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Tax structure for consumption and income inequality: an empirical assessment

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Abstract

In this study, we assess the relationship between several tax items and consumption and income inequality levels. For OECD countries between 1980 and 2015, we use panel data techniques and find tax threshold values regarding inequality levels and consumption. In particular, we obtain threshold values for social security contributions between 9.50 and 11.80% (of GDP), for long-run consumptions, while to promote a reduction in income inequalities we found a 15.51% share of social security contributions over GDP, in both short- and long-term perspectives. Lastly, our results would support higher taxes on firms, in GDP terms, to decrease income inequalities, although that might hamper aggregate consumption.

Keywords Income inequality · Consumption · Tax thresholds

JEL Classification D63 · E21 · H21

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1 Introduction

Is there a correlation between tax structures regarding consumption and inequality levels? This question arises from the extreme importance to understand and to contribute with novelties for the effects of taxes on each variable. On the one hand, and as trivially recognized, consumption is one of the most important concepts for economic science. Consumption happens mostly through economic markets. However, consumption can also lead to several economic disruptions, namely the non-inclusion of several externalities—either positive or negative. On the other hand, income inequalities are another subject that have been a recurrent subject over the past few years. In fact, inequalities have been introduced as an explanatory variable for several economic issues, as it is the case of economic growth. In fact, several economists point out inequalities as one of the most challenging dimensions in explaining economic performance among countries.

Therefore, and aiming to study both variables, we opt to investigate them dynamics related to fiscal policy. In detail, we investigate whether tax systems arrangements can lead us to conclude for better tax designs to efficiently promote consumption and to reduce income distribution inequalities. Furthermore, several sources of taxation, such as on individual income and property, can lead to a reduction in income inequalities, as mentioned by Piketty (2014). Other some studies, as Mo (2000), Cingano (2014) and Ostry et al. (2014), highlight the positive linkage between income inequality reduction and economic performance. Additionally, and besides taxes being the privileged source to satisfy the financial needs for government to conduct its policies, it also makes use of taxation in order to correct from the economic disruptions regarding consumption and inequalities. Affecting the price system, taxes are a really useful instrument for governments to stabilize economic performance.

Summing up, our intention is to empirically assess the effects of tax structure, from the ratio of revenues over the GDP of each tax source over consumption, measured by the households' consumption (in GDP terms), and inequalities dynamics, making use of Gini index. Moreover, we also try to assess nonlinear relationships between taxes and both variables. This nonlinear assessment can lead us to find possible tax thresholds regarding each variable under research. In fact, while we hope to find thresholds that can minimize or maximize the dynamics of each variable, we also expect with this empirical exercise to provide empirical values for tax structures to fiscal policy in order to promote household consumption and, on the other hand, to decrease income inequalities. This provision of efficient macroeconomic tax systems can provide new insights to fiscal authorities to arrange their tax systems in order to prioritize them in accordance with the desired fiscal policy goal.

Our article resorts to panel data techniques, covering all OECD countries, for the period between 1980 and 2015. The article's analysis is conducted for both short and long run, by assessing tax items effects on both consumption and inequalities in a yearly and a 5-year average, respectively. The results of our study provide some thresholds regarding a subset of tax sources under analysis. In detail, and in what respects consumption dynamics, while we found a maximizing threshold of 5.67%

for taxes on firms income, we find a minimizing threshold for payroll taxes of 1.44%, both thresholds for the short-run analysis, while we find a 11.80% of social security contributions over GDP that maximizes consumption, only in long run. Regarding inequalities, several thresholds are found. With the exception of individual income taxes and taxes on goods and services in what are found thresholds that maximize inequalities, the other tax source seems to present minimizing thresholds, which can be useful to reduce inequalities.

The paper is structured as follows: Sect. 2 reviews the literature regarding taxation effects on both consumption and income inequality; Sect. 3 presents the methodology employed, as well as the data and its sources; Sect. 4 reports and discusses the results; and lastly, Sect. 5 provides our conclusions, some tax policy recommendations as also to outline some possible lines of future research.

2 Literature review

The composition of taxation presents several challenges to public finance, as pointed out by Boadway et al. (1994). In fact, the existence of several direct–indirect tax mix can lead to different economic outcomes. Moreover, the authors analyse what source of taxation—direct or indirect taxes—should be preferable in case of assuming tax evasion hypothesis. Consequently, and by considering a nonlinear income tax and a linear tax on commodity, the authors conclude that it should be given priority to commodity taxation, by efficiency reasons. In accordance with this study, De Freitas (2012) also evaluate inequality dynamics derived from taxation impacts: the authors incorporate tax evasion features regarding income taxes to a classical Downsian model to assess why unequal societies distribute less income among individuals, despite larger proportion of low-income voters demanding more income. Consequently, the authors found a non-monotonic correlation between redistribution and inequality, and higher taxes on consumption are levied when there is a higher degree of informal sector in what respects income taxation and, lastly, it is also found that on developing countries, income tax plays a limited role to redistribution. In addition, while Mayeres and Proost (1997) whose authors develop an applied general equilibrium model conclude that the externality tax level is not influenced by the distributional features, Cremer et al. (2001) investigate both direct and indirect tax structures. By incorporating some unobservable and heterogeneous features for individuals as productivity, it is concluded that that commodity taxation plays a crucial role in fiscal policy, which differs from Atkinson–Stiglitz's viewpoint.

In what respects the impact of taxation on economic growth, Arnold et al. (2011) conduct an empirical analysis to assess those effects for 21 OECD countries over the 1971–2004 period. The main results achieved by the authors highlight that taxation should be levied over consumption and property to favour growth. Moreover, and despite the authors consider that it should be improved the income tax design, the reduction in these taxes appears to be the most favourable to enhance growth. The income tax reduction would allow to increase demand in low-income individuals, as well as, to reduce income disparities.

On the other hand, and as Piketty and Saez (2003) highlight, the existence of progressive income and estate tax systems has prevented a rapid recovery of the wealth inequalities after the Great Depression and WWII, for the US case. In fact, and in what concerns the taxation effects on inequality, Saez (2004) concludes that both short- and long-term direct and progressive taxation is crucial for distributional purposes. However, the author highlights that indirect taxes can complement the effect of direct taxation in the short run for the reduction in inequalities. The difference between the short- and long-term arises, mainly from the assumption that individuals only adjust the labour supply in the short term. Moreover, Denvil and Peter (2016) agree with Saez (2004). By assessing the impact of progressivity changes in income tax systems and the effect of those changes on income inequality degree, the authors found a positive relationship between the increase in tax progressivity and the decrease in income inequality. However, the authors highlight the inverse nexus between tax progressivity and efficiency cost in revenues collection.

Additionally, in accordance with previous studies, Clark and Lawson (2008) also find that a higher degree of government interventionism on the economy is counterproductive for redistribution objectives. Liu and Martinez-Vazquez (2015) evaluate the impact linkage between economic growth and income disparities and that outcome on the overall tax design. The study is conducted for a set of 150 developed and developing countries over 40 years resorting to panel data techniques. The main founds of this study are generally in accordance with economic theory in the sense that income taxation is related to income disparities decreasing. Moreover, the authors also reflect that direct taxes can also play an important factor in macroeconomic stability via automatic tax stabilizers.

