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The individual Laffer curve: evidence from the Spanish income tax

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Abstract

This paper characterises the Laffer curve of each individual taxpayer in a schedular multi-rate income tax with income shifting. Analytical expressions for the revenue-maximising tax rate and the revenue-maximising elasticity are provided for the individual taxpayer and the aggregate population, as well as new estimates of the Elasticity of Taxable Income. Applying these to the Spanish income tax demonstrates that 44.72% (58.49%) of the taxpaying population in the non-savings tax base (savings tax base) is on the "normal" side of the Laffer curve. On average, these taxpayers are 6.59 points (24.73 points) above (below) the maximum of the Laffer curve. The fraction of total tax revenue lost through behavioural responses amounts to 53.77%. However, this fraction varies by population subgroup and decreases when we account for income-shifting responses, suggesting the presence of fiscal externalities in the Spanish PIT.

Keywords Personal income tax · Laffer curve · Tax revenue · Elasticity of Taxable Income

JEL Classification H24 · H21 · H26 · H31

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1 Introduction

The severe impact of COVID-19 on the economy has raised public deficits to unprecedented levels. Although the worldwide ratio of public debt to GDP has stabilised since 2021, public debt in the coming years is expected to remain persistently higher than projected before the pandemic through 2026 (IMF 2022). As an illustration, the ratio of government debt to GDP in the euro area is expected to reach 89% over the next 5 years, and higher in countries such as Italy (145%), Spain (110%) and the USA (129%). With public debt at a record-high level, countries prioritise lowering public debt by strengthening their tax capacity. To this end, governments are forced to implement essential tax reforms to raise additional revenue in the least-distorting ways in the short term. In this context, the study of the revenue capacity of tax systems is of primary concern.

A rigorous tool often used to monitor revenue maximisation is the Laffer curve, whose origins date back to the 1970s, prompted by Arthur Laffer. The inverted U-form of the Laffer curve reflects the potential inverse relationship between tax rates and revenue. On the ascending side of the curve—the "normal" side—any increase in the statutory marginal tax rate raises tax revenue. Conversely, only tax cuts can increase revenue in the descending segment—the "prohibitive" side. Thus, the peak of the Laffer curve identifies the revenue-maximising tax rate (Laffer tax rate), which represents a threshold above which any additional increase in tax rates produces a decrease in revenue. Since the 1970s, much research has been done on the Laffer curve, mainly from a macroeconomic perspective. However, the literature has moved recently towards a more microeconomic-oriented analysis. In addition, more attention has also been given to modelling the complexities of current income tax structures. This tendency towards micro-oriented analysis and more detailed modelling of the tax design is due to the firm recognition that each taxpayer faces his own Laffer curve.

Consequently, identifying the side on which each taxpayer falls within its own Laffer curve, separately and individually, becomes the critical issue. Only after this first query is answered will it be possible to refer to the Laffer curve of an economy or a country, which will be interpreted as the algebraic sum of all the taxpayers' individual Laffer curves. This analytical approach, more robust in characterising the Laffer curve than fitting a "general" macroeconomic tax function, is gaining advocates. For instance, several studies have made analytical efforts to introduce the complexities of modern Personal Income Tax (PIT) designs into modelling the Laffer curve. These efforts have benefited from the increased availability of tax microdata and the development of a sufficient statistic, the Elasticity of Taxable Income (ETI), which, under some assumptions, captures all behavioural responses to taxation in a single elasticity measure (Saez et al. 2012; Creedy 2022). Using this analytical approach, Creedy and Gemmell (2013, 2015) have complemented the existing literature by extending the expression of the revenue-maximising elasticity (Laffer elasticity) to multi-rate income taxes. These authors have also revived the notion of the revenue-maximising elasticity, proposed initially by Fullerton (1982). Similar to the revenue-maximising tax rate, it represents the maximum value the ETI should take to assure revenue neu-

trality given a tax rate change.[1] For Spain, the studies by Sanz-Sanz (2016a, 2016b, 2022) constitute solid modelling for the analysis of the Laffer curve. Taking the Spanish income tax as a yardstick, Sanz-Sanz (2016a) extends the analysis of the Laffer curve into a more complex tax setting with a multi-rate income tax schedule and non-standard allowances.

Furthermore, Sanz-Sanz (2016b) extends the analysis to capture the impact of PIT rate changes on consumption tax revenue, highlighting that ignoring such an impact may overestimate the magnitude of the actual revenue-maximising tax rates. More recently, Sanz-Sanz (2022) further shows how consumption taxes, social security contributions and administrative and compliance costs may affect the actual shape of the Laffer curve. Sanz-Sanz (2022) demonstrates that in Spain, neglecting the influence of marginal personal income tax rates on the collection of other taxes and costs leads to an overestimation of the "normal" zone of the Laffer curve and the potential revenue-raising capacity of the tax system. Specifically, according to Sanz-Sanz (2022), when accounting for all these additional revenue effects, the actual revenue-maximising tax rates in the Spanish PIT decrease significantly from 62.50 to 28.20%.

