325,231	325,045	323,033	322,999	322,965	322,897
	N45	51,932	51,323	51,558	51,069	48,978	48,984	49,015	49,006	50,186	50,175	50,164	50,141	49,824	49,822	49,820	49,815
	N46	149,345	147,527	147,946	146,562	140,841	140,749	140,993	140,854	144,048	144,015	143,981	143,914	143,019	143,010	143,002	142,986
	N47	308,240	305,575	310,130	306,934	292,181	292,572	291,887	292,309	300,980	300,872	300,765	300,550	298,521	298,474	298,428	298,335
	N48	65,847	65,014	65,099	64,498	61,963	61,931	62,043	61,987	63,387	63,369	63,351	63,316	62,932	62,925	62,919	62,906
	N49	132,229	130,617	130,979	129,754	125,625	125,376	125,760	125,470	127,863	127,883	127,904	127,945	127,088	127,127	127,167	127,246
	N50	228,339	225,729	226,939	224,770	218,470	217,919	218,611	218,009	221,866	221,969	222,072	222,278	220,674	220,807	220,940	221,205
	N51	197,615	195,649	197,616	195,649	197,566	195,610	197,566	195,609	195,633	196,122	196,611	197,589	195,626	196,115	196,604	197,583
	N52	130,799	129,490	130,765	129,466	130,635	129,359	130,638	129,362	129,419	129,737	130,055	130,690	129,400	129,719	130,037	130,673
	N53	592,554	586,659	592,539	586,643	591,131	585,518	591,129	585,519	586,179	587,582	588,985	591,791	585,987	587,394	588,802	591,617
Competitive Imports	A01	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	A02	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
	A03	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	A04	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	A05	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	A06	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	A07	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	A08	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	A09	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	A10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	A11	203	201	-	-	190	191	190	191	197	197	197	197	195	195	195	195
	A12	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	A13	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	A14	94	93	-	-	88	88	88	89	90	90	90	90	90	90	90	90
	A15	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	A16	12,280	12,223	12,309	12,167	11,419	11,539	11,388	11,515	12,077	12,061	12,045	12,014	11,937	11,925	11,913	11,888
	A17	2,016	2,462	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	A18	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	A19	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	A20	-	-	-	-	-	-	-	12	-	-	-	-	-	-	-	-

	A21	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	A22	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	A23	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	A24	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	A25	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	A26	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	A27	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	A28	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	A29	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	A30	-	-	-	-	-	-	-	0	-	-	-	-	-	-	-	-
	A31	-	-	-	-	-	-	-	90	-	-	-	-	-	-	-	-
	A32	1,265	1,255	-	-	-	-	1,184	1,195	-	-	-	-	-	-	-	-
	A33	-	-	-	-	-	-	388	978	-	-	-	-	-	-	-	-
	A34	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	A35	-	-	-	-	1,154	1,154	-	-	1,154	1,154	1,154	1,154	1,154	1,154	1,154	1,154
	A36	-	-	-	-	347	347	-	-	347	347	347	347	347	347	347	347
	A37	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	A38	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	A39	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	E06	-	-	-	2,562	415	738	-	-	-	1,533	1,473	-	1,369	-	1,261	1,153
	A40	-	-	2,652	-	-	-	-	-	1,592	-	-	1,354	-	1,315	-	-
	A41	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	A42	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	A43	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	A44	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	A45	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	A46	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	A47	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	A48	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Exports (basic prices or toe)	N01	30,836	31,134	33,377	32,885	27,676	27,988	27,413	27,808	30,608	30,384	30,159	29,711	29,666	29,465	29,264	28,861
