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Optimal Threshold Taxation: An Empirical Investigation for Developing Economies

Abstract

In this empirical study we assess both linear and nonlinear relationship between total taxation and several tax items with real *per capita* GDP growth rates for 43 developing countries between 1990 and 2019. We use panel data techniques to evaluate the effects of taxation on economic growth for both short and long run perspectives, and to find optimal tax threshold values. We obtain evidence of nonlinear relationships between all tax items, except for corporate income taxation, as well as an optimal value for total tax burden around 23,5% of GDP for the whole sample. When the sample is subdivided by countries' income levels, we find threshold values for all tax items and an optimal tax burden around 23,6% of GDP for high income countries and 21,3% of GDP for low income. Our results provide support regarding the existence of nonlinearities and about policies focused on raising certain tax revenues, as a percentage of GDP, without hampering economic growth.

JEL-Codes: E620, H210, O470.

Keywords: economic growth, fiscal policy, optimal taxation, tax thresholds.

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1. Introduction

Tax policy has recurrently been in the centre of academic, political and informal debates about the design of policies and social systems which may help or disturb the economic performance of a country. In this sense, taxation has an important role on the individual and collective decision-making process of a society, to which it serves as means for an equilibrium on the conflict between individual economic liberties and the social well-being.

Although its primary function is to be the main source of government revenues to fund public expenditures, it also serves as an instrument to redistribute income and respond to social needs, to efficiently allocate investment funds, to indirectly control consumption and production, and to stabilize the economy in face of fluctuations and externalities. This should be done in the most effective way by a tax system designed to limit its distortionary effects and to promote economic growth with social development.

Consequently, the core of the issue usually becomes what would be the optimal government size for each country and how it should be measured, whether by the expenditure side or by the revenue side. From theoretical models to empirical evidence on the relationship between government size and economic growth, such as Wagner's Law[4] and endogenous growth models (Romer, 1986; Lucas, 1998), until recent meta-analysis on the literature, such as Alinaghi and Reed (2021), the focus has been on the understanding of this relationship and investigating if there are in fact optimal levels.

Accordingly, the study of tax policy and optimal tax levels has been constantly revised over time, as data and estimation methods improved. However, discussions are not yet finished, and the evidence has not reached a consensus, in a sense which makes the study of an optimal tax structure important to further development of the topic, also willing to help governments to improve tax system compositions across countries.

Therefore, in this article we propose to empirically study the relationship between different taxes and economic growth for developing economies, investigating if there is evidence of a nonlinear impact of tax revenues on economic performance. To this matter, we evaluate both linear and nonlinear relationships between several types of tax revenues and *per capita* GDP growth rates in 43 developing countries, addressing their effects according to income levels on both short and long-term perspectives, for the period

[4] From the studies of Adolf Wagner which formulated in the 19th century a "law" about the expansion of government. Based on the data available, he argued that as the wealth of a society increases, the size of government does too.

between 1990 and 2019. We use different panel data estimation techniques and identify threshold values for total tax burden and for different taxes, to which governments and societies could consider in order to improve their tax designs and stimulate economic growth.

The remaining of the paper is structured as follows: Section 2 presents a literature review about the related theoretical and empirical evidence on the topic; Section 3 provides information about the data and methodology adopted; Section 4 brings the empirical results; and Section 5 summarizes the results and presents the conclusions.

2. Literature Review

Empirical studies commonly try to assess the linear relationship between economic growth and fiscal policy indicators through cross-section and panel data estimations. Early works to address the effects of fiscal variables on GDP growth rates were conducted by Landau (1983, 1986), Grier and Tullock (1989) and Barro (1989, 1991). Although they differed in datasets and used mainly cross-sectional data, the main common finding is that government consumption expenditures present a detrimental effect to economic growth.[5]

Moreover, although Engen and Skinner (1992) have found strong negative effects of both government spending and taxation on output growth, Levine and Renelt (1992) conducted a sensitivity analysis for the existing studies and found that results were mainly fragile and not robust to small variations. Unstable evidence was also found by Slemrod (1995), which presented evidence that results may change depending on the specification of parameters and countries studied.

On the other hand, by making a distinction between productive and unproductive expenditures, Kneller et al. (1999) found robust evidence that increases in productive public expenditures significantly enhances growth, while Devarajan et al. (1996) showed that even productive expenditures could become unproductive if excessively used. Additionally, even though Fölster and Henrekson (2000) did not distinguish between different types of public expenditures, the authors found robust evidence on the negative relationship between government expenditure and GDP growth for a sample of rich countries, while Odedokun (2001) and Romero de Ávila and Strauch (2007) found similar

[5] Kormendi and Meguire (1985) is another example of early empirical literature, but the authors found no evidence that government consumption significantly affects economic growth.

results for developing and European countries, respectively, also presenting evidence of a growth-enhancing effect of public spending on education and investment.

Besides corroborating with previous evidence, Afonso and Alegre (2011) identified that the main impact of fiscal variables comes through changes in investment and that there was a crowding-in effect of public into private investment, provoking an overall positive effect of public investment on economic growth for European countries. Afonso and Jalles (2014) also concluded for a negative effect of government expenditures, particularly for public wages, interest payments, subsidies and government consumption, while government spending on health and education seemed to enhance growth rates.

Besides that, another branch of the literature focused on optimal government sizes through the estimation of the commonly known Armey (1995) curve for different sets of countries. Forte and Magazzino (2011) estimated optimal government expenditures lying in the interval between 37-43% of GDP for EU member countries, while Asimakopoulos and Karavias (2015) estimated optimal levels of government consumption expenditure (not including investment) around 18% of GDP for a large set of developed and developing countries.[6]

Focusing on developing economies, Lazarus et al. (2017) and Nouira and Kouni (2018) addressed this relationship for African countries and found government expenditures threshold values between 15-25% of GDP. Moreover, Jain et al. (2021) found threshold values around 24% of GDP for government total expenditures, 13% of GDP for government consumption and 7% for investment for a set of 16 emerging economies.[7]

Thereby, this study is based on the empirical literature addressing the effects of fiscal policy on economic growth indicators. However, as has been shown, large part of the literature focused mainly on the effects of fiscal policy measured by the expenditure side, through different specifications of public spending. Apart from that, our research relates to the literature exploring the link between government revenues, more specifically the tax system composition, with real *per capita* GDP growth rates across countries, in the short and long run perspectives. Below, we explore this part of the literature by dividing the section into those adopting a linear estimation approach, and those assessing the non-linear relationship between these variables.

[6] For an empirical evidence review, see Coayla (2021).
[7] Rajput and Tariq (2019) also found substantial evidence supporting the Armey curve across non-OECD countries.

2.1. *Linear hypothesis*

Focusing on the revenue side, early empirical studies about the effects of total tax burden were conducted by Koester and Kormendi (1989), Easterly and Rebelo (1993) and Mendoza et al. (1997), which found only limited evidence on the relationship between total taxation and economic growth. Yet, Cashin (1995) was able to find robust evidence about the negative effect of distortionary taxation on growth for developed countries, a result also found by Kneller et al. (1999) and Gemmel et al. (2008) for OECD countries, as well as by Romero de Ávila and Strauch (2007) and Benos (2009) for European countries.

Still, Kneller et al. (1999) described inconsistencies in previous studies arguing that the non-robustness may in part be a reflect of the *ad hoc* manner of adding fiscal variables without considering the linear restriction implied by the government constraint, which could lead to systematic biases.[8] The authors also highlighted possible problems of endogeneity on fiscal variables and with the common use of 5-year averaging to control for business cycles.[9]

Accounting for these inconsistencies, Arnold (2008, 2011) adopted Pesaran's (1999) Pooled Mean Group Estimator (PMG) to estimate the relationship between tax variables and economic growth for OECD countries in a 35-year period. The author established a ranking of taxes with respect to their effects on growth, where property taxes seemed to be the most growth-friendly type of tax, followed by consumption taxes, personal income taxes and by last, as the most detrimental tax to growth, corporate income taxation. These results seemed to be corroborated by Ormaechea and Yoo (2019), which found evidence for a large set of high, medium and low-income countries that property and consumption taxes are positively associated with growth, while income taxes and social security contributions present negative effects.

These robust findings may suggest that studies looking at changes in the tax structure, instead of the overall tax burden, could present more conclusive contributions to the literature, as argued by Widmalm (2001). However, Xing (2011, 2012) examined how robust is the empirical evidence on this relationship for OECD countries. The author assessed heterogeneity issues in short and long-term perspectives, concluding that there

[8] The authors argued that one element of the budget constraint must be omitted of the regression as the implicit financing element. Although this idea had already been discussed by Miller and Russek (1997), the authors had not tested for the existence of biases if this condition is ignored.

