UNIVERSIDADE D
COIMBRA

Pedro Aquino Pereira

The relationship between economic growth and the tax mix in OECD countries

Dissertation for Master's Program in Economics, with specialization in Financial Economics, presented to the Faculty of Economics of the University of Coimbra for obtaining a Master's degree

Advised by: José Alberto Fuinhas, Ph.D.

February 2021

Agradecimentos

Gostaria de expressar minha mais profunda e sincera gratidão a todos, e a cada um em particular, os quais caminharam comigo ao longo desse intenso, porém gratificante percurso acadêmico que agora chega a seu fim.

A Deus, por ter-me colocado em uma universidade tão renomada e tradicional como a Universidade de Coimbra, a qual, juntamente com todos os colegas que fiz, certamente ficará para sempre em minhas lembranças, fazendo parte de quem agora sou.

A meu orientador professor José Alberto Fuinhas, o qual muito mais do que orientar de forma profissional, soube me acompanhar de maneira precisa, gentil e atenciosa. Atributos que me ajudaram a perceverar nesse dificílimo cenário pandémico no qual nos encontramos, e sem os quais eu, com absoluta certeza, não teria conseguido até aqui chegar.

À coordenação do mestrado da Faculdade de Economia, desde a minha admissão com o então coordenador, professor Helder Sebastião, até esse momento final com os professores coordenadores Marta Simões e Pedro Bação. Meu muito obrigado.

Por fim, mas não menos importante, a minha amada família, a qual abriu mão de nosso convívio cotidiano, lidando com a saudade e me apoiando a cada segundo em minha decisão de fazer o caminho inverso que outrora fizeram meus avós portugueses.

Abstract

This work's main objective is to analyze the relationship between taxation and growth in the context of the Organization of Economic Cooperation for Development (OECD) members while filling a gap in the current literature that mostly tackles the issue by the perspective of how growth is affected by taxation. This work project took a different perspective that has been neglected by doctrine: how growth, measured by GDP per capita, can influence the tax mix. The analyses were performed by using panel data that incorporates both dimensions of time and space, exclusively taken from both the OECD and World Bank database for 36 countries of the OECD in a period of 24 years (1995-2018). We estimated a set of fixed and random effects models with the explanatory variable of interest as the GDP per capita and the dependent variable the respective share in the total tax revenue of each tax category. Following Tosun and Abizadeh (2005) as an inspiration, the variables that we used in order to estimate this model were: tax mix, measured separately for each type of the most relevant classes of taxes in relation to the relative share of each of those taxes in question to total tax revenue; economic growth; and a series of control variables, such as the openness of the economy; a dummy variable that accounts for the geographical location – to distinguish countries that are members of the European Union from the rest of the sample; an old-age dependency ratio; gross capital formation and the unemployment rate. Was concluded that each tax responded differently to the growth of GDP per capita. It is shown that while the shares of Personal Income and Payroll tax have responded positively to economic growth, shares of Social Security, Corporate, Goods and Services, and Property tax have responded negatively to it.

Keywords: growth, tax mix, OECD, member countries

JEL Classification: E62, H20, O40

Resumo

O principal objetivo deste trabalho é analisar a relação entre a tributação e o crescimento no contexto dos membros da Organização para a Cooperação e Desenvolvimento Econômico (OCDE), e ao mesmo tempo preencher uma lacuna na literatura atual que majoritariamente aborda o tema pela perspectiva de como o crescimento é afetado pela tributação. Este projeto de trabalho abordou uma perspectiva diferente que tem sido negligenciada pela doutrina: como é que o crescimento, medido pelo PIB per capita, pode influenciar o mix de impostos. As análises foram realizadas utilizando dados em painel que incorporam as dimensões de tempo e espaço, e foram foram obtidos na base de dados da OCDE e do Banco Mundial, para 36 países da OCDE, para um período de 24 anos (1995-2018). Foi estimado um conjunto de regressões de efeitos fixos e efeitos aleatórias, sendo a variável explicativa o PIB per capita e a variável dependente a respectiva parcela de cada um dos tributos em relação com o total da arrecadação tributária. Seguindo Tosun and Abizadeh (2005) como inspiração, as variáveis que inicialmente nos interessam para estimar este modelo são: mix de impostos, medido separadamente para cada tipo das classes de impostos mais relevantes em relação à participação relativa de cada uma delas sobre a receita fiscal total; crescimento econômico; e uma série de variáveis de controle (a abertura da economia; uma variável muda (dummy) que controla a localização geográfica - para distinguir os países que fazem parte da União Europeia do restante da amostra; um rácio de dependência dos idosos; a formação bruta de capital; e a taxa de desemprego). Conclui-se que cada tipo de tributo respondeu diferente ao crescimento do PIB per capita. Mostrou-se que enquanto a parcela do imposto sobre a renda pessoal e sobre a folha de pagamento responderam positivamente ao crescimento econômico, as partes referentes a previdência social, impostos corporativos, bens e serviços e sobre a propriedade, responderam negativamente.

Palavras-chave: crescimento, mix tributário, OCDE, países membros

Classificação JEL: E62, H20, O40

Summary

Index of tables

1. Introduction

The origins of taxation intertwine itself with the origin of the first social relations, carrying the duality of being one of the factors that allow the coexistence of men among themselves but also being the cause of great revolutions. Present since the early civilizations of antiquity, not only was it present throughout the middle and modern ages, but it continues to follow the evolution of man in contemporary society (Salanie 2011). Hence, the tax system, empirically represented by its tax mix, is intrinsically connected and interrelated with the history of man himself as a social being, not being possible to be dissociated from it considering that they affect and influence each other.

Not only with the advent of the welfare state and considering that the overwhelming majority of the sources of revenue with which governments finance themselves come from the taxation, but also taking into consideration that the relationship between growth and development is a "sine qua non" factor for the formation and maintenance of any Nation, this dialectical relationship has been deeply studied and worked by researchers.

In the massive part of the literature, the relationship between growth and taxation is mostly comprehensively tackled by how taxes, in it varies forms, tend to affect growth, normally measured by GDP. Thus, authors have formulated their respective works throughout this approach by, initially, taking as base the exogenous neoclassical growth models of Solow (1956) and Swan (1956) and, afterward, being able to expand their analysis by counting on the endogenous growth models (Romer 1986) and the pioneer contributions of Barro (1990), King and Rebelo (1990) and Lucas (1990), however, fell authors have debated the opposite relationship of how the different types of tax instruments that are at the disposal of policymakers can be affected by growth.

Given the present gap in the literature, throughout this research, we aim to empirically investigate and work upon this less approached perspective by taking advantage of the fact that both growth and taxation are intrinsically related to each other. Thus we will analyze the usual prevailing relationship on its reverse perspective, which is how growth, measured by the

GDP, affects the tax mix, representing the variety of tax instruments within reach of governments.

Therefore, we will do it by exploiting one of the few, if not the unique, articles that tackle this perspective, Economic growth, and tax components: an analysis of tax changes in OECD written by the authors Mehmet Serkan Tosun and Sohrab Abizadeh.

The remaining of this work project is organized into five main sections. Section 2 provides an overview of the literature concerning the relationship between economic growth and taxation. Section 3 presents and defines both the dependents and explanatory variables, the descriptive statistics, econometrics tests, and the empirical model. Section 4 presents the data while discussing the results obtained and, lastly, Section 5 concludes.