	N02	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	E01	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	A01	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	A02	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	N03	4,519	4,562	4,891	4,819	4,056	4,101	4,017	4,075	4,486	4,453	4,420	4,354	4,347	4,318	4,288	4,229
	E02	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	A03	30,310	30,602	32,807	32,324	27,204	27,510	26,945	27,333	30,086	29,865	29,645	29,203	29,160	28,962	28,764	28,369
	A04	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	A05	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	N04	25,260	25,504	27,342	26,939	22,672	22,927	22,456	22,780	25,074	24,890	24,706	24,338	24,302	24,137	23,972	23,643
	N05	3,122	3,153	3,380	3,330	2,802	2,834	2,776	2,816	3,099	3,077	3,054	3,008	3,004	2,984	2,963	2,922
	E03	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	A06	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	A07	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	A08	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

	A09	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	A10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	A11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	A12	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	A13	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	A14	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	A15	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	A16	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	N06	52,146	52,650	56,443	55,611	46,803	47,329	46,357	47,026	51,761	51,382	51,002	50,243	50,168	49,828	49,487	48,807
	N07	3,579	3,614	3,874	3,817	3,213	3,249	3,182	3,228	3,553	3,527	3,501	3,449	3,444	3,420	3,397	3,350
	N08	2,773	2,799	3,001	2,957	2,488	2,516	2,465	2,500	2,752	2,732	2,712	2,671	2,667	2,649	2,631	2,595
	N09	269	271	291	287	241	244	239	242	267	265	263	259	259	257	255	252
	N10	4,008	4,047	4,339	4,275	3,598	3,638	3,563	3,615	3,979	3,950	3,921	3,862	3,856	3,830	3,804	3,752
	N11	2,980	3,009	3,226	3,178	2,675	2,705	2,649	2,687	2,958	2,936	2,915	2,871	2,867	2,848	2,828	2,789
	N12	9,899	9,995	10,715	10,557	8,885	8,985	8,800	8,927	9,826	9,754	9,682	9,538	9,523	9,459	9,394	9,265
	N13	156	157	168	166	140	141	138	140	154	153	152	150	150	149	148	146
	E04	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	A17	2,167	2,188	2,345	2,311	1,945	1,967	1,926	1,954	2,151	2,135	2,119	2,088	2,085	2,071	2,056	2,028
	A18	8,024	8,102	8,686	8,558	7,202	7,283	7,134	7,236	7,965	7,907	7,848	7,731	7,720	7,668	7,615	7,511
	A19	1,908	1,927	2,065	2,035	1,713	1,732	1,696	1,721	1,894	1,880	1,866	1,839	1,836	1,823	1,811	1,786
	A20	5	5	6	5	5	5	5	5	5	5	5	5	5	5	5	5
	A21	14	14	15	15	12	12	12	12	14	14	13	13	13	13	13	13
	A22	43	44	47	46	39	39	38	39	43	43	42	42	42	41	41	40
	A23	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	A24	1,874	1,892	2,028	1,998	1,682	1,701	1,666	1,690	1,860	1,846	1,833	1,805	1,803	1,790	1,778	1,754
	A25	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	A26	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	A27	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	A28	242	244	262	258	217	220	215	218	240	239	237	233	233	231	230	227
	A29	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	A30	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
	A31	73	73	79	77	65	66	65	65	72	72	71	70	70	69	69	68
	A32	51	51	55	54	45	46	45	46	50	50	50	49	49	48	48	47
	A33	402	406	435	429	361	365	358	363	399	396	393	388	387	384	382	376
	A34	10	10	11	10	9	9	9	9	10	10	10	9	9	9	9	9
	E05	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	A35	897	906	971	957	805	814	798	809	891	884	878	865	863	857	852	840
	A36	1,023	1,033	1,107	1,091	918	929	910	923	1,016	1,008	1,001	986	984	978	971	958
	A37	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	A38	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	A39	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	N14	6,791	6,856	7,350	7,242	6,095	6,164	6,037	6,124	6,741	6,691	6,642	6,543	6,533	6,489	6,445	6,356