Furthermore, while Adam et al. (2015) verify that, for a 75 sample of both developed and developing countries, high-income inequality countries rely more on capital taxes and, consequently, hamper both investment and economic growth, Pestel and Sommer (2016) assess the effect for changing from labour income taxes to consumption over labour supply and distribution effects for the German case. The authors agree that the above-mentioned tax shift results in a regressive impact in short-run labour supply. Moreover, Johansson (2016) also demonstrates that tax shifts from income to consumption taxes have inequality reduction implications, given the higher progressivity degree of income taxes when compared to other tax sources; however, indirect taxes are less harmful for growth when compared to income taxation. Additionally, Brys et al. (2016) emphasizes the need to assess the overall tax system to evaluate its efficiency and equity effects to promote an inclusive economic growth. In order to reduce the trade-off between the efficiency–equity goals, the authors highlight the need for a higher tax progressivity and stimulate higher efficiency in tax administrations, among others. Iosifidi and Mylonidis (2017) assess the effects of capital, labour income and consumption taxes for redistribution purposes. The authors find that increases in labour income and consumption taxes prevent the reduction in inequality. However, and for redistributive purposes, it is preferable to levy taxes on labour than on consumption.

In addition, Akgun et al. (2017) study the long-term impact of tax changes over *per capita* GDP and income distribution for 34 OECD countries between 1980 and 2014, concluding for a positive effect on *per capita* income with income tax cuts,

keeping the overall government size. Islam et al. (2018) study the impact of income inequality on the personal income tax-to-GDP ratio. The analysis, conducted for 21 OECD countries for more than 140 years, reveals stronger effects of a decrease in the income taxation proportion on GDP revenues on an increase in income inequalities. In fact, the authors found a long-run elasticity of income tax to the Gini index of almost -1.00, approximately. In conclusion, Yi (2012) introduces the effect of the political system on income disparities and finds that high levels of taxation can emphasize the democratization process, even with a higher degree of inequality.

In what respects the impact of taxation on consumption, several studies found a negative relationship between taxation and consumption, namely Blanchard and Perotti (2002), and Mountford and Uhlig (2009), among others. More specifically, Romer and Romer (2010) analyse the exogenous tax increase on three types of consumption items for the US case after WWII until the first decade of the twenty-first century. They conclude that different types of consumption respond heterogeneously to a tax increase. Yet, while consumption on both non-durables goods and services decreases after a tax increase, the consumption on durable goods reacts more drastically to a tax growth (Carmignani 2008).

Lastly, Blanchard and Perotti (2002) show that, for the US economy after WWII until the 1997, a tax increase leads to a reduction in all private consumption components (a 1% increase in taxes implies a reduction of 0.36% in the private consumption-to-GDP ratio). Alm and El-Ganainy (2013) highlight the detrimental effect of VAT on consumption. In fact, the analysis conducted for 15 European countries between 1961 and 2015 period shows that an increase in 1% of VAT decreases private consumption, between 0.04% and 0.21%, in the short run, and 0.26% to more than 1% in the long run.

3 Methodology and data

We consider that aggregate consumption and inequalities are functions of taxation, i.e. $C = F(T)$ and $Ineq = F(T)$, where C represents the households' consumption, $Ineq$ is the degree of income inequalities, and $F(T)$ is a function of taxation structure represented generically by the set T. Those relations are formalized, for both consumption and inequalities, in Eq. (1):

$$Y_{i,t} = \alpha_{i,t} + \beta_{0,i,t} y_{i,t-1} + \sum \beta_{n,i,t} \tau_{n,i,t} + \beta_j x_{i,t} + \nu_i + \eta_t + \varepsilon_{i,t}, j = 1, 2, t = 1, \ldots, T, \quad i = 1, \ldots, N \tag{1}$$

where $Y = \left\{C_{i,t}, Ineq_{i,t}\right\}$, where $C_{i,t}$ is household final consumption expenditures, in percentage of GDP, $Ineq_{i,t}$ is the income inequalities among individuals, $y_{i,t-1}$ is the one-lag real *per capita* GDP, $\tau_{n,i,t}$ represents the revenue of each tax source n, in GDP term, $x_{i,t}$ represents the set of control variables, ν_i and η_t are, respectively, the country- and time-specific effects and $\varepsilon_{i,t}$ is the error term of the white noise type.

Additionally, we introduce a squared term for each tax component to evaluate the existence of nonlinearity effects of tax structure on household's consumption and income inequalities as detailed in Eq. (2).

$$Y_{i,t} = \alpha_{i,t} + \beta_{0,i,t} y_{i,t-1} + \sum \beta_{1,n,i,t} \tau_{n,i,t} + \sum \beta_{2,n,i,t} \tau^2_{n,i,t} + \beta_j x_{i,t} + \nu_i + \eta_t + \varepsilon_{i,t},$$
$$t = 1, \ldots, T, \quad i = 1, \ldots, N \tag{2}$$

Therefore, and by deriving Eq. (2) in respect to each tax component, $\tau_{n,i,t}$, as expressed in Eq. (3), and then equalizing the derivative function to zero, as detailed in Eq. (4), we can obtain each tax item threshold in respect to both consumption and inequalities:

$$\frac{\partial \backslash Y_{i,t}}{\partial\left(\tau_{n,i,t}\right)} = \frac{\partial\left(\alpha_{i,t} + \beta_{0,i,t} y_{i,t-1} + \sum \beta_{1,i,t} \tau_t + \sum \beta_{2,i,t} \tau^2_t + \beta_i x_{i,t} + \nu_i + \eta_t + \varepsilon_{i,t}\right)}{\partial\left(\tau_{i,t}, \tau^2_{i,t}\right)}. \tag{3}$$

$$0 = \beta_{1,n,i,t} + 2\beta_{2,n,i,t} \tau^*_{n,i,t} \Leftrightarrow \tau^*_{n,i,t} = \frac{-\beta_{1,n,i,t}}{2\beta_{2,n,i,t}} \tag{4}$$

Furthermore, if we obtain a significant negative signal for $\beta_{2,i,t}$, we have a concave relationship between a tax item and the corresponding dependent variable (consumption or inequalities), translating into a maximizing value for that tax source on the variable under research. However, it is important to highlight that when we achieve to a determined maximizing tax threshold on inequalities, we are reaching to a threshold value, whose value means a maximization of income inequalities. On the other hand, when we get a convex relationship through a positive coefficient for $\beta_{2,i,t}$, this means that those thresholds are minimizing household consumption or, in what respects the study of inequality degree, those thresholds translate the share of tax source revenues, as share of GDP, that can help to reduce inequalities among individuals income. Therefore, in the empirical results section when we get nonlinear relations, we will highlight each coefficient to differentiate between maximum and minimum threshold levels.

The model is estimated for a period between 1980 and 2015 and for the OECD countries: Australia (AUS), Austria (AUT), Belgium (BEL), Canada (CAN), Chile (CHL), Czech Republic (CZE), Denmark (DNK), Estonia (EST), Finland (FIN), France (FRA), Germany (DEU), Greece (GRC), Hungary (HUN), Iceland (ISL), Ireland (IRL), Israel (ISR), Italy (ITA), Japan (JPN), South Korea (KOR), Latvia (LVA), Luxembourg (LUX), Mexico (MEX), the Netherlands (NLD), New Zealand (NZL), Norway (NOR), Poland (POL), Portugal (PRT), Slovak Republic (SVK), Slovenia (SVN), Spain (ESP), Sweden (SWE), Switzerland (CHE), Turkey (TUR), United Kingdom (GBR) and United States (USA).

Regarding the set of exogenous and control variables, we have: GDP based on purchasing-power-parity (PPP) *per capita* GDP (*realgdppc*) in thousands, output gap in per cent of potential GDP (*outputgap*) and government debt-to-GDP ratio,

which are all sourced from World Economic Outlook (IMF). In addition, taxes on income, profits and capital gains of individuals (*taxinc*), taxes on income, profits and capital gains of corporates (*taxfirms*), social security contributions (*ssc*), taxes on payroll and workforce (*taxpayroll*), taxes on property (taxprop), taxes on goods and services (*taxvat*), gross fixed capital formation (*gfcf*), current account balance in GDP ratio (*current*), average hours worked (*avg*) and unemployment rates (*unem*) are from OECD.Stats database.