2. Literature Review

Considering that growth and taxation have been extensively debated over the last century, both individually speaking and in what concerns on how one can affect the other, in this section, we will start by giving an overview of how the literature has tacked the issue so far and identifying the gap that the present study will focus at.

2.1 The relationship between taxation and growth

A pioneering paper that set the tone for a comprehensive set of work in what concerns taxation was done by Ramsey (1927), presenting the optimal taxation by going through how to increase revenue without diminishing utility, considering that commodities taxes are distortionary. The author divided his analyses into two parts, being the first one concerning the government`s necessity to raise what he called “infinitesimal (tax) revenue”; and the second by assuming that the utility function is quadratic, which signifies that both the supply and demand curves are straight lines. Although, despite its importance and strong influence on the optimal theory of taxation as it can be seen, for example, at Mankiw et al. (2009), there is still much more than meets the eye in respect of the evolution of the tax structure on the literature.

In what concerns the relationship between taxation and economic growth, the overwhelming part of the literature tackles it more comprehensively by how taxes' vary forms tend to affect growth, usually measured by GDP. Although this relationship has been extensively debated among authors taking advantage of the growth theory, there is no consensus on whether or not the tax mix imposed through tax policies has a considerable effect on growth in both short and long-term considered.

On the one hand, we have the Solow exogenous neoclassical growth model (Solow 1956), which, based on a production function, considers some possibilities in which taxes can affect the output growth. In his paper, nuances that can influence the relationship between taxation and growth, such as the use of the former to foster or restrain investments by affecting the decision-making of investors, are taken into consideration. However, in an apparently contradictory way, the paper also implies that taxation does not influence the long-term rates of growth through its conventional growth model (Engen and Skinner 1996).

On the other hand, we have the endogenous growth models (Romer 1986) that can, in a more effective manner, demonstrate whether or not growth could be affected by taxation by introducing the sustained growth factor on the model and empirically determining its level. Gareth Myles (2000) explains that even though the theoretical analyses on the endogenous literature have shown that the economy can be influenced by taxation, they do it inconclusively. Considering this dubious outcome, the author analyzes the empirical evidence of developed countries over the last century and finds out that notwithstanding their proportion of GDP has had an expressive rise, their growth levels were relatively stable.

The results obtained by the article led it to the conclusion that even though endogenous models can provide the effects of taxation over economic growth, considering that they take into consideration the benefits that elements such as the "learning by doing" and the "spillover" effects, the empirical observation of both tax and growth rates suggests that there is a weak connection between them. Thus, some regressions have demonstrated that tax rates are an inconsiderable explanatory variable, others admitted a small but significant tax effect, although none of those results are worth compared to the distress in determining the marginal rates of tax.

Similarly, in the more current literature on endogenous growth, another important landmark in the analysis of the interrelation between taxation and economic growth is the work of Lucas (1988), which lies within the category of AK growth models. In this model, we have many different causes that can create positive externalities. Even though the neoclassical growth models did not consider them, they significantly impact the long-run growth causes. One of these causes, according to the author, that could create a positive externality is education, which was labeled as "learning-by-studying" and can be explained considering the fact that one can learn while watching and paying attention to his/her more educated peers.

Moreover, in another contribution to conciliate economic aspects and the practice of taxing, Salanie (2011) has pointed out the criteria given by Smith (1776) on his celebrated "The Wealth of Nations" in order to achieve fair optimal taxation. The first criteria pointed out by Adam Smith discuss the taxpayer's ability to pay, who should be treated equally if in equal conditions or be taxed accordingly to his wealth, to receive a counterpart from the government.

Others points cited by Smith, accordingly with Salanie, focus on how taxes must have a logical and well-defined set of rules, thus avoiding any possibility of arbitrariness and able to be known by the interested parties while also being charged in a subtle and fairly manner. Finally, considering that "the cure cannot be worse than the disease," the author ponders that the taxation process cannot be costly both from an administrative and economic perspective. To this last criteria, Salanie states that, in modern times, he would also add to the list the capability of adjusting itself to the fluctuations in the economy and a straightforward manner in order for the taxpayer to know who bears the tax burden.

According to Volkerink and Haan (1999), institutional and political circumstances have an important hole when trying to explain the actual tax mix, which has only received superficial attention from the literature and cannot be understood on account of optimality conditions. Thus, by taking another perspective while approaching the relationship between growth and the tax mix, we will take as inspiration the article from Tosun and Abizadeh, Economic growth and tax components: an analysis of tax changes in OECD.

Throughout their study, the authors have examined the tax changes through the tax mix's responsiveness to economic growth, measured by the changes in GDP per capita. The tax mix of their work is composed of the major tax classifications constants in the 2001 OECD Revenue Statistics, whose sum is the total tax revenue. In order to investigate this relationship between growth and the tax mix of 24 OECD countries for the years 1980 to 1999, the author used panel data of 480 observations.

As explanatory variables, the authors have "GDP per capita in constant 1995 US dollars", "Openness (%)", "Share of international tourism receipts in total exports (%)", "gross capital formation in constant 1995 millions US dollars", "unemployment rate (%)", "old-age dependency ratio (%)" and a "European Union dummy", which are the same as we do on our work.

They have also conducted a series of econometrics tests. After conducting the Hausman specification test[1], the authors found out that fixed effects specifications were considered more appropriated for six of their eight explained variables, thus, for a consistency matter and also by considering that fixed effects regressions would be able to provide more trustful and reliable results, they used fixed effects model on their entirely empirical examinations.

As the direction of causality can be an important issue in time series analysis (given the possibility of bidirectionality), the authors have run pairwise Granger's causality tests between the rate of growth of per capita income and each one of the different tax ratios. Finding no direct casual relationship, they proceeded with the analysis. Their next step was to run the Cook-Weisberg test to check for heteroscedasticity, which was detected and corrected with Huber/White/Sandwich robust standard errors. The final point in their diagnostic investigation was to run OLS regressions and check for autocorrelation. As the Durbin-Watson statistics indicated serially correlated residuals, AR(1) terms were included in the fixed effects estimations, correcting the issue.

Their study had as a result that economic growth measured by GDP per capita has had a significant effect on the tax mi, but not in all tax categories. The coefficients for the growth

[1] See Hausman (1978) for the original description of this test.

variable were statistically significant in the cases of goods and services taxes (negative coefficient), property taxes (positive coefficient), personal taxes (positive), and payroll taxes (negative), but not for social security tax and corporate tax.

3. Empirical analysis

In order to analyze how economic growth can affect the tax mix among countries, we have used a panel data of 864 observations, which are almost double the number of the observations in comparison with the Tosun and Abizadeh (2005), our reference article (from here on referred to as TA 2005).

The countries comprehended on this empirical analysis are Australia, Austria, Belgium, Canada, Switzerland, Chile, Colombia, Czech Republic, Germany, Denmark, Spain, Estonia, Finland, France, United Kingdom, Greece, Hungary, Ireland, Iceland, Israel, Italy, Japan, Republic of Korea, Lithuania, Luxembourg, Latvia, Netherlands, Norway, New Zealand, Poland, Portugal, Slovak Republic, Slovenia, Sweden, Turkey, and the United States. A group that amounts to 36 OECD countries versus the 24 for the TA 2005 article, in a time range of 24 years (1995-2018), corresponds to the maximum temporal number of years with available information for all countries. The 12 added countries consist of the new OECD members' totality incorporated since 2005, except Mexico, which was excluded due to lack of data.

