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Progressivity in the Portuguese Personal Income Tax System

Ana Pedroso de Lima Martins, 734

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Susana Peralta

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Abstract

This Work Project analyzes the evolution of the Portuguese personal income tax system's progressivity over the period of 2005 through 2013. It presents the first computation of cardinal progressivity measures using administrative tax data for Portugal. We compute several progressivity indices and find that progressivity has had very modest variations from 2005 to 2012, whilst from 2012 to 2013 there has been a relatively stronger decrease, excluding the impact of the income tax surcharge of the years 2012 and 2013. When this latter is included, progressivity of 2012 and 2013 decreases considerably. Analyzing the effective average tax rates of the top income percentiles in the income scale, we find that these rates have increased over the period 2010–2013, suggesting that an analysis of effective tax rates is insufficient to assess progressivity in the whole tax scheme.

Keywords

Progressivity, Tax burden, Income tax, Income distribution

1. Introduction

A progressive tax scheme is one where the average tax rate increases with an increase in the tax base, i.e., one's income, in the case of personal income taxes. Tax progressivity can be discussed in both positive and normative grounds. A positive analysis entails measuring income inequality and inequality in the tax payment, as well as the efficiency costs or gains of more progressive tax schemes. The decision about the optimal degree of progressivity is, however, a normative one, ultimately driven by ethical and political considerations.

Evaluating a tax system's progressivity is of great importance for public finance. Without having computed a progressivity index or a similar indicator, one can only take an informed guess as to whether a change in income taxes' brackets will increase or decrease the system's progressivity. This is of particular interest for the design of tax rates, in order to allow policymakers to achieve their desired amount of progressivity. Computing a cardinal measure of progressivity allows us to assess the effect of different types of changes in the tax scheme, which cannot be accounted for by simply analyzing the evolution of the statutory (i.e., as published in the law) marginal and average rates before and after the changes. This happens because the statutory tax rates differ from the effective ones, due to the existence of deductions and tax evasion that are not homogeneous across income levels. Ignoring these factors tends to overestimate progressivity: deductions are often allowed on some goods (such as private health and education expenditures) that are disproportionately consumed by the better-off in the economy; tax evasion is usually easier for upper classes and the share of income that is consumed (and, thus, taxed through taxes on consumption) tends to decrease as income increases.

This project's objective is to shed light on the progressivity path that the Portuguese tax system has been taking in the last ten years, by computing the progressivity indices introduced by Stroup (2004), Kakwani (1977), Suits (1977), Mathews (2013), Musgrave & Thin (1948) and Reynolds & Smolensky (1977) (which will hereafter be referred simply as indices). Progressivity can be evaluated on the individual taxes level or considering the system as a whole – taking into account not only income but also wealth, indirect taxes transfers aimed at the low-income families as well. We will be analyzing progressivity in the PIT (Personal Income Tax) system, as enlarging the scope of the study would require us to make too many assumptions and lose rigor in the computations, due to lack of available data. We will use publicly available PIT data from the Portuguese tax authority – *Autoridade Tributária e Aduaneira* (AT) – ranging from 2005 to 2013 and grouped in brackets. Although

AT claims that this series has been made since 1990 (cf. *Notas Prévias*¹), we submitted a formal request to access this data and the request was denied. We were denied access to individual data as well. A progressivity index has never been computed for Portuguese PIT so far (which increases this work project's relevance on the discussion on PIT progressivity).

Table 1 shows the number of households and the amount of PIT revenues collected in each bracket in 2013 (we will be using the brackets determined by the AT in this study). Bracket 0 corresponds to exempt incomes subject to aggregation² and to incomes declared by non-residents, which explains why there are taxes being paid in this bracket³.

Gross income brackets (€)	Number of households	Tax revenues (million €)
0 – [0]	108 051	52
1 – [1, 5 000[	741 307	55
2 – [5 000, 10 000[	1 599 767	205
3 – [10 000, 13 500[	667 356	319
4 – [13 500, 19 000[	659 121	653
5 – [19 000, 27 500[	552 617	1 265
6 – [27 500, 32 500[	175 336	741
7 – [32 500, 40 000[	181 153	1 114
8 – [40 000, 50 000[	138 370	1 155
9 – [50 000, 100 000[	196 993	3 073
10 – [100 000, 250 000[	33 333	1 414
11 – [250 000, +∞[	2 276	450
Total	5 055 680	10 498

Table 1 – Number of households and PIT revenues by income brackets in 2013. Source: AT

In the absence of individual tax files, our progressivity indices will use these data by intervals. Progressivity in PIT structures is a “social requirement” in most advanced economies (such as European countries, US, Canada, Australia, and Japan). It has been socially, politically and economically consensual along the 20th century in western countries that a tax system that promotes income redistribution is important to avoid excessive levels of inequality. Sabirianova Peter, Buttrick & Duncan (2010) use a panel of 189 countries between 1981 and 2005, and conclude that progressivity has decreased due to a decrease in the number of tax brackets and lower top marginal tax rates. Piketty and Saez (2007) analyze progressivity in the US, the UK and in France, concluding that PIT progressivity has been decreasing since 1970, particularly in the United Kingdom, where the average effective PIT rate for the top

¹ http://info.portaldasfinancas.gov.pt/NR/ronlyres/EA4E2508-08FD-489A-8FA1-315B325B7B5F/0/Notas_Previas_IRS_2011_2013.pdf last visited in 15.01.2016

² In Portuguese, “agregação”.

³ Bracket 0 will not be considered in the calculations as it concerns exempt incomes subject to aggregation and incomes declared by non-residents, instead of being divided by the remaining income brackets.

99,95% households in the income distribution dropped from over 0,69 to less than 0,35 in 2000.

At the basis of this transition to flatter PIT rates is the idea that there is a trade-off between efficiency and progressivity, as illustrated by the Laffer curve (Wanniski, 1978). This may result from richest individuals having easier access to tax evasion (Slemrod, 1994), especially in countries with higher tax evasion, such as developing ones (Sabirianova Peter and Duncan, 2012). It may also result from the fact that the labor supply of more productive individuals, measured in efficiency units, is higher.

This report is organized as follows: in Section 2 we introduce a simplified framework for the analysis of the tax system, Section 3 summarizes the literature review, while Section 4 describes the data and methodology. We examine the results in Sections 5 and 6 and present the conclusions and policy implications Section 7. The project's limitations and possible paths for further research are discussed in the final section.

2. A framework for tax analysis

We present some basic concepts about tax schemes that will be useful throughout this study and, afterwards, a brief description of the evolution of the Portuguese economy in the 2005-2013 period.

Statutory tax rates are the tax rates set by the government and published by law. Let $t(y)$ define the tax liability of an individual with gross (i.e, before taxes) income level y and $D(y)$ denote both the tax credits and deductions that decrease the individual's tax bill.⁴ The actual tax bill will then be $T(y) = t(y) - D(y)$. The average statutory tax rate is $t(y)/y$, while the marginal statutory tax rates is $\partial t(y)/\partial y$ (see Tables 2 to 5).

Effective tax rates, conversely, are computed using the actual tax bill as provided by the AT. The average effective tax rates is $T(y)/y$ and the marginal effective tax rate is $\partial T(y)/\partial y$.