	N15	3,913	3,951	4,236	4,173	3,512	3,552	3,479	3,529	3,885	3,856	3,828	3,771	3,765	3,739	3,714	3,663
	N16	1,620	1,636	1,754	1,728	1,454	1,471	1,440	1,461	1,608	1,597	1,585	1,561	1,559	1,548	1,538	1,517
	N17	888	896	961	947	797	806	789	800	881	875	868	855	854	848	842	831
	N18	792	799	857	844	711	719	704	714	786	780	774	763	762	756	751	741

N19	358	361	387	381	321	324	318	322	355	352	350	344	344	342	339	335
N20	1,802	1,819	1,950	1,922	1,617	1,635	1,602	1,625	1,789	1,776	1,762	1,736	1,734	1,722	1,710	1,687
N21	3,997	4,035	4,326	4,262	3,587	3,628	3,553	3,604	3,967	3,938	3,909	3,851	3,845	3,819	3,793	3,741
N22	64	65	69	68	57	58	57	58	64	63	63	62	62	61	61	60
N23	2,529	2,554	2,738	2,697	2,270	2,296	2,248	2,281	2,510	2,492	2,474	2,437	2,433	2,417	2,400	2,367
N24	15,930	16,084	17,243	16,989	14,298	14,459	14,162	14,366	15,813	15,697	15,581	15,349	15,326	15,222	15,118	14,910
N25	11,031	11,137	11,939	11,764	9,900	10,012	9,806	9,947	10,949	10,869	10,789	10,628	10,612	10,540	10,468	10,324
N26	3,143	3,173	3,402	3,352	2,821	2,852	2,794	2,834	3,120	3,097	3,074	3,028	3,024	3,003	2,983	2,942
N27	10,368	10,468	11,223	11,057	9,306	9,411	9,217	9,350	10,292	10,216	10,141	9,990	9,975	9,907	9,840	9,704
N28	405	409	438	432	364	368	360	365	402	399	396	390	390	387	384	379
N29	612	618	662	653	549	555	544	552	608	603	599	590	589	585	581	573
N30	5,086	5,135	5,505	5,424	4,565	4,616	4,522	4,587	5,049	5,012	4,975	4,901	4,893	4,860	4,827	4,761
N31	3,527	3,561	3,817	3,761	3,165	3,201	3,135	3,180	3,501	3,475	3,449	3,398	3,393	3,370	3,347	3,301
N32	1,108	1,119	1,199	1,182	994	1,006	985	999	1,100	1,092	1,084	1,067	1,066	1,059	1,051	1,037
N33	6,239	6,299	6,753	6,653	5,599	5,662	5,546	5,626	6,193	6,147	6,102	6,011	6,002	5,961	5,921	5,839
N34	2,882	2,910	3,120	3,074	2,587	2,616	2,562	2,599	2,861	2,840	2,819	2,777	2,773	2,754	2,735	2,697
N35	7,372	7,444	7,980	7,862	6,617	6,691	6,554	6,649	7,318	7,264	7,211	7,103	7,093	7,045	6,997	6,900
N36	10,824	10,929	11,716	11,544	9,715	9,824	9,623	9,761	10,744	10,666	10,587	10,429	10,414	10,343	10,272	10,131
N37	1,561	1,577	1,690	1,665	1,401	1,417	1,388	1,408	1,550	1,539	1,527	1,504	1,502	1,492	1,482	1,461
N38	472	477	511	504	424	429	420	426	469	465	462	455	454	451	448	442
E06	104	105	113	111	93	94	92	94	103	102	102	100	100	99	99	97
A40	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A41	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A42	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A43	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A44	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A45	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A46	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A47	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A48	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
N39	1,695	1,711	1,834	1,807	1,521	1,538	1,506	1,528	1,682	1,670	1,657	1,633	1,630	1,619	1,608	1,586
N40	38,681	39,054	41,868	41,251	34,717	35,108	34,387	34,882	38,396	38,114	37,832	37,269	37,213	36,961	36,709	36,204
N41	10,572	10,674	11,443	11,275	9,489	9,595	9,398	9,534	10,494	10,417	10,340	10,186	10,171	10,102	10,033	9,895
A49	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A50	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A51	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A52	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A53	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
N42	1,214	1,226	1,315	1,295	1,090	1,102	1,080	1,095	1,206	1,197	1,188	1,170	1,168	1,160	1,153	1,137
N43	3,017	3,046	3,266	3,217	2,708	2,738	2,682	2,721	2,995	2,973	2,951	2,907	2,902	2,883	2,863	2,824
N44	2,374	2,397	2,570	2,532	2,131	2,155	2,110	2,141	2,356	2,339	2,322	2,287	2,284	2,268	2,253	2,222
N45	68	69	73	72	61	62	60	61	67	67	66	65	65	65	64	64
N46	1,400	1,413	1,515	1,493	1,256	1,270	1,244	1,262	1,389	1,379	1,369	1,349	1,347	1,337	1,328	1,310
N47	24,635	24,873	26,665	26,272	22,111	22,359	21,900	22,216	24,453	24,274	24,095	23,736	23,700	23,540	23,379	23,058
N48	107	108	115	114	96	97	95	96	106	105	104	103	103	102	101	100
N49	371	374	401	396	333	337	330	334	368	365	363	357	357	354	352	347