3.1 Dependent Variables

In this section, we also analyze the descriptive statistics of six main categories of tax revenue, adopted from the 2020 OECD Revenue Statistics, and measured in percentage of the GDP and total taxation, that, combined, make up more than 98% of the total tax (TT) revenues of the average group of countries the OECD when analyzing the latest data available which, refers to the year of 2018.

These taxes are Social Security tax (SST), Corporate tax (CT), Goods and Services tax (GST), Payroll tax (PAYT), Personal Income tax (PIT), and Property tax (PROPT) which, added together, make up the totality of the (TT) as

$$TT = SST + CT + GST + PAYT + PIT + PROPT \qquad (1)$$

in which, by drawing from their definition on the OECD Revenue Statistics, we now explain each of them as follows:

Social Security taxes usually are mandatory contributions that are normally used to finance the welfare state's future social benefits, which institutions of general government provide to the public, such as unemployment insurance, retirement, and disability pension. It also expresses a considerable share of the total taxation of OECD members, accounting for 25.7% in 2018 and an average of 9.0% of GDP for the same period, which makes SST the second biggest tax classification of those two themes, being only behind Goods and Services tax as we will see ahead. Important to say that SST is also appraised on all types of income earned by both a self-employed individual and an employee, in which case it will also be levied by his or her employer.

Corporate tax accounted for 3.1% of GDP on average for OECD member countries during the year of 2018 and was equivalent to 10% of the group's total taxation share during that same year. It is levied on the profits that a corporation makes and englobes all its earnings, not only on the corporation's capital gains but also on its net profits, which are its gross income decreased by the tax reliefs at its disposal, such as depreciation, for instance. Even though some countries have very high CT, in fact, the rate a corporation pays tends to be much lower by taking advantage of loopholes and deductions.

Goods and Services tax is basically composed of sales and value-added taxes. It has its base on every profitable activity that can accrue from goods and services through all its levels and stages of both production and commercialization inbound or overseas. It is paid to the government from the owner of the business, but the burden really falls on the final consumer of the respective good or service. Thus, it is an indirect tax, considering that the seller adds it to the final goods price. During the year 2018, GST was accountable for 10.9% of the GDP for the average of the OECD group of countries. In what concerns the percentage of the total taxation among the members, this tax classification represented 32.7% of it. Considering such numbers, GST represents the largest portion of each of the two previous two topics at hand.

Payroll tax is a percent that is withheld, generally by the employer, and can be calculated over the employee's payroll, which is constituted considering salaries plus tips. However, it can also be paid if one is self-employed. Either way, it does not necessarily link to the right to receive any social benefits. It can be stipulated as a fixed amount per individual, usually estimated by year, or calculated as a portion of their payroll. Among all the six taxes here presented, PAYT is the one which accounts for the lesser part of the GDP for the average of the OECD members, being accountable for just 0.42% of it. Regarding the share on the percentage of the total taxation amidst the member countries, it is no different, with just 1.15%, both values for the year of 2018.

Personal income tax covers all income received through the most diverse types of sources, such as dividends from investments and wages, by either households or individuals, minus any allowable tax reliefs at their disposal. It has a close relationship with the economy, considering that the amount of consumption one tends to make is directly related to how much they make and that most households' salaries and rentability tend to follow the fluctuations of the economy. When focusing on the percentage of the representation of the personal income tax on the GDP for the average of the OECD members during the year of 2018, we can notice that it was responsible for 8.1% of it and accounted for 23.5% of the share of total taxation for the group of countries on this same year.

Property tax is the tax due by the owner of such property, an individual or legal entity, on its personal use or transfer. The tax is paid by the proprietor and is customarily calculated on the property's value in reference that can be movable or immovable, tangible or intangible, recurrent taxes on net wealth, and taxes on the change of ownership over inheritance or gift. In what concerns to its expression on the average GDP of the component countries of the OECD, PROPT is responsible for 1.86% of it and 5.6% of the average taxation among the members, which makes it one of the smallest components of all previous six, behind only of the Payroll tax.

3.2 Explanatory Variables

Having presented the study's explained variables and defining them, we now move on to the explanatory variables. As one of the main pillars of this work, in the name of consistency, we have taken most of the following variables and their definitions from the same source, which is the World Bank, only except for the first two of them, which had their data taken from the OECD.

GDPcapita is the Gross Domestic Product per capita in constant 2015 US dollars deflated by the Consumer Price Index base 2015=100. In order to catch sight of changes in the tax structures of the European Union countries, *UE* is a dummy variable for this specific group of members.

The old-age dependency ratio is estimated based on the ratio of older dependents, who are expected to be economically inactive, to the working-age individuals per 100 persons, where the former ones are those agents with at least 65 years old and the latter are people with ages between 15 to 64 years old. It is inserted here to control the possible reliance on a specific type of tax because, considering that each age group has its own peculiarity, having different needs and demands, they tend to rely more on one tax over the other. Also, and forasmuch as that what can be expected from them separately is diverse from one age group to another, authorities have to pay special attention to how those groups will and can contribute to the development of their nations since a high ratio can bring political and social distress as it implies a bigger pressure on the working class.

Moreover, the old age dependency ratio focuses on capturing the difference in the proportions of elderly and working-age people. The first is supposedly the dependent of the second that tends to bear the economic burden. However, it is important to point out that dependency ratios do not take into account that some elderly individuals continue to be active in the labor force and, on the other hand, some so-called working-age individuals are not yet contributing to the economy.

Gross capital formation consists in expenditure with purchase of fixed assets of the economy, such as the construction of infrastructure (schools, hospitals, roads and industrial

buildings, etc.), land improvements, which are recorded apart from land, considering they are depreciated and have a limited life in comparison with the land itself, like driveways and fences, added to the net changes of inventory, which, in turn, are goods that companies stock in order to respond to unanticipated variations on their activity on the market.

Total unemployment refers to the share of the labor force, which is the total number of individuals employed and unemployed. Even though jobless, it is still available and searching for vacancies. The typical definition of an unemployed individual is people between the age of 15 to 74 years old that are out of work through the reference week either because they have voluntarily left their previous work or that have been fired, but are now willing to work during the reference week or until the end of the next two weeks, and either are engaged on looking for jobs opportunities or already has a work promise-contract supposedly to start on a period comprehending to no later than three months.

This methodology of the definition of an unemployed individual tends to vary among the OECD countries as, for instance, nations that tend to rely on an agrarian economy have inherent problems while measuring the rate of employment and unemployment in agriculture, for considering this type of labor have seasonal unemployment, the timing of the survey can either boost or diminish the factual job reality of the sector. Moreover, many of those vacancies are informal and often are not trackable.

Along with it, we must have in mind what concerns the data is the fact that by cause of structural issues such as discrimination and cultural bias, some people who want to work are not considered within the labor market. This gap certainly influences the accuracy of the unemployment count, particularly in women, considering that this group is more affected by the previously cited obstacles.