[9] Bleaney et al. (2001) also confirms the volatility of results due to the use of 5-year moving average and the existence of endogeneity on fiscal variables.

was no robust ranking between corporate income taxes, personal income taxes and consumption taxes, and that even the evidence about property taxes possibly being associated with higher levels of per capita income is weak and not significant for long-run coefficients. In addition, Zimčík (2016) found evidence that corporate income taxes present an insignificant relationship with growth, whilst non-distortionary taxes, such as consumption taxes, have negative effects on growth, for a sample of 20 EU countries.

For Latin American countries, Bacarreza et al. (2013) did not find clear evidence on the expected negative effect of personal income taxes, which according to the authors may be explained by the small collection of this type of tax in the region[10], but found evidence that corporate taxes and consumption taxes might have contributed to economic growth. However, results were not homogeneous when analyzing countries individually.

Further, by assessing the effects of fiscal volatility for a set of OECD and EU countries, Afonso and Furceri (2010) found evidence that the size and volatility of public revenues seemed to negatively affect growth rates in both country samples, and that the most growth detrimental variables are indirect taxes and social security contributions. This result was corroborated by Karras and Furceri (2009) and by Afonso and Jalles (2012), which also estimated the relationship between fiscal variables and financial crises, concluding that during these periods' government spending is stickier than revenues and its detrimental effects to growth are deepened.

Lastly, Alinaghi and Reed (2021) performed a meta-analysis on studies assessing the effects of taxes on economic growth, according to the government budget constraints adopted in the regressions. Thus, the authors categorized different tax-spending-deficit specifications and found that a 10 percent increase in taxes can be associated to a 0.2 percent decrease in GDP growth, in the combination denominated as *TaxNegative*, or a 0.2 percent increase, in the *TaxPositive* combination.[11] The authors argued that these different specifications could be a source for the lack of consensus in the literature, also finding evidence of publication bias in favor of negative estimated coefficients.

2.2 *Non-linear hypothesis*

Although Barro (1989), Scully (1995), Armey (1995) and Rahn and Fox (1996) have all developed theoretical frameworks for the existence of an optimal government size

[10] Bird and Zolt (2005) and Tanzi et al. (2008) had already discussed this issue previously.

[11] The *TaxNegative* combination is given by an increase in distortionary taxes to fund unproductive expenditures or followed by decreases in non-distortionary taxes, while the *TaxPositive* combination refers to increases in non-distortionary taxes to fund productive expenditures, to decrease the public deficit or accompanied by decreases in distortionary taxes.

through the representation of an inverted U-shaped curve between public expenditures or revenues and economic growth, commonly known as the Armey curve or "BARS" curve (as a reference to Barro, Armey, Rahn and Scully), the first empirical attempts to address the non-linear relationship between fiscal policy variables and economic growth were possibly made by Scully (1995, 1996), which developed a model as an alternative to Barro's (1991), in order to estimate optimal levels of government spending and tax rates for the USA and New Zealand, respectively.[12] Thereafter, many studies focused on the estimation of optimal government levels for specific countries, such as Chao and Grubel (1998) for Canada, Stone et al. (2006) for USA and Facchini and Melki (2013) for France.

On the other hand, some studies concentrated on the estimation of optimal levels of public revenues across panels of different countries, such as Amgain (2017), which used Scully's model and quadratic methods on a panel of 32 Asian countries, finding through both methods that total tax revenues around 18% of GDP maximize real per capita GDP growth rates. Further, Aydin and Esen (2019) also explored the non-linear impact of tax revenues on economic growth for 11 central and south-eastern European countries during their transition processes and found optimal levels of total tax revenues around 18% of GDP for full transition economies and 23% for developed ones. Similar results were found by Hang et al. (2020), which estimated an optimal threshold tax revenue around 15,3% of GDP for 6 Asian countries.

Contrastingly, focusing on OECD countries, De Witte and Moesen (2010) proceeded by using non-parametric Data Envelopment Analysis (DEA) to compute a value of optimal tax burden around 41% of GDP, while Milasi and Waldmann (2017) assessed the non-linear relationship between top marginal tax rates and economic growth, finding evidence of a quadratic (concave) top tax-growth relationship, with estimates that suggested a growth maximizing top tax rate on the order of 60%.

Concentrating on the non-linear effects of the tax structure, through the adoption of different panel estimation techniques for all OECD countries between 1980-2015, Alves (2019, 2021) found optimal threshold values for different types of taxes which could enhance per capita GDP and investment growth rates in the short and long-run perspectives. Additionally, Afonso and Alves (2019) adopted the same dataset and found optimal threshold tax values for increasing household consumption and reducing income

[12] See also Scully (2003, 2006).

inequalities. The authors concluded that there is fiscal space to higher total tax-to-GDP ratios and increases in specific taxes depending on the policies pursued.

3. Methodology and Data

For our analysis we consider a neoclassical growth model with a production function of the type *Y=F(T)*, where the economic performance output ($Y_{i,t}$) is a function of the tax structure ($T_{n,i,t}$) and of a set of control variables ($X_{q,i,t}$), as expressed in Equation (1) below:

$$Y_{i,t} = \alpha_{i,t} + \beta_{0,i,t} Y_{i,t-1} + \sum \beta_{1,i,t} T_{n,i,t} + \beta_j X_{q,i,t} + \delta_i + \mu_t + \varepsilon_{i,t}, i = 1, \ldots, N, \quad t = 1, \ldots, T \tag{1}$$

where $Y_{i,t}$ is the real *per capita* GDP growth rate, $Y_{i,t-1}$is the one-lag real *per capita* GDP, $T_{n,i,t}$ represents the revenues of each tax item n, in percentage of GDP, $X_{q,i,t}$ refers to the q different control variables, δ_i and μ_t are country and time-specific effects, $\varepsilon_{i,t}$ represents the unobserved zero mean white noise-type errors satisfying the standard assumptions, while *t* and *i* are the time and country indices, respectively.

To assess possible non-linear effects of each tax item on economic performance, we insert an additional squared term for each tax variable, as expressed in the following equation:

$$Y_{i,t} = \alpha_{i,t} + \beta_{0,i,t} Y_{i,t-1} + \sum \beta_{1,i,t} T_{n,i,t} + \sum \beta_{2,i,t} {T^2}_{n,i,t} + \beta_j X_{q,i,t} + \delta_i + \mu_t + \varepsilon_{i,t}, \quad i = 1, \ldots, N, \quad t = 1, \ldots, T \tag{2}$$

Further, by deriving this equation with respect to the tax components and equalizing it to zero, it should be possible to compute optimal threshold values for each tax item, as describe below:

$$\beta_{1,n,i,t} + 2\beta_{2,n,i,t} {T^*}_{n,i,t} = 0 \leftrightarrow {T^*}_{n,i,t} = \frac{-\beta_{1,n,i,t}}{2\beta_{2,n,i,t}} \tag{3}$$

Therefore, if the estimation results present a significant positive value for $\beta_{1,n,i,t}$ and negative for $\beta_{2,n,i,t}$, it means that there is a concave relationship between the tax variable coefficient and economic performance, implying a maximum value of tax revenue that promotes economic growth. Oppositely, a significant negative value for $\beta_{1,n,i,t}$ and positive for $\beta_{2,n,i,t}$ means that there is a convex relationship and a threshold value that minimizes economic growth. Thus, for interpretation of non-linear relationships we

consider only results where both linear and non-linear coefficients are statistically significant and highlight which are the maximum and minimum optimal threshold cases.

The model is estimated using a set of 43 developing countries for the period between 1990 and 2019.[13] The database was retrieved from different sources, where data on real per capita GDP, in thousands of dollars, based on purchasing-power-parity (*gdppc*), general government gross debt-to-GDP ratio (*govdebt*) and the share of general government total expenditure in GDP (*govexp*) were collected from the World Economic Outlook (WEO) of the International Monetary Fund (IMF).

Data about taxation as a percentage of GDP, namely the total tax revenue (*totaltax*), taxes on income, profits and capital gains of individuals (*indivinctax*), taxes on income, profits and capital gains of corporates (*corpinctax*), social security contributions (*ssc*), taxes on payroll and workforce (*payrolltax*), taxes on property (*propertytax*) and taxes on goods and services (*consumptax*) were taken from the OECD.Stats database. As many developing countries do not have a completely solid social security system and/or do not collect payroll taxes revenues, we classified *ssc* and *payrolltax* together as working contributions (*workcontrib*) for reasons of better reliability of the results.

Moreover, gross fixed capital formation (*gfkf*), in percentage of GDP, the sum of exports and imports of goods and services (*trade*), measured as a share of GDP, unemployment (*unemp*), as a percentage of the total labor force, deposit interest rates (*intrate*) and the labor force (*labor*), in thousands of people, were all collected from the World Development Indicators (WDI).

Lastly, data about the informal sector or "shadow economy" (*shadow*), as a percentage of GDP, was taken from Medina and Schneider (2017). Table 1 shows the summary statistics for each variable used in the regressions.

Table 1 - Summary statistics of the variables, 1990-2019.