Furthermore, we also consider additional variables as the deposit interest rate (*depositrate*), net foreign direct investment-to-GDP ratio (*foreigninvestment*), the GDP percentage of household final consumption expenditure (*hconsggdp*) and old age dependency ratio, old (*ageratioold*) data retrieved from the World Development Indicators (WDI).

From the Government Finance Statistics, we used data on the functional classification of government spending, specifically, government expenditures on general public services (*pubser*), on defence (*def*), on public order and safety (*pubor*), on economic affairs (*eco*), on environment protection (*env*), on housing and community amenities (*hou*), on health (*hea*), on recreation, culture, and religion (*cul*), on education (*edu*) and on social protection (*socpro*). Moreover, we construct two variables based on functional public spending: (i) the so-called productive public expenditures (*proexp*), resulting from the sum of public spending related to public services, defence, public order and safety, economic affairs, environment protection, housing and community amenities, health, and education, and unproductive public expenditures (*unproexp*), calculated through the sum of recreation, culture, and religion and social protection expenditures.

Based in Feenstra et al. (2015) data, we also use data for population in millions (*pop*), the real total factor productivity (*rtfpna*) and human capital index, based on years of schooling and returns to education (*hc*). Finally, we take the liquid liabilities-to-GDP ratio (*llgdp*) based on International Financial Statistics (IFS), IMF and Gini index of inequality in equivalized household disposable income (*ginidisp*) based in Solt (2016). Table 1 presents summary statistics for each variable.

In the empirical analysis, we used panel data techniques, namely by applying OLS, OLS-fixed effects (FE), generalized method of moments (GMM) and robust least squares (RLS) approaches. The estimations are run through the white diagonal covariance matrix assumption, except for RLS. In addition, we estimate Eqs. (1) and (2) for both consumption and inequalities for short and long run, this last by applying a 5-year average for the respective dependent variables.

Regarding the analysis, tax items threshold values will only be discussed when the tax items' coefficients have statistical significance for both linear and nonlinear tax regressors, for at least a 90% confidence interval.

4 Results

4.1 Short-run impacts of taxation structure on aggregate consumption and inequality dynamics

In what respects the short-term analysis of taxes on households' aggregate consumption, our results evidence that both types of public expenditures—productive and unproductive—seem not to explain households' consumption. In fact, this is a surprising result since several studies point out a positive correlation between government spending and households' consumption, as highlighted, for example, in Galí et al. (2007). Moreover, and following the previous variables, also the gross fixed capital formation, human capital, unemployment rates appear to not have an influence on aggregate consumption on a shot-term basis.

On the other hand, while population growth, government debt and deposit rates evidence a positive impact on households consumption, current account balances, outputgap and money supply appear to have a contrary effect. In addition, some of these effects need to accurately be investigated. In fact, we hoped that deposit rates and unemployment rates had a countercyclical effect with consumption.

Regarding the linear effects of taxation on consumption, which can be observed in equations (1), (3), (5) and (7), there are little evidences for tax items effects on households' consumption decisions, with the exception of taxes on firms, taxes on payroll and workforce, and property taxation. Those tax items depict an expected negative correlation with household consumption. However, and when we consider nonlinear relationships between tax revenues' structure and consumption, the results led us to conclude for the existence of a two-tax item threshold: one for taxes on payroll and workforce and another one for firm's taxation. More specifically, there is a minimizing threshold value of 1.44% for payroll taxes, and a 5.67% maximizing threshold value for taxes on firm's income with respect to household consumption. These results lead us to conclude that to efficiently promote consumption, the revenues from firms' income should round almost 5.7% of GDP. Under or beyond that value, fiscal authorities are reducing the incentives for households to consume. The same logic can be applied to taxes on payroll, although inversely. In fact, by achieving a minimizing threshold for payroll taxes on consumption, and being aware the negative linear impact of this tax source on consumption, fiscal authorities have an incentive to not get revenues from this kind of taxes. The results of the above-mentioned analysis are presented in Table 2.

When we look for the obtained results on income inequalities, presented in Table 3, we can conclude that increase in the average of hours worked as well as in unemployment rates, population and total factor productivity growth, government expenditures on defence, public order and safety, on housing, on culture activities, old age dependency ratio and deposit rates exacerbates income disparities. In fact and remembering that the higher the Gini index is, the higher are income inequalities, positive signals as it was obtained for the above-mentioned variables evidence an increment in income disparities among individuals.

On the opposite side, human capital stock, government spending related to public services, economic affairs, environment protection, health care, education and social protection, besides investment growth, through gross fixed capital formation, as well as foreign investment and household consumption evidence a procyclical movement with reductions in income inequalities.

Revisiting the tax revenues' effects on income disparities in the short run, the results we reached 3 show a non-conclusive effect of income, payroll and property taxation. However, a raise in the ratio of tax on firms-to-GDP revenues seems to be beneficial to reduce inequality. We can draw the same conclusions for a raise in social security contributions, while a raise in taxation of consumption of goods and services has a positive and expected signal by worsening the gap between the richest and the poorest individuals in the countries' sample.

In what respects the existence of thresholds for several tax items, we have obtained results for all tax sources. In particular, income taxes and consumption on goods and services taxes show maximizing average values of 7.19% and 11.88% of GDP, respectively. Therefore, those values maximize the gap between different income individuals.

On the other hand, the maximizing threshold for income taxes leads us to conclude for a necessary further investigation. In fact, as trivially recognized, one of the purposes of (progressive) income taxes is to promote a reduction in income disparities. By computing an unexpected maximizing threshold, we think that it would be necessary to explore each income tax system and its design for all OECD countries, since inefficient income tax systems conduct to a raise in income inequalities. In addition, we also uncover minimizing values for all the other tax items: an average value of 7.46% for taxes on firms, 15.51% for social security contributions and, lastly, a mean value of 1.01% and 1.56% for taxes on payroll and workforce and on property, respectively. Therefore, fiscal authorities should promote to levy taxes on these tax sources to reach the minimizing threshold values in order to get lower values for income inequalities.

4.2 Long-run impacts of taxation structure on aggregate consumption and inequality dynamics

From a long-run perspective, our results regarding long-run effects on households consumption, detailed in Table 4, evidence the same negligible effect of both productive and unproductive type of government expenditures. In addition, while population growth and government debt still remain the positive impact on consumption over the long run, current account balance seems to have a detrimental impact on long-run consumption and outputgap and monetary supply loses their significance in long-run consumption explanation. On the other hand, unemployment rates, average hours actually worked and deposit rates show a positive correlation with households' consumption in the long run.

Relatively to tax items' revenues effects on consumption, and in what respects the linear tax impacts, the raising of revenues over GDP from taxes from taxes on goods and services evidences a positive signal, which is a counter-intuitive result. In fact, in a future research we need to explore what economic channels can help us to explain this relationship. Moreover, and similarly to short-run analysis, tax revenues levied on firms income evidence the same negative impact on consumption, although the effect seems to be stronger in the short run. In addition, also social security contributions present the more detrimental impact on consumption dynamics. In specific, an increase of 1% of this tax item revenue, as percentage of GDP, implies a reduction of 0.3%, approximately, of household's final consumption.

On the nonlinear tax effects analysis on households' consumption on the long run, we only find tax item threshold values for taxes on payroll and social security contribution. Specifically, while we find a minimizing value of 1.30% for payroll taxes, as a percentage of GDP, we find both maximizing and minimizing threshold values for social security contributions. Regarding this last tax item, although the results show a minimizing value of 9.50%, we also achieve a maximum value of 11.80%. Therefore, we can conclude for an interval where the share of social contributions must be set to promote, or not, household consumption by the fiscal authorities.