	N50	2,236	2,257	2,420	2,384	2,007	2,029	1,987	2,016	2,219	2,203	2,187	2,154	2,151	2,136	2,122	2,093
	N51	46	47	50	49	42	42	41	42	46	46	45	45	45	44	44	43
	N52	3	3	3	3	2	2	2	2	3	3	3	2	2	2	2	2
	N53	1,011	1,021	1,094	1,078	907	918	899	912	1,004	996	989	974	973	966	960	946
Exports at consumer prices	N01	39,426	39,806	42,674	42,046	35,386	35,784	35,049	35,554	39,135	38,848	38,561	37,987	37,930	37,673	37,416	36,901
	N02	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	E01	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	A01	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	A02	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	N03	5,502	5,555	5,955	5,868	4,938	4,994	4,891	4,962	5,461	5,421	5,381	5,301	5,293	5,257	5,221	5,150
	E02	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	A03	19,878	20,070	21,516	21,199	17,841	18,042	17,672	17,926	19,732	19,587	19,442	19,153	19,124	18,994	18,865	18,605
	A04	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	A05	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	N04	29,606	29,892	32,046	31,573	26,572	26,871	26,319	26,699	29,388	29,172	28,956	28,525	28,483	28,290	28,096	27,710
	N05	3,594	3,628	3,890	3,832	3,225	3,262	3,195	3,241	3,567	3,541	3,515	3,462	3,457	3,434	3,410	3,363
	E03	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	A06	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	A07	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	A08	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	A09	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	A10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	A11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	A12	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	A13	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	A14	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	A15	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	A16	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	N06	65,590	66,224	70,995	69,949	58,870	59,532	58,309	59,150	65,106	64,629	64,151	63,197	63,102	62,674	62,246	61,390
	N07	6,456	6,518	6,987	6,885	5,794	5,859	5,739	5,822	6,408	6,361	6,314	6,220	6,211	6,168	6,126	6,042
	N08	3,510	3,544	3,799	3,743	3,150	3,186	3,120	3,165	3,484	3,459	3,433	3,382	3,377	3,354	3,331	3,285
	N09	417	421	451	444	374	378	371	376	414	411	408	402	401	398	396	390
	N10	5,648	5,703	6,114	6,024	5,070	5,127	5,021	5,094	5,607	5,566	5,525	5,442	5,434	5,397	5,360	5,287
	N11	3,724	3,760	4,031	3,972	3,343	3,380	3,311	3,358	3,697	3,670	3,642	3,588	3,583	3,559	3,534	3,486
	N12	11,060	11,167	11,971	11,795	9,927	10,038	9,832	9,974	10,978	10,898	10,817	10,656	10,640	10,568	10,496	10,352
	N13	213	215	231	228	192	194	190	192	212	210	209	206	205	204	203	200
	E04	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	A17	1,861	1,879	2,014	1,985	1,670	1,689	1,654	1,678	1,847	1,834	1,820	1,793	1,790	1,778	1,766	1,742
	A18	6,892	6,958	7,460	7,350	6,186	6,255	6,127	6,215	6,841	6,791	6,740	6,640	6,630	6,585	6,540	6,450
	A19	1,639	1,655	1,774	1,748	1,471	1,487	1,457	1,478	1,627	1,615	1,603	1,579	1,577	1,566	1,555	1,534
	A20	4	4	5	5	4	4	4	4	4	4	4	4	4	4	4	4
	A21	12	12	13	13	11	11	10	11	12	12	12	11	11	11	11	11
	A22	37	37	40	40	33	34	33	33	37	37	36	36	36	35	35	35
	A23	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	A24	1,609	1,625	1,742	1,716	1,444	1,461	1,431	1,451	1,597	1,586	1,574	1,550	1,548	1,538	1,527	1,506

A25	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A26	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A27	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A28	208	210	225	222	187	189	185	188	206	205	203	200	200	199	197	195
A29	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A30	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A31	62	63	68	67	56	57	55	56	62	61	61	60	60	60	59	58
A32	44	44	47	46	39	40	39	39	43	43	43	42	42	42	41	41
A33	345	349	374	368	310	314	307	312	343	340	338	333	332	330	328	323
A34	8	8	9	9	8	8	7	8	8	8	8	8	8	8	8	8
E05	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A35	1,396	1,409	1,511	1,489	1,253	1,267	1,241	1,259	1,385	1,375	1,365	1,345	1,343	1,334	1,325	1,306
A36	1,591	1,607	1,723	1,697	1,428	1,444	1,415	1,435	1,580	1,568	1,557	1,533	1,531	1,521	1,510	1,490