The *share of international tourism receipts in total exports* are the expenses made by international aliens that includes costs of national carriers for international transport, prepayment realized for goods or services sent to the buyers' nation, and other peculiarities that may vary from one country to another, which is also a hindrance for comparability. The data is obtained mainly from information on arrivals and disbursements from, categorically,

international tourists. The first is measured generically by counting arrivals and departures, not in a personal and individual way.

Considering that it fosters economic progress through the implementation of job opportunities and the need to develop infrastructure to attract tourists, international tourism has become an important indicator through export revenues. Thus, many countries have invested in it, and, especially for developing nations, it has been one of the biggest ways to attract foreign revenue.

Openness was obtained as a result of the summation of exports and imports of goods and services divided by the gross domestic product net of the result of exports less imports.[2] As predicted by TA 2005, with the tendency of liberalization of the trade structure, not only the revenue from international trade taxes shifted to other taxes, but also it has been completely deleted from the OECD Revenue Statistics.

3.3 Descriptive Statistics

Table 1 - Descriptive Statistics

Variable	Mean	Median	Min	Max	Std Dev
Social Security tax	25.70	28.23	0.00	44.76	12.18
Corporate tax	9.25	8.05	1.30	29.48	4.95
Goods and Services tax	33.26	33.05	15.79	65.22	8.06
Payroll tax	1.04	0.00	0.00	11.56	1.99
Personal Income tax	23.52	21.95	0.77	56.03	10.49
Property tax	5.66	5.02	0.68	34.18	3.60
GDPcapita	38396.10	34683.10	1.89	1130730.00	47809.40
Old-Age	22.32	22.68	7.60	46.17	5.93
Openness	9.30	0.08	0.01	621.74	35.57
GKF	258137.00	76367.70	1556.82	3877850.00	538392.00
Tourism	8.09	6.09	0.00	35.36	5.98
Unemployment	8.02	7.14	1.81	27.47	4.18
EU	0.56	1.00	0.00	1.00	0.50

Source: elaborated by the author utilizing the software Gretl.

[2] Openness = $\frac{Exports+imports}{GDP-(Exports-imports)}$

Table 1 contains the descriptive statistics for all the variables, dependent and explanatory, explained in the previous subchapter which were used in the model for annual data from 1995 to 2018.

3.4 Econometrics Tests

The following tests' main goal is to define which econometric technique is more appropriate to the task at hand to properly work on the data and the relationships between the variables. However, each econometric technique has a set of hypotheses behind it, so we had to put each of them into the test to analyze which of these hypotheses, together with their peculiarities, better fit the nature of data, considering that depending on the test results we are able to know which one is most relevant, adequate and efficient.

Table 2 - Durbin-Watson[3] for autocorrelation

	Dependent variable	Durbin–Watson statistic
1ª	Social Security tax	0.037542
2ª	Corporate tax	0.11314
3ª	Goods and Services tax	0.06706
4ª	Payroll tax	0.022361
5ª	Personal Income tax	0.043318
6ª	Property tax	0.244931

Source: elaborated by the author utilizing the software Gretl.

Considering that tax policies, as a matter of fact, tend to depend on the vastest and bureaucrats peculiarities, it is only natural to acknowledge that taxes and their respective properties do not easily change over time, thus while analyzing historical data, as we are doing here, autocorrelation may be an issue if not adequately addressed.

The value of a variable in one year tends to be correlated with its value in the previous year, considering the slow actualization of taxes. Indeed, what happened in the past has a strong influence on what is happening in the future. Along these lines, the past should not be disregarded, nor should the present be analyzed in an exclusive way.

[3] See Durbin and Watson (1971) for the original description of this test.

When we run the OLS estimation, to evaluate how the explanatory variables may be influencing the dependents ones, and observe at the results of the Durbin-Watson test (table 2), we can see that this statistic has a very low value, which indicates a positive autocorrelation, and since that the OLS is not able to treat this time dependency we have to correct those estimates by, for example, introducing a lagged variable in the model.

Also, by looking at the residuals, we see that they exhibit an autocorrelation pattern; that is, they are not white noises that we would expect. Therefore, the model was run again but this time with the lagged dependent variable as one of the explanatory variables.

Table 3 - White Test

	Dependent variable	Chi-square	p-Value
1ª	Social Security tax	163.179936	0.00000
2ª	Corporate tax	265.897526	0.00000
3ª	Goods and Services tax	0.177368	0.00000
4ª	Payroll tax	147.658316	0.00000
5ª	Personal Income tax	169.530622	0.00000
6ª	Property tax	76.642639	0.00000

Source: elaborated by the author utilizing the software Gretl.

This test was performed to determine whether or not there was heteroscedasticity throughout the residuals' variance, in which case the OLS model would not be appropriate, considering that this model has homoscedasticity as one of its assumptions. As the table shows, the null hypothesis of homoscedasticity was rejected for all variables. The variances of the residuals are not constant. Therefore, having the test rejected the null hypothesis of equal variances.

Given the impossibility of using the OLS model according to the test results that have pointed out the existence of heteroscedasticity among the residues, it was necessary to use another econometric estimation model that accepts heteroscedasticity among the residues, which leads us to use fixed or random effects specifications. Complementarily, both as an intellectual exercise and double-checking the OLS model's inadequacy, we have performed two other tests that compare the simple pooled model with the fixed and random effects individually speaking.

Table 4 – Joint significance of common means

	Dependent variable	F	p-Value
1ª	Social Security tax	564.402	0.00000
2ª	Corporate tax	60.0425	0.00000
3ª	Goods and Services tax	123.479	0.00000
4ª	Payroll tax	192.468	0.00000
5ª	Personal Income tax	515.159	0.00000
6ª	Property tax	119.516	0.00000

Source: elaborated by the author utilizing the software Gretl.

Table 5 – Breusch–Pagan Test[4]

	Dependent variable	Chi-square	p-Value
1ª	Social Security tax	7914.9	0.00000
2ª	Corporate tax	4406.86	0.00000
3ª	Goods and Services tax	5094.9	0.00000
4ª	Payroll tax	7738	0.00000
5ª	Personal Income tax	7733.65	0.00000
6ª	Property tax	6379.32	0.00000

Source: elaborated by the author utilizing the software Gretl.

Table 4 brings the F-test results, whose null-hypothesis is that all countries have a common intercept. As H0 is rejected for all variables, we conclude, once more, that polled OLS is inadequate.

The Breusch-Pagan test (table 5) is the counterpart of the F-test for the random effect model and, by rejecting H0, indicates that it is more suitable than pooled OLS for all six types of taxes.

Therefore, both tests gave the same result as the White test, considering that they have indicated that OLS is definitely not appropriate considering the residuals are heteroscedastic.

Table 6 - Hausman Test[5]

	Dependent variable	Chi-square	p-Value	GLS consistent
1ª	Social Security tax	29.3372	0.00013	No
2ª	Corporate tax	19.1385	0.00776	No
3ª	Goods and Services tax	33.574	0.00002	No

[4] See Breusch Pagan (1979) for the original description of this test.
[5] See Hausman (1978) for the original description of this test.

4ª	Payroll tax	1.50157	0.98226	Yes
5ª	Personal Income tax	21.9532	0.00259	No
6ª	Property tax	10.0039	0.18836	Yes

Source: elaborated by the author utilizing the software Gretl.