Collectable income refers to the gross income net from specific deductions⁵ (the expenditures that are necessary for an individual to earn their income, such as payroll payments, union fees and some property related expenditures), and rebates⁶, such as aliments to ex-spouses. The taxable income is set above a given threshold below which incomes are exempted from PIT taxes. The maximum of deductions a household is allowed to have varies both with its income and with the number of persons comprising the household.

⁴ Tax credits correspond to items deductible from collectable income.

⁵ In Portuguese, "deduções específicas".

⁶ In Portuguese, "abatimentos".

The tax liability is computed by applying the appropriate marginal tax rate to the household income that falls within each bracket.

The Portuguese PIT scheme is a piece-wise linear one. In December 2005, it consisted of 7 branches as shown in Table 2. The higher marginal tax rate increased by 2 p.p. (to 42%) from its previous configuration, with a new top bracket, which caused households with incomes higher than €60 000 to face a higher effective tax rate. Up until March 2010 (Table 3), the PIT rates remain unchanged, while the taxable income considered for defining the brackets was adjusted yearly, increasing very marginally. In March 2010, another bracket is added, for those earning more than €150 000 per year, and so the higher marginal statutory tax rate is increased; additionally, all the marginal tax rates are slightly revised higher.

Collectable income (€)	Statutory Rates (%)	
	Marginal	Average
[0, 4 451[	10,5	10,5
[4 451, 6 732[	13	11,3471
[6 732, 16 692[	23,5	18,5986
[16 692, 38 391[	34	27,3037
[38 391, 55 639[	36,5	30,1545
[55 639, 60 000[	40	30,8701
[60 000, +∞[	42	–

Table 2 – Statutory tax rates in effect from December 2005 to December 2006. Source: AT

Collectable income (€)	Statutory Rates (%)	
	Marginal	Average
[0, 4 793[	10,5	10,5
[4 793, 7 250[	13	11,3471
[7 250, 17 979[	23,5	11,5996
[17 979, 41 349[	34	27,3039
[41 349, 59 926[	36,5	30,1546
[59 926, 64 623[	40	30,8702
[64 623, 150 000[	42	37,205
[150 000, +∞[	45	–

Table 3 – Statutory tax rates in effect from March 2010 to June 2010. Source: AT

Collectable income (€)	Statutory Rates (%)	
	Marginal	Average
[0, 4 898[	11,5	11,5
[4 898, 7 410[	14	12,348
[7 410, 18 375[	24,5	19,599
[18 375, 42 259[	35,5	28,586
[42 259, 61 244[	38	31,504
[61 244, 66 045[	41,5	32,231
[66 045, 153 300[	43,5	38,645
[153 300, +∞[	46,5	–

Table 4 – Statutory tax rates in effect from December 2010 to December 2012. Source: AT

Collectable income (€)	Statutory Rates (%)	
	Marginal	Average
[0, 7 000[	14,5	14,5
[7 000, 20 000[	28,5	23,6
[20 000, 40 000[	37	30,3
[40 000, 80 000[	45	37,65
[80 000, +∞[	48	–

Table 5 – Statutory tax rates currently in effect, since December 2012. Source: AT

Table 4 presents the statutory tax rates for the years 2011 and 2012.⁷ In Table 5, he have the tax rates used in 2013. There has been a decrease in the number of brackets from 2012 to 2013, while both the average and marginal statutory rates have increased.

Thus, 2010 (with effect from March on) and 2013 are the years in which the PIT structure changes the most. The tables summarizing the statutory rates for the 2005-2013 period and which were not depicted above are available in Appendix 1.

Regarding deductions, these were not considered in our computations provided that the data available did not allow us to separate them from the collectable income within brackets.

In 2012 and 2013, the taxpayers have faced an extraordinary surcharge of 3,5%,⁸ levied on the amount of income above €6 790 (which is equivalent to the annual minimum wage – €485/month for both years⁹).

Moreover, the period under analysis is characterized by a global crisis that deeply affects Portugal's economy and its financial situation. Real GDP growth is positive and crescent from 2005 to 2007, but cools to an almost zero level in 2008 and becomes negative in 2009. While in 2010 real GDP growth becomes positive again, in the years 2011-2013 real GDP falls successively. The economic and financial turmoil faced by Portugal was one of the factors influencing the deep changes in the PIT structure in this period.

3. Literature Review

This literature review is divided into two parts. In the first, we present the few empirical papers that have measured progressivity of the Portuguese tax system – albeit with a methodology different from the one used in this paper. In the second, we discuss the several progressivity indices, and provide a comparison of their respective approaches.

Catarino and de Moraes e Soares (2014)¹⁰ analyzed the PIT's fiscal level and fiscal effort using the tax authority PIT data.¹¹ They conclude that for different brackets there are uneven

⁷ (Lei n.º 55-A/2010-31/12).

⁸ Lei n.º 49/2011-07/09 from CIRS and Lei n.º 66-B/2012-31/12 from *Orçamento de Estado 2013*

⁹ <http://www.pordata.pt/Portugal/Sal%C3%A1rio+m%C3%ADnimo+nacional-74> last visited at 17.01.2016

levels of fiscal effort and that this does not increase with income. The households with the highest fiscal effort are those with gross incomes from €50 000 to €100 000.

Caselli, Centeno, Novo and Tavares (2016) use European Union Statistics on Income and Living Conditions (SILC) data to compute several inequality measures for EU countries.¹² The authors find that there is a disparity in European countries' effectiveness of income redistribution: poorer countries, such as Portugal, are less effective in redistributing income, either due to policy design and implementation mistakes or due to lack of a sufficient number of high income individuals. Portugal stands as a particularly high-inequality country both pre and post-tax – the EU Gini index pre-tax is 0,39 and after-tax it is 0,32, whereas for Portugal it is 0,43 and 0,36, respectively.

Measures of progressivity can be divided in two groups: the distributional or progressivity indices, based both on the tax rate structure and the distribution of income within the population subject to taxation, mostly computing the “disproportionality of tax payments relative to pre-tax incomes”, and the structural indices, depending only on the tax rate structure, i.e, measuring “the difference between pre-and post-tax income distributions”.¹³

Progressivity indices include those of Kakwani, Suits, Stroup, and Mathews. The indices of Musgrave & Thin and Reynolds & Smolensky belong to the second group.

These indices have been computed for the U.S. Federal Income Tax by several researchers. We highlight the computations of Kakwani (1977), Suits (1977), Stroup (2005), and Mathews (2013).¹⁴

Musgrave & Thin (1948) used income distributions to compare the change in inequality before-tax and after-tax, where a progressive system is associated to a decrease in inequality. The index uses pre- and post-tax Gini indices, G_I and G_F , respectively:

$$\text{Musgrave \& Thin (MT)} = \frac{1 - G_F}{1 - G_I}$$

¹⁰ https://aquila4.iseg.ulisboa.pt/aquila/instituicao/ISEG/docentes-e-investigacao/conference-theme/papers?_request_checksum_=bc7eef06e2f3ab8b2f2d51ed9a51129c16826775, last visited at 30.12.2015

¹¹ The first measures the pressure exerted over groups of taxpayers with different levels of income and the second measures the weight of the PIT on the income earned by the household in average terms, compared to the portion of tax liabilities.

¹² SILC is a micro-data set of self-reported income and living conditions measures. Regarding self-reported data, Cowell (2009) states that “a principal difficulty is (...) that of non-response or misinformation by those approached in the survey. A common presumption is that disproportionately many of those refusing to cooperate will be among the rich, and thus a potentially significant bias may be introduced in the results.” (ibid: 100)

¹³ Please refer to Sarralde, Garcimartin, & Ruiz-Huerta (2013), Mathews (2015), and Kiefer (2015) for details about this classification.