A37	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A38	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A39	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
N14	7,661	7,735	8,293	8,170	6,876	6,954	6,811	6,909	7,605	7,549	7,493	7,382	7,371	7,321	7,271	7,171
N15	4,274	4,315	4,626	4,558	3,836	3,879	3,799	3,854	4,242	4,211	4,180	4,118	4,112	4,084	4,056	4,000
N16	2,717	2,743	2,940	2,897	2,438	2,466	2,415	2,450	2,697	2,677	2,657	2,617	2,614	2,596	2,578	2,543
N17	1,041	1,051	1,126	1,110	934	944	925	938	1,033	1,025	1,018	1,003	1,001	994	987	974
N18	1,389	1,402	1,503	1,481	1,246	1,260	1,235	1,252	1,379	1,368	1,358	1,338	1,336	1,327	1,318	1,300
N19	482	487	522	514	433	438	429	435	479	475	472	465	464	461	458	451
N20	2,128	2,149	2,303	2,269	1,910	1,931	1,892	1,919	2,112	2,097	2,081	2,050	2,047	2,033	2,019	1,992
N21	5,336	5,387	5,776	5,690	4,789	4,843	4,744	4,812	5,296	5,258	5,219	5,141	5,133	5,099	5,064	4,994
N22	92	92	99	98	82	83	81	83	91	90	90	88	88	87	87	86
N23	3,462	3,495	3,747	3,692	3,107	3,142	3,078	3,122	3,436	3,411	3,386	3,336	3,331	3,308	3,285	3,240
N24	17,866	18,038	19,338	19,053	16,035	16,215	15,883	16,111	17,734	17,604	17,474	17,214	17,188	17,071	16,955	16,722
N25	12,027	12,143	13,018	12,826	10,794	10,916	10,692	10,846	11,938	11,850	11,763	11,588	11,570	11,492	11,413	11,257
N26	3,776	3,812	4,087	4,027	3,389	3,427	3,357	3,405	3,748	3,720	3,693	3,638	3,632	3,608	3,583	3,534
N27	13,768	13,901	14,903	14,683	12,358	12,496	12,240	12,416	13,667	13,567	13,466	13,266	13,246	13,156	13,066	12,887
N28	830	838	898	885	745	753	738	748	824	818	812	800	798	793	788	777
N29	962	971	1,041	1,026	863	873	855	867	955	948	941	927	925	919	913	900
N30	6,373	6,435	6,899	6,797	5,720	5,785	5,666	5,748	6,326	6,280	6,234	6,141	6,132	6,090	6,048	5,965
N31	4,634	4,679	5,016	4,942	4,159	4,206	4,120	4,179	4,600	4,566	4,533	4,465	4,458	4,428	4,398	4,337
N32	1,578	1,593	1,708	1,682	1,416	1,432	1,402	1,423	1,566	1,554	1,543	1,520	1,518	1,507	1,497	1,477
N33	9,186	9,275	9,943	9,797	8,245	8,338	8,167	8,284	9,119	9,052	8,985	8,851	8,838	8,778	8,718	8,598
N34	3,521	3,555	3,811	3,755	3,160	3,196	3,130	3,175	3,495	3,470	3,444	3,393	3,388	3,365	3,342	3,296
N35	8,890	8,976	9,623	9,481	7,979	8,069	7,903	8,017	8,825	8,760	8,695	8,566	8,553	8,495	8,437	8,321
N36	12,192	12,310	13,197	13,002	10,943	11,066	10,839	10,995	12,102	12,014	11,925	11,747	11,730	11,650	11,571	11,412
N37	2,567	2,592	2,779	2,738	2,304	2,330	2,282	2,315	2,548	2,530	2,511	2,474	2,470	2,453	2,436	2,403
N38	573	578	620	611	514	520	509	517	569	564	560	552	551	547	544	536
E06	1,589	1,604	1,720	1,695	1,426	1,442	1,413	1,433	1,577	1,566	1,554	1,531	1,529	1,518	1,508	1,487
A40	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A41	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A42	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A43	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

	A44	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	A45	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	A46	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	A47	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	A48	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	N39	1,741	1,758	1,884	1,857	1,562	1,580	1,548	1,570	1,728	1,715	1,703	1,677	1,675	1,663	1,652	1,629
	N40	445	450	482	475	400	404	396	402	442	439	435	429	428	425	423	417
	N41	7,311	7,381	7,913	7,797	6,562	6,635	6,499	6,593	7,257	7,204	7,150	7,044	7,033	6,986	6,938	6,843
	A49	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	A50	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	A51	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	A52	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	A53	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	N42	1,437	1,451	1,555	1,532	1,289	1,304	1,277	1,296	1,426	1,416	1,405	1,384	1,382	1,373	1,363	1,345
	N43	3,259	3,291	3,528	3,476	2,925	2,958	2,897	2,939	3,235	3,211	3,188	3,140	3,136	3,114	3,093	3,051
	N44	2,424	2,447	2,623	2,585	2,175	2,200	2,155	2,186	2,406	2,388	2,370	2,335	2,332	2,316	2,300	2,268
	N45	2	2	2	2	1	1	1	1	2	2	2	1	1	1	1	1