While the structural factors—linked to the design of the tax—have been examined in detail, only a few studies (e.g., Creedy 2015; Creedy and Gemmell 2013, 2014, 2015) have analysed the implications of behavioural responses to taxation on the Laffer curve. In this paper, we explore some behavioural factors, such as income shifting and taxpayers' circumstances, which can affect the profile of the Laffer curve and taxpayers' location on it. Using microdata from the Spanish Institute for Fiscal Studies, we calculate the total revenue impact of the 2012 tax reform, the revenue-maximising tax rate and the revenue-maximising elasticity of each taxpayer and its location on the Laffer curve. This reform entailed the most intense and widespread change in tax rates since the inception of personal income taxation in Spain, which occurred in 1978.

The total revenue impact of a tax rate change is composed of two opposing effects: mechanical and behavioural. While the former captures the tax revenue change without behavioural responses, the latter quantifies the revenue variation produced by behavioural changes. We derive analytical expressions for the revenue-maximising tax rate and the revenue-maximising elasticity in a schedular multi-rate income tax with income shifting. The analysis is performed for the individual taxpayer and the aggregate population. We find that the ETI estimates are between 0.313 and 0.693 in the general base and 0.708 and 0.823 in the savings base. These estimates are especially high for women, single and separate tax filers in the general base, and for women, married and separate tax filers in the savings base. The ETI estimates significantly affect the efficiency and revenue implications for tax policy. Applying these estimates to the Spanish income tax in 2011 reveals that 44.72% and 58.49% of the taxpaying population in the non-savings tax base and the savings tax base, respectively, were

[1] Specifically, Fullerton proposes drawing a "modified Laffer curve" that delimits the combination of rates and elasticities that ensure revenue maximisation instead of relating marginal rates and revenue. Therefore, the Fullerton curve identifies the boundary value of the elasticity separating the Laffer curve's "normal" and "prohibitive" zones. Elasticities to the southeast of the Fullerton curve signify the "normal" zone of the Laffer curve, while the points to the northwest identify the combinations of rates and elasticities falling into the "prohibitive" zone of the Laffer curve.

situated on the "normal" side of the Laffer curve. On average, taxpayers in the non-savings base exceeded the Laffer curve's maximum by 6.59 points, whereas those in the savings base fell short by 24.73 points. This result suggests that the marginal tax rate increase in 2012 resulted in revenue loss for half of the taxpaying population. Considering only the mechanical effect, the expected revenue of the reform is 5.208 billion euros. However, when considering the behavioural effect, the effective gain in revenue from the reform is reduced by half to 2.408 billion euros. That is, the fraction of tax revenue lost through behavioural responses is 53.77% of the mechanical (i.e., ignoring behavioural responses) projected increase in tax revenue. However, this fraction varies by population subgroup and decreases when we account for income-shifting responses, suggesting the presence of fiscal externalities in the Spanish PIT.

Accounting for structural and behavioural factors, such as income shifting and taxpayers' circumstances, substantially modifies the shape of the Laffer curve and the magnitude of the revenue-maximising tax rates and the revenue-maximising elasticities. Thus, omitting these factors in identifying the Laffer curve can misrepresent the "normal" side of the Laffer curve, as well as the potential revenue power of the tax system.

In terms of policy implications, it is vital to account for behavioural responses when determining the tax rate that maximises tax revenue—the Laffer tax rate. These responses can significantly alter the calculation of tax revenues expected by authorities when tax rates are increased. Moreover, it is essential to recognise that these behavioural responses vary across the population, with some tax bases showing greater sensitivity to tax rate adjustments than others.

The structure of this paper is as follows. Section 2 derives the analytical expressions needed to characterise the Laffer curve. Then, calculations are performed for the individual taxpayer and the aggregate population. Section 3 provides an overview of the institutional context, while Sect. 4 details the microdata used in the empirical application. Following this, Sect. 5 presents the estimations of the ETI, and Sect. 6 conducts a simulation exercise. Finally, Sect. 7 presents the results, and Sect. 8 concludes.

2 Empirical model

This section derives analytical expressions for the revenue-maximising tax rates and revenue-maximising elasticities in the context of schedular multi-rate income taxes with income shifting. Analytical expressions are computed for the individual taxpayer and the aggregate population.

2.1 Characterisation of the individual Laffer curve[2]

Given a schedular income tax with B tax bases, where each tax base is taxed according to a stepwise tax schedule characterised by a set of income thresholds

[2] The following model is an extension of Sanz-Sanz (2016a) to income shifting. For a complete derivation of the model, see Sanz-Sanz (2016a).