¹⁴ Kakwani uses the years 1968, 1969, and 1970, Suits uses the years 1966 and 1970, Stroup uses the period ranging from 1980 to 2000, and Mathews (2013) uses the period ranging from 1929 to 2010.

The Gini indices are given by:

$$G_i = \frac{a}{a + b} = 2a$$

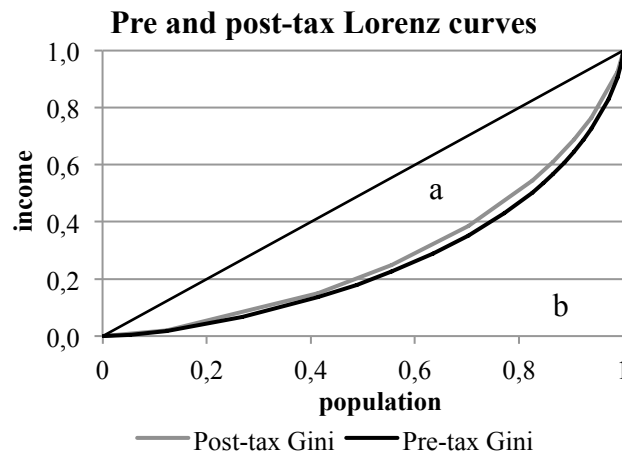
where $i = \{F, I\}$, a is the area between the main diagonal and the relevant pre or post-tax Lorenz curve, and b is the area under the relevant Lorenz curve, as illustrated in Graph 1.

In a similar fashion, Reynolds and Smolensky (1977) compute an index that is obtained simply as the difference between the two Gini indices.

$$\text{Reynolds \& Smolensky (RS)} = G_I - G_F$$

With a progressive tax, individuals with higher incomes face higher rates, which consequently reduces income inequality, by having $G_F < G_I$, as in Graph 1, we have $RS > 0$ and $MT > 1$.

Mathews (2015) suggests a simple transformation of Musgrave & Thin's index: $\overline{MT} = MT - 1$ in order to easily compare the two indices. This transformation renders $\overline{MT} = \frac{RS}{1 - G_I}$, thus making the values of both indices positive for a progressive tax.



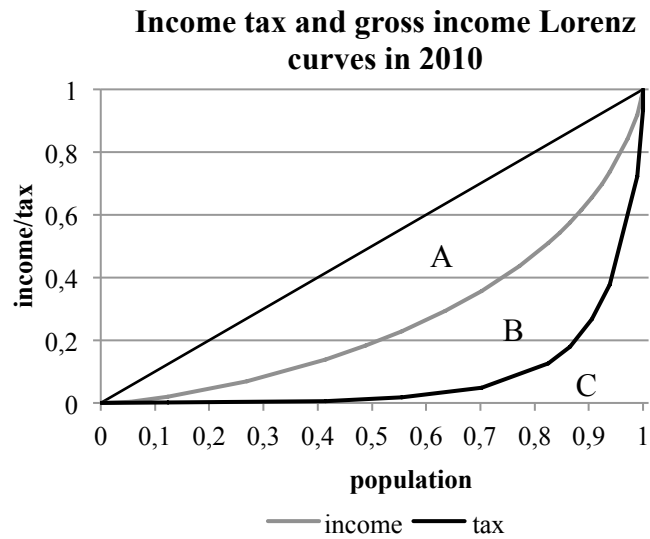
Graph 1 – Pre and Post-tax Lorenz curves for the year of 2010. Source: Author's calculations using data from AT

The remaining tax progressivity indices use the Lorenz curves of the pre-tax income and tax liability. Graph 2 presents both curves for the year of 2010. A is the area between the main diagonal and the gross income Lorenz curve, while B is the area between the gross income and the tax liability Lorenz curves, and C is the area below the tax liability Lorenz curve. Kakwani's index is computed as follows:

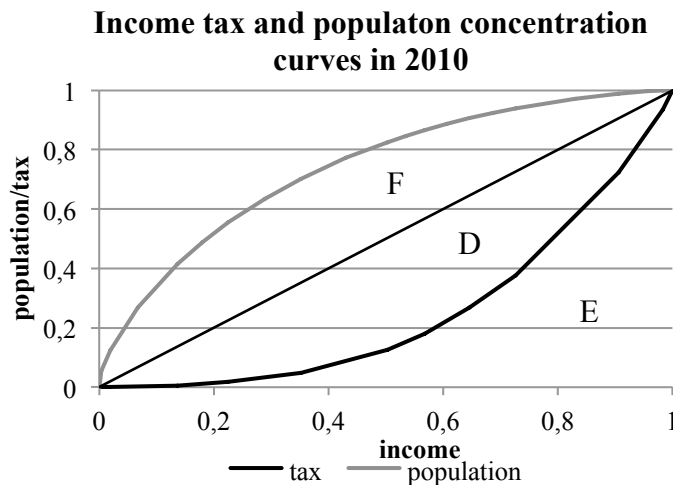
$$\text{Kakwani index} = \frac{B}{A + B + C} = 2B$$

The Stroup index, in contrast, computes tax progressivity as a ratio, not a difference, of the area between the income and tax burden Lorenz curves:

$$\text{Stroup index} = \frac{B}{B + C}$$



Graph 2 – Income and tax concentration curves with respect to population for the year of 2010. Source: Author's calculations using data from AT



Graph 3 - Income and tax concentration curves with respect to income for the year of 2010. Source: Author's calculations using data from AT

In the Suits and Mathews' indices, contrary to the above ones, the x-axis represents the percent of income earned across the tax base. The two curves represented in Graph 3 are now the population Lorenz curve with respect to income (in grey), and the tax Lorenz curve with respect to income (in black). We can see in Graph 3 that the population curve is now concave (for example, the lowest 10% of income are held by around 35% of the population), unless there is full income equality, in which case it will be linear. In Graph 3, D is the area between the income concentration curve and the tax concentration curve, E is the area below the tax concentration curve, and F is the area between the population concentration curve and the income concentration curve.

The Suits index is given by:

$$\text{Suits index} = \frac{D}{D + E} = 2D$$

Similarly, the Mathews index computes the ratio of the area between the income curve with respect to income and the tax concentration curve and the area under the population concentration curve:

$$\text{Mathews index} = \frac{D}{D + E + F} = \frac{2D}{1 + 2F}$$

While the Kakwani and Stroup indices weigh different segments of the population equally, the Suits and Mathews indices weigh them according to their marginal contribution to the cumulative income – that is, giving a higher weight to the households with top incomes.