The long-run analysis of taxation structure on income inequalities shows a similar pattern as the one observed in the short-run analysis for nonlinear connections between tax structures and household income gaps (see Table 5). In particular, with exception of foreign investment, in which this variable seems to lose explanatory power in the long-run income inequalities dynamics, all the other control variables follow the same pattern as analysed in Sect. 4.1.

Analysing the linear impacts of taxes on income disparities, through regressions (9), (11), (13) and (15) of Table 5, our results evidence that in long run the positive impact of income taxes on income inequalities reduction is less strong when compared with the short-run analysis. The same conclusion is valid for social security contributions. On the other hand, the positive impact in income disparities growth is found stronger for long run than in the short run for payroll taxes and for taxes on consumption of goods and services. Lastly, the positive effect of property taxes in promoting income disparities' reduction is found more significantly in the long run.

Analysing the long-run tax thresholds, for income taxation and taxes on consumption of goods and services, we find average maximizing values of 6.94% and 11.83%, respectively, and on average, meaning that converging the revenues in GDP proportion of those tax items until the threshold values will exacerbate income disparities. On the other hand, we find mean minimizing values of 7.80% for firm's taxation, 15.51% for social security contributions, and mean values of 1.00% and 1.53% for payroll and property taxes, respectively, which reduces the Gini index coefficient. In fact, the results we reach help us to delineate more accurately best tax designs regarding long-run income inequalities.

In sum and comparing the short- and long-run threshold values for each tax item revenue with the mean values for the respective tax source revenue, registered for the OECD sample between 1980 and 2015, we can retrieve for Table 6 some additional conclusions.

First, and regarding the promotion of consumption, the revenues levied over firms' income should be reduced by almost 3% of GDP in short run, while we verify that it would be better for the fiscal policy to analyse the tax design in order to increase revenues by almost 3.5% of GDP when comparing to the average value of social security contributions (8.345%). In what respects payroll taxes, we can conclude that on one hand, there is no incentive in short run to increase the overall revenues over the GDP of this tax source, since increasing it will lead to a decreasing movement in consumption. On the other hand, in the long run the government may levy more taxes from this source in order to promote households' consumption.

In what respects income inequalities and the strategy that government should have, we can also face the sample's average values and conclude that in order to promote lesser inequalities. In fact and excluding taxes from individuals' income and from goods and services, which are no incentive to promote a decreasing in its revenues since it will lead to an increase in inequalities, we can state that public authorities should make an effort to reduce tax revenues on property since it would be beneficial for both short- and long-run income inequalities decreasing, by approximately 0.2% of GDP. On the opposite side, all the revenues of the other tax sources should be increased to promote a reduction in Gini index. In particular, and to efficiently promote reduction in this index, revenues for firms' income and social security contributions have to increase by nearly 5% and 7.2%, respectively, for both short and long run. In regard to payroll taxes, those revenues should also be increased by almost 0.63% not only in short but also in the long run. Besides the comparisons made between the achieved results for tax thresholds, we know that the reality across countries varies a lot.

5 Conclusions

As recognized, the dynamics of consumption and inequalities are affected by tax systems. The diversification of fiscal revenues composition can lead to different economic outcomes, namely in those two economic aggregates. Therefore, in this article we intended to analyse the impact of tax structures over households' income and income disparities behaviour. Our empirical analysis was conducted not only to analyse both short- and long-run effects, but also to understand whether there were nonlinear impact of tax revenues over consumption and inequalities. Moreover, and with respect to nonlinear effects of taxes on consumption and income inequalities analysis, we have assessed the empirical threshold values for the tax items considered in our study. In that sense, we have found some limit values mainly for the relationship between taxes and inequality.

Our analysis resorts to panel data techniques, and it covers all OECD countries, between 1980 and 2015. Regarding consumption dynamics, our results only support threshold values for tax revenues for firms' income taxes, only in short run, social security contributions for the long run. In addition, only revenues from taxes on payroll and workforce evidence thresholds for both short and

long run. In particular, we only find a minimizing threshold value for payroll taxes, while we find a thresholds' interval for social security contribution, i.e. we computed both minimizing and maximizing social security revenues for long run, highlighting an efficient interval of this kind of revenues, depending on the fiscal goal.

In terms of the tax items effects on income disparities, measured by Gini index dynamics, we find thresholds for all tax sources' revenues and both short and long run. In detail, our results point out minimizing effects on income disparities for firms' taxation, social security contributions and payroll and property taxes, while consumption and personal income taxes seem to increase income gaps. The possible surprising effect of income taxation as a negative factor for income disparities may have to do with the fact of an inefficient progressive tax system, taxing several individual income sources in different ways that increase income inequalities.

Regarding other variables' effects on both consumption and inequalities dynamics, our results point out several channels that can be deeply studied to understand those impacts in consumption and inequalities, as are the cases of current account balance, for consumption, and old age dependency ratio regarding inequalities' evolution, for example.

Finally, it is important to mention that we have provided a set of stylized, empirical results, and not necessarily, recommendations based on optimal policy schemes. Therefore, our results can be understood as a starting point for future research on taxation and on its impact on several economic aggregates.

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Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

Ethical approval This article does not contain any studies with human or animals participants performed by any of the authors.

Informed consent This article does not contain any information that requires informed consent.

Appendix

See Tables 1, 2, 3, 4, 5 and 6.

Table 1 Summary statistics of the variables set for income, consumption and inequalities, 1980–2015

	realgdppc	*taxinc*	*taxfirms*	*ssc*	*taxpayroll*	*taxprop*	*taxvat*
Mean	24.448	8.82	2.806	8.345	0.369	1.745	10.588
SD	14.313	4.635	1.5	4.981	0.728	1.003	3.046
Max	101.054	26.78	12.594	19.173	5.661	7.334	18.73
Min	2.184	0.873	0.261	0	0	0.074	2.979
Obs.	1195	1106	1106	1137	1137	1137	1137
	hconsggdp	*proexp*	*unproexp*	*gfcf*	*pop*	*hc*	*outputgap*
Mean	56.382	27.536	16.71	23.161	33.531	3.02	−0.319
SD	7.069	4.24	4.837	4.091	52.235	0.435	2.85
Max	79.551	48.082	28.285	39.404	319.449	3.734	14.911
Min	29.918	0.537	0	11.546	0.228	1.469	−11.437
Obs.	1174	586	586	1174	1173	1173	851
	debt	*llgdp*	*unem*	*avg*	*current*	*depositrate*	*rtfpna*
Mean	55.728	72.91	7.349	1797.237	−0.578	9.253	0.941
SD	35.901	48.689	3.835	249.343	5.565	25.364	0.123
Max	242.113	399.11	27.467	2911	16.467	682.53	1.539
Min	3.664	6.865	1.854	1361.7	−23.201	−0.18	0.472
Obs.	943	1139	741	986	727	1055	1173
	pubser	*def*	*pubor*	*eco*	*env*	*hou*	*hea*
Mean	6.703	1.681	1.698	4.76	0.689	0.756	5.901
SD	2.274	1.333	0.44	1.763	0.346	0.44	1.686
Max	16.701	8.851	3.761	25.28	1.758	5.411	9.123
Min	2.98	0	0.815	1.307	−0.284	−0.083	0.379
Obs.	585	586	585	585	583	585	585
	cul	*edu*	*socpro*	*ageratioold*	*foreigninvestment*		*gini*
Mean	1.176	5.394	15.562	20.094	3.645		30.44
SD	0.57	1.08	4.708	5.519	10.487		6.562
Max	3.63	8.116	26.18	42.653	252.308		51.17
Min	0.248	3.021	5.44	6.641	−58.323		18.18
Obs.	585	585	585	1260	1120		1172