With the hypothesis of the OLS's pertinency surpassed, we now move on to test the possibilities that we have left, which means if the best option is to use a model with fixed effects or a model with random effects.

We will take advantage of a test called the Hausman test, which has as its null hypothesis that the random effects specification is more suitable than using fix effects. Thus, a high p-value will indicate that the former is preferable to the latter, and if the p-value is low, we can infer that the null hypothesis has been rejected, and fixed effects are better than random effects.

As we can see in table 6, the Hausman test has pointed out that fixed effects are preferable for four of our dependent variables, the exception being both Payroll tax and Property tax. The test has concluded that random effects are more suitable than the fixed effects. On TA 2005, the authors had the same issue and explained that, for consistency sakes, they would use fixed effects for all of their variables.

Here, not only for the same motive as the authors but also considering that our sample has peculiars characteristics, we will also use fixed effects for all of them. Thus, not only for consistency but also acknowledging that our sample represents a very specific and exclusive set of countries, for they tend to be the richest and better-structured ones, fixed effects are better suitable to deal with this set of countries that were not randomly picked throughout all the other nations in the entire world.

However, taking into consideration that the test has indeed pointed out that random effects are preferable for those two variables, we also ran random effects for both Payroll tax and Property tax, whose results will be presented shortly.

3.5 Empirical Model

We have used a panel of 828 observations (for the fixed effects) and 864 observations (for the random effects) in which were included 36 country members of the OECD for the years of 1995 to 2018 in order to analyze the relationship between economic growth and the changes in the tax mix of those nations.

We also have performed several tests in order to consider the best procedure for estimating a model with our panel data. However, the two most common approaches for this kind of examination are the fixed-effects and random-effects procedures, where the first has the convenience of dealing with an eventual bias created by a correlation between the explanatory variables, and also can present solid estimates even when the tests indicates that the random model is pertinent. The latter would be a better fit if our sample were randomly picked among the world's nations, which is not the case considering that the OECD is an exclusive group.

Thus, considering that we intend to examine the data of a specific set of nations that do not represent the totality of the countries that there is, our regression equation, inspired on TA 2005, can be written as

$$TAX_{it} = \propto + (GDPcapita_{\ it})\beta_i + Z_{it}n + f_i + \varepsilon_{it} \qquad (2)$$

where "TAX_{it}" is the individual share in the total tax revenue, as presented in (1), for each of the dependent variables, in the country *i* at time t. GDPcapita is GDP per capita in constant 2015 US dollars. β_i represents an indicator of how economic growth affects the tax share and is the coefficient of interest. In equation 2, Z_{it} is a matrix that incorporates all remaining control variables where n is a vector of coefficients.

In fixed-effects models, we have coefficients that can vary from individual to individual, even though they remain as fixed constants, therefore, not random (Marques, 2000). This refers to the term f_i which represents an individual effect that we cannot observe, is specific for each country, and, although it can vary between them, it is always fixed individually speaking. When we go to the random effect model, this f_i is a realization of a random variable that has its own probabilistic distribution. That is, it can have several values with different

probabilities. ε_{it} is the usual identically and independently distributed error term, assumed to follow a normal distribution with mean zero and finite variance: $\varepsilon_{it} \sim N(0, \sigma^2)$.

4. Empirical Results

We now present the fixed effects regressions results for all our six dependent variables and the random effects regressions for the two variables. The Hausman test (Table 6) indicated it would be more suitable, namely Property and Payroll taxes. As we are about to see throughout the analyses, we got mixed results on how economic growth tends to influence the tax mix of OECD countries and some different outcomes compared with TA 2005.

This tends to be expected considering that, as history has shown, the option of which tax instrument the government will choose and their aliquots' level tends to be mostly related to political purposes instead of economic aspects, however, this is also taken into account (Winer, 2013).

Moreover, we have fifty percent more countries than the cited article had. Our period is set mostly during the 2000s years when both the economy and taxation realities are profoundly diverse compared with the 80s and 90s decades that were the period of TA 2005.

4.1 Fixed and random effects and interpretation

Table 7 – Dependent variable: Social Security tax

Fixed effects model with 828 observations
36 cross-section unities
Time series length = 23
Robust standard errors (HAC)

Variable	Coefficient	Std. Error	t-Ratio	p-Value
const	4.226899	0.675839	6.254299	6.56E-10
GDPcapita	-1.25E-06	6.04E-07	-2.0673	0.039033**
Old-Age	0.016318	0.011299	1.444178	0.149088
Openness	0.000634	0.001217	0.521236	0.602349
GKF	-1.70E-07	2.35E-07	-0.72263	0.470123
Tourism	0.010556	0.01301	0.811382	0.417393
Unemployment	-0.01377	0.019069	-0.72192	0.470559
EU	0.066123	0.233305	0.283417	0.776932
TAXSS_1	0.825053	0.02396	34.43453	5.35E-159***

Mean dependent var	25.71453	S.D. dependent var	12.17028
Sum squared resid	860.89	S.E. of regression	1.04789
R-squared LSDV	0.992972	Adjusted R-squared	0.758977
F (43, 784) LSDV	2575.985	P-valor(F)	0
Log-likelihood	-1191.01	Akaike criterion	2470.016
Schwarz criterion	2677.652	Hannan-Quinn	2549.651
Rho	0.06608	Durbin-Watson	1.79675

Notes: ***; **; * indicate statistical significance at the 1%, 5% and 10% level, respectively.
Source: elaborated by the author utilizing the software Gretl.

In the case of the Social Security Tax shown above in Table 7, the statistically significant negative sign on the coefficient for GDP per capita goes accordingly to our expectations considering that the more economically prosper a population is, the lesser they tend to rely on government social contributions, thus, organizing their respectively tax planning to dimmish the maximum on those contributions. This tendency was also found in the work of Almosova et al. (2020) that documented that for most of their sample countries, the average social security tax also had fluctuated counter-cyclically in comparison with growth.

Moreover, the wealthier a person is the more their preferences focus on privates plans instead of counting on the less beneficial government subsidy. In the same direction, even though the TA 2005 had a positive sign on this coefficient, it already had a dropping tendency considering that it was not statistically significant.

Table 8 – Dependent variable: Corporate tax

Fixed effects model with 828 observations
36 cross-section unities
Time series length = 23
Robust standard errors (HAC)

Variable	Coefficient	Std. Error	t-Ratio	p-Value
const	2.94E+00	6.20E-01	4.734135	2.61E-06
GDPcapita	-1.54E-06	7.07E-07	-2.17855	2.97E-02**
Old-Age	-0.01186	0.015287185	-0.77593	0.438026
Openness	1.06E-03	9.37E-04	1.133446	0.257373
GKF	-1.53E-07	3.04E-07	-0.50448	0.614066
Tourism	-0.01377	0.021893703	-0.62885	5.30E-01
Unemployment	-0.05176	0.020066896	-2.57925	0.010083**
EU	0.072418	0.197491013	0.36669	0.71395
TAXSS_1	0.779823	0.034158543	22.82953	7.61E-89***

Mean dependent var	9.296371	S.D. dependent var	4.987244
Sum squared resid	1495.294	S.E. of regression	1.381037
R-squared LSDV	0.927306	Adjusted R-squared	0.675094
F (43, 784) LSDV	232.5792	P-valor(F)	0
Log-likelihood	-1419.58	Akaike criterion	2927.164
Schwarz criterion	3134.8	Hannan-Quinn	3006.799
Rho	0.098972	Durbin-Watson	1.734387

Notes: ***; **; * indicate statistical significance at the 1%, 5% and 10% level, respectively.
Source: elaborated by the author utilizing the software Gretl.