$\Lambda^b = (a_1^b, \ldots, a_k^b)$ and marginal tax rates $\zeta^b = (\tau_1^b, \ldots, \tau_k^b)$, the tax bill of an individual taxpayer i, with taxable income, y_i^b, who is entitled to "non-genuine" allowances of magnitude m_i^b, will be given by

$$R_i = \sum_{b=1}^{B} T_i^b - \sum_{b=1}^{B} \theta_i^b \tag{1}$$

where T_i^b represents the tax due resulting from applying the tax schedule to taxable income, y_i^b, while θ_i^b denotes the tax savings obtained from applying the tax schedule separately to the entitled allowances,[3] m_i^b. Following Creedy and Gemmell (2006), we express T_i^b and θ_i^b as follows:

$$T_i^b = \tau_k^b \cdot \left[\left(y_i^b - s \cdot y_i^b\right) - \hat{a}_k^b\right] \tag{2}$$

$$\theta_i^b = \min\left\{\tau_k^b \cdot \left(m_i^b - \hat{a}_k^b\right), T_i^b\right\} \tag{3}$$

where τ_k^b indicates the marginal tax rate of the taxpayer while $\widehat{a}_k^b$ denotes the corresponding effective thresholds[4] defined by $\hat{a}_k^b = \frac{1}{\tau_k^b} \cdot \sum_{j=1}^{k} a_j^b \cdot \left(\tau_j^b - \tau_{j-1}^b\right)$. Whenever taxable incomes are subject to different marginal tax rates, the taxpayer is incentivised to move a fraction $s > 0$ of high-marginal-rate bases to low-marginal-rate bases. Equation (2) illustrates this income-shifting possibility.

Using Eq. (1) and assuming that allowances are exogenous to marginal tax rate changes $\left(\partial m_i^b / \partial \tau_h^b = 0\right)$ and that there are no cross-base elasticities, a tax rate modification in $\tau_h^b \mid \tau_h^b \in \zeta^b$ will induce a change in the tax bill of the individual taxpayer, R_i, as follows:

$$\frac{\mathrm{d}R_i}{\mathrm{d}\tau_h^b} = \left(\frac{\partial T_i^b}{\partial \tau_h^b} - \frac{\partial \theta_i^b}{\partial \tau_h^b}\right) + \left(\frac{\partial T_i^b}{\partial y_i^b} \cdot \frac{\partial y_i^b}{\partial \tau_h^b}\right) \tag{4}$$

The first term in brackets on the right-hand side of Eq. (4) represents the individual mechanical effect (ME). This effect captures the tax revenue change produced by modifying the marginal tax rate without behavioural responses. The second term in brackets on the right-hand side of Eq. (4) represents the behavioural effect (BE)

[3] Modern tax systems implement family and personal allowances in different formats: tax deductions ("genuine" allowances) or tax credits ("non-genuine" allowances). It is important to mention this distinction because the way these allowances are modelled has implications for tax revenue and subsequently for the Laffer curve. For instance, under "genuine" allowances, Eq. (3) would not exist.

[4] Note that the marginal tax rate of the taxpayer and the effective threshold associated with taxable income in Eq. (2) do not have to coincide with those associated with allowances in Eq. (3) because the taxable income and the allowances do not need to fall into the same tax bracket.

associated with taxable income. It quantifies the revenue variation due to taxpayers' behavioural responses.

The stepwise schedule influences the explicit form of Eq. (4). ME and BE will ultimately depend on whether the changed marginal tax rate τ_h^b is equal to, less or greater than the taxpayer's relevant marginal tax rate τ_k^b. Both effects (ME and BE) will be determined by the relative position of the changed marginal tax rate to the taxpayer's marginal tax rate. To be specific,

$$\frac{\partial T_i^b}{\partial \tau_h^b} = \begin{cases} \left(a_{h+1}^b - a_h^b\right) & \text{if } \tau_h^b < \tau_k^b \\ \left(\left(y_i^b - s \cdot y_i^b\right) - a_k^b\right) & \text{if } \tau_h^b = \tau_k^b \\ 0 & \text{if } \tau_h^b > \tau_k^b \end{cases} \tag{5}$$

$$\frac{\partial \theta_i^b}{\partial \tau_h^b} = \begin{cases} \left(a_{h+1}^b - a_h^b\right) & \text{if } \tau_h^b \tau_k^b \\ \left(m_i^b - a_k^b\right) & \text{if } \tau_h^b = \tau_k^b \\ 0 & \text{if } \tau_h^b \tau_k^b \end{cases} \tag{6}$$

Both (ME and BE) move in opposite directions and together allow the calculation of the actual revenue impact of a tax rate change and the characterisation of the Laffer curve, see Fig. 1. The Laffer curve's increasing side is characterised by ME > BE, while the decreasing segment is characterised by ME < BE. At the maximum, ME = BE, the revenue-maximising tax rates and revenue-maximising elasticities are obtained. Based on this, we can empirically characterise the Laffer curve faced by any individual taxpayer and identify his exact location and, therefore, calculate the marginal tax rates and ETIs that maximise the tax bill of each taxpayer.