For reasons of parsimony, the results of *realgdppc* are expressed in thousands of USD

Table 2 Linear and nonlinear short-run impact results of taxation structure on household consumption

	OLS		OLS-FE		GMM		RLS	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$realgdppc_{-1}$	0.000	0.000**	0.000	0.000	0.000	0.000	0.000	0.000*
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
taxinc	0.004	−0.108	−0.013	−0.130	−0.258	−0.610	0.022	0.046
	(0.033)	(0.176)	(0.130)	(0.433)	(0.898)	(1.511)	(0.025)	(0.147)
$taxinc^2$		0.006		0.002		0.046		−0.001
		(0.010)		(0.021)		(0.105)		(0.008)
taxfirms	−0.016	0.297	−0.393***	−0.204	−0.053	0.010	−0.040	0.261*
	(0.070)	(0.215)	(0.139)	(0.223)	(0.425)	(0.674)	(0.058)	(0.152)
$taxfirms^2$		−0.025		−0.015		−0.008		−0.023**
		(0.016)		(0.018)		(0.050)		(0.012)
ssc	−0.044	−0.060	0.038	1.785	−0.439	−0.107	−0.055	0.014
	(0.053)	(0.135)	(0.136)	(1.110)	(1.146)	(0.390)	(0.036)	(0.100)
ssc^2		0.005		−0.072		0.017		−0.001
		(0.008)		(0.044)		(0.027)		(0.006)
taxpayroll	−0.158*	0.072	−0.636*	−2.093**	−0.787	0.983	−0.044	−0.023
	(0.088)	(0.406)	(0.352)	(0.903)	(2.175)	(1.950)	(0.073)	(0.360)
$taxpayroll^2$		−0.106		0.728*		−0.492		−0.021
		(0.162)		(0.389)		(0.666)		(0.147)
taxprop	−0.277***	−0.251	0.151	1.491	−0.032	−3.740	−0.227***	−0.630
	(0.088)	(0.492)	(0.198)	(1.043)	(0.763)	(4.802)	(0.088)	(0.494)
$taxprop^2$		−0.053		−0.289		0.628		0.076
		(0.119)		(0.200)		(0.854)		(0.109)
taxvat	0.086	−0.172	0.324**	1.012	−0.748	−1.535	0.091	−0.489
	(0.102)	(0.455)	(0.151)	(0.714)	(2.508)	(1.683)	(0.076)	(0.341)
$taxvat^2$		0.013		−0.028		0.072		0.026*
		(0.019)		(0.029)		(0.098)		(0.014)

Table 2 (continued)

	OLS		OLS-FE		GMM		RLS	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$hconsggdp_{-1}$	0.861***	0.861***	0.552***	0.550***	0.948***	0.802***	0.873***	0.865***
	(0.036)	(0.035)	(0.061)	(0.062)	(0.143)	(0.171)	(0.024)	(0.026)
proexp	0.023	0.031	−0.051	−0.046	0.258	−0.046	0.008	0.018
	(0.029)	(0.030)	(0.048)	(0.047)	(0.927)	(0.129)	(0.021)	(0.022)
unproexp	0.051	0.029	0.079	0.074	0.642	−0.210	0.034	0.007
	(0.044)	(0.044)	(0.054)	(0.051)	(1.928)	(0.696)	(0.027)	(0.031)
$gfcf_{-1}$	0.011	0.010	−0.012	0.040	0.093	−0.122	−0.012	−0.050
	(0.055)	(0.070)	(0.076)	(0.077)	(0.142)	(0.261)	(0.032)	(0.040)
log (*pop*)	0.342**	0.408***	−4.642	−5.121	−0.267	0.726	0.340***	0.392***
	(0.142)	(0.142)	(5.091)	(5.059)	(1.339)	(1.363)	(0.117)	(0.136)
hc	0.119	0.069	1.835	2.645	−0.883	−2.117	−0.127	−0.193
	(0.272)	(0.388)	(1.984)	(1.680)	(1.249)	(2.038)	(0.250)	(0.349)
outputgap	−0.098***	−0.108***	−0.065	−0.069	0.049	−0.041	−0.079***	−0.098***
	(0.036)	(0.038)	(0.049)	(0.051)	(0.174)	(0.137)	(0.023)	(0.024)
$debt_{-1}$	0.008**	0.007*	0.008	0.002	−0.012	0.018	0.008***	0.005
	(0.003)	(0.004)	(0.010)	(0.010)	(0.094)	(0.017)	(0.003)	(0.003)
llgdp	−0.002	−0.004	−0.027***	−0.022***	−0.003	−0.013	0.000	−0.003
	(0.003)	(0.004)	(0.008)	(0.008)	(0.021)	(0.009)	(0.003)	(0.003)
unem	0.007	0.018	0.040	0.076	−0.074	0.077	0.008	0.011
	(0.018)	(0.020)	(0.048)	(0.048)	(0.355)	(0.150)	(0.018)	(0.020)
avg	0.001	0.001	0.004	0.008**	0.003	0.002	0.000	0.000
	(0.001)	(0.001)	(0.003)	(0.003)	(0.011)	(0.001)	(0.001)	(0.001)
current	−0.160***	−0.168***	−0.179***	−0.172***	0.132	−0.213	−0.139***	−0.16***
	(0.038)	(0.041)	(0.047)	(0.050)	(0.598)	(0.302)	(0.025)	(0.027)
depositrate	0.044	0.049	0.073	0.074	0.066	0.361	0.066*	0.100**
	(0.046)	(0.053)	(0.080)	(0.082)	(0.485)	(0.260)	(0.037)	(0.039)

Table 2 (continued)

	OLS		OLS-FE		GMM		RLS	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Tax thresholds								
taxinc	–	–	–	–	–	–	–	–
taxfirms	–	–	–	–	–	–	–	5.67%
ssc	–	–	–	–	–	–	–	–
taxpayroll	–	–	–	**1.44%**	–	–	–	–
taxprop	–	–	–	–	–	–	–	–
taxvat	–	–	–	–	–	–	–	–
R^2	0.984	0.984	0.991	0.992	0.937	0.974	0.768	0.782
DW stat	1.941	1.963	2.145	2.133	1.489	1.755	n.a.	n.a.
Obs.	244	244	244	244	221	221	244	244

*, ** and ***Represent statistical significance at levels of 10%, 5% and 1%, respectively. The robust standard errors are in brackets. The white diagonal covariance matrix is used in order to assume residual heteroscedasticity, with the exception of RLS technique. The DW statistic is the Durbin–Watson statistic. The non-bold and bold values express, respectively, maximum and minimum threshold tax items levels

Table 3 Linear and nonlinear short-run impact results of taxation structure on household income inequalities