	N46	2,482	2,506	2,686	2,647	2,228	2,253	2,206	2,238	2,464	2,446	2,427	2,391	2,388	2,372	2,355	2,323
	N47	25,525	25,771	27,628	27,221	22,909	23,167	22,691	23,018	25,336	25,151	24,965	24,593	24,556	24,390	24,223	23,890
	N48	106	107	115	113	95	96	94	96	105	104	104	102	102	101	101	99
	N49	212	214	230	227	191	193	189	192	211	209	208	205	204	203	202	199
	N50	1,331	1,344	1,441	1,419	1,195	1,208	1,183	1,200	1,321	1,311	1,302	1,282	1,280	1,272	1,263	1,246
	N51	48	49	52	52	43	44	43	44	48	48	47	47	47	46	46	45
	N52	3	3	3	3	3	3	2	3	3	3	3	3	3	3	3	3
	N53	979	988	1,059	1,044	879	888	870	883	972	964	957	943	942	935	929	916
Economic Variables	cf L	2,533,626	2,500,922	2,501,628	2,478,735	2,379,306	2,378,220	2,382,876	2,380,798	2,434,952	2,434,067	2,433,181	2,431,411	2,417,024	2,416,583	2,416,141	2,415,259
	cf U	2,533,746	2,501,042	2,501,748	2,478,854	2,379,420	2,378,334	2,382,989	2,380,912	2,435,068	2,434,183	2,433,298	2,431,527	2,417,139	2,416,698	2,416,257	2,415,375
	cnpish	68,769	68,084	68,769	68,084	68,769	68,084	68,769	68,084	68,084	68,255	68,427	68,769	68,084	68,255	68,427	68,769
	cpr L	2,616,062	2,583,425	2,587,143	2,563,340	2,463,650	2,461,863	2,463,869	2,462,152	2,519,137	2,518,416	2,517,695	2,516,253	2,501,038	2,500,765	2,500,492	2,499,947
	cpr U	2,616,142	2,583,505	2,587,223	2,563,419	2,463,726	2,461,939	2,463,945	2,462,227	2,519,215	2,518,494	2,517,773	2,516,331	2,501,115	2,500,842	2,500,569	2,500,024
	g	922,816	913,633	922,816	913,633	922,816	913,633	922,816	913,633	913,633	915,929	918,225	922,816	913,633	915,929	918,225	922,816
	cfr L	2,522,494	2,490,851	2,493,849	2,470,956	2,371,527	2,370,441	2,371,744	2,370,727	2,427,173	2,426,288	2,425,402	2,423,632	2,409,245	2,408,803	2,408,362	2,407,480
	cfr U	2,522,615	2,490,970	2,493,969	2,471,075	2,371,641	2,370,555	2,371,858	2,370,841	2,427,289	2,426,404	2,425,519	2,423,748	2,409,360	2,408,919	2,408,478	2,407,595
	cpe	11,131	10,071	7,779	7,779	7,779	7,779	11,131	10,071	7,779	7,779	7,779	7,779	7,779	7,779	7,779	7,779
	cpm L	24,758	24,449	24,484	24,259	23,316	23,299	23,318	23,301	23,841	23,834	23,827	23,813	23,669	23,667	23,664	23,659
	cpm U	24,800	24,490	24,526	24,300	23,355	23,338	23,357	23,341	23,881	23,874	23,867	23,854	23,709	23,707	23,704	23,699
	sc	-10,159	-10,069	-10,206	-10,101	-9,533	-9,620	-9,525	-9,613	-9,944	-9,946	-9,948	-9,953	-9,879	-9,883	-9,887	-9,895
	gfcf	861,608	853,035	861,608	853,035	811,462	827,329	810,786	826,564	853,035	855,178	857,322	861,608	853,035	855,178	857,322	861,608
	impwtcif L	426,334	422,157	426,135	421,883	401,020	403,729	401,152	403,873	415,825	415,955	416,084	416,343	413,292	413,485	413,677	414,061
	impwtcif U	426,338	422,162	426,139	421,888	401,024	403,733	401,156	403,877	415,830	415,959	416,089	416,347	413,296	413,489	413,681	414,065
	impwtfob L	411,925	407,889	411,732	407,624	387,467	390,083	387,593	390,223	401,771	401,896	402,021	402,272	399,324	399,509	399,695	400,067
	impwtfob U	411,952	407,917	411,760	407,652	387,493	390,110	387,620	390,249	401,798	401,924	402,049	402,299	399,351	399,536	399,722	400,094
	impfob L	436,683	432,338	436,216	431,884	410,782	413,382	410,911	413,524	425,612	425,730	425,849	426,085	422,993	423,176	423,360	423,726

impfob L	436,752	432,407	436,285	431,952	410,848	413,448	410,976	413,590	425,679	425,798	425,916	426,152	423,060	423,243	423,426	423,793
expcpt	397,681	400,353	426,181	420,017	354,722	358,622	354,771	358,663	391,477	388,663	385,849	380,221	379,663	377,142	374,620	369,577
expcpwt	386,550	390,282	418,402	412,237	346,943	350,843	343,639	348,592	383,698	380,884	378,070	372,442	371,884	369,362	366,841	361,798
cfm L	88,722	87,577	87,601	86,800	83,318	83,280	83,443	83,370	85,266	85,235	85,204	85,142	84,639	84,623	84,608	84,577
cfm L	88,726	87,581	87,605	86,804	83,322	83,284	83,447	83,374	85,271	85,240	85,209	85,147	84,643	84,627	84,612	84,581
cnpishm	253	251	253	251	253	251	253	251	251	252	252	253	251	252	252	253
gm	1,205	1,193	1,205	1,193	1,205	1,193	1,205	1,193	1,193	1,196	1,199	1,205	1,193	1,196	1,199	1,205
gfcfm	81,263	80,454	81,263	80,454	76,533	78,030	76,469	77,957	80,454	80,656	80,858	81,263	80,454	80,656	80,858	81,263