The results for Corporate Tax in Table 8 show that the coefficient for per capita GDP carries a statistically significant negative sign that, at first glance, may look controversial if analyzed without contextualization. However, it is consistent with the tax avoidance trending that legal maneuvers corporations do to avoid paying taxes. As a response to the fiscal complications brought by the financial crisis, policymakers put the tax avoidance of multinationals in the spotlight (Cobham, Janský, 2018). Consequently, countries tend to diminish as lower as they can these types of taxes, prevent companies from moving overseas, look for better taxes' benefits, and attract outbounds investments.

Thus, by using this as an important attractiveness for investment, governments guarantee the fostering of company creation that, in turn, will buster the job vacancies opportunities that are directly responsible for the origin of the levy of social security tax, which represents one of the biggest shares in total taxes revenue with over 25% of it. Likewise, the encouragement incentive for companies' formation will directly influence collecting the single biggest tax constant in the tax share, which is the goods and service tax, responsible for over 32% of the total tax revenue. Valid to observe that even though on the TA 2005 this coefficient was not statistically significant.

Moreover, the unemployment coefficient shows that the higher the unemployment rate is, the lower the Corporate Tax share is. An outcome that seems reasonable natural considering that one can expect that if the level of unemployment is high, it demonstrates that the economy is probably working in a slower rhythm. Thus the corporations are most probably making fewer profits, having a lower tax base to be taxed.

Table 9 – Dependent variable: Goods and Services tax

Fixed effects model with 828 observations
36 cross-section unities
Time series length = 23
Robust standard errors (HAC)

Variable	Coefficient	Std. Error	t-Ratio	p-Value
const	5.67262018	0.642769312	8.825281596	7.03E-18
GDPcapita	-2.95E-06	7.44E-07	-3.964905302	8.01E-05***
Old-Age	-1.86E-02	1.63E-02	-1.142664465	2.54E-01
Openness	0.000283404	0.000655765	0.432173537	0.665734128
GKF	-4.40E-07	5.22E-07	-0.841707072	4.00E-01
Tourism	2.40E-02	1.82E-02	1.317960824	1.88E-01
Unemployment	0.058654951	0.017174845	3.415166295	0.000670214***
EU	8.25E-01	1.60E-01	5.158593465	3.15E-07***
TAXSS_1	8.13E-01	2.08E-02	39.12794544	1.63E-186***

Mean dependent var	33.23327295	S.D. dependent var	8.029728912
Sum squared resid	1315.428512	S.E. of regression	1.295315595
R-squared LSDV	0.975330521	Adjusted R-squared	0.719434891
F (43, 784) LSDV	720.8409456	P-valor(F)	0
Log-likelihood	-1366.523611	Akaike criterion	2821.047221
Schwarz criterion	3028.6838	Hannan-Quinn	2900.682055
Rho	-0.006873802	Durbin-Watson	1.946683805

Notes: ***; **; * indicate statistical significance at the 1%, 5% and 10% level, respectively.
Source: elaborated by the author utilizing the software Gretl.

The estimated model, using the Goods and Service tax share, in Table 9 presents, as it also did on TA 2005, a negative sign and a statistically significant result for the GDP per capita coefficient. Thus, we can infer that countries that are more developed than others tend to lower the taxation over goods and services in a tentative to attract foreign investment and keep the ones that are already doing business within its bounders, because, otherwise, those investors would prefer to invest in a more tax-friendly country. Even though this tax is indirect, the final price highly determines both the demand and level of competitiveness of businesses.

Another significant coefficient was the one that represents the rate of unemployment. This may be because even though someone is unemployed, one has to keep consuming goods and services. Other taxes will most probably have a smaller share on the total revenue in as much that people tend to spend less on other things but keep spending on goods and services.

Also, it is important to take into consideration that, as we have already pointed out, it is the relative growth in tax bases that affect one another that we are considering here, not the absolute growth. Hence, its share tends to get a larger proportion, even supposing that it could decrease in absolute terms.

In the case of the dummy for the members of the European Union, this tax tends to be higher because it was significant and has a positive sign, which may make sense if we think from the perspective that these countries tend to keep such taxes higher than the others from the sample because they know that to have a business presence in the European market is fundamental.

Table 10 – Dependent variable: Personal Income tax

Fixed effects model with 828 observations
36 cross-section unities
Time series length = 23
Robust standard errors (HAC)

Variable	Coefficient	Std. Error	t-Ratio	p-Value
const	4.96E+00	9.54E-01	5.202386024	2.51E-07
GDPcapita	3.42E-06	6.81E-07	5.024953732	6.24E-07***
Old-Age	1.82E-02	1.21E-02	1.502807236	1.33E-01
Openness	1.40E-04	1.32E-03	0.106504007	0.915209722
GKF	7.60E-07	2.48E-07	3.064330833	2.26E-03***
Tourism	-7.09E-03	1.83E-02	-0.388200564	6.98E-01
Unemployment	-0.007580235	0.021065549	-0.35984038	7.19E-01
EU	-7.02E-01	2.60E-01	-2.703435584	7.01E-03***
TAXSS_1	7.78E-01	4.39E-02	17.73524868	1.98E-59***

Mean dependent var	23.48683213	S.D. dependent var	10.46695453
Sum squared resid	1182.19035	S.E. of regression	1.22796411
R-squared LSDV	0.986952082	Adjusted R-squared	0.6606501
F (43, 784) LSDV	1379.121245	P-valor(F)	0
Log-likelihood	-1322.311089	Akaike criterion	2732.622178
Schwarz criterion	2940.258757	Hannan-Quinn	2812.257012
Rho	-0.016899459	Durbin-Watson	1.986179757

Notes: ***; **; * indicate statistical significance at the 1%, 5% and 10% level, respectively.
Source: elaborated by the author utilizing the software Gretl.

As for Personal Income tax in Table 10, as we would expect, the coefficient for GDP per capita and the coefficient for gross fixed capital formation carry a positive sign, what shows

that income growth results in personal income expansion; thus, the bigger both the GDPcapita and GKF are, the bigger is the representative share of personal income tax on the total tax share, a trendy that was also observed on the TA 2005 article.

The positive sign for the coefficient for GDP per capita, together with a negative sign for the European Union dummy that we also can observe on our results, were both detected by TA 2005, where the latter shows that members of the European Union tend to rely less on this type of tax.