Variables	Obs.	Mean	Std. Dev.	Min.	Max.
gdppc	1281	8.750	6.222	.560	31.638
totaltax	1130	18.093	6.233	5.07	33.57
indivinctax	1090	2.239	1.868	0	10.05
corpinctax	1080	3.177	2.319	0	21.17
workcontrib	1130	2.33	2.299	0	10.8
propertytax	1126	.611	.706	0	4.16
consumptax	1130	9.257	3.084	2.88	20.37
govdebt	1038	51.298	27.898	.071	236.543

[13] The countries considered are: Argentina, Barbados, Belize, Bhutan, Bolivia, Brazil, Bulgaria, Burkina Faso, Cabo Verde, Cameroon, Colombia, Côte d'Ivoire, Dominican Republic, Egypt, El Salvador, Eswatini, Guatemala, Guyana, Honduras, Jamaica, Kazakhstan, Kenya, Lesotho, Madagascar, Malaysia, Mali, Mauritius, Morocco, Nicaragua, Niger, Panama, Papua New Guinea, Paraguay, Peru, Philippines, Rwanda, Saint Lucia, Senegal, South Africa, Thailand, Trinidad and Tobago, Tunisia and Uruguay.

Variables	Obs.	Mean	Std. Dev.	Min.	Max.
govexp	1123	24.878	7.996	9.402	64.641
intrate	991	31.611	368.325	.027	9394.293
gfkf	1144	21.496	7.651	4.452	69.673
unemp	1247	8.411	7.019	.21	37.97
trade	1182	76.714	39.035	13.753	274.973
shadow	1080	37.147	8.936	17.8	70.5
labor	1290	8706.76	14589.638	54.671	105542.22

Notes: For reasons of parsimony, the results of *gdppc* and *labor* variables are expressed in thousands of USD and in thousands of people, respectively.

The regressions are estimated through the following panel data estimation techniques to address some possible common problems: (*i*) OLS with robust standard errors; (*ii*) OLS-Fixed Effects (OLS-FE) to consider unobserved heterogeneity; (*iii*) Robust Least Squares (RLS) to deal with possible outliers and retrieve more robust results; (*iv)* Two-Stage Least Squares (2SLS) to deal with endogeneity issues.

To address short-run and long-run dynamics, the analysis consists on the regression estimation of annual and 5-year average economic growth rates, as well as the specification of different group regressions according to countries' income levels for robustness and sensitivity analysis. In this sense, we divide the country sample according to countries' income levels, where *High-Income* countries refers to the ones which have *per capita* income higher than the average (around USD 8.500,00) for at least half of the period analyzed, and *Low-Income* countries refers to the ones which have *per capita* income lower than this level for at least half the period.

4. Results

4.1. *Short run effects*

The results regarding the short run effects are displayed in Table 2, 3, 4 and 5. Each table displays the estimation methods adopted and the results of each regression with and without the quadratic terms. At the bottom of each table, we also show the tax threshold values achieved when both linear and non-linear coefficients are significant and calculated as explained in the previous section.

Table 2 presents the results of regressions addressing the short run linear and nonlinear relationships between total taxation and economic growth. First, it shows that there is some limited evidence of a β-convergence process through the negative and significant coefficient of the lagged real *per capita* GDP in columns 3 and 4, which implies a "catch-up" type of process from poorer countries to the richer ones. Moreover, we can notice statistically significant negative coefficients for government debt

(*govdebt*), which is consistent with Afonso and Alves' (2015) findings, and for unemployment (*unemp*), interest rates (*intrate*) and shadow economy (*shadow*), as could be expected, as well as positive significant effects for investment (*gfkf*) on all regression specifications.

Additionally, the results about the effects of government expenditure (*govexp*), trade openness (*trade*) and labor growth (*gr_labor*), as well as the linear analysis on the effects of total tax burden (*totaltax*), are not highly significant and robust, showing only limited evidence about a positive linear relationship between total taxation and economic growth, which may illustrate the weak results obtained in early empirical literature addressing only the linear effects of total taxation. Nevertheless, the non-linear analysis (inserting the square term) shows a significant concave relationship between total taxation and growth, with an optimal maximum threshold value of total tax burden, on average, around 23,4% of GDP. This is a similar value to the one found by Aydin and Esen (2019) for transition south-eastern European economies, which might also be considered as developing countries.

Table 3 addresses the effects of each tax item on economic growth, and we can still note some evidence of a significant convergence process. In fact, except for unemployment (*unemp*), which does not seem to present such significant coefficients anymore, we can also come to similar conclusions about the coefficients on control variables, especially for investment (*gfkf*), interest rates (*intrate*), shadow economy (*shadow*) and government debt (*govdebt*). On the other hand, trade openness (*trade*) seems to present more robust negative coefficients, in line with the findings of Kim et al. (2011), which finds that trade openness may hamper economic growth in agricultural low-income countries, also arguing that it causes uneven growth and tends to increase income inequality across these nations.[14] We can also notice that there is some evidence regarding a negative effect of labor growth on certain regression specifications in the short run, a result also found by Angelopoulos (2007) for OECD countries.

Regarding the linear effects of each tax item in Table 3, we can notice significant positive coefficients for working contributions (*workcontrib*) and property taxes (*propertytax*), as well as negative effects of individual income taxation (*indivinctax*). This seems to be consistent with the findings of Arnold (2008) and Ormaechea and Yoo (2019)

[14] See also Sakyi et al. (2014) for more empirical evidence.

about property taxes being the most growth-friendly type of tax, while individual income taxation presents negative effects to economic performance.

Table 2 - Linear and non-linear short-run results for total taxation

	OLS		**OLS-FE**		**RLS**		**2SLS**	
VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
lngdppc_1	0.267	0.262	-7.312***	-8.390***	0.379**	0.380**	-14.020	-17.150
	(0.174)	(0.191)	(1.896)	(1.622)	(0.154)	(0.154)	(11.550)	(11.810)
totaltax	-0.024	0.011	0.171	0.907**	-0.016	-0.010	0.172**	0.923***
	(0.026)	(0.135)	(0.121)	(0.397)	(0.023)	(0.100)	(0.070)	(0.255)
totaltax_sqr		-0.000		-0.019**		-0.000		-0.019***
		(0.003)		(0.009)		(0.002)		(0.006)
govdebt	-0.014***	-0.014***	0.004	0.008	-0.019***	-0.019***	0.002	0.006
	(0.004)	(0.004)	(0.011)	(0.011)	(0.003)	(0.003)	(0.008)	(0.008)
govexp	0.027	0.027	-0.055	-0.043	0.023	0.023	-0.058*	-0.044
	(0.019)	(0.018)	(0.049)	(0.049)	(0.017)	(0.017)	(0.034)	(0.035)
gfkf	0.069***	0.069***	0.111***	0.088**	0.075***	0.075***	0.116***	0.097***
	(0.017)	(0.019)	(0.040)	(0.043)	(0.015)	(0.015)	(0.039)	(0.036)
intrate	-0.130***	-0.076***	-0.139***	0.015	-0.104***	-0.076***	-0.140***	-0.143***
	(0.025)	(0.021)	(0.049)	(0.071)	(0.022)	(0.019)	(0.044)	(0.043)
unemp	-0.075***	-0.128***	0.038	-0.138***	-0.076***	-0.103***	0.036	0.008
	(0.022)	(0.025)	(0.070)	(0.049)	(0.019)	(0.023)	(0.065)	(0.067)
trade	-0.004	-0.005	-0.022*	-0.021	-0.000	-0.000	-0.022***	-0.023***
	(0.003)	(0.003)	(0.011)	(0.012)	(0.002)	(0.002)	(0.008)	(0.008)
shadow	-0.022	-0.022*	-0.331***	-0.373***	-0.020*	-0.020	-0.358***	-0.402***
	(0.013)	(0.011)	(0.063)	(0.069)	(0.012)	(0.012)	(0.056)	(0.059)
gr_labor	-0.119*	-0.121*	-0.078	-0.070	-0.092	-0.092	-0.067	-0.058
	(0.069)	(0.069)	(0.071)	(0.073)	(0.061)	(0.062)	(0.053)	(0.053)
Thresholds	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
totaltax	-	-	-	23,25%	-	-	-	23,54%
Observations	610	610	610	610	610	610	604	604
R-squared	0.174	0.174	0.348	0.365	0.222	0.222	0.491	0.500

Notes: Total taxation refers to *totaltax*. Constant term, lagged values, country and time fixed effects estimated and omitted for reasons of parsimony. Robust standard errors in parenthesis. *, **, *** represent statistical significance at levels of 10%, 5% and 1%, respectively. The non-bold and bold values express, respectively, maximum and minimum optimal tax levels.