scm	939	931	944	934	882	890	881	889	920	920	920	920	914	914	914	915
expm	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
gav	3,758,095	3,720,820	3,758,493	3,721,077	3,573,847	3,577,999	3,573,399	3,577,544	3,665,056	3,665,935	3,666,814	3,668,572	3,642,066	3,643,514	3,644,963	3,647,860
emp L	54,986,233	54,448,211	55,029,437	54,479,504	52,620,781	52,629,288	52,618,383	52,626,952	53,763,431	53,793,982	53,824,532	53,885,633	53,473,354	53,511,089	53,548,825	53,624,295
emp U	55,538,859	54,995,429	55,582,497	55,027,037	53,149,633	53,158,226	53,147,211	53,155,866	54,303,767	54,334,625	54,365,482	54,427,198	54,010,775	54,048,889	54,087,004	54,163,233
gdpinc L	4,351,326	4,308,040	4,351,326	4,308,040	4,132,335	4,138,445	4,131,805	4,137,874	4,241,727	4,242,511	4,243,294	4,244,860	4,214,497	4,215,954	4,217,412	4,220,328
gdpinc U	4,351,337	4,308,051	4,351,337	4,308,051	4,132,345	4,138,455	4,131,816	4,137,884	4,241,738	4,242,521	4,243,304	4,244,871	4,214,507	4,215,965	4,217,423	4,220,338
gdppro L	4,351,326	4,308,040	4,351,326	4,308,040	4,132,335	4,138,445	4,131,805	4,137,874	4,241,727	4,242,511	4,243,294	4,244,860	4,214,497	4,215,954	4,217,412	4,220,328
gdppro U	4,351,337	4,308,051	4,351,337	4,308,051	4,132,345	4,138,455	4,131,816	4,137,884	4,241,738	4,242,521	4,243,304	4,244,871	4,214,507	4,215,965	4,217,423	4,220,338
gdpcurr L	6,734,744	6,692,215	6,839,914	6,764,792	6,453,559	6,452,594	6,453,804	6,452,917	6,632,629	6,631,455	6,630,282	6,627,935	6,578,497	6,578,664	6,578,832	6,579,166
gdpcurr U	6,737,055	6,694,522	6,842,303	6,767,152	6,455,680	6,454,733	6,455,926	6,455,057	6,634,892	6,633,711	6,632,531	6,630,169	6,580,721	6,580,882	6,581,043	6,581,365
gts	2,479	2,454	2,479	2,454	2,479	2,454	2,479	2,454	2,454	2,461	2,467	2,479	2,454	2,461	2,467	2,479
expts	23,256	23,481	25,173	24,802	20,873	21,108	20,675	20,972	23,085	22,915	22,746	22,407	22,374	22,222	22,070	21,767
cnpishts	1,343	1,330	1,343	1,330	1,343	1,330	1,343	1,330	1,330	1,333	1,337	1,343	1,330	1,333	1,337	1,343
cfts L	230,485	227,510	227,574	225,492	216,447	216,348	216,771	216,582	221,509	221,428	221,348	221,187	219,878	219,838	219,798	219,717
cfts U	230,496	227,521	227,585	225,502	216,457	216,358	216,782	216,593	221,519	221,439	221,358	221,197	219,888	219,848	219,808	219,728
gfcfts	59,134	58,545	59,134	58,545	55,692	56,781	55,646	56,728	58,545	58,692	58,839	59,134	58,545	58,692	58,839	59,134
scts	-86	-85	-86	-85	-81	-81	-81	-81	-84	-84	-84	-84	-84	-84	-84	-84
ts L	593,231	587,220	592,833	586,963	558,488	560,445	558,406	560,330	576,672	576,576	576,480	576,289	572,431	572,440	572,449	572,468
ts U	593,242	587,231	592,844	586,974	558,498	560,456	558,416	560,341	576,682	576,586	576,491	576,299	572,441	572,451	572,460	572,479
gcurr	1,368,743	1,368,743	1,457,891	1,368,743	1,368,743	1,368,743	1,368,743	1,368,743	1,368,743	1,368,743	1,368,743	1,368,743	1,368,743	1,368,743	1,368,743	1,368,743
gfcfcurr	1,090,940	1,090,940	1,107,001	1,163,545	1,090,940	1,090,940	1,090,940	1,090,940	1,141,803	1,146,716	1,151,628	1,161,454	1,133,015	1,138,146	1,143,276	1,153,537
wagcurr L	3,152,445	3,121,368	3,154,275	3,122,807	3,021,650	3,020,509	3,021,351	3,020,153	3,082,951	3,084,845	3,086,738	3,090,525	3,066,747	3,069,042	3,071,337	3,075,927
wagcurr U	3,184,128	3,152,739	3,185,976	3,154,192	3,052,018	3,050,866	3,051,716	3,050,506	3,113,936	3,115,848	3,117,761	3,121,586	3,097,569	3,099,887	3,102,205	3,106,840
gfcfg	107,013	108,089	107,013	302,553	107,013	108,089	107,013	108,089	108,089	107,820	107,551	107,013	108,089	107,820	107,551	107,013
pig L+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
pig U+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
pig L-	205,222	203,926	208,428	206,138	196,650	196,622	196,658	196,631	202,110	202,074	202,038	201,966	200,459	200,464	200,469	200,479
pig U-	202,907	201,626	206,075	203,812	194,435	194,406	194,443	194,416	199,830	199,795	199,760	199,689	198,199	198,204	198,209	198,220
tk L	11,952	11,877	12,139	12,006	11,453	11,451	11,454	11,452	11,771	11,769	11,767	11,763	11,675	11,675	11,676	11,676
tk U	11,976	11,900	12,163	12,030	11,476	11,474	11,476	11,475	11,794	11,792	11,790	11,786	11,698	11,698	11,699	11,699