Table 11 – Dependent variable: Payroll tax

Fixed effects model with 828 observations
36 cross-section unities
Time series length = 23
Robust standard errors (HAC)

Variable	Coefficient	Std. Error	t-Ratio	p-Value
const	1.08E-01	1.40E-01	0.772572765	4.40E-01
GDPcapita	1.60E-07	1.44E-07	1.113262579	2.66E-01
Old-Age	1.75E-03	2.26E-03	0.775382937	4.38E-01
Openness	-2.07E-04	1.43E-04	-1.45015413	0.147415469
GKF	7.48E-08	7.28E-08	1.027063536	3.05E-01
Tourism	7.74E-04	4.19E-03	0.184472007	8.54E-01
Unemployment	0.002230725	0.003310777	0.673776732	0.500651859
EU	-1.32E-01	1.28E-01	-1.037950692	3.00E-01
TAXSS_1	8.91E-01	1.89E-02	47.12525236	6.15E-231***

Mean dependent var	1.042044686	S.D. dependent var	1.996127265
Sum squared resid	61.55433213	S.E. of regression	0.280202032
R-squared LSDV	0.981320009	Adjusted R-squared	0.816458933
F (43, 784) LSDV	957.8149268	P-valor(F)	0
Log-likelihood	-98.85663646	Akaike criterion	285.7132729
Schwarz criterion	493.3498517	Hannan-Quinn	365.3481066
Rho	0.029538442	Durbin-Watson	1.906225227

Notes: ***; **; * indicate statistical significance at the 1%, 5% and 10% level, respectively.
Source: elaborated by the author utilizing the software Gretl.

Table 12 – Dependent variable: Payroll tax

Random effects model (GLS), with 864 observations
36 cross-section unities
Time series length = 24

Variable	Coefficient	Std. Error	t-Ratio	p-Value
const	0.969815543	0.413914109	2.343035722	0.019355663

GDPcapita	1.42E-07	5.30E-07	0.267453282	7.89E-01
Old-Age	1.44E-02	8.67E-03	1.658026728	9.77E-02*
Openness	-3.23E-05	6.57E-04	-0.04919414	9.61E-01
GKF	6.27E-08	2.34E-07	0.268088246	0.788695982
Tourism	-5.82E-03	8.82E-03	-0.660137478	5.09E-01
Unemployment	-1.40E-03	8.84E-03	-0.158001283	8.74E-01
EU	-0.390350877	0.117444659	-3.323700541	0.000926034***

Mean dependent var	1.04E+00	S.D. dependent var	1.990040372
Sum squared resid	3445.637233	S.E. of regression	2.005138449
Log-likelihood	-1823.544765	Akaike criterion	3663.08953
Schwarz criterion	3701.182112	Hannan-Quinn	3677.669618

Notes: ***; **; * indicate statistical significance at the 1%, 5% and 10% level, respectively.
Source: elaborated by the author utilizing the software Gretl.

As for the payroll tax, we have that both fixed effects in table 11 and random effects in Table 12 have pointed out that the GDP per capita coefficient carries a positive sign, although they were not statistically significant. These results were expected considering that government does not want to make this type of taxation high enough that could cause a negative effect on work incentives but also there is the issue of financing the benefits of the retirees and other categories of non-productive workers.

Therefore, capturing this modern tendency of the less young workforce and more old people population, which is also formed of the baby boomer of the ’60s, which now are inactive workforce, the random effects have captured a statistically significant result old-age coefficient, with a positive sign.

However, it is important to say that despite those results, it does not mean that the payroll tax has been substantially increased in absolute terms, what can also be noticed when looking to the negative sign of the EU coefficient, that demonstrate that countries that are part of the Europe Union tend to resort less on this type of tax.

Table 13 – Dependent variable: Property tax

Fixed effects model with 828 observations
36 cross-section unities
Time series length = 23
Robust standard errors (HAC)

Variable	**Coefficient**	**Std. Error**	**t-Ratio**	**p-Value**

const	3.47E+00	9.10E-01	3.810599436	1.49E-04
GDPcapita	-2.34E-06	5.86E-07	-3.994316571	7.10E-05***
Old-Age	8.08E-03	3.01E-02	0.268276275	7.89E-01
Openness	-6.20E-04	7.87E-04	-0.787465236	4.31E-01
GKF	1.20E-06	7.57E-07	1.580349755	1.14E-01
Tourism	3.23E-02	4.55E-02	0.708623298	4.79E-01
Unemployment	0.008866749	0.020599939	0.430425985	6.67E-01
EU	6.36E-02	2.68E-01	0.237041981	8.13E-01
TAXSS_1	2.55E-01	2.51E-01	1.017335068	3.09E-01

Mean dependent var	5.678327295	S.D. dependent var	3.599106754
Sum squared resid	1170.875584	S.E. of regression	1.222073547
R-squared LSDV	0.890701102	Adjusted R-squared	0.092619588
F (43, 784) LSDV	148.5811836	P-valor(F)	0
Log-likelihood	-1318.329603	Akaike criterion	2724.659207
Schwarz criterion	2932.295785	Hannan-Quinn	2804.29404
Rho	-0.06752057	Durbin-Watson	2.094653553

Notes: ***; **; * indicate statistical significance at the 1%, 5% and 10% level, respectively.
Source: elaborated by the author utilizing the software Gretl.

Table 14 – Dependent variable: Property tax

Random effects model (GLS), with 864 observations
36 cross-section unities
Time series length = 24

Variable	**Coefficient**	**Std. Error**	**t-Ratio**	**p-Value**
const	4.684025112	0.658189182	7.116533118	2.34E-12
GDPcapita	-9.88E-07	1.01E-06	-0.977024558	3.29E-01
Old-Age	4.71E-03	1.65E-02	0.285372913	7.75E-01
Openness	-2.02E-04	1.25E-03	-0.160631688	8.72E-01
GKF	1.95E-06	4.28E-07	4.554777347	6.00E-06***
Tourism	4.35E-02	1.67E-02	2.60222792	9.42E-03***
Unemployment	2.87E-03	1.68E-02	0.17076553	8.64E-01
EU	0.059166123	0.2227573	0.265608011	7.91E-01

Mean dependent var	5.66E+00	S.D. dependent var	3.596628837
Sum squared resid	9378.54119	S.E. of regression	3.308089373
Log-likelihood	-2256.113003	Akaike criterion	4528.226007
Schwarz criterion	4566.318589	Hannan-Quinn	4542.806095

Notes: ***; **; * indicate statistical significance at the 1%, 5% and 10% level, respectively.
Source: elaborated by the author utilizing the software Gretl.

The results for Property tax in Table 13 refer to the fixed effect estimated model. We just had as statistically significant the coefficient for GDP per capita, carrying a negative sign.

This is an expected outcome considering it is part of the trend among countries on attracting both wealthy individuals and corporations, while also keeping the ones that are already within its borders, and is totally justified considering that nowadays taxation is a crucial part of the decision making of individuals and corporations, and tax planning is more common than ever. Although it can be controversial considering that while economists advocate for an expanded reliance on it by considering the attractiveness of the property tax's economic peculiarities, there is a diffused political resistance to its expansion (Norregaard, 2013).

As for Table 14, in which we have the results of the random effects, we have as statistically significant with a positive sign both gross capital formation and tourism. A result that makes sense considering that both of them tend to create appreciation on the properties subject to the tax, which will naturally make the amount levied get higher. In the first case, we have, for example, that any land improvement will affect the value of the taxable property in which this improvement was performed. In the second case, we can conceive that the higher the tourism in a specific region gets, the higher the property's price in this locality and the property's investment to explore the tourism business will be.