	OLS		OLS-FE		GMM		RLS	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$realgdppc_{-1}$	0.000***	0.000***	0.000***	0.000***	0.000***	0.000***	0.000***	0.000***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
taxinc	−0.099**	0.281***	−0.003	0.328**	−0.080	0.352***	−0.149***	0.196***
	(0.049)	(0.092)	(0.080)	(0.155)	(0.052)	(0.1000)	(0.038)	(0.063)
$taxinc^2$		−0.019***		−0.023***		−0.020***		−0.018***
		(0.003)		(0.008)		(0.004)		(0.002)
taxfirms	−0.398***	−1.305***	−0.075	−0.243**	−0.399***	−1.759***	−0.177***	−0.950***
	(0.076)	(0.185)	(0.082)	(0.115)	(0.080)	(0.252)	(0.054)	(0.117)
$taxfirms^2$		0.082***		0.01		0.128***		0.063***
		(0.015)		(0.007)		(0.023)		(0.01)
ssc	−0.297***	−0.529***	−0.295**	−1.179***	−0.304***	−0.615***	−0.319***	−0.622***
	(0.04)	(0.114)	(0.122)	(0.324)	(0.042)	(0.141)	(0.035)	(0.082)
ssc^2		−0.002		0.038***		0.004		0.002
		(0.008)		(0.013)		(0.01)		(0.005)
taxpayroll	0.668***	−2.029***	−0.359	−1.645***	0.621***	−1.681***	0.567***	−1.761***
	(0.162)	(0.573)	(0.407)	(0.43)	(0.163)	(0.599)	(0.112)	(0.365)
$taxpayroll^2$		1.023***		0.795***		0.84***		0.872***
		(0.239)		(0.199)		(0.251)		(0.152)
taxprop	−0.135	−2.904***	−0.083	−0.587	−0.326*	−3.407***	0.337***	−0.928**
	(0.167)	(0.605)	(0.243)	(0.601)	(0.187)	(0.613)	(0.124)	(0.382)
$taxprop^2$		0.845***		0.086		0.95***		0.392***
		(0.131)		(0.119)		(0.145)		(0.088)
taxvat	0.005	0.862***	−0.127	0.771***	−0.085	0.518	0.014	1.660***
	(0.094)	(0.320)	(0.100)	(0.275)	(0.102)	(0.380)	(0.063)	(0.218)
$taxvat^2$		−0.033**		−0.036***		−0.024		−0.070***
		(0.016)		(0.012)		(0.017)		(0.010)

Table 3 (continued)

	OLS		OLS-FE		GMM		RLS	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
avg	0.004***	0.004***	−0.001	−0.001	0.004***	0.004***	0.006***	0.007***
	(0.001)	(0.001)	(0.002)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
unem	0.171***	0.151***	0.113***	0.111***	0.154***	0.125***	0.138***	0.125***
	(0.035)	(0.030)	(0.031)	(0.018)	(0.035)	(0.029)	(0.027)	(0.019)
log (*pop*)	0.676***	0.856***	4.122	5.447***	0.664***	0.723***	0.479***	0.859***
	(0.164)	(0.162)	(3.758)	(1.825)	(0.165)	(0.146)	(0.116)	(0.094)
hc	−5.123***	−4.277***	−0.862	−0.047	−5.372***	−4.933***	−3.696***	−2.695***
	(0.402)	(0.556)	(1.407)	(0.872)	(0.398)	(0.576)	(0.308)	(0.336)
rtfpna	4.161**	5.833***	0.046	0.071	3.797*	5.994***	−0.690	−1.166
	(2.029)	(2.075)	(2.133)	(1.097)	(1.961)	(1.775)	(1.44)	(1.155)
pubser	−0.537***	−0.416***	0.175***	0.202***	−0.532***	−0.444***	−0.341***	−0.229***
	(0.084)	(0.080)	(0.060)	(0.061)	(0.083)	(0.078)	(0.063)	(0.049)
def	1.241***	1.080***	−0.153	−0.016	1.323***	1.169***	1.034***	0.868***
	(0.123)	(0.146)	(0.180)	(0.145)	(0.128)	(0.133)	(0.087)	(0.078)
pubor	2.050***	1.614***	−0.205	−0.298	2.190***	1.706***	2.597***	0.980***
	(0.433)	(0.418)	(0.247)	(0.237)	(0.410)	(0.351)	(0.281)	(0.231)
eco	−0.208**	−0.260***	−0.047*	−0.045	−0.183*	−0.230***	−0.233***	−0.277***
	(0.099)	(0.088)	(0.027)	(0.032)	(0.094)	(0.057)	(0.053)	(0.039)
env	−2.293***	−0.957**	−0.141	−0.230	−2.159***	−0.881**	−2.959***	−0.723***
	(0.466)	(0.416)	(0.330)	(0.270)	(0.457)	(0.341)	(0.303)	(0.230)
hou	0.600	0.907**	0.391	0.250	0.620	0.850***	0.750***	1.071***
	(0.438)	(0.434)	(0.295)	(0.153)	(0.433)	(0.280)	(0.236)	(0.187)
hea	−0.164	−0.276**	0.181	0.107	−0.158	−0.298***	−0.084	−0.355***
	(0.119)	(0.134)	(0.146)	(0.099)	(0.121)	(0.097)	(0.071)	(0.061)

Table 3 (continued)

	OLS		OLS-FE		GMM		RLS	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
cul	1.122**	0.541	0.594	0.971***	1.270***	0.560*	2.276***	1.849***
	(0.486)	(0.511)	(0.454)	(0.283)	(0.485)	(0.326)	(0.254)	(0.201)
edu	−0.663***	−0.445**	0.209	0.207	−0.689***	−0.573***	−0.781***	−0.335***
	(0.178)	(0.188)	(0.215)	(0.140)	(0.170)	(0.164)	(0.133)	(0.108)
socpro	−0.284***	−0.198***	−0.271***	−0.287***	−0.265***	−0.165***	−0.290***	−0.157***
	(0.048)	(0.060)	(0.066)	(0.045)	(0.049)	(0.043)	(0.035)	(0.029)
ageratioold	0.294***	0.291***	0.121**	0.106***	0.287***	0.273***	0.346***	0.377***
	(0.031)	(0.031)	(0.053)	(0.035)	(0.032)	(0.028)	(0.023)	(0.018)
depositrate	0.155***	0.15***	−0.039	−0.052**	0.157***	0.129***	−0.081***	−0.018
	(0.045)	(0.035)	(0.036)	(0.024)	(0.045)	(0.034)	(0.031)	(0.023)
foreigninvestment	−0.011*	−0.007	0.001	0.000	−0.012*	−0.007	−0.004	−0.003
	(0.006)	(0.005)	(0.004)	(0.003)	(0.006)	(0.007)	(0.007)	(0.005)
gfcf	−0.106**	−0.061*	−0.001	−0.008	−0.126***	−0.081**	−0.127***	−0.030
	(0.041)	(0.035)	(0.050)	(0.030)	(0.041)	(0.033)	(0.030)	(0.022)
hconsggdp	−0.036**	−0.053***	−0.014	−0.018	−0.031*	−0.069***	−0.028**	−0.029***
	(0.016)	(0.014)	(0.018)	(0.016)	(0.016)	(0.016)	(0.013)	(0.010)
Tax thresholds								
taxinc	–	7.39%	–	7.13%	–	8.80%	–	5.44%
taxfirms	–	**7.96%**	–	–	–	**6.87%**	–	**7.54%**
ssc	–	–	–	**15.51%**	–	–	–	–
taxpayroll	–	**0.99%**	–	**1.03%**	–	**1.00%**	–	**1.01%**
taxprop	–	**1.72%**	–	–	–	**1.79%**	–	**1.18%**
taxvat	–	13.06%	–	10.71%	–	–	–	11.86%
R^2	0.893	0.932	0.990	0.992	0.894	0.930	0.739	0.773

Table 3 (continued)

	OLS		OLS-FE		GMM		RLS	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
DW stat	0.351	0.531	0.622	0.763	0.335	0.594	n.a.	n.a.
Obs.	361	361	361	361	360	360	361	361

*, ** and ***Represent statistical significance at levels of 10%, 5% and 1%, respectively. The robust standard errors are in brackets. The white diagonal covariance matrix is used in order to assume residual heteroscedasticity, with the exception of RLS technique. The DW statistic is the Durbin–Watson statistic. The non-bold and bold values express, respectively, maximum and minimum threshold tax items levels

Table 4 Linear and nonlinear long-run impact results of taxation structure on household consumption