Stroup and Hubbard (2013) analyze how the differences in computation between the Kakwani, Stroup and Suits indices affect the ability to measure progressivity. They create three scenarios, a first one where the poorest 50% pay no PIT and earn 10% of all income while the remaining 50% pay 90% of the tax, a second where the poorest 90% pay no PIT and earn 10% of all income and a third where 99% of people pay no PIT and earn 10% of income, while the remaining 1% bear 100% of the tax burden. Both income and tax burden are evenly split within brackets, which means that the average tax rates are equal for every tax paying individual. This implies that the average tax rates are lower in the first scenario and heavier in the third scenario, implying an increasing progressivity. However, both the Kakwani and the Suits indices yield the exact same value (0,10) for each of the three cases, failing to capture this increase. The values obtained with the Stroup index are 0,17, 0,50 and 0,91, respectively. Given that even in the less progressive case the Stroup index yields a higher value than the other two indices, it may overstate progressivity – which is also the case in the indices computed by Mathews (2015). This is not too worrisome since we will be focusing more on the indices comparison over the years than on their absolute values.¹⁵

There are several other approaches of evaluating progressivity in the literature: Baum (1987) studies the effect of a tax on the share of income owned by the different sectors using the concept of “relative share adjustment”, Allen & Campbell (1994) look into the difference in the average tax rate charged to middle and high income households, and Piketty & Saez (2007) compare the average tax rates paid by individuals with distinct levels of income, focusing on the very-high income ones. However, none of these three approaches intends to

¹⁵ Two additional measures were developed by Khetan and Poddar (1976), but they can be expressed as a monotonic transformation of Suits’ and Stroup’s indices, respectively (Mathews, 2013).

develop a single uni-dimensional progressivity index, contrarily to the ones previously discussed.

4. Data and Methodology

The data used for the first part of this research is drawn from the aggregate data on Portuguese individual tax files (*Declarações Modelo 3*), available at the AT website.¹⁶ The PIT statistics available are Total Number of Households, the Gross Annual Income and the Amount of Collected Taxes, by income brackets.

The methodology described in the aforementioned indices is very straightforward and requires only the computation of an income Lorenz curve and of a tax Lorenz curve, for each year. Since we are only considering grouped data, already divided in brackets with different lengths and relative frequencies, we must build the tax Lorenz curves for each year as a piecewise linear function passing through each pair of values, so we do not make any additional specification about its functional form¹⁷. The areas between the Lorenz curves will be broken into triangles and trapezoids for computation.

We opted to compute the density of the inequality distributions using the split histogram density method suggested by Cowell (2009) for the cases in which the only available information are the interval boundaries (which we will call a_i and a_{i+1}), the relative frequency of the interval (f_i) and the interval mean (μ_i).

The main caveat of grouped data, as compared to individual data, is that we do not know the gross income and tax liability distribution inside each tax bracket. One may, however, compute a lower bound for the inequality by supposing that all the households' incomes in the tax bracket are equal to the average one. Conversely, the upper bound inequality is obtained supposing that households in the tax bracket locate either at the lower or at the upper interval boundary, with the relative frequencies appropriately estimated to fit the interval average.

Figure 1 illustrates both curves. The lower bound corresponds to the curve with the solid line, connecting the interval boundaries 8 to 11, and the upper bound corresponds to the curve with the dotted lines, connecting the points A to C that correspond to the interval averages. Cowell's split histogram density allows one to obtain a compromise measure of inequality which lies between the lower and upper bounds just described by allowing for a different density for income values below and above the interval mean. The author also suggests using

¹⁶ http://info.portaldasfinancas.gov.pt/pt/dgci/divulgacao/estatisticas/estatisticas_ir/ last visited at 13.01.2015. The data we used corresponds to the Maps 31, 34 and 40 available in the webpage.

¹⁷ Stroup (2004) estimates an exponential regression for each year.

$\frac{1}{3}G_L + \frac{2}{3}G_U$ as a compromise estimate to compute Gini indices, where G_L is the lower bound's Gini index and G_U is the upper bound's Gini index, which as we can see from the pre-tax indices computed in Table 4 yields very similar results.

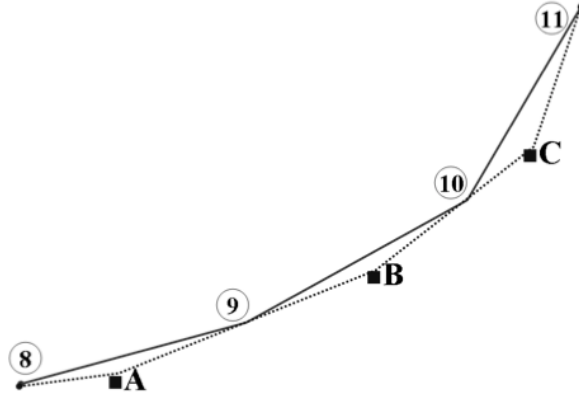


Figure 1 – Lower and upper bounds of a Lorenz curve. Source: Cowell (2009)

We will first compute the split histogram density function ($\phi_i(y)$) in each interval $[a_i, a_{i+1}[$, and with it we will compute the cumulative frequencies function ($F(y)$), which will give us the percentage of people that have less than a certain y , and the cumulated density function ($\Phi(y)$), which gives us the amount of income that is below this same y .

The split histogram density for each interval $[a_i, a_{i+1}[$ is given by:

$$\phi_i(Y) = \begin{cases} \frac{f_i}{a_{i+1} - a_i} \frac{a_{i+1} - \mu_i}{\mu_i - a_i}, & a_i \leq y < \mu_i \\ \frac{f_i}{a_{i+1} - a_i} \frac{\mu_i - a_i}{a_{i+1} - \mu_i}, & \mu_i \leq y < a_{i+1} \end{cases}$$

The f_i can also be written as the integral of the distribution's density function:

$$f_i = \int_{a_i}^{\mu_i} \phi_{y < \mu_i} dy + \int_{\mu_i}^{a_{i+1}} \phi_{y \geq \mu_i} dy$$

Where $\phi_{y < \mu_i}$ corresponds to the density of the Lorenz curve in the interval $[a_i, \mu_i[$ and $\phi_{y \geq \mu_i}$ corresponds to the density of the Lorenz curve in the interval $[\mu_i, a_{i+1}[$. Afterwards, using the estimated ϕ_i s we can calculate the cumulative frequencies ($F(y)$) and densities ($\Phi(y)$) through the following equations:

$$F(y) = F_i + \int_{a_i}^y \phi_i(x) dx$$

$$\Phi(y) = \Phi_i + \int_{a_i}^y x \phi_i(x) dx$$

Each point in the Lorenz curve is given by the pair $F(y), \Phi(y)$, where y takes the values of all a_i and μ_i . It is important to keep in mind that the $\Phi(y)$ correspond to the percentages of income owned by the corresponding percentage of the population (the corresponding $F(y)$).

For each year we shall be computing the Lorenz curve of the gross income and that of tax liability.

As we do not know the interval boundaries in the tax burden curve, nor in the after-tax income Lorenz curve (we do not know the amount of tax paid by the households who earn the incomes that correspond to the interval boundaries in the pre-tax income Lorenz curve), we will not be able to use the split histogram methodology (nor Cowell's compromise estimate) there¹⁸. The estimated curves will correspond to the lower bound, that is, will assume that income is distributed equally within brackets.

It is important to note that we do not know the value of the highest bracket's upper boundary because we do not have access to micro data. We will assume that it is set as €20 000 000¹⁹. Since the relative frequency of the highest bracket is rather small (its highest value is 0.09% in 2009 and its lowest is 0.05% in 2013), this assumption will not affect the global results. We test the robustness by computing the indices with upper boundaries of €5 000 000, €20 000 000 and €100 000 000, and the indices are identical. These results can be observed in Appendix 2.