In most countries, the income tax has a stepwise schedule. In addition, it is usual for tax reforms to entail simultaneous changes in more than one tax rate. However, most of the existing literature on the Laffer curve ignores this by implicitly assuming a flat income tax structure, i.e., a tax with a single marginal tax rate. This assumption has critical consequences for the profile of the Laffer curve and the magnitude of the revenue-maximising tax rates and the revenue-maximising elasticities. Therefore, in

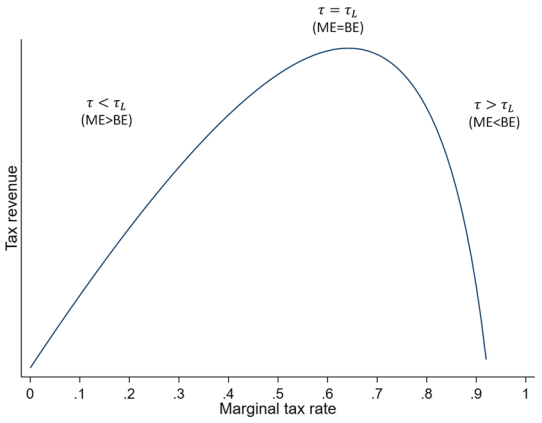

Fig. 1 Laffer curve

what follows, we will consider a simultaneous change in all marginal tax rates of a stepwise income tax schedule. We compute the individual Laffer rates and the individual Laffer elasticities using Eq. (4) and taking into consideration the fact that at the maximum of the Laffer curve, the condition $\mathrm{d}R_i/\mathrm{d}\tau_h^b = 0$ is met. From $\mathrm{d}R_i/\mathrm{d}\tau_h^b = 0$, we obtain the following expressions for the individual Laffer rates and the individual Laffer elasticities:

$$\tau_i^{b*} = \frac{1}{1 + \left(\frac{e_k^b \cdot y_i^b \cdot (1-s)}{\mathrm{ME}_i^b}\right)} \tag{7}$$

$$e_i^{b*} = \left(\frac{1-\tau_k^b}{\tau_k^b}\right) \cdot \frac{ME_i^b}{y_i^b \cdot (1-s)} \tag{8}$$

where ME_i^b captures the *within* and *outside* MEs associated with taxable income and allowances.[5] Note that τ_i^{b*} depends on structural parameters as well as on the behavioural parameter ETI, while e_i^{b*} depends solely on structural parameters linked to the design of the tax (Creedy and Gemmell 2013).

2.2 Characterisation of the aggregate Laffer curve

In what follows, we examine the impact of a modification in $\tau_h^b \mid \tau_h^b \in \zeta^b$ on aggregate tax revenue. In aggregate, Eq. (4) becomes

$$\frac{\mathrm{d}R_h}{\mathrm{d}\tau_h^b} = \left(\sum_{i=1}^{N_h^b} \frac{\partial T_i^b}{\partial \tau_h^b} - \sum_{i=1}^{M_h^b} \frac{\partial \theta_i^b}{\partial \tau_h^b}\right) + \sum_{i=1}^{N_h^b} \left(\frac{\partial T_i^b}{\partial y_i^b} \cdot \frac{\partial y_i^b}{\partial \tau_h^b}\right) \tag{9}$$

As mentioned above, a change in τ_h^b will induce a *within* ME and BE for taxpayers located in h (where the tax rate is changed) and an *outside* ME for taxpayers above h. Taking this into account, Eq. (9) becomes

$$\frac{\mathrm{d}R_h}{\mathrm{d}\tau_h^b} = \left[\left(\sum_{i=1}^{N_h^b} \frac{\partial T_i^b}{\partial \tau_h^b} + \sum_{l=1_h^+}^{N_h^{b+}} \frac{\partial T_l^b}{\partial \tau_h^b}\right) - \left(\sum_{i=1}^{M_h^b} \frac{\partial \theta_i^b}{\partial \tau_h^b} + \sum_{l=1_h^+}^{M_h^{b+}} \frac{\partial \theta_l^b}{\partial \tau_h^b}\right)\right] + \left[\sum_{i=1}^{N_h^b} \left(\frac{\partial T_i^b}{\partial y_i^b} \cdot \frac{\partial y_i^b}{\partial \tau_h^b}\right)\right]$$

[5] Note that a modification of τ_h^b will have an ME and BE on taxpayers falling into the bracket of the modified tax rate h, and an additional revenue effect on taxpayers who are located above h, known as *outside* ME. There is no *outside* BE: the BE is confined to the bracket of the modified tax rate, as we assume that taxable income is only responsive to changes in marginal tax rates and not to changes in average tax rates.