	OLS		OLS-FE		GMM		RLS	
	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
$realgdppc_{-1}$	0.000*	0.000***	0.000	0.000	0.000	0.000	0.000	0.000**
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
taxinc	−0.013	−0.210	−0.114	−0.214	−0.694	−2.502	−0.043	−0.116
	(0.030)	(0.164)	(0.102)	(0.475)	(2.379)	(4.298)	(0.026)	(0.155)
$taxinc^2$		0.013		0.002		0.176		0.006
		(0.010)		(0.024)		(0.310)		(0.009)
taxfirms	−0.100	0.212	−0.275**	−0.066	−0.021	−0.112	−0.099*	0.156
	(0.072)	(0.181)	(0.107)	(0.220)	(1.073)	(0.985)	(0.060)	(0.160)
$taxfirms^2$		−0.022		−0.015		0.000		−0.019
		(0.014)		(0.016)		(0.069)		(0.012)
ssc	−0.109**	−0.247**	−0.058	1.746*	−1.079	−0.206	−0.133***	−0.137
	(0.047)	(0.111)	(0.145)	(1.035)	(3.057)	(0.843)	(0.038)	(0.105)
ssc^2		0.013**		−0.074*		0.050		0.004
		(0.007)		(0.041)		(0.065)		(0.006)
taxpayroll	−0.074	0.492	−0.369	−1.626***	−1.663	3.502	−0.119	0.436
	(0.075)	(0.378)	(0.261)	(0.588)	(5.676)	(6.256)	(0.076)	(0.378)
$taxpayroll^2$		−0.296*		0.624**		−1.383		−0.261*
		(0.155)		(0.260)		(2.080)		(0.155)
taxprop	0.000	−1.366**	−0.230	0.846	0.313	−9.918	−0.179*	−1.155**
	(0.000)	(0.617)	(0.215)	(1.074)	(1.929)	(13.835)	(0.092)	(0.519)
$taxprop^2$		0.153		−0.218		1.706		0.163
		(0.133)		(0.210)		(2.377)		(0.114)
taxvat	0.181*	−0.263	0.402***	0.228	−1.726	−2.753	0.170**	−0.102
	(0.102)	(0.395)	(0.129)	(0.601)	(6.500)	(4.820)	(0.079)	(0.359)
$taxvat^2$		0.021		0.008		0.161		0.011
		(0.017)		(0.026)		(0.295)		(0.015)
$hconsggdp_{-1}$	0.802***	0.784***	0.458***	0.448***	0.995***	0.617	0.842***	0.826***
	(0.031)	(0.033)	(0.052)	(0.054)	(0.346)	(0.479)	(0.025)	(0.027)
proexp	0.006	0.018	−0.050	−0.050	0.720	−0.134	0.003	0.013
	(0.026)	(0.026)	(0.038)	(0.039)	(2.478)	(0.509)	(0.022)	(0.023)

Table 4 (continued)

	OLS		OLS-FE		GMM		RLS	
	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
unproexp	0.026 (0.037)	−0.017 (0.043)	0.040 (0.052)	0.034 (0.048)	1.467 (5.054)	−1.023 (2.198)	0.051* (0.029)	0.017 (0.033)
$gfcf_{-1}$	0.020 (0.043)	0.007 (0.051)	0.031 (0.051)	0.070 (0.055)	0.206 (0.372)	−0.256 (0.737)	0.040 (0.034)	0.014 (0.042)
log (*pop*)	0.486*** (0.134)	0.675*** (0.154)	0.237 (3.451)	−1.346 (3.343)	−0.708 (3.338)	2.406 (3.888)	0.361*** (0.123)	0.477*** (0.143)
hc	−0.245 (0.258)	−0.831** (0.377)	4.956*** (1.580)	5.76*** (1.785)	−1.354 (2.958)	−4.842 (5.854)	−0.269 (0.262)	−0.566 (0.367)
outputgap	−0.017 (0.031)	−0.021 (0.032)	−0.037 (0.032)	−0.041 (0.033)	0.258 (0.481)	−0.009 (0.341)	0.016 (0.024)	−0.003 (0.026)
$debt_{-1}$	0.014*** (0.004)	0.014*** (0.004)	0.009 (0.008)	0.006 (0.009)	−0.049 (0.245)	0.039 (0.045)	0.011*** (0.003)	0.012*** (0.003)
llgdp	−0.003 (0.003)	−0.003 (0.004)	−0.016** (0.008)	−0.013 (0.008)	0.008 (0.055)	−0.014 (0.022)	−0.001 (0.003)	−0.002 (0.003)
unem	0.042** (0.020)	0.065*** (0.022)	0.021 (0.036)	0.051 (0.038)	−0.161 (0.910)	0.296 (0.4000)	0.034* (0.019)	0.045** (0.021)
avg	0.001 (0.001)	0.002** (0.001)	0.003 (0.003)	0.007** (0.003)	0.007 (0.028)	0.002 (0.002)	0.000 (0.001)	0.001 (0.001)
current	−0.138*** (0.033)	−0.146*** (0.033)	−0.116*** (0.033)	−0.120*** (0.034)	0.488 (1.573)	−0.417 (0.944)	−0.083*** (0.026)	−0.104*** (0.028)
depositrate	0.121** (0.049)	0.142*** (0.051)	0.200*** (0.073)	0.201*** (0.072)	−0.190 (1.274)	0.599 (0.774)	0.100*** (0.038)	0.129*** (0.041)
Tax thresholds								
taxinc	–	–	–	–	–	–	–	–
taxfirms	–	–	–	–	–	–	–	–
ssc	–	**9.50%**	–	11.80%	–	–	–	–
taxpayroll	–	–	–	**1.30%**	–	–	–	–

Table 4 (continued)

	OLS		OLS-FE		GMM		RLS	
	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
taxprop	–	–	–	–	–	–	–	–
taxvat	–	–	–	–	–	–	–	–
R^2	0.985	0.986	0.993	0.993	0.652	0.908	0.767	0.765
DW stat	1.486	1.534	1.756	1.814	1.266	1.168	n.a.	n.a.
Obs.	244	244	244	244	221	221	244	244

*, ** and *** represent statistical significance at levels of 10%, 5% and 1%, respectively. The robust standard errors are in brackets. The white diagonal covariance matrix is used in order to assume residual heteroscedasticity, with the exception of RLS technique. The DW statistic is the Durbin–Watson statistic. The non-bold and bold values express, respectively, maximum and minimum threshold tax items levels

Table 5 Linear and nonlinear long-run impact results of taxation structure on household income inequalities

	OLS		OLS-FE		GMM		RLS	
	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
$realgdppc_{-1}$	0.000***	0.000***	0.000***	0.000***	0.000***	0.000**	0.000***	0.000***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
taxinc	−0.086*	0.253***	0.043	0.328**	−0.079	0.311***	−0.140***	0.146**
	(0.047)	(0.092)	(0.047)	(0.155)	(0.052)	(0.105)	(0.038)	(0.062)
$taxinc^2$		−0.017***		−0.023***		−0.018***		−0.016***
		(0.003)		(0.008)		(0.004)		(0.002)
taxfirms	−0.388***	−1.190***	0.024	−0.243**	−0.410***	−1.706***	−0.197***	−0.863***
	(0.070)	(0.180)	(0.050)	(0.115)	(0.081)	(0.286)	(0.053)	(0.117)
$taxfirms^2$		0.072***		0.010		0.122***		0.053***
		(0.015)		(0.007)		(0.029)		(0.010)
ssc	−0.290***	−0.487***	−0.281***	−1.179***	−0.303***	−0.594***	−0.315***	−0.578***
	(0.039)	(0.119)	(0.062)	(0.324)	(0.042)	(0.137)	(0.034)	(0.082)
ssc^2		−0.004		0.038***		0.003		0.000
		(0.008)		(0.013)		(0.010)		(0.005)
taxpayroll	0.700***	−1.854***	−0.149	−1.645***	0.642***	−1.689**	0.591***	−1.552***
	(0.164)	(0.582)	(0.198)	(0.430)	(0.167)	(0.658)	(0.110)	(0.365)
$taxpayroll^2$		0.970***		0.795***		0.862***		0.772***
		(0.240)		(0.199)		(0.276)		(0.152)
taxprop	−0.114	−2.930***	0.091	−0.587	−0.305	−3.330***	0.280**	−0.802**
	(0.167)	(0.646)	(0.128)	(0.601)	(0.187)	(0.71)	(0.122)	(0.381)
$taxprop^2$		0.849***		0.086		0.938***		0.368***
		(0.137)		(0.119)		(0.150)		(0.088)
taxvat	0.017	0.894***	−0.056	0.771***	−0.069	0.514	−0.015	1.745***
	(0.095)	(0.322)	(0.073)	(0.275)	(0.102)	(0.375)	(0.061)	(0.217)
$taxvat^2$		−0.034**		−0.036***		−0.023		−0.075***
		(0.015)		(0.012)		(0.018)		(0.010)
avg	0.004***	0.003***	0.000	−0.001	0.004***	0.004***	0.006***	0.007***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)