A possible drawback of our analysis, which is shared by all the empirical studies of tax liabilities based on fiscal authority data, is that it fails to take into account the income which is generated in the economy and is exempt from personal income taxes. As described by Mathews (2015), if individuals with incomes below a certain level are not even required to file a return (as in the U.S. case, but contrary to the Portuguese one), then this approach ultimately understates the degree of progressivity at each point in time.²⁰ Additionally, if the number of adults exempt from filing tax returns changes considerably, then focusing only on tax returns could provide misleading results in terms of level of progressivity.

¹⁸ We can obtain it through linear interpolation by computing the marginal effective tax rates but it would only yield points within the lower bound curve.

¹⁹ It is worth mentioning that Cowell (2009) states that “[i]f the average income in each class is known, the simplest solution is to make a sensible guess” (ibid: 120). The average gross income in this bracket ranges from €418 422 to €456 503 throughout the years we are evaluating. Moreover, the former director of AT recently referred that there are around 1 000 households with incomes superior to €5 000 000 per year in Portugal (cf. <http://sicnoticias.sapo.pt/programas/negociosdasemana/2015-12-10-Edicao-de-9-12-2015>), which we must take into account when deciding the value of the highest upper bound.

²⁰ In Portugal there are individuals who are not required to file in tax returns, such as research scholarship receivers. This is, however, different from the U.S. case in that the exception is not based on an income threshold but on the type of income involved.

Using this framework, we obtain the inequality indices by computing the area under the Lorenz curve and the area under the tax share curve and making the aforementioned calculations for each index. The higher the value of the indices, the higher is the progressivity in this economy.

5. Progressivity indices

This section presents the computed progressivity indices and analyzes their evolution and the differences across the different indices. It is divided into two parts: in the first, we provide results using the raw AT data, which excludes the income tax surcharge of the years 2012 and 2013. We then move to include our own estimates of the impact of this surcharge.

5.1 Using the AT data that excludes the income tax surcharge

Table 4 displays the Gini indices of the pre and post-tax incomes, as well as the one computed by Statistics Portugal (INE), which presents a substantially lower value. The difference is explained by the fact that INE uses SILC data on disposable income data, i.e., including government transfers. Moreover, it provides a measure of individual inequality, whereas ours is household-based. The pre-tax income Ginis vary between 0,468 and 0,492, compared to a range of 0,423 and 0,45 for the net income ones and 0,342 to 0,377 of the INE ones. This confirms the expected inequality-decreasing impact of transfers.

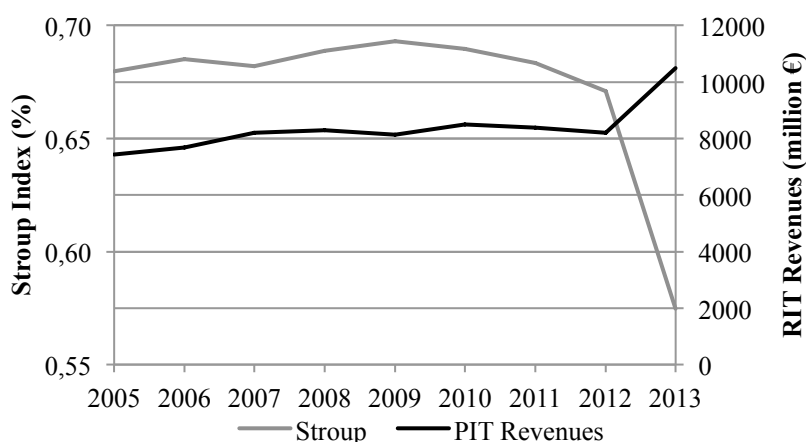
Year	Pre-tax Gini	After-tax Gini	INE Gini	Pre-tax Gini (1)
2005	0,492	0,450	0,377	0,494
2006	0,487	0,444	0,368	0,489
2007	0,486	0,443	0,358	0,489
2008	0,482	0,439	0,354	0,484
2009	0,480	0,437	0,337	0,482
2010	0,478	0,434	0,342	0,480
2011	0,471	0,427	0,345	0,473
2012	0,468	0,423	0,342	0,470
2013	0,474	0,432	0,345	0,477

Table 6 - Gini indices evolution over the years. Note: Pre-tax Gini (1) was computed using Cowell (2009)'s rule of thumb mentioned in Section 4. Sources: INE; author's calculations using AT data

The indices have been decreasing over the years, although from 2012 to 2013 there has been a slight increase in all three of them, signaling a more unequal distribution of income, breaking the downward trend.

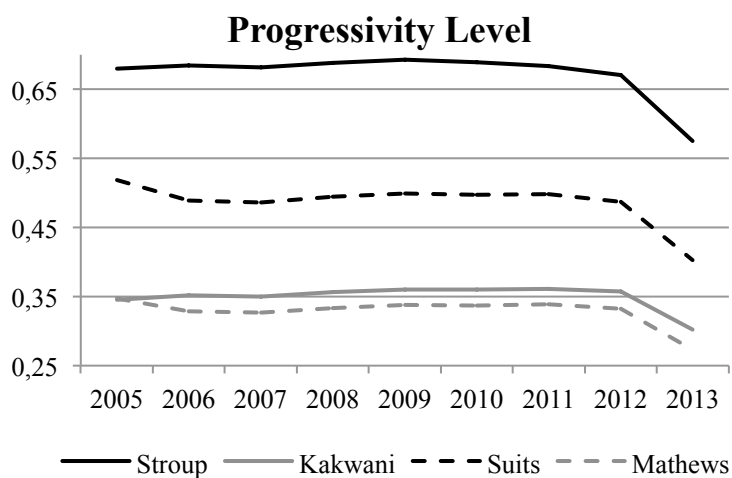
Graph 4 shows the evolution of the PIT revenues compared with the Stroup index evolution. As we can see, the increase in revenues that occurred in 2013 happened at the expense of a

decrease in progressivity, meaning that the top income households were proportionally less affected by the increase in tax rates.



Graph 4 - Stroup indices and collected PIT evolution over the years. Source: Author’s calculations using AT data

Graph 5 shows the Stroup, Kakwani, Suits and Mathews indices. Although the indices indicate different levels of progressivity, their variations over years are very similar.



Graph 5 - Comparison between Stroup, Kakwani, Mathews and Suits indices. Source: author’s calculations using AT data

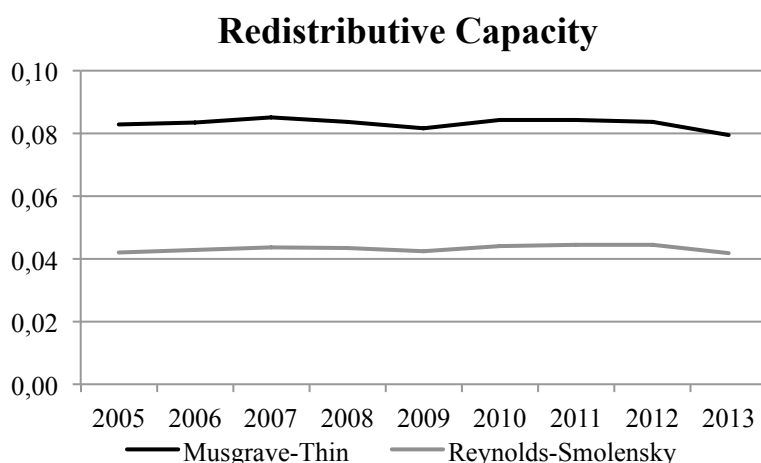
Table 7 shows that from 2005 to 2006, Kakwani and Stroup increase while Mathews and Suits decrease, although it must be noted that the variations are relatively small.