Using Eqs. (2) and (3) yields

$$\begin{aligned}\frac{\mathrm{d}R_h}{\mathrm{d}\tau_h^b} = &\left[\left(\left(\left(\overline{y}_h^b - s\cdot\overline{y}_h^b\right) - a_h^b\right)\cdot N_h^b + \left(a_{h+1}^b - a_h^b\right)\cdot N_h^{b^+}\right)\right. \\ &\left. - \left(\left(\overline{m}_h^b - a_h^b\right)\cdot M_h^b + \left(a_{h+1}^b - a_h^b\right)\cdot M_h^{b^+}\right)\right] \\ &- \left[\left(\frac{\tau_h^b}{1-\tau_h^b}\right)\cdot\overline{e}_h^b\cdot\overline{y}_h^b\cdot(1-s)\cdot N_h^b\right] \end{aligned} \tag{10}$$

where $\overline{e}_h^b$ denotes the average ETI in h (weighted by income), and $\overline{y}_h^b$ and $\overline{m}_h^b$ are the arithmetic mean of taxable incomes and effective allowances falling in h. Finally, N_h^b indicates the number of taxpayers whose taxable income falls within h and $N_h^{b^+}$ the number of taxpayers with taxable income above a_{h+1}^b. Likewise, M_h^b and $M_h^{b^+}$ denote the same population concepts but refer to the value of the effective allowances. The first term in brackets on the right-hand side of Eq. (10) represents the aggregate ME associated with taxable income and allowances. The second term in brackets indicates the aggregate BE related to taxable income.

Using Eq. (10) and condition $\mathrm{d}R_h/\mathrm{d}\tau_h^b = 0$, we obtain the following expressions for the aggregate Laffer tax rate and the aggregate Laffer elasticity:

$$\tau_h^{b^*} = \frac{1}{1+\left(\frac{\overline{e}_h^b\cdot\overline{y}_h^b\cdot(1-s)\cdot N_h^b}{\mathrm{ME}_h^b}\right)} \tag{11}$$

$$e_h^{b^*} = \left(\frac{1-\tau_h^b}{\tau_h^b}\right)\cdot\frac{\mathrm{ME}_h^b}{\overline{y}_h^b\cdot(1-s)\cdot N_h^b} \tag{12}$$

3 Institutional context

3.1 The Spanish PIT

In the years covered by this paper, the Spanish PIT operates as a dual tax, with savings income (the savings tax base) taxed separately from other sources of income (the general tax base). The general tax base encompasses earnings from labour, profits of individual entrepreneurs and income from movable capital (including proceeds from intellectual and industrial property, technical services, leasing of movable assets, businesses or mines, subleasing and licencing of image rights), as well as income from real estate leasing, capital gains (excluding those from asset transfers) and imputed income. Conversely, the tax base for savings comprises income from movable capital such as dividends, interest, proceeds from insurance and capital gains arising from

Table 1 Spanish PIT schedule

Tax bracket	Tax rate	Tax bracket	Tax rate	Tax bracket	Tax rate	Tax bracket	Tax rate
Panel A: General tax base							
2007–2010		2011		2012–2014		2015–2016	
0	0.24	0	0.24	0	0.25	0	0.19
17,707	0.28	17,707	0.28	17,707	0.30	12,450	0.24
33,007	0.37	33,007	0.37	33,007	0.40	20,200	0.30
53,407	0.43	53,407	0.43	53,407	0.47	35,200	0.37
		120,000	0.44	120,000	0.49	60,000	0.45
		175,000	0.45	175,000	0.51		
				300,000	0.52		
Panel B: Savings tax base							
2007–2009		2010–2011		2012–2014		2015–2016	
0	0.18	0	0.19	0	0.21	0	0.19
		6,000	0.21	6,000	0.25	6,000	0.21
				24,000	0.27	50,000	0.23

transfers of tangible and financial assets. Both tax bases are subject to progressive rate schedules, see Table 1.

Taxable income is the key variable in this study. It is defined as gross income after substructing the deductions for income-related expenses, and specific and itemised deductions such as contributions to Pension Plans. Taxable income embodies the concept of income subject to taxation, serving as the basis for the application of the tax schedule. It is worth mentioning that during our period of study, the definition of the main components of taxable incomes did not change.

Moreover, in the Spanish PIT joint filing is allowed for married couples and for cohabiting unmarried couples or single taxpayers with underage children or disabled dependent individuals. However, during the period under analysis, the tax unit in the Spanish PIT is the individual. Therefore, we consider the individual as the unit of analysis. Finally, it is noteworthy that a peculiar anomaly exists within the tax regarding the application of personal and family allowances. Diverging from practices observed in other tax systems, the Spanish PIT categorises personal and family allowances as amounts that do not effectively reduce the taxpayer's taxable income. Instead, these allowances, misleadingly termed, function as tax credits determined by separately applying the tax schedule to the total allowances to which the taxpayer is entitled (Sanz-Sanz 2016a). We incorporate this anomaly into the model as outlined in Sect. 2.