Table 3 - Linear and non-linear short-run results for tax structure

	OLS		**OLS-FE**		**RLS**		**2SLS**	
VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
lngdppc_1	0.053	0.021	-6.804***	-7.308***	0.279	0.231	-17.450	-19.050
	(0.229)	(0.235)	(2.004)	(1.245)	(0.183)	(0.187)	(11.520)	(11.600)
indivinctax	-0.266***	-0.063	-0.545*	-0.453	-0.157*	0.107	-0.638**	-0.615
	(0.089)	(0.183)	(0.288)	(0.477)	(0.084)	(0.170)	(0.287)	(0.527)
indivinctax_sqr		-0.046**		-0.024		-0.051**		-0.018
		(0.020)		(0.051)		(0.021)		(0.043)
corpinctax	-0.020	0.504	0.105	0.293	-0.063	0.346	0.121	0.262
	(0.097)	(0.313)	(0.162)	(0.392)	(0.087)	(0.288)	(0.139)	(0.375)
corpinctax_sqr		-0.056		-0.013		-0.039		-0.005
		(0.034)		(0.040)		(0.032)		(0.042)
workcontrib	0.027	-0.415**	0.363	0.996*	0.119*	-0.363**	0.392*	1.068**
	(0.076)	(0.206)	(0.282)	(0.526)	(0.067)	(0.178)	(0.200)	(0.455)
workcontrib_sqr		0.049**		-0.063		0.055***		-0.066
		(0.024)		(0.045)		(0.019)		(0.043)
propertytax	0.067	0.029	1.486*	3.175**	-0.035	0.239	1.640***	3.779***
	(0.261)	(0.761)	(0.807)	(1.464)	(0.252)	(0.671)	(0.584)	(1.444)

	OLS		OLS-FE		RLS		2SLS	
propertytax_sqr		0.061		-0.725		-0.091		-0.883*
		(0.326)		(0.521)		(0.261)		(0.493)
consumptax	0.007	0.295	0.158	0.765***	-0.032	0.226	0.171	0.860***
	(0.051)	(0.236)	(0.173)	(0.291)	(0.047)	(0.193)	(0.104)	(0.324)
consumptax_sqr		-0.015		-0.034**		-0.013		-0.038**
		(0.012)		(0.014)		(0.009)		(0.015)
govdebt	-0.011**	-0.013***	0.005	0.007	-0.015***	-0.017***	0.003	0.005
	(0.004)	(0.004)	(0.011)	(0.008)	(0.003)	(0.004)	(0.008)	(0.008)
govexp	0.024	0.027	-0.032	-0.028	0.014	0.021	-0.027	-0.022
	(0.019)	(0.022)	(0.058)	(0.040)	(0.018)	(0.020)	(0.039)	(0.041)
gfkf	0.071***	0.061***	0.127**	0.123***	0.082***	0.075***	0.142***	0.139***
	(0.019)	(0.020)	(0.047)	(0.026)	(0.015)	(0.015)	(0.041)	(0.041)
unemp	-0.035	-0.010	0.044	0.025	-0.045*	-0.021	-0.142***	-0.140***
	(0.028)	(0.031)	(0.069)	(0.072)	(0.026)	(0.028)	(0.047)	(0.047)
intrate	-0.162***	-0.159***	-0.133**	-0.133***	-0.125***	-0.122***	0.032	0.013
	(0.027)	(0.029)	(0.050)	(0.041)	(0.025)	(0.026)	(0.067)	(0.068)
trade	-0.002	-0.002	-0.025**	-0.026***	0.001	0.000	-0.028***	-0.030***
	(0.003)	(0.003)	(0.011)	(0.008)	(0.003)	(0.003)	(0.009)	(0.009)
shadow	-0.030**	-0.024*	-0.301***	-0.310***	-0.028**	-0.017	-0.325***	-0.336***
	(0.012)	(0.012)	(0.066)	(0.060)	(0.012)	(0.013)	(0.055)	(0.055)
gr_labor	-0.112	-0.093	-0.105	-0.107	-0.059	-0.030	-0.096*	-0.098*
	(0.070)	(0.070)	(0.078)	(0.068)	(0.063)	(0.063)	(0.054)	(0.055)
Thresholds	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
indivinctax	-	-	-	-	-	-	-	-
corpinctax	-	-	-	-	-	-	-	-
workcontrib	-	**4,21%**	-	-	-	**3,29%**	-	-
propertytax	-	-	-	-	-	-	-	2,13%
consumptax	-	-	-	11,02%	-	-	-	11,14%
Observations	595	595	595	595	595	595	591	591
R-squared	0.191	0.206	0.366	0.378	0.233	0.252	0.502	0.511

Notes: Tax structure refers to *indivinctax, corpinctax, workcontrib, propertytax* and *consumptax*. Constant term, lagged values, country and time fixed effects estimated and omitted for reasons of parsimony. Robust standard errors in parenthesis. *, **, *** represent statistical significance at levels of 10%, 5% and 1%, respectively. The non-bold and bold values express, respectively, maximum and minimum optimal tax levels.

On top of that, when we analyze the non-linear coefficients of the several tax items (Columns 2, 4, 6 and 8), we achieve some tax threshold values. First, we obtain evidence that working contributions (*workcontrib*) has a minimizing effect on growth when they are, on average, around 3,75% of GDP. Second, we compute a maximizing threshold value of property taxes (*propertytax*) of 2,13% of GDP and of consumption taxes (*consumptax*), on average, around 11,08% of GDP. This value for consumption taxes is also similar to the one found by Aydin and Esen (2019) for transition economies and Alves (2021) for OECD countries, which may be explained by the fact that developing countries usually rely on consumption taxes in a similar level to the ones adopted by developed OECD countries.

In Table 4 and 5, we show the regression results by dividing the country sample according to their income levels, where high-income countries refers to the ones which have *per capita* income higher than the average and low-income countries refers to the ones which have *per capita* income lower than the average, for at least half of period analyzed. We inform and discuss only the non-linear regressions for reasons of parsimony, although the linear regressions are available upon request.

Table 4 - Non-linear short-run results by income level for total taxation

	OLS		**OLS-FE**		**RLS**		**2SLS**	
VARIABLES	High	Low	High	Low	High	Low	High	Low
lngdppc_1	-3.722***	0.073	-6.315*	-9.041***	-3.880***	0.098	-24.970***	-16.030
	(0.842)	(0.423)	(3.227)	(2.486)	(0.863)	(0.302)	(9.543)	(16.120)
totaltax	0.403	0.122	0.408	1.108*	0.454*	0.052	0.336	1.134***
	(0.251)	(0.200)	(0.569)	(0.533)	(0.237)	(0.137)	(0.398)	(0.385)
totaltax_sqr	-0.005	-0.005	-0.006	-0.025**	-0.006	-0.003	-0.003	-0.026***
	(0.005)	(0.005)	(0.011)	(0.011)	(0.004)	(0.003)	(0.008)	(0.008)
govdebt	-0.023***	-0.005	-0.000	0.018	-0.029***	-0.010**	-0.001	0.018
	(0.006)	(0.007)	(0.015)	(0.014)	(0.006)	(0.005)	(0.016)	(0.011)
govexp	-0.070*	0.078***	-0.146	0.028	-0.042	0.055***	-0.235***	0.035
	(0.042)	(0.025)	(0.115)	(0.060)	(0.043)	(0.021)	(0.075)	(0.047)
gfkf	0.132***	0.030	0.022	0.068	0.119**	0.049**	0.016	0.075
	(0.043)	(0.029)	(0.068)	(0.058)	(0.046)	(0.019)	(0.058)	(0.047)
unemp	-0.227***	-0.081**	-0.074	-0.041	-0.255***	-0.067**	-0.205***	-0.123*
	(0.043)	(0.034)	(0.090)	(0.114)	(0.046)	(0.027)	(0.052)	(0.074)
intrate	-0.162***	-0.114**	-0.182***	-0.112*	-0.148***	-0.102**	-0.085	-0.056
	(0.035)	(0.051)	(0.059)	(0.063)	(0.031)	(0.046)	(0.094)	(0.113)
trade	-0.010*	-0.006	-0.051***	-0.012	-0.005	-0.001	-0.062***	-0.013
	(0.005)	(0.007)	(0.016)	(0.019)	(0.004)	(0.005)	(0.016)	(0.011)
shadow	-0.122***	-0.024	-0.398***	-0.396***	-0.125***	-0.016	-0.492***	-0.419**
	(0.025)	(0.019)	(0.094)	(0.076)	(0.027)	(0.019)	(0.096)	(0.083)
gr_labor	-0.042	-0.153	-0.006	-0.144*	0.020	-0.111	0.042	-0.144**
	(0.123)	(0.092)	(0.142)	(0.081)	(0.092)	(0.083)	(0.084)	(0.069)
Thresholds	High	Low	High	Low	High	Low	High	Low
totaltax	-	-	-	21,39%	-	-	-	21,15%
Observations	257	353	257	353	257	353	253	351
R-squared	0.344	0.165	0.552	0.319	0.382	0.202	0.625	0.486

Notes: Total taxation refers to *totaltax*. Constant term, lagged values, country and time fixed effects estimated and omitted for reasons of parsimony. Robust standard errors in parenthesis. *, **, *** represent statistical significance at levels of 10%, 5% and 1%, respectively. The non-bold and bold values express, respectively, maximum and minimum optimal tax levels.