As is clear from Tables 2 and 3, the biggest changes in statutory tax scheme from 2012 to 2013 were a decrease in the number of brackets, as well as a decrease in the lower boundary of highest bracket, and an overall increase in both the average and marginal rates. A change in tax deductions may have taken part in this fall in progressivity but the available AT data does not discriminate them by income brackets, making it impossible to assess its potential effect.

Year	Progressivity Level				Redistributive Capacity	
	Stroup	Kakwani	Suits	Mathews	Musgrave-Thin	Reynolds-Smolensky
2005	0,680	0,346	0,518	0,347	0,083	0,042
2006	0,685	0,351	0,489	0,329	0,084	0,043
2007	0,682	0,350	0,486	0,327	0,085	0,044
2008	0,689	0,357	0,494	0,334	0,084	0,043
2009	0,693	0,361	0,500	0,338	0,082	0,042
2010	0,690	0,360	0,498	0,337	0,084	0,044
2011	0,683	0,361	0,498	0,339	0,084	0,045
2012	0,671	0,357	0,487	0,332	0,084	0,045
2013	0,575	0,302	0,403	0,273	0,079	0,042

Table 7 – Progressivity indices by year. Source: Author’s calculations using AT data

To assess the evolution of the tax system’s redistributive capacity, the Musgrave & Thin and Reynolds & Smolensky indices, available in Graph 6, must be analyzed. These indices have a similar evolution during the period, although Musgrave & Thin shows higher values, around 0,08, while Reynolds & Smolensky shows values around 0,04, suggesting that the changes in the progressivity have not affected the PIT’s ability to alter income distribution.

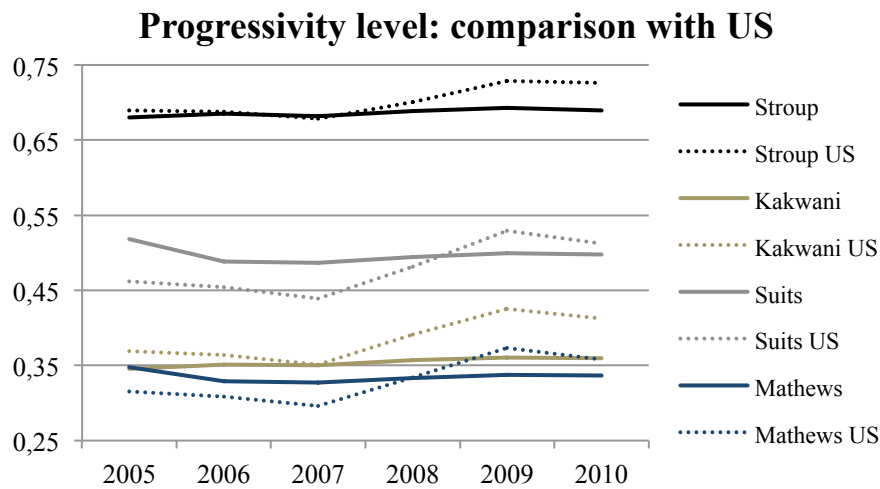


Graph 6 – comparison between Musgrave & Thin and Reynolds & Smolensky indices. Source: Author’s calculations using AT data

Graphs 7 and 8 show the comparison with Mathews (2013)’ values for the U.S., for 2005 through 2010. During this period, the Portuguese and the U.S. PIT systems had similar levels of progressivity, the U.S. appearing a little lower from 2005 to 2008 and a little higher from 2008 to 2010.

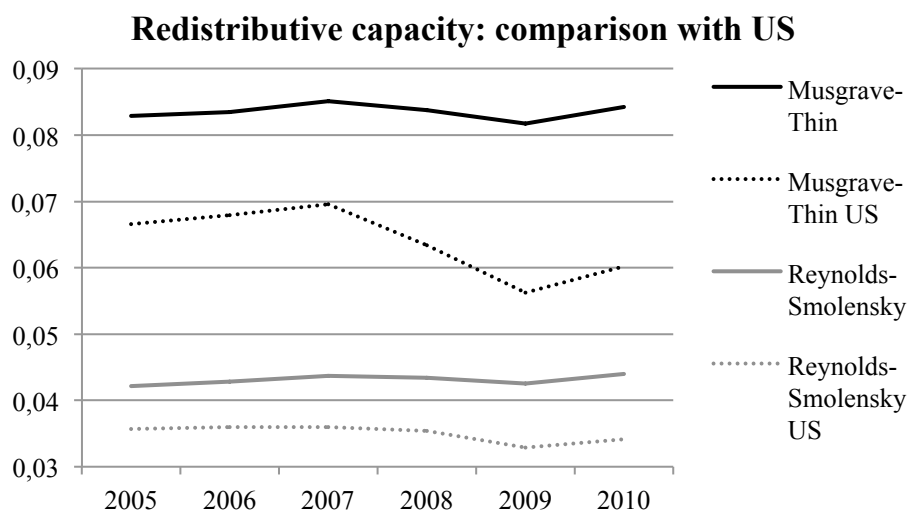
The four U.S. indices follow the same pattern during this time period, decreasing from 2005 to 2007, increasing from 2007 to 2009 and then decreasing again from 2009 to 2010. It is apparent that the differences in values from index to index also happens in the U.S., with Stroup having the higher values, followed by Suits, and with Kakwani and Mathews having the lowest values. It remains to compare both indices in the most recent years, namely in

order to access whether or not the US has also faced a huge increase in inequality in the last few years.



Graph 7 - comparison between the progressivity level indices for Portugal and the progressivity level indices for the US. Sources: Mathews (2013), author's calculations using AT data

Graph 8 shows that the redistributive capacity of the Portuguese PIT is higher than in the U.S. This is in concordance with the findings by Caselli, Centeno, Novo and Tavares (2016), although the authors used disposable income in their calculations instead of net-of-tax income.



Graph 8 - comparison between the redistributive capacity indices for Portugal and the redistributive capacity indices for the US. Sources: Mathews (2013), author's calculations using AT data

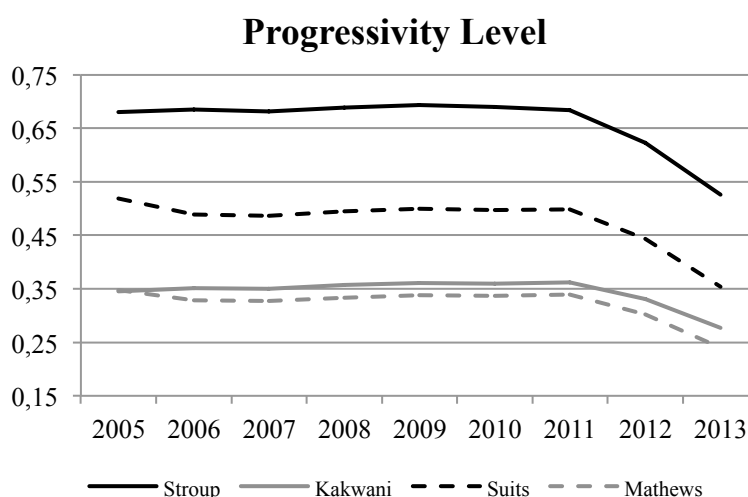
5.2 The impact of the income tax surcharge

This extraordinary surcharge that affected PIT revenues from 2012 and 2013 has a single marginal rate that doesn't vary with income level. This may have an impact on the progressivity level and is thus important to be considered in the calculations. We computed

the indices including the surcharge as a percentage of gross income for these two years. Since, for comparability purposes, AT data does not include the surcharge revenues, we computed an estimate, charging 3,5% on the amount of income above €6 790, for all households. The indices including this estimate are summarized in Graph 9 and Table 8.