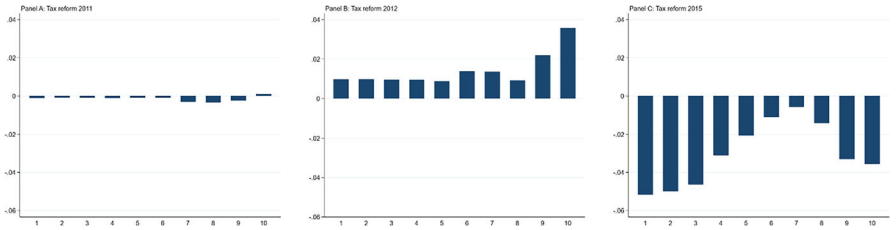

Fig. 2 Difference in marginal tax rates by gross income deciles

3.2 Tax reforms

The Spanish PIT schedule has been subject to several changes over the 2007–2016 period. The core reforms of the tax that provide us with useful identifying variation to estimate the ETI were the tax changes implemented in 2011, 2012 and 2015. These changes are summarised in Table 1. The *2011 Reform* introduced two additional brackets at the top of the general base (44% for taxable income between €120,000 and €175,000, and 45% for taxable income above €175,000), and one additional bracket at the top of the savings base (21% for taxable income above €6,000). The *2012 Reform* increased the marginal tax rates for all brackets and introduced one additional bracket at the top of both tax bases, leaving the tax schedule for the general taxable income with seven brackets and savings taxable income with three brackets. The *2015 Reform* was a year of reforms in the PIT. For our analysis, we exploit two significant changes: the reduction of all income tax rates and income thresholds in both tax bases. It is important to note that marginal tax rates and income thresholds remain constant within each period.

Figure 2 illustrates the impact of each reform on actual marginal tax rates across income deciles. In contrast to the 2011 reform, both the 2012 and 2015 reforms substantially modified the marginal tax rates for individuals across the income distribution. However, while the 2012 reform increased the marginal tax rates for taxpayers, especially those with higher incomes, the 2015 reform reduced the marginal tax rates for taxpayers, particularly those with lower incomes.[6]

4 Data

The computation of the individual revenue-maximising tax rates and elasticities requires complete knowledge of the taxpayers' empirical distributions and tax bases in the PIT structure. This implies that it is necessary to have detailed tax microdata to quantify the analytical expressions presented in Sect. 2. To estimate the ETI, we use a balanced panel dataset for 2007–2016, collected and prepared by the Spanish Institute

[6] To demonstrate the applicability of the model, we relied on the 2012 reform. However, it is important to note that any of the tax reforms outlined in this section could have been used. We chose the 2012 reform because we aimed to illustrate the impact of a *tax increase* on revenue collection. Among the three reforms covered in the study period, the 2012 reform exhibits the highest increase in marginal tax rates compared to the 2011 reform, as evidenced in Table 1 and Fig. 2.

for Fiscal Studies. The sample is stratified by income level (10 categories), region (15 autonomous communities and the cities of Ceuta and Melilla) and income source (2 categories: labour main income source or not). As a result, the final number of strata was 300 ($10 \times 15 \times 2$). The sample size was calculated with a standard error below 1%. Each tax return is associated with a sampling weight. The use of these weights makes the annual value of the variables very representative of those declared in the taxpaying population [see Onrubia et al. (2011) for more detail].

The database consists of 1,729,522 observations over the period (on average, 288,000 per year), with detailed information about the tax unit reported income and socio-economic characteristics. All monetary variables are valued in real 2012 euros. We restrict the estimation sample as follows. First, we exclude individuals under 16 and above 65 years old to consider working-age taxpayers and non-pensioners.[7] Second, we only include taxpayers with a positive taxable income from 2007 to 2016 as the outcome variable is defined as the change in log taxable income, see Eq. (13). Third, we restrict the sample to taxpayers with base-year gross income above €6,390.13 (the Public Income Indicator of Multiple Effects) to correct for potential mean reversion and heterogeneous income trends. Table 10 in the Appendix reports robustness tests to check that our results are not affected by these sample selection decisions.

Table 2 reports summary statistics for the final sample used in the regression analysis for each tax base, covering the period 2007–2016. The real average gross income in the general tax base is €33,640, and the real average taxable income is €27,270 (in the general base) and €2,850 (in the savings base). Taxable income in both tax bases is quite dispersed and considerably small, on average, in the case of savings. The change in the log real taxable income is between -15.20 and 16.06 (in the general base) and between -17.06 and 17.65 (in the savings base). Although the average change in the log net-of-tax rate is close to zero in both tax bases, there is also substantial heterogeneity on both sides of the distribution. Finally, the average age of taxpayers is similar in both tax bases (around 45 years old), 66–68% of taxpayers are married, 61–63% of taxpayers are male, and 20–22% of taxpayers report their tax returns jointly.

5 The ETI in Spain

5.1 Estimations of the ETI

The advantage of working with microdata is that most of the parameters needed to calculate the revenue-maximising tax rates and the revenue-maximising elasticities are relatively straightforward to measure, except for the ETI. This behavioural elasticity captures all individuals' responses to taxation—income shifting being one of them .