Table 5 - Non-linear short-run results by income level for tax structure

	OLS		**OLS-FE**		**RLS**		**2SLS**	
VARIABLES	High	Low	High	Low	High	Low	High	Low
lngdppc_1	-2.559**	-0.591	-6.442**	-6.582***	-2.947***	-0.288	-33.22***	-21.95
	-1.006	(0.460)	-3.263	-1.773	-1.045	(0.326)	(10.07)	(18.05)
indivinctax	-0.588	0.767***	-1.753**	-0.165	-0.254	0.839***	-2.256***	-0.436
	(0.478)	(0.274)	(0.757)	(0.785)	(0.487)	(0.236)	(0.751)	(0.911)
indivinctax_sqr	-0.00539	-0.150***	0.148**	-0.0770	-0.0279	-0.132***	0.184***	-0.0658
	(0.0453)	(0.0453)	(0.0732)	(0.0819)	(0.0492)	(0.0363)	(0.0526)	(0.0804)
corpinctax	0.313	0.172	1.241**	-0.695	0.342	-0.261	1.411**	-0.921
	(0.458)	(0.541)	(0.589)	(0.594)	(0.428)	(0.437)	(0.568)	(0.689)

	OLS		OLS-FE		RLS		2SLS	
corpinctax_sqr	0.0166	-0.0431	-0.0930	0.0742	0.0217	-0.00421	-0.0949	0.0983
	(0.0575)	(0.0526)	(0.0606)	(0.0611)	(0.0513)	(0.0460)	(0.0624)	(0.0722)
workcontrib	-0.494	0.876*	1.145	1.705	-0.381	1.174***	1.429**	1.771*
	(0.325)	(0.488)	(0.740)	-1.193	(0.312)	(0.370)	(0.601)	(0.948)
workcontrib_sq	0.0661**	-0.102	-0.0634	-0.171	0.0639**	-0.112*	-0.0745	-0.184*
	(0.0304)	(0.0708)	(0.0577)	(0.139)	(0.0293)	(0.0590)	(0.0533)	(0.100)
propertytax	-1.701*	0.268	0.468	7.602***	-1.378	-0.513	0.339	8.642***
	-1.015	-1.512	-2.293	-2.285	(0.978)	-1.307	-2.081	-2.462
propertytax_sqr	0.888**	-0.350	0.183	-2.955**	0.757**	-0.176	0.282	-3.260***
	(0.413)	(0.813)	(0.731)	-1.212	(0.357)	(0.740)	(0.632)	-1.083
consumptax	0.184	-0.0389	-0.773	1.198***	0.200	-0.312	-0.730	1.288***
	(0.518)	(0.370)	(0.694)	(0.392)	(0.489)	(0.254)	(0.682)	(0.494)
consumptax_sqr	0.00908	-0.0111	0.0237	-0.0548**	0.00633	0.00195	0.0255	-0.0606**
	(0.0256)	(0.0195)	(0.0288)	(0.0203)	(0.0226)	(0.0138)	(0.0293)	(0.0220)
govdebt	-0.00798	0.00374	0.00128	0.0126	-0.0127	0.00142	-0.00307	0.0116
	(0.00990)	(0.00823)	(0.0197)	(0.0115)	(0.00945)	(0.00592)	(0.0194)	(0.0113)
govexp	-0.149**	0.127***	-0.149	0.0506	-0.164***	0.106***	-0.177**	0.0712
	(0.0650)	(0.0348)	(0.101)	(0.0487)	(0.0631)	(0.0264)	(0.0851)	(0.0555)
gfkf	0.199***	0.0240	0.0971	0.0898**	0.167***	0.0437**	0.135*	0.106**
	(0.0525)	(0.0322)	(0.0805)	(0.0329)	(0.0482)	(0.0210)	(0.0761)	(0.0541)
unemp	0.0740	-0.105**	-0.0761	-0.0807	0.0266	-0.114***	-0.256***	-0.0951
	(0.0738)	(0.0452)	(0.124)	(0.136)	(0.0725)	(0.0381)	(0.0628)	(0.0789)
intrate	-0.230***	-0.144***	-0.213***	-0.0761	-0.198***	-0.110**	-0.0888	-0.108
	(0.0512)	(0.0534)	(0.0607)	(0.0776)	(0.0393)	(0.0489)	(0.110)	(0.129)
trade	-0.0149**	-0.000399	-0.0447**	-0.00819	-0.0108**	0.000867	-0.0592**	-0.00880
	(0.00620)	(0.00711)	(0.0171)	(0.0119)	(0.00504)	(0.00652)	(0.0201)	(0.0116)
shadow	-0.0550*	-0.0435	-0.352***	-0.343***	-0.0761**	-0.0408*	-0.417***	-0.384***
	(0.0303)	(0.0285)	(0.126)	(0.0821)	(0.0322)	(0.0218)	(0.114)	(0.0818)
gr_labor	-0.122	-0.162*	-0.0863	-0.178*	-0.0547	-0.0653	-0.0456	-0.180**
	(0.126)	(0.0964)	(0.0981)	(0.100)	(0.0997)	(0.0851)	(0.0873)	(0.0715)
Thresholds	High	Low	High	Low	High	Low	High	Low
indivinctax	-	2,55%	**5,92%**	-	-	3,17%	**6,13%**	-
corpinctax	-	-	-	-	-	-	-	-
workcontrib	-	-	-	-	-	5,24%	-	4,81%
propertytax	**0,95%**	-	-	1,28%	-	-	-	1,32%
consumptax	-	-	-	10,93%	-	-	-	10,62%
Observations	242	353	242	353	242	353	240	351
R-squared	0.424	0.231	0.592	0.349	0.450	0.292	0.647	0.494

Notes: Tax structure refers to *indivinctax*, *corpinctax, workcontrib, propertytax* and *consumptax*. Constant term, lagged values, country and time fixed effects estimated and omitted for reasons of parsimony. Robust standard errors in parenthesis. *, **, *** represent statistical significance at levels of 10%, 5% and 1%, respectively. The non-bold and bold values express, respectively, maximum and minimum optimal tax levels.

Thereby, in Table 4 we can notice more robust evidence pointing to a β-convergence process, as well as some expected effects on the control variables, such as negative coefficients for government debt (*govdebt*), unemployment (*unemp*) and shadow economy (*shadow*), and positive for investment (*gfkf*), especially for high-income countries. Meanwhile, one result which deserves to be highlighted is the significant positive effect of government expenditures (*govexp*) for low-income countries, while it is negative for high-income ones. Besides, when analyzing the non-linear effects of total

taxation in the short run, it was possible to compute an optimal threshold value of total tax burden, on average, around 21,3% of GDP for the low-income group.

Further, Table 5 addresses the effects of each tax item according to countries' income levels and still presents robust evidence of a significant convergence process for high-income countries, and even though government debt (*govdebt*) does not appear to be statistically significant anymore for either group of countries, we still obtain significant coefficients with the expected signs for investment (*gfkf*), unemployment (*unemp*), interest rates (*intrate*) and shadow economy (*shadow*), besides the same evidence regarding government expenditure (*govexp*) being growth-detrimental to the high-income countries and growth-enhancing to the low-income. Moreover, we can notice that trade openness (*trade*) presents negative effects for high income countries but is not significant for low-income ones.

Lastly, we compute optimal threshold values for different types of taxes at each of the income groups. For high-income countries we calculate minimizing threshold values for individual income taxes (*indivinctax*), on average, around 6,02% of GDP and for property taxes (*propertytax)* of 0,95% of GDP. For low-income countries we calculate optimal threshold values for individual income taxes (*indivinctax*), on average, around 2,71% of GDP, for working contributions (*workcontrib*) around 5,03% of GDP, for property taxes (*propertytax*), on average, around 1,3% of GDP and for consumption taxes (*consumptax*) of 10,8% of GDP.

4.2. *Long run effects*

Regarding the long-run effects on economic growth, to which we use 5-year average real *per capita* GDP growth rates as dependent variables, the results are shown in Table 6, 7, 8 and 9. First, in Table 6, we can see some mixed results regarding the β-convergence process and government expenditure (*govexp*) coefficients, as well as the fact that total taxation (*totaltax*) presents significant negative linear coefficients now. Moreover, as in the short-run analysis, we still obtain negative coefficients for government debt-to-GDP ratios (*govdebt*), unemployment (*unemp*), interest rate (*intrate*), shadow economy (*shadow*) and trade openness (*trade*), whereas government expenditure (*govexp*) and investment (*gfkf*) seem to present significant positive effects. When we evaluate the non-linear relationship between total taxation and economic growth (Columns 2, 4, 6 and 8), we also conclude that a total tax burden around 23,5% of GDP could maximize long run GDP growth rates.

Table 7, which addresses the long-run effects of each tax item to long run economic growth, also shows mixed results regarding the convergence process and some similar results on the control variables coefficients. Nevertheless, government expenditures (*govexp*) still seems to have positive long run effects. Regarding the linear tax coefficients, although we find only weak evidence about a negative effect of taxes on goods and services (*consumptax*), we still obtain significant negative coefficients for individual income taxes (*indivinctax*) and positive for property taxes (*propertytax*), as in the short run analysis.