Graph 9 shows that in 2012 including the surcharge decreases all four indices in both years, making the decrease from 2012 to 2013 seen in section 5.1 even more accentuated.

As to the distributive capacity, the Musgrave & Thin index increases to 0,095 in 2012 and to 0,091 in 2013 (see Table8), corresponding to an increase of 13% in both years comparing with the index values before the surcharge, while the Reynolds & Smolensky increases to 0,05 in 2012 and to 0,048 in 2013, corresponding to an increase of 13% in 2012 and 14% in 2013. This means that the PIT causes more income redistribution after the inclusion of the surcharge. This happens because in both years the after-tax Gini index has decreased with the inclusion of the surcharge, decreasing from 0,423 to 0,4175 in 2012 and from 0,432 to 0,4264 in 2013. Moreover, as Mathews (2015) refers, these indices are affected by the dimension of the system: “A tax that is relatively small (...) will not be able to substantially alter the distribution of income, regardless of how the burden of the tax is spread over different segments of the population” (ibid: 15). Provided that the tax burden is progressive before and after the tax size increase, then it will result in a larger income redistribution directly from the PIT.



Graph 9 – Stroup, Kakwani, Suits and Mathews indices considering the extraordinary surcharge in 2012 and 2013. Source: author’s calculations using AT data

Year	Progressivity Level				Redistributive Capacity		Gini Indices	
	Stroup	Kakwani	Suits	Mathews	Musgrave-Thin	R.-Smolensky	Pre-tax	After-tax
2012	0,623	0,331	0,443	0,302	0,095	0,050	0,468	0,418
surcharge effect	-7%	-7%	-9%	-9%	13%	13%	0%	-1%
2013	0,526	0,277	0,354	0,240	0,091	0,048	0,474	0,426
surcharge effect	-8%	-8%	-12%	-12%	14%	14%	0%	-1%

Table 8 – Progressivity and Gini indices considering the extraordinary surcharge in 2012 and 2013 and their variations from the pre-surcharge indices. Source: author’s calculations using AT data

6. Effective tax rates

We now discuss the evolution of the effective PIT rates (that is, the average effective rates paid by each bracket, obtained by dividing the tax collected by the total gross income of households in each bracket (cf. Piketty and Saez, 2007 and *Notas Prévias*)), we can see in Table 9 the pattern of different brackets’ average effective rates for 2005 through 2013.

Table 9 shows that 2009 was the year with the lowest overall effective rates and 2013 was the year with the highest overall rates. In 2009 the average taxes collected were rather linear from the 40th to the 90th percentile on (as one can see in Graphs 11 and 12 below). In this year, the average tax rate increases smoothly with income from less than 1% in the first quintile to around 18% at the 94th percentile of the income distribution (Graph 11). In the top percentiles, the effective tax rate increases to 26,4% in the 99th percentile and then to 35,5% at the very top. From 2009 to 2013, although taxes collected from the top income brackets have increased, a proportionally bigger increase has occurred for those with low and intermediate incomes.

We can compare these rates with the statutory ones in Section 2, allowing us to grasp the impact of deductions and tax credits across the income distribution.

From 2009 to 2010 we observe a generalized increase in effective tax rates for all income brackets, although the variations are small, provided that the changes in the tax system were not substantial. From Table 9, we can observe that in 2011, the increase in taxation becomes more marked, and even more in 2012. Yet, it is in 2013 that we see the deepest change in the tax system, because marginal statutory taxes experience a strong increase and because the number of brackets of taxable income is reduced, from 8 to 5.

In 2013, the increase in the lower incomes’ average effective rates becomes even larger in percentage terms than before, with even some middle income intervals facing a higher percentage point increase in effective taxation than the upper levels. Real GDP growth faced a huge decrease in 2012 (decreasing also in 2009, 2011 and 2013), contributing to reduce the households’ taxable income and placed some households in a lower bracket (which would

have caused an increase in average effective rates for this bracket), making it harder to make a comparison between “neighbor” brackets. Nevertheless, effective rates in the last few years show an increase in both tax levels and in the burden that is attributed to the lower incomes, reflecting the strong increase in statutory taxation that has occurred.

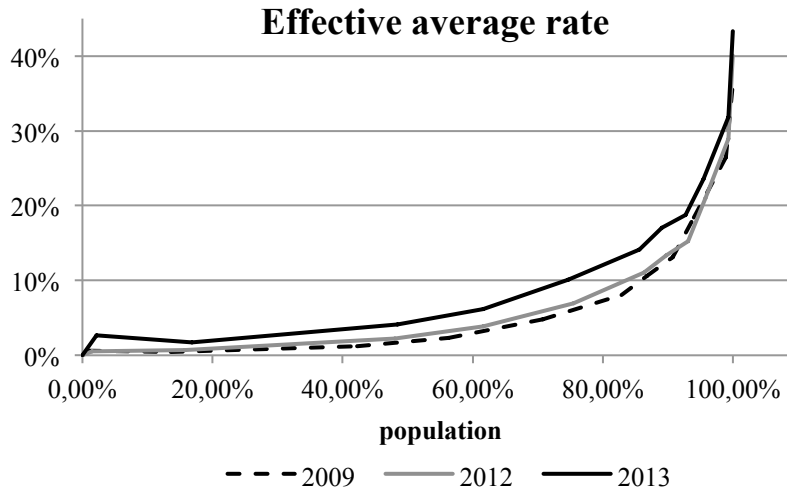
Gross income brackets (€)	2005	2006	2007	2008	2009	2010	2011	2012	2013
Full Population	10,3%	10,2%	10,3%	9,9%	9,6%	9,9%	9,9%	10,1%	12,9%
1 – [1, 5 000[	0,5%	0,5%	0,6%	0,5%	0,6%	0,6%	0,6%	0,6%	2,6%
2 – [5 000, 10 000[	0,8%	0,7%	0,7%	0,5%	0,4%	0,4%	0,5%	0,7%	1,7%
3 – [10 000, 13 500[	1,7%	1,5%	1,5%	1,4%	1,2%	1,3%	1,4%	2,2%	4,1%
4 – [13 500, 19 000[	3,1%	2,8%	2,8%	2,5%	2,3%	2,4%	2,6%	3,9%	6,2%
5 – [19 000, 27 500[	6,4%	6,0%	5,7%	5,1%	4,8%	5,0%	5,3%	6,9%	10,1%
6 – [27 500, 32 500[	9,9%	9,5%	9,2%	8,5%	8,0%	8,3%	8,9%	11,1%	14,2%
7 – [32 500, 40 000[	12,4%	11,8%	11,7%	11,1%	10,7%	10,9%	11,9%	13,3%	17,1%
8 – [40 000, 50 000[	14,7%	14,4%	14,2%	13,6%	13,1%	13,5%	14,1%	15,3%	18,8%
9 – [50 000, 100 000[	19,8%	19,4%	19,3%	18,9%	18,4%	18,9%	19,7%	21,0%	23,6%
10 – [100 000, 250 000[	27,3%	27,2%	27,2%	26,7%	26,4%	27,2%	28,0%	28,9%	31,9%
11 – [250 000, +∞[	35,4%	36,4%	36,7%	36,1%	35,5%	37,7%	38,8%	40,0%	43,3%

Table 9 – Mverage effective rates from 2005 to 2013. Source: Author’s calculations using AT data

It is clear from Table 7 that the Portuguese PIT system is generally progressive (although in the years 2009, 2010, 2011 and 2013, the average effective rates decrease from the first bracket to the second) and that its average effective rates have increased from 2009 to 2013. We can attribute this progressivity in the average effective rates to the increase in statutory tax rates along the income scale, combined with deductions and credits, which benefit lower incomes more.