[7] We perform robustness checks on our sample selection decision. Eliminating any age restrictions at the upper end (excluding only individuals under 16), we find that our ETI estimate for the savings tax base increases from 0.823 to 1.386. Moreover, excluding individuals under 16 and above 85 yields an elasticity of 1.180, while excluding those under 16 and above 75 results in an elasticity of 0.692. All estimates are significant at 1%. Although the significance remains consistent, the magnitude of the elasticity slightly amplifies with the broadening of the sample. These robustness checks are available from the authors upon request.

Table 2 Summary statistics

	Mean	SD	Min	Max	Obs
Panel A: General tax base					
Gross income (in 2012 euros)	33,640	41,512	6,390	> 10 M	1,132,819
Taxable income (in 2012 euros)	27,270	38,715	0.01	> 10 M	1,132,819
Change in log taxable income	− 0.03	0.55	− 15.20	16.06	1,132,819
Change in log net-of-tax rate	0.00	0.06	− 0.46	0.52	1,132,819
Age (in years)	44.83	9.07	16.00	65.00	1,132,819
Married (dummy)	0.66	0.47	0	1	1,132,819
Male (dummy)	0.63	0.48	0	1	1,132,819
Joint filing (dummy)	0.22	0.41	0	1	1,132,819
Panel B: Savings tax base					
Taxable income (in 2012 euros)	2850	70,878	0.01	> 10 M	596,703
Change in log taxable income	− 0.12	2.27	− 17.06	17.65	596,703
Change in log net-of-tax rate	0.00	0.03	− 0.10	0.10	596,703
Age (in years)	45.85	9.03	16.00	65.00	596,703
Married (dummy)	0.68	0.46	0	1	596,703
Male (dummy)	0.61	0.49	0	1	596,703
Joint filing (dummy)	0.20	0.40	0	1	596,703

Table reports summary statistics for observations included in the panel dataset covering the period 2007–2016, used in the estimation of the ETI, e.g., Tables 3, 4 and 5. Statistics are calculated taking into account sampling weights, except for the total number of observations

The empirical model used to estimate the ETI is the usual one in the literature (see, for example, Weber 2014 and Saez et al. 2012), which can be expressed as

$$\Delta \log y_{i,t}^{b} = \beta_0 + \beta_1 \Delta \log\left(1 - \tau_{k_{i,t}}^{b}\right) + \beta_2 f\left(y_{i,t}^{b}\right) + \beta_3 X'_{it} + u_{it} \qquad (13)$$

where Δ represents the difference in the variable between the year $t + j$ and the benchmark year t, β_1 is the ETI, $f\left(y_{i,t}^{b}\right)$ is a benchmark year income control, X'_{it} is a vector of demographic controls and u_{it} is the error term.

The literature has identified two main problems regarding the estimation of the ETI. First, the endogeneity of the marginal tax rate, which biases any estimation of Eq. (13) by ordinary least squares (OLS). Therefore, the conventional estimation procedure estimates Eq. (13) by the Instrumental Variables (IV) method with an instrument for the marginal tax rate. To construct this instrument, we index with inflation the benchmark year income and allocate the marginal tax rate corresponding to the period $t + j$. It is as if income did not change from year t to year $t + j$, apart from inflation. The second econometric problem in estimating the ETI is the presence of mean reversion and heterogeneous income trends. They occur when taxpayers' income fluctuates for reasons unrelated to tax changes and converges to its mean value. These fluctuations

in income can be confused with responses to taxation. To face this problem, previous studies (Auten and Carroll 1999; Gruber and Saez 2002) proposed the use of a base-year income control $f\left(y_{i,t}^{b}\right)$. However, more recently, there has been a growing concern about the complete exogeneity of the instrument and the income control, as income shocks can be serially correlated. To address this, we follow Weber's (2014) proposal and use different lags of taxable income in constructing the instrument and the income control.[8]

To estimate the ETI, we use the core changes in the income tax schedule implemented during 2007–2016, see Table 1. It is important to note that since 2009 regional governments have had legislative power over some elements defining the PIT; therefore, the tax rate we work with is a combination of the tax rates set by central and regional governments. Table 3 provides empirical estimates of the ETI for 2007–2016. We estimate Eq. (13) by OLS and by 2SLS (Two-Stage Least Squares) using the methods of Gruber and Saez (2002) and Weber (2014) for different specifications. All specifications include regional and year-fixed effects to capture the changes in reported income not caused by changes in the tax rate. In all regressions, we use 2-year differences ($j = 2$). Panel A includes additional controls for marital status, tax filing status, age, age squared, gender and indicators for taxpayers' main income source (wages, self-employment and savings). All estimates are weighted by a population-weighting factor (except in panel B). Column 1 reports the ETI estimates using OLS. The estimates are negative, large and statistically significant at the 1% level, especially in the savings base. This result confirms the effect of the endogeneity bias. Column 2 shows the results obtained using the method of Gruber and Saez (2002) with no lags in the instrument or the income control; the estimated ETI is 0.693 in the general base and 0.708 in the savings base. Column 3 repeats column 2, but adds a more flexible income control, a five-piece spline of base-year income. The estimated ETI is 0.689 in the general base and 0.823 in the savings base, both statistically significant at the 1% level. Columns 4 and 5 report the ETI estimated using the method of Weber (2014) with further lags in the instrument and the income control: using a five-piece cubic spline of the lagged value of the dependent variable as income control yields an ETI of 0.313 in column 4. Adding a base-year income control increases the ETI to 0.546 in column 5. First-stage tests (partial R^2 and F-statistic) indicate that the instruments are not weak. Our best estimates are in columns 3 and 5 for the savings and the general base, respectively. Table 10 in the Appendix reports robustness checks for these preferred estimates.