Table 6 - Linear and non-linear long-run results for total taxation

	OLS		**OLS-FE**		**RLS**		**2SLS**	
VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
lngdppc_1	0.447***	0.435***	-2.530**	-2.947***	0.542***	0.534***	35.970***	35.420***
	(0.109)	(0.109)	(1.010)	(0.948)	(0.096)	(0.096)	(9.811)	(9.957)
totaltax	-0.060***	0.041	0.068	0.353**	-0.068***	0.078	0.014	0.146
	(0.014)	(0.069)	(0.075)	(0.170)	(0.014)	(0.062)	(0.044)	(0.119)
totaltax_sqr		-0.002		-0.007*		-0.003**		-0.003
		(0.001)		(0.004)		(0.001)		(0.002)
govdebt	-0.012***	-0.012***	-0.005	-0.003	-0.013***	-0.014***	-0.000	-0.000
	(0.002)	(0.002)	(0.006)	(0.006)	(0.002)	(0.002)	(0.005)	(0.005)
govexp	0.049***	0.051***	-0.034	-0.030	0.053***	0.056***	-0.038**	-0.036**
	(0.010)	(0.011)	(0.029)	(0.029)	(0.010)	(0.010)	(0.017)	(0.017)
gfkf	0.051***	0.051***	0.058	0.049	0.055***	0.055***	0.010	0.007
	(0.011)	(0.010)	(0.037)	(0.037)	(0.009)	(0.009)	(0.020)	(0.019)
intrate	-0.120***	-0.073***	-0.089***	0.018	-0.114***	-0.062***	-0.055**	-0.055**
	(0.014)	(0.012)	(0.026)	(0.045)	(0.014)	(0.012)	(0.024)	(0.024)
unemp	-0.071***	-0.112***	0.027	-0.089***	-0.060***	-0.104***	0.086*	0.081*
	(0.011)	(0.015)	(0.047)	(0.026)	(0.012)	(0.014)	(0.038)	(0.039)
trade	-0.005***	-0.005***	-0.013	-0.012	-0.005***	-0.005***	-0.003	-0.003
	(0.001)	(0.001)	(0.008)	(0.009)	(0.001)	(0.001)	(0.004)	(0.004)
shadow	-0.017**	-0.019***	-0.121***	-0.137***	-0.015**	-0.018**	-0.021	-0.029
	(0.006)	(0.006)	(0.041)	(0.043)	(0.007)	(0.007)	(0.044)	(0.046)
gr_labor	-0.032	-0.035	0.027	0.030	-0.032	-0.035	-0.015	-0.014
	(0.038)	(0.038)	(0.031)	(0.032)	(0.038)	(0.038)	(0.032)	(0.032)
Thresholds	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
totaltax	-	-	-	23,47%	-	-	-	-
Observations	610	610	610	610	610	610	604	604
R-squared	0.331	0.333	0.275	0.285	0.360	0.373	0.626	0.629

Notes: Total taxation refers to *totaltax*. Constant term, lagged values, country and time fixed effects estimated and omitted for reasons of parsimony. Robust standard errors in parenthesis. *, **, *** represent statistical significance at levels of 10%, 5% and 1%, respectively. The non-bold and bold values express, respectively, maximum and minimum optimal tax levels.

Table 7 - linear and non-linear long-run results for tax structure

	OLS		**OLS-FE**		**RLS**		**2SLS**	
VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
lngdppc_1	0.340***	0.308**	-1.972*	-2.325**	0.460***	0.477***	35.920***	35.940**
	(0.119)	(0.119)	(1.072)	(1.092)	(0.115)	(0.115)	(10.450)	(10.350)
indivinctax	-0.149***	0.207*	-0.391*	-0.008	-0.158***	0.157	-0.069	0.492
	(0.054)	(0.110)	(0.205)	(0.357)	(0.052)	(0.105)	(0.215)	(0.392)
indivinctax_sqr		-0.062***		-0.051		-0.051***		-0.070**

	OLS		OLS-FE		RLS		2SLS	
		(0.013)		(0.032)		(0.012)		(0.030)
corpinctax	-0.017	0.225	0.051	0.181	-0.085	0.205	-0.006	0.268
	(0.059)	(0.185)	(0.096)	(0.259)	(0.054)	(0.177)	(0.081)	(0.233)
corpinctax_sqr		-0.024		-0.011		-0.029		-0.031
		(0.019)		(0.025)		(0.019)		(0.026)
workcontrib	-0.021	-0.277*	0.129	0.558	-0.044	-0.200*	0.020	0.351
	(0.067)	(0.156)	(0.169)	(0.389)	(0.042)	(0.110)	(0.144)	(0.281)
workcontrib_sqr		0.027		-0.043		0.023**		-0.034
		(0.023)		(0.041)		(0.012)		(0.031)
propertytax	-0.094	0.394	1.331***	1.599*	0.049	0.934**	0.776**	-0.106
	(0.212)	(0.452)	(0.329)	(0.866)	(0.158)	(0.413)	(0.329)	(0.887)
propertytax_sqr		-0.191		-0.140		-0.456***		0.305
		(0.192)		(0.317)		(0.161)		(0.293)
consumptax	-0.047	0.231	0.069	0.266	-0.063**	0.174	0.018	0.021
	(0.031)	(0.150)	(0.102)	(0.225)	(0.029)	(0.119)	(0.059)	(0.181)
consumptax_sqr		-0.015**		-0.012		-0.013**		-0.001
		(0.007)		(0.010)		(0.006)		(0.008)
govdebt	-0.011***	-0.014***	-0.006	-0.003	-0.013***	-0.015***	-0.001	0.001
	(0.002)	(0.002)	(0.006)	(0.007)	(0.002)	(0.002)	(0.005)	(0.004)
govexp	0.044***	0.059***	-0.013	-0.014	0.051***	0.063***	-0.031	-0.034
	(0.013)	(0.013)	(0.027)	(0.028)	(0.011)	(0.012)	(0.021)	(0.021)
gfkf	0.051***	0.042***	0.065*	0.064*	0.056***	0.053***	0.014	0.012
	(0.011)	(0.011)	(0.038)	(0.037)	(0.009)	(0.009)	(0.022)	(0.022)
unemp	-0.052***	-0.040*	0.061	0.052	-0.048***	-0.037**	-0.053**	-0.058**
	(0.018)	(0.022)	(0.050)	(0.048)	(0.016)	(0.017)	(0.025)	(0.026)
intrate	-0.130***	-0.121***	-0.083***	-0.087***	-0.133***	-0.115***	0.108***	0.104***
	(0.016)	(0.017)	(0.025)	(0.028)	(0.015)	(0.016)	(0.039)	(0.038)
trade	-0.004**	-0.004**	-0.014	-0.016	-0.003	-0.004**	-0.003	-0.005
	(0.001)	(0.002)	(0.009)	(0.009)	(0.002)	(0.002)	(0.005)	(0.005)
shadow	-0.022***	-0.019**	-0.088**	-0.097**	-0.018**	-0.018**	-0.006	-0.014
	(0.007)	(0.008)	(0.037)	(0.039)	(0.007)	(0.008)	(0.041)	(0.042)
gr_labor	-0.026	-0.008	0.005	0.008	-0.024	-0.014	-0.027	-0.020
	(0.037)	(0.035)	(0.033)	(0.035)	(0.039)	(0.039)	(0.031)	(0.033)
Thresholds	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
indivinctax	-	1,65%	-	-	-	-	-	-
corpinctax	-	-	-	-	-	-	-	-
workcontrib	-	-	-	-	-	**4,21%**	-	-
propertytax	-	-	-	-	-	1,02%	-	-
consumptax	-	-	-	-	-	-	-	-
Observations	595	595	595	595	595	595	591	591
R-squared	0.340	0.373	0.312	0.324	0.377	0.418	0.626	0.631

Notes: Tax structure refers to *indivinctax*, *corpinctax*, *workcontrib*, *propertytax* and *consumptax*. Constant term, lagged values, country and time fixed effects estimated and omitted for reasons of parsimony. Robust standard errors in parenthesis. *, **, *** represent statistical significance at levels of 10%, 5% and 1%, respectively. The non-bold and bold values express, respectively, maximum and minimum optimal tax levels.

Additionally, when we address the non-linear coefficients, we can compute maximizing threshold values around 1,65% of GDP for individual income taxes (*indivinctax*) and around 1,02% of GDP for property taxes (*propertytax*), as well as a minimizing threshold value around 4,20% of GDP for working contributions (*workcontrib*).

In Table 8 and 9, the country sample is again divided according to income levels, and we address the nonlinear effects of taxation on long run economic growth. Table 8 analyzes the effects of total tax burden and shows negative coefficients for government debt (*govdebt*) and government expenditures (*govexp*) in high income countries, whereas in low-income government expenditures (*govexp*) have the opposite effect and government debt (*govdebt*) is weakly significant. Ultimately, we achieve similar results for the control variables and compute an optimal maximum value of total tax burden around 23,6% of GDP for high income countries in the long run.