Table 5 (continued)

	OLS		OLS-FE		GMM		RLS	
	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
unem	0.154***	0.135***	0.106***	0.111***	0.143***	0.115***	0.124***	0.094***
	(0.034)	(0.03)	(0.017)	(0.018)	(0.035)	(0.031)	(0.026)	(0.019)
log (*pop*)	0.667***	0.873***	5.405***	5.447***	0.672***	0.745***	0.555***	0.87***
	(0.159)	(0.163)	(1.649)	(1.825)	(0.163)	(0.172)	(0.115)	(0.094)
hc	−5.182***	−4.323***	0.143	−0.047	−5.371***	−4.893***	−3.794***	−2.609***
	(0.381)	(0.555)	(0.768)	(0.872)	(0.385)	(0.689)	(0.303)	(0.335)
rtfpna	4.989**	6.322***	1.395	0.071	4.758**	6.858***	0.426	−0.417
	(2.027)	(2.072)	(0.996)	(1.097)	(2.007)	(2.098)	(1.420)	(1.153)
pubser	−0.575***	−0.444***	0.178***	0.202***	−0.556***	−0.463***	−0.326***	−0.221***
	(0.083)	(0.082)	(0.041)	(0.061)	(0.084)	(0.086)	(0.062)	(0.049)
def	1.313***	1.134***	−0.051	−0.016	1.380***	1.220***	1.057***	0.846***
	(0.127)	(0.150)	(0.135)	(0.145)	(0.135)	(0.175)	(0.086)	(0.078)
pubor	2.307***	1.885***	0.030	−0.298	2.369***	1.948***	2.506***	1.130***
	(0.423)	(0.416)	(0.188)	(0.237)	(0.421)	(0.423)	(0.277)	(0.230)
eco	−0.194**	−0.245***	−0.054*	−0.045	−0.177*	−0.227***	−0.221***	−0.207***
	(0.096)	(0.085)	(0.029)	(0.032)	(0.093)	(0.080)	(0.053)	(0.039)
env	−2.432***	−1.159***	−0.541***	−0.230	−2.310***	−1.112***	−2.783***	−1.133***
	(0.436)	(0.400)	(0.184)	(0.270)	(0.435)	(0.390)	(0.299)	(0.229)
hou	0.571	0.840*	0.307*	0.250	0.585	0.797*	0.706***	0.905***
	(0.439)	(0.441)	(0.170)	(0.153)	(0.436)	(0.451)	(0.233)	(0.187)
hea	−0.176	−0.273*	0.249**	0.107	−0.162	−0.290**	−0.118*	−0.310***
	(0.122)	(0.140)	(0.097)	(0.099)	(0.126)	(0.146)	(0.07)	(0.061)
cul	1.049**	0.523	0.900***	0.971***	1.169**	0.456	2.218***	2.025***
	(0.507)	(0.533)	(0.305)	(0.283)	(0.510)	(0.533)	(0.251)	(0.201)
edu	−0.724***	−0.496***	0.260**	0.207	−0.714***	−0.576***	−0.699***	−0.359***
	(0.165)	(0.181)	(0.113)	(0.14)	(0.166)	(0.187)	(0.131)	(0.108)

Table 5 (continued)

	OLS		OLS-FE		GMM		RLS	
	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
socpro	−0.276*** (0.046)	−0.199*** (0.058)	−0.306*** (0.038)	−0.287*** (0.045)	−0.258*** (0.047)	−0.170*** (0.059)	−0.277*** (0.035)	−0.155*** (0.028)
ageratioold	0.299*** (0.031)	0.296*** (0.032)	0.106*** (0.028)	0.106*** (0.035)	0.290*** (0.032)	0.275*** (0.033)	0.331*** (0.022)	0.366*** (0.018)
depositrate	0.162*** (0.050)	0.158*** (0.040)	−0.022 (0.029)	−0.052** (0.024)	0.162*** (0.049)	0.136*** (0.042)	−0.079*** (0.03)	−0.028 (0.023)
foreigninvestment	−0.009 (0.006)	−0.006 (0.005)	0.001 (0.002)	0.000 (0.003)	−0.009 (0.006)	−0.004 (0.005)	−0.003 (0.007)	−0.002 (0.005)
gfcf	−0.114*** (0.041)	−0.074** (0.036)	−0.021 (0.023)	−0.008 (0.030)	−0.126*** (0.041)	−0.083** (0.037)	−0.119*** (0.029)	−0.046** (0.022)
hconsggdp	−0.035*** (0.016)	−0.049*** (0.014)	−0.015 (0.016)	−0.018 (0.016)	−0.028* (0.016)	−0.064*** (0.015)	−0.022* (0.013)	−0.022** (0.010)
Tax thresholds								
taxinc	–	7.44%	–	7.13%	–	8.64%	–	4.56%
taxfirms	–	**8.26%**	–	**–**	–	**6.99%**	–	**8.14%**
ssc	–	**–**	–	**15.51%**	–	**–**	–	–
taxpayroll	–	**0.96%**	–	**1.03%**	–	**0.98%**	–	**1.01%**
taxprop	–	**1.73%**	–	–	–	**1.78%**	–	**1.09%**
taxvat	–	13.15%	–	10.71%	–	.	–	11.63%
R^2	0.897	0.932	0.992	0.992	0.896	0.929	0.749	0.786
DW stat	0.386	0.554	1.042	0.763	0.376	0.627	n.a.	n.a.
Obs.	362	362	362	362	361	361	362	362

*, ** and ***Represent statistical significance at levels of 10%, 5% and 1%, respectively. The robust standard errors are in brackets. The white diagonal covariance matrix is used in order to assume residual heteroscedasticity, with the exception of RLS technique. The DW statistic is the Durbin–Watson statistic. The non-bold and bold values express, respectively, maximum and minimum threshold tax items levels

Table 6 Summary of tax items threshold values for households' consumption and inequalities

	Consumption		Inequalities		Mean (%)
	Short run (%)	Long run (%)	Short run (%)	Long run (%)	
taxinc	–	–	*7.19*	*6.94*	8.82
taxfirms	5.67	–	***7.46***	***7.80***	2.81
ssc	–	**9.50**/11.80	**15.51**	**15.51**	8.35
taxpayroll	**1.44**	1.30	***1.01***	***1.00***	0.37
taxprop	–	–	***1.56***	***1.53***	1.75
taxvat	–	–	*11.88*	*11.83*	10.59

The non-bold and bold values presented in the short-run and long-run columns express, respectively, the maximum and minimum threshold tax items levels. The values expressed in italics represent average values

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