5. Conclusion

This work's main objective was to empirically investigate how economic growth can affect taxation using the tax mix of the OECD in the context of its members countries. This empirical research was motivated by a gap in the literature concerning studies that explore this approach, since the preponderant bulk of articles that analyze this relationship tend to focus on the opposite direction of causation, which is how taxation affects growth.

The finds of our empirical analysis have shown that economic growth measured by GDP per capita has a compelling and significant effect on the tax mix of the OECD countries, considering that its coefficients were statistically significant for five out of six of our tax categories. Accordingly, GDP per capita has had a statistically significant negative sign for social security tax, corporate tax, goods and services tax and property tax, and a statistically significant positive sign for personal income tax.

Furthermore, other explanatory variables have had statistical significance besides the GDP per capita throughout our empirical analysis. One can conclude that: (i) the old-age dependency ratio has had a statistically significant positive sign in the equation for the share of payroll taxes; (ii) the gross capital formation coefficient was positive for both personal income tax and property tax; (iii) total unemployment rate was shown to have a negative impact on corporate tax and a positive one on goods and services tax; the share of international tourism receipts in total exports has presented a statistically significant positive coefficient in the equation for property tax; and (v) our European Union dummy was shown to have a statistically significant negative effect on both personal income and payroll taxes, and positive impact on goods and service tax.

Our perspective with this work was also to help policymakers formulate the tax structure, considering that taxation has, among its objectives, the noble goal of promoting income redistribution. And also because there is widely recognition that the tax mix influences economic performance. Thus, we dare to comment and justify some of these growth driven tax share changes, however we also acknowledge that many other less logical factors, that are out of our scope, such as political motivations, tend to influence these results highly. So, as suggestions for future analysis, it would be interesting to have, for example, a dummy showing if left or right-wing governs a respective country, and perhaps also to know its corruption level.

List of references

Almosova, A., Burda, M. C., & Voigts, S. (2020). Social Security Contributions and the Business Cycle. *Journal of Macroeconomics*, 65, 103209. https://doi.org/10.1016/j.jmacro.2020.103209

Barro, R. J. (1990). Government spending in a simple model of endogeneous growth. *Journal of political economy*, 98(5, Part 2), S103-S125. https://doi.org/10.1086/261726

Breusch, T. S., & Pagan, A. R. (1979). A simple test for heteroscedasticity and random coefficient variation. *Econometrica: Journal of the econometric society*, 1287-1294. https://doi.org/10.2307/1911963

Cobham, A., & Janský, P. (2018). Global distribution of revenue loss from corporate tax avoidance: re-estimation and country results. *Journal of International Development*, 30(2), 206-232. https://doi.org/10.1002/jid.3348

Durbin, J., & Watson, G. S. (1971). Testing for serial correlation in least squares regression. III. *Biometrika*, 58(1), 1-19. https://doi.org/10.2307/2334313

Engen, E. M., & Skinner, J. (1996). Taxation and economic growth (No. w5826). *National Bureau of Economic Research*. https://doi.org/10.3386/w5826

Hausman, J. A. (1978). Specification tests in econometrics. Econometrica: *Journal of the econometric society*, 1251-1271. https://doi.org/10.2307/1913827

King, R. G., & Rebelo, S. (1990). Public policy and economic growth: developing neoclassical implications. *Journal of political Economy*, 98(5, Part 2), S126-S150. https://doi.org/10.1086/261727

Lucas Jr, R. E. (1988). On the mechanics of economic development. Journal of monetary economics, 22(1), 3-42. https://doi.org/10.1016/0304-3932(88)90168-7

Lucas Jr, R. E. (1990). Supply-side economics: An analytical review. *Oxford economic papers*, 42(2), 293-316. https://doi.org/10.1093/oxfordjournals.oep.a041948

Mankiw, N. G., Weinzierl, M., & Yagan, D. (2009). Optimal taxation in theory and practice. Journal of Economic Perspectives, 23(4), 147-74. https://doi.org/10.3386/w15071

Marques, L. D. (2000). Modelos dinâmicos com dados em painel: revisão de literatura. *Centro de estudos Macroeconómicos e Previsão, faculdade de Economia do Porto*, 30, 37.

Myles, G. D. (2000). Taxation and economic growth. Fiscal studies, 21(1), 141-168. https://doi.org/10.1111/j.1475-5890.2000.tb00583.x

Norregaard, M. J. (2013). Taxing immovable property revenue potential and implementation challenges (No. 13-129). *International Monetary Fund*. https://doi.org/10.5089/9781484369050.001

OECD (2019), Revenue Statistics 2019, *OECD Publishing*, Paris, https://doi.org/10.1787/0bbc27da-en

Ramsey, F. P. (1927). A Contribution to the Theory of Taxation. The economic journal, 37(145), 47-61. https://doi.org/10.2307/2222721

Revenue Statistics: Comparative tables", OECD Tax Statistics (database). https://doi.org/10.1787/data-00262-en

Romer, P. M. (1986). Increasing returns and long-run growth. *Journal of political economy*, 94(5), 1002-1037. https://doi.org/10.1086/261420

Salanie, B. (2011). The economics of taxation. *MIT press*.

Smith, A. (1776). The wealth of nations.

Solow, R. M. (1956). A contribution to the theory of economic growth. *The quarterly journal of economics*, 70(1), 65-94. https://doi.org/10.2307/1884513

Swan, T. W. (1956). Economic growth and capital accumulation. *Economic record*, 32(2), 334-361. https://doi.org/10.1111/j.1475-4932.1956.tb00434.x

Tosun, M. S., & Abizadeh, S. (2005). Economic growth and tax components: an analysis of tax changes in OECD. Applied Economics, 37(19), 2251-2263. https://doi.org/10.1080/00036840500293813

Volkerink, B., & De Haan, J. (1999). Political and institutional determinants of the tax mix: an empirical investigation for OECD countries. *Graduate School/Research Institute Systems, Organisation and Management*.

Winer, S. L. (2013). The political economy of taxation. *In The Oxford Handbook of Public Choice*, Volume 2. https://doi.org/10.1093/oxfordhb/9780190469771.013.22

World Bank. (2017). World Development Indicators. Washington, DC. World Bank. https://openknowledge.worldbank.org/handle/10986/26447 License: CC BY 3.0 IGO.

Appendix

Figure A.1 – Description and source of variables

	Variable	Description	Source
Dependent variables	SST	Social security contributions %TAX	OECD
	CT	Tax on corporate profits %TAX	OECD
	GST	Tax on goods and services %TAX	OECD
	PAYT	Tax on payroll %TAX	OECD
	PIT	Tax on personal income %TAX	OECD
	PROPT	Tax on property %TAX	OECD
Independent variables	GDPcapita	Gross Domestic Product per capita, (constat 2015 US$). Deflated from the Consumer Price Index (base 2015=100) - OCDE.	OECD
	OLD-AGE	Age dependency ratio, old (% of working-age population)	World Bank
	Openness	Degree of trade openness (%), calculated from current values (millions US$): $Openness = \frac{Exports + imports}{GDP - (Exports - imports)}$.	OECD, World Bank
	GKF	Gross capital formation (constant 2010, million US$)	World Bank
	Tourism	International tourism, receipts (% of total exports)	World Bank
	Unemployment	Unemployment, total (% of total labor force) (modeled ILO estimate)	World Bank
	EU	Dummy for European Union countries	OECD