Table 8 - Non-linear long-run results by income level for total taxation

	OLS		**OLS-FE**		**RLS**		**2SLS**	
VARIABLES	High	Low	High	Low	High	Low	High	Low
lngdppc_1	-1.429***	0.415**	-1.905	-1.624	-1.192**	0.497***	29.340***	31.520**
	(0.504)	(0.204)	(1.445)	(1.002)	(0.503)	(0.187)	(6.514)	(12.950)
totaltax	0.251	0.072	0.475	0.021	0.251*	0.088	0.261	-0.105
	(0.162)	(0.091)	(0.313)	(0.177)	(0.138)	(0.084)	(0.205)	(0.149)
totaltax_sqr	-0.004	-0.004*	-0.007	-0.004	-0.005*	-0.004**	-0.005	-0.000
	(0.003)	(0.002)	(0.005)	(0.004)	(0.002)	(0.002)	(0.004)	(0.003)
govdebt	-0.018***	-0.006	-0.010	-0.002	-0.015***	-0.007**	-0.000	-0.005
	(0.003)	(0.003)	(0.015)	(0.008)	(0.003)	(0.003)	(0.010)	(0.007)
govexp	-0.020	0.101***	-0.164**	0.035	-0.026	0.098***	-0.115***	0.003
	(0.025)	(0.013)	(0.060)	(0.024)	(0.025)	(0.012)	(0.043)	(0.023)
gfkf	0.129***	0.010	0.038	0.027	0.153***	0.019	0.012	-0.002
	(0.034)	(0.014)	(0.037)	(0.034)	(0.027)	(0.012)	(0.034)	(0.023)
unemp	-0.130***	-0.082***	-0.046	0.094	-0.152***	-0.061***	-0.052*	-0.054
	(0.028)	(0.020)	(0.093)	(0.068)	(0.026)	(0.017)	(0.027)	(0.042)
intrate	-0.117***	-0.111***	-0.083**	-0.109**	-0.092***	-0.101***	-0.001	0.168**
	(0.022)	(0.030)	(0.034)	(0.045)	(0.018)	(0.029)	(0.059)	(0.065)
trade	-0.008***	-0.009**	-0.028***	-0.003	-0.009***	-0.008**	-0.010	-0.000
	(0.001)	(0.004)	(0.006)	(0.014)	(0.002)	(0.003)	(0.008)	(0.005)
shadow	-0.053***	-0.031***	-0.081	-0.126***	-0.063***	-0.032***	-0.006	-0.017
	(0.015)	(0.010)	(0.071)	(0.042)	(0.015)	(0.011)	(0.064)	(0.062)
gr_labor	-0.017	-0.019	0.032	-0.010	0.031	-0.010	-0.035	-0.011
	(0.067)	(0.042)	(0.037)	(0.047)	(0.053)	(0.051)	(0.053)	(0.036)
Thresholds	High	Low	High	Low	High	Low	High	Low
totaltax	-	-	-	-	23,59%	-	-	-
Observations	257	353	257	353	257	353	253	351
R-squared	0.436	0.394	0.538	0.282	0.517	0.432	0.756	0.670

Notes: Total taxation refers to *totaltax*. Constant term, lagged values, country and time fixed effects estimated and omitted for reasons of parsimony. Robust standard errors in parenthesis. *, **, *** represent statistical significance at levels of 10%, 5% and 1%, respectively. The non-bold and bold values express, respectively, maximum and minimum optimal tax levels.

Table 9 - Non-linear long-run results by income level for tax structure

	OLS		**OLS-FE**		**RLS**		**2SLS**	
VARIABLES	High	Low	High	Low	High	Low	High	Low
lngdppc_1	-0.228	-0.080	1.169	-0.619	-0.657	-0.040	28.170***	29.520**
	(0.669)	(0.187)	(2.281)	(1.020)	(0.572)	(0.192)	(6.398)	(13.090)
indivinctax	-0.185	0.959***	-0.764	-0.431	-0.379	0.976***	-0.257	0.099
	(0.251)	(0.164)	(0.660)	(0.597)	(0.266)	(0.139)	(0.426)	(0.595)

	OLS		**OLS-FE**		**RLS**		**2SLS**	
indivinctax_sqr	-0.048*	-0.165***	0.029	-0.040	-0.028	-0.145***	-0.006	-0.062
	(0.025)	(0.029)	(0.041)	(0.053)	(0.026)	(0.021)	(0.031)	(0.055)
corpinctax	0.045	-0.247	0.340	-0.656**	0.147	-0.224	0.169	-0.212
	(0.216)	(0.287)	(0.282)	(0.290)	(0.234)	(0.258)	(0.316)	(0.388)
corpinctax_sqr	0.036	0.016	-0.010	0.063**	0.028	0.013	-0.008	0.016
	(0.026)	(0.030)	(0.033)	(0.025)	(0.028)	(0.027)	(0.031)	(0.042)
workcontrib	-0.246	1.031***	0.415	1.047	-0.598***	1.059***	0.128	0.917*
	(0.310)	(0.244)	(0.299)	(0.955)	(0.171)	(0.218)	(0.387)	(0.542)
workcontrib_sqr	0.030	-0.159***	0.001	-0.169	0.084***	-0.125***	0.012	-0.144**
	(0.037)	(0.042)	(0.023)	(0.104)	(0.016)	(0.034)	(0.037)	(0.063)
propertytax	-0.885	-1.996**	-0.357	2.501*	-1.273**	-1.430*	-0.227	0.462
	(0.768)	(0.779)	(1.614)	(1.234)	(0.536)	(0.771)	(1.099)	(1.366)
propertytax_sqr	0.325	1.113**	0.633	-0.671	0.440**	0.507	0.533	-0.073
	(0.298)	(0.485)	(0.503)	(0.408)	(0.196)	(0.437)	(0.341)	(0.535)
consumptax	0.590*	-0.138	0.135	-0.057	0.841***	-0.282*	0.092	-0.234
	(0.342)	(0.202)	(0.531)	(0.270)	(0.268)	(0.150)	(0.331)	(0.227)
consumptax_sqr	-0.016	-0.007	-0.002	-0.005	-0.030**	0.000	-0.004	0.005
	(0.016)	(0.011)	(0.021)	(0.013)	(0.012)	(0.008)	(0.013)	(0.011)
govdebt	-0.011**	0.001	-0.005	-0.006	-0.007	0.001	-0.001	-0.004
	(0.004)	(0.003)	(0.016)	(0.009)	(0.005)	(0.003)	(0.009)	(0.006)
govexp	-0.092***	0.149***	-0.167***	0.054**	-0.089**	0.129***	-0.139***	0.013
	(0.033)	(0.016)	(0.047)	(0.019)	(0.034)	(0.015)	(0.042)	(0.028)
gfkf	0.141***	-0.000	0.070	0.032	0.164***	0.015	0.031	-0.000
	(0.038)	(0.014)	(0.051)	(0.031)	(0.026)	(0.012)	(0.038)	(0.025)
unemp	0.117**	-0.124***	0.058	0.075	0.111***	-0.130***	-0.049	-0.067*
	(0.053)	(0.023)	(0.090)	(0.089)	(0.039)	(0.028)	(0.033)	(0.035)
intrate	-0.147***	-0.160***	-0.092**	-0.105**	-0.148***	-0.116***	0.071	0.129*
	(0.027)	(0.031)	(0.036)	(0.042)	(0.021)	(0.022)	(0.068)	(0.070)
trade	-0.010***	-0.003	-0.014*	-0.003	-0.011***	-0.005	-0.000	-0.001
	(0.002)	(0.004)	(0.008)	(0.014)	(0.002)	(0.003)	(0.008)	(0.005)
shadow	-0.009	-0.028*	-0.024	-0.120***	-0.027	-0.032**	0.040	-0.040
	(0.018)	(0.014)	(0.074)	(0.037)	(0.017)	(0.012)	(0.060)	(0.051)
gr_labor	-0.017	0.027	-0.009	-0.011	-0.027	0.029	-0.050	-0.007
	(0.065)	(0.045)	(0.035)	(0.035)	(0.054)	(0.050)	(0.050)	(0.038)
Thresholds	High	Low	High	Low	High	Low	High	Low
indivinctax	-	2,90%	-	-	-	3,36%	-	-
corpinctax	-	-	-	**5,18%**	-	-	-	-
workcontrib	-	3,24%	-	-	**3,52%**	4,23%	-	3,18%
propertytax	-	**0,89%**	-	-	**1,45%**	-	-	-
consumptax	-	-	-	-	13,70%	-	-	-
Observations	242	353	242	353	242	353	240	351
R-squared	0.545	0.557	0.581	0.362	0.655	0.550	0.769	0.701

Notes: Tax structure refers to *indivinctax*, *corpinctax*, *workcontrib*, *propertytax* and *consumptax*. Constant term, lagged values, country and time fixed effects estimated and omitted for reasons of parsimony. Robust standard errors in parenthesis. *, **, *** represent statistical significance at levels of 10%, 5% and 1%, respectively. The non-bold and bold values express, respectively, maximum and minimum optimal tax levels.