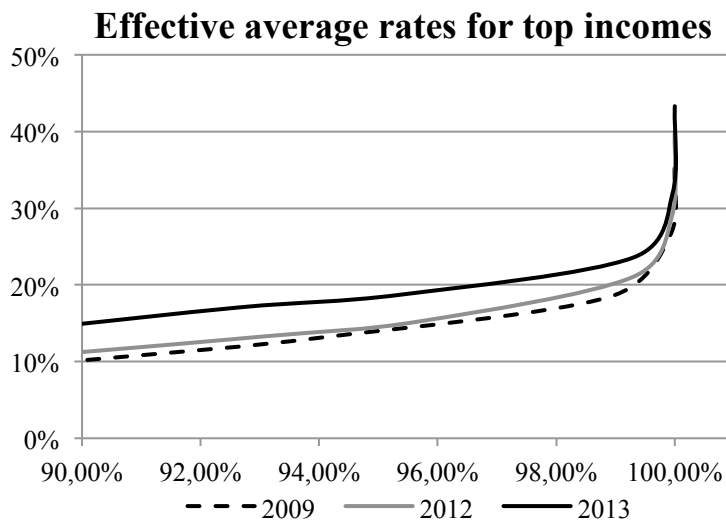
Graphs 10 and 11 reproduce the graphical analysis in Piketty and Saez (2007) and compares the effective rates in 2009, 2012 and 2013, which correspond to the years of major changes in effective rates.

In 2012, we observe higher average effective rates on all brackets except the first two, and relatively higher rates from the 5th percentile on, becoming even steeper from the 9th bracket to the top. In the very end of the income scale, however, the effective rates become more progressive in 2012, increasing to 28,9% at the 99th percentile and to 40% at the 99,9th percentile. This increase in progressivity in the very end of the income scale illustrates the reason why Piketty and Saez (2007) place such an importance on decomposing the top of the income distribution into very small groups, in order to assess the progressivity on the top incomes of a tax system. They do so because the richest households represent a considerable share of the income earned and an even greater share of the tax burden.



Graph 10 – Effective PIT rates for the years of 2009, 2012 and 2013. Source: Author’s calculations using AT data

In 2013, we observe a very uneven increase in the effective rates. Firstly, contrary to what had happened in all the previous years, the lowest income bracket, earning between €1 and €5 000 and corresponding to percentile 2, bears a significantly large effective rate than those earning between €5 000 and €10 000 (percentile 17). Then, between percentile 17 and percentile 95, the increase in the effective rates is sharper than it was in 2012, slowing down between the 89th and the 93th percentiles and above the 95th as well.



Graph 11 – Effective PIT rates for the years of 2009, 2012 and 2013, with a closer look on the top 10% of the population. Source: Author’s calculations using AT data

The graphical analysis is coherent with the previously computed progressivity indices, in the sense that 2009, which is the year where the lower brackets face the smallest average effective rates, increasing moderately until the 90th percentile and then sharply, is also the year with the

highest progressivity indices, while 2013, where the lower brackets face the highest tax rates and there is even a fragment where the effective rates decline, is the year with the lowest progressivity indices.

7. Conclusion and Policy Implications

This Work Project analyzed PIT progressivity between 2005 to 2013, computing the Stroup, Kakwani, Suits and Mathews indices, measuring progressivity level, and the Musgrave & Thin and Reynolds & Smolensky, measuring redistributive capacity.

We find that the progressivity level has had very modest variations from 2005 to 2012, whilst the variation from 2012 to 2013 was the largest in the timespan considered, mostly due to a reduction in the number of tax brackets and a diminution in the upper boundary of the highest bracket – thus making the PIT system proportional and not progressive for incomes above €80 000 per year. Similarly, the redistributive capacity also had small variations in the period we analyzed, while decreasing slowly from 2007 to 2013. When taking into account the extraordinary surcharge that affected the years of 2012 and 2013 and was a proportional tax, this effect deepens. This means that the PIT has decreased its capacity of altering the distribution of income.

Analyzing the effective tax rates in the top percentiles in the income scale, we find that these rates have increased over the period 2010-2013, suggesting that an analysis of effective tax rates in the top income percentiles is insufficient to assess progressivity in the whole tax scheme, provided that although upper income individuals now face a higher tax burden, this increase in taxation was insufficient to “equalize” the increase faced by low and middle income individuals.

Concerning policy implications, it is important to stress that using progressivity indices to measure changes in progressivity can bring a better insight to this debate because it is the best way of really assessing what is going on.

Moreover, given the findings in this study, it is important to take into account that decreasing the number of tax brackets and the income of the last tax bracket decreases progressivity, and that including a proportional part on the tax, as what happened with the extraordinary surcharges in 2012 and 2013, decreases progressivity, unless the threshold for its application is placed at a sufficiently high value. Lastly, progressivity may decrease even when higher-income households are facing higher tax rates, as this work proves for Portugal when analyzing the period 2009-2013.

8. Limitations and Further Research

Due to only having eight years of PIT data, there were not enough observations to make a robust statistical analysis of the effect of changes in the tax scheme in progressivity. Moreover, working with aggregated data forced us to make assumptions about the distribution of income and tax liability within the income brackets which we would not have to make if we had had access to AT's micro data. We also do not know how the households' compositions vary across the income scale, which affects for example how much surcharge each household pays. It will be important for further research that the AT discloses micro PIT data to researchers, or publishing in their website all the aggregated data series they have been building since 1990.

For comparability purposes, AT did not include the extraordinary surcharge for the years of 2011 (which was collected in 2012) and 2013. These values were computed as a percentage of gross income, excluding the households with monthly incomes under the minimum wage, who were exempt from paying the tax. However, without having access to the actual values of the surcharge revenues, we cannot compute entirely accurate progressivity indices.

In this analysis, we did not include payroll taxes, which are a fixed percentage of income that comes from wages, and are thus proportional rather than progressive. This, in a similar fashion to what happened when we included the extraordinary surcharge in the indices computations, will alter progressivity, tending to diminish it because the top income households have access to other sources of revenue other than wages, such as revenues from capital and business. It is important to include this in a further research. Only focusing on PIT data draws another backlash on the study, provided that we are limiting our analysis to a flow variable (income), neglecting the role of stock variables on defining inequality. "Without taking estate and wealth taxation into account, it would not be apparent that tax progressivity has increased somewhat in a country like France between 1970 and 2005, while declining enormously in the United Kingdom and in the United States" (Piketty and Saez, 2007: 22).

Lastly, even after including in our analysis all the remaining taxes in the Portuguese tax system, it will be interesting to perform an analysis of how this tax revenue is utilized, as it can promote redistribution through government transfers or be used to provide public services, for example, whose impact will not be measured by progressivity indices nor by the disposable income, but which will help reduce inequality nevertheless.

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