itsub L	1,087,010	1,076,054	1,086,559	1,075,784	1,023,317	1,026,921	1,023,165	1,026,715	1,056,777	1,056,590	1,056,403	1,056,028	1,048,962	1,048,968	1,048,974	1,048,986
itsub U	1,090,621	1,079,629	1,090,169	1,079,358	1,026,716	1,030,332	1,026,565	1,030,126	1,060,288	1,060,100	1,059,912	1,059,536	1,052,446	1,052,453	1,052,459	1,052,471
itsubg L	1,087,010	1,076,054	1,086,559	1,075,784	1,023,317	1,026,921	1,023,165	1,026,715	1,056,777	1,056,590	1,056,403	1,056,028	1,048,962	1,048,968	1,048,974	1,048,986
itsubg U	1,090,621	1,079,629	1,090,169	1,079,358	1,026,716	1,030,332	1,026,565	1,030,126	1,060,288	1,060,100	1,059,912	1,059,536	1,052,446	1,052,453	1,052,459	1,052,471
ssc L	588,822	583,018	589,164	583,287	564,392	564,179	564,336	564,113	575,842	576,196	576,550	577,257	572,816	573,244	573,673	574,530

ssc U	595,722	589,850	596,068	590,122	571,006	570,790	570,949	570,723	582,590	582,948	583,306	584,021	579,528	579,962	580,395	581,263
dt L	269,039	265,682	266,065	263,617	253,365	253,181	253,387	253,210	259,071	258,997	258,923	258,774	257,210	257,182	257,153	257,097
dtd U	269,491	266,129	266,512	264,060	253,791	253,607	253,813	253,636	259,507	259,433	259,358	259,210	257,642	257,614	257,586	257,530
dtc L	362,325	360,037	367,983	363,942	347,198	347,146	347,211	347,163	356,831	356,768	356,705	356,579	353,919	353,928	353,937	353,955
dtc U	363,048	360,756	368,720	364,670	347,885	347,834	347,899	347,852	357,543	357,479	357,415	357,288	354,624	354,632	354,641	354,658
trgh	890,704	890,704	890,704	890,704	890,704	890,704	890,704	890,704	890,704	890,704	890,704	890,704	890,704	890,704	890,704	890,704
pi+	65,746	64,077	64,077	64,077	64,077	64,077	64,077	64,077	64,077	64,077	64,077	64,077	64,077	64,077	64,077	64,077
pi-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ctr+	-	-	84,219	83,381	84,219	83,381	84,219	83,381	83,381	83,590	83,800	84,219	83,381	83,590	83,800	84,219
ctr-	55,440	14,316	-	-	-	-	-	-	-	-	-	-	-	-	-	-
yd L	2,778,909	2,744,241	2,748,190	2,722,905	2,617,010	2,615,112	2,617,243	2,615,418	2,675,951	2,675,185	2,674,419	2,672,888	2,656,725	2,656,435	2,656,145	2,655,566
yd U	2,783,584	2,748,857	2,752,813	2,727,486	2,621,412	2,619,511	2,621,645	2,619,818	2,680,453	2,679,686	2,678,919	2,677,384	2,661,194	2,660,904	2,660,614	2,660,034
ydcurr L	4,633,210	4,575,408	4,581,993	4,539,836	4,363,279	4,360,114	4,363,668	4,360,625	4,461,551	4,460,274	4,458,997	4,456,443	4,429,495	4,429,012	4,428,529	4,427,563
ydcurr U	4,633,353	4,575,549	4,582,134	4,539,976	4,363,413	4,360,249	4,363,802	4,360,760	4,461,689	4,460,412	4,459,135	4,456,581	4,429,632	4,429,149	4,428,666	4,427,700
ctrg	93,407	92,477	93,407	92,477	93,407	92,477	93,407	92,477	92,477	92,710	92,942	93,407	92,477	92,710	92,942	93,407
trkg	15,975	15,816	15,975	15,816	15,975	15,816	15,975	15,816	15,816	15,855	15,895	15,975	15,816	15,855	15,895	15,975
gbg L+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
gbg _U+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
gbg L-	140,837	164,199	230,393	358,884	251,790	250,771	251,968	251,005	198,780	198,176	197,573	196,367	212,861	211,909	210,957	209,053
gbg U-	131,441	154,903	221,023	349,606	242,855	241,826	243,034	242,062	189,630	189,023	188,416	187,203	203,764	202,807	201,850	199,936
dat	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
dat	33,370	33,038	33,370	33,038	33,370	33,038	33,370	33,038	-	-	-	-	-	-	-	-
debt L	4,560,020	4,583,814	4,649,602	4,778,517	4,671,434	4,670,737	4,671,613	4,670,973	4,651,578	4,650,971	4,650,364	4,649,151	4,665,712	4,664,755	4,663,798	4,661,885
debt U	4,569,416	4,593,110	4,658,971	4,787,795	4,680,368	4,679,681	4,680,547	4,679,916	4,660,728	4,660,125	4,659,521	4,658,315	4,674,809	4,673,857	4,672,905	4,671,001
debt-1	4,461,948	4,461,948	4,461,948	4,461,948	4,461,948	4,461,948	4,461,948	4,461,948	4,461,948	4,461,948	4,461,948	4,461,948	4,461,948	4,461,948	4,461,948	4,461,948
jurg L	710,251	712,125	717,304	727,453	719,022	718,968	719,037	718,986	717,459	717,412	717,364	717,268	718,572	718,497	718,421	718,271
jurg U	711,703	713,570	718,760	728,912	720,446	720,392	720,460	720,410	718,898	718,851	718,803	718,708	720,008	719,933	719,858	719,708