Table 9 addresses the nonlinear effects of each tax variable according to income levels. In this sense, we do not obtain any evidence on the β-convergence process and only weak results on the effects of government debt (*govdebt*) for both high- and low-income countries. However, we can still notice negative coefficients for government expenditures (*govexp*) in high income countries, while positive for low-income ones.

Lastly, we computed several maximum and minimum threshold values according to the countries analyzed. For the high-income country sample, we calculate minimum threshold values for working contributions (*workcontrib*) around 3,52% of GDP and 1,45% of GDP for property taxes (*propertytax*), while for consumption taxes (*consumptax*) we calculate an optimal maximum value around 13,7% of GDP.

For low-income countries, we achieve minimizing threshold values around 5,2% of GDP for corporate income taxes (*corpinctax*) and 0,89% of GDP for property taxes (*propertytax*), whereas for individual income taxes (*indivinctax*) we find a maximum optimal value, on average, around 3,13% of GDP and 3,42% of GDP for working contributions (*workcontrib*).

Finally, it is worth emphasizing the non-significance of labor growth in any regression specification for the long run, which is consistent with the results obtained by Bleaney et al. (2001) when testing Barro's endogenous growth model for OECD countries.

5. Conclusions

In this article we resort to different panel data estimation techniques to address the linear and non-linear relationship between total taxation and several tax items revenues, as a share of GDP, with economic growth rates for developing economies between 1990 and 2019. The study was conducted for both short and long run perspectives, to which we used a set of control variables and divided the sample by countries' income levels to better understand the impact of the tax structure on different groups.

We obtained results which support the evidence that optimal tax thresholds exist and can be computed to achieve maximizing and minimizing values, which may enhance or harm GDP growth rates. Particularly, we found optimal tax burdens around 23,5% of GDP for the whole sample in both short and long-run perspectives.

With respect to the linear results on the effects of specific taxes in the short run, we obtained empirical evidence supporting the conclusions of Arnold (2008) and Ormaechea and Yoo (2019), suggesting that individual income taxes may be the most harmful tax to economic growth, while property taxes could represent the most growth-friendly type of tax. Besides, we also obtained evidence regarding a positive effect of working contributions (social security contributions and payroll taxes) in the short perspective.

When analyzing the short run non-linear relationship between taxes and growth, we obtained minimizing values for working contributions and optimal maximum values for property and consumption taxes. In the long run, we computed optimal values for

individual income taxation and property taxes, as well as a minimizing value for working contributions. All these results are summarized in Table 10.

We can notice that, on average, there is fiscal margin to increases in the overall tax burden, as a percentage of GDP, when compared to the current mean, as well as on property taxes and consumption taxes, while for individual income taxes it seems that the optimal level for the long run is lower than the current average.

Table 10 - Summary of tax threshold values

	Short-Run	**Long-Run**	**Mean**
totaltax	*23,39%*	23,47%	18,09%
indivinctax	-	1,65%	2,23%
corpinctax	-	-	3,17%
workcontrib	***3,75%***	**4,21%**	2,39%
propertytax	2,13%	1,02%	0,61%
consumptax	*11,08%*	-	9,25%

Notes: The non-bold and bold values, presented in the short-run and long-run columns express maximum and minimum optimum levels, respectively. The values expressed in *italics* represent average values. The mean refers to the calculated average for all countries during the period 1990-2019.

Even so, when comparing our results to the ones found by Alves (2021) for OECD countries, we can conclude that the optimal values obtained for developing countries are lower than the ones for developed countries members of the OECD, specifically for property and consumption taxes in the short run - 2,13% and 11,08%, respectively, against 4,58% and 14,52% obtained by the author.

Table 11 summarizes the threshold values for total tax burden and for different types of taxes according to countries income levels. First, we can notice that the optimal tax burden for both high- and low-income countries is higher than their current means, with the values for high income countries being larger than for low ones, as would be expected, and similar to the levels obtained in previous studies, such as Amgain (2017) and Hang et al. (2020).

Second, we can infer that there may be fiscal space for increases in property taxes on high-income countries, both in the short and long run perspectives, as well as for working contributions in the long run, to which we obtained minimizing values higher than the current average, possibly meaning that from this point onwards the effects on growth are positive. Contrastingly, for individual income taxes the minimizing threshold value is quite higher than the current average, which possibly means that raising this type of tax up to that point will reduce economic growth rates.

Moreover, for Low-Income countries we can conclude that there is large fiscal margin for increases in total taxation and in almost all tax variables, except for corporate income taxation in the long run, to which we obtained a minimizing value much higher than the average. More precisely, we can notice that the optimal values for individual income taxes and working contributions, for both short and long run, are quite larger than their current means. For property taxes, as we obtained a maximizing value for the short run which is higher than the minimizing one for the long run, we may also conclude that there is fiscal margin for relative increases, as well as for consumption taxes in the short run, which presents an optimal value higher than the current mean.

Table 11 - Summary of tax threshold values by income level

	Short-Run		**Long-Run**		**Mean**	
	High	Low	High	Low	High	Low
totaltax	-	*21,27%*	23,59%	-	20,71%	15,33%
indivinctax	***6,025%***	*2,71%*	-	*3,13%*	2,54%	1,91%
corpinctax	-	-	-	**5,18%**	3,61%	2,71%
workcontrib	-	*5,03%*	**3,52%**	*3,42%*	3,06%	1,56%
propertytax	**0,95%**	*1,30%*	**1,45%**	**0,89%**	0,86%	0,35%
consumptax	-	*10,78%*	13,70%	-	9,99%	8,48%

Notes: The non-bold and bold values, presented in the short-run and long-run columns express maximum and minimum optimum levels, respectively. The values expressed in *italics* represent average values. The mean refers to the calculated average for all countries, according to income levels, during the period 1990-2019.

Regarding the control variables' effects on economic growth, our results point out to different features commonly obtained, analyzed, and discussed in the literature, such as negative effects for government debt, unemployment, interest rates and the share of informal economy, as well as positive effects for investment and for government expenditures in low-income countries. Additionally, we found evidence that labor growth and trade openness may have detrimental effects on growth, especially for the short and long run perspectives, respectively.

Nevertheless, we are aware that there may be significant differences regarding the tax variables in each country, derived from intrinsic features of the different tax systems and social organization schemes. In this sense, it is important to mention that we provided a set of empirical results, not necessarily policy recommendations, such that our results should be taken as contributions to the literature and as one of the starting points for future research on tax policy and its impact on economic performance, particularly for developing economies.

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Appendix

Table 12 - Correlation matrix

Variables	gdppc	totaltax	indivinctax	corpinctax	workcontrib	propertytax	consumptax	govdebt
gdppc	1.000							
totaltax	0.529	1.000						
indivinctax	0.129	0.436	1.000					
corpinctax	0.334	0.291	0.176	1.000				
workcontrib	0.426	0.722	-0.035	0.015	1.000			
propertytax	0.569	0.698	0.249	0.089	0.501	1.000		
consumptax	0.350	0.839	0.167	-0.048	0.568	0.567	1.000	
govdebt	0.053	0.185	0.096	0.118	-0.056	0.175	0.200	1.000
govexp	0.263	0.543	0.401	0.367	0.355	0.298	0.294	0.249
intrate	-0.107	-0.125	-0.213	-0.403	0.017	0.116	-0.018	0.135
gfkf	-0.049	-0.088	0.012	0.322	-0.219	-0.109	-0.132	0.137
unemp	0.137	0.236	0.616	-0.033	0.095	0.247	0.002	0.009
trade	0.146	-0.001	0.223	0.330	-0.189	-0.220	-0.071	0.092
shadow	-0.283	-0.075	-0.295	-0.105	0.079	-0.204	0.024	-0.014
labor	0.262	0.375	0.032	0.168	0.411	0.331	0.184	0.073

	govexp	intrate	gfkf	unemp	trade	shadow	labor
govexp	1.000						
intrate	-0.108	1.000					
gfkf	0.321	-0.167	1.000				
unemp	0.434	-0.005	-0.142	1.000			
trade	0.175	-0.274	0.253	0.218	1.000		
shadow	-0.209	0.079	-0.319	-0.202	-0.036	1.000	
labor	0.137	0.138	-0.161	-0.055	-0.316	0.015	1.000

Source: Authors' calculations.

Table 13 - Fiscal variables classification

Theoretical classification	**Functional classification**
Distortionary taxation	Taxation on income and profit Social security contributions Taxation on payroll and manpower Taxation on property
Non-distortionary taxation	Taxation on domestic goods and services (consumption taxation)
Other revenues	Taxation on international trade Non-tax revenues Other tax revenues