Table 3 indicates that the estimates of the ETI of the Spanish PIT in 2007–2016 are between 0.313 and 0.693 in the general base and between 0.708 and 0.823 in the savings base. These are in line with previous studies for Spain (see, Almunia and López-Rodríguez 2019; Arrazola et al. 2019). Estimates higher in the savings base than in the general base suggest that savings income (i.e., income from financial capital)

[8] It is important to note that inequality and inflation were stable in Spain during 2007–2016. Based on the World Inequality Database for Spain, we see no significant changes in the pre-tax income earned by taxpayers in the top 1%, the top 10%, the middle 40% and the bottom 50% of the population. Therefore, heterogeneous income trends are not a first-order issue in our study.

Table 3 Elasticity of Taxable Income, all population

	OLS	Gruber and Saez		Weber	
	(1)	(2)	(3)	(4)	(5)
Panel A: General tax base					
$\Delta(1-t)$	− 4.424***	0.693***	0.689***	0.313***	0.546***
	(0.014)	(0.045)	(0.045)	(0.068)	(0.103)
N	1,132,819	1,132,819	1,132,819	1,132,819	1,132,819
Panel B: Savings tax base					
$\Delta(1-t)$	− 40.692***	0.708**	0.823***		
	(0.324)	(0.280)	(0.288)		
N	596,703	596,703	596,703		
Partial R^2					
General		0.0603	0.0603	0.0228	0.0140
Savings		0.294	0.293		
F on excluded instruments					
General		39,776	39,780	16,349	5,838
Savings		76,031	76,004		

Table reports the ETI estimates for the period 2007–2016 for the general base (panel A) and the savings base (panel B). Column 1 reports the OLS estimates of Eq. (13). Columns 2 and 3 report the 2SLS estimates applying the method of Gruber and Saez (2002) with no lags in the instrument. Column 2 includes a control for base-year income. Column 3 adds a five-piece spline of base-year income. Columns 4 and 5 report the results of applying the estimation method proposed by Weber (2014), where the instrument relies on further lags of taxable income. Column 4 includes a five-piece cubic spline of the lagged value of the dependent variable. Column 5 adds a base-year income control. All specifications include regional- and year-fixed effects. Panel A includes additional controls for marital status, tax filing status, age, age squared, gender and indicators for taxpayers' main source of income (wages, self-employment and savings). In all regressions, we use two-year differences. Observations in all regressions are weighted by population (except in panel B). Standard errors clustered by the taxpayer are in parentheses. ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$

is more sensitive to taxation than non-savings income (i.e., labour income, business income and non-financial capital).

5.2 Robustness checks

In the spirit of Kopczuk (2005) and Lefebvre et al. (2022), to analyse the sensitivity of our estimates to income control specifications, Table 4 presents estimates of the ETI using the full sample for each tax base and various income controls. The first specification excludes income controls and leads to elasticities of high magnitude in both tax bases. The following two specifications are as in Gruber and Saez (2002). In the case of the general base, introducing the lagged value of the dependent variable as an income control has a substantial impact, it reduces the estimated elasticity by half from 1.296 to 0.537. However, controlling for the current income has relatively little impact on the estimated elasticity. Allowing for nonlinearities the elasticity is unchanged around 0.999–1.007 for splines of base-year income and around 0.519–0.532 for splines of the

Table 4 Robustness checks: Income controls

		$\frac{\partial \log y^g}{\partial \log(1-\tau^g)}$	$\frac{\partial \log y^s}{\partial \log(1-\tau^s)}$
		(1)	(2)
1	No income controls	1.296***	15.745***
		(0.041)	(0.368)
2	Base-year income	1.009***	0.708**
		(0.045)	(0.280)
3	Lagged value of the dependent variable	0.537***	14.982***
		(0.035)	(0.354)
4	(Linear) Splines of (2)	1.007***	5.699***
		(0.045)	(0.289)
5	(Nonlinear) Splines of (2)	0.999***	5.861***
		(0.044)	(0.290)
6	(Linear) Splines of (3)	0.532***	14.541***
		(0.035)	(0.356)
7	(Nonlinear) Splines of (3)	0.519***	14.670***
		(0.035)	(0.356)
8	(2) and (6)	0.234***	0.012
		(0.041)	(0.261)
9	(2) and (7)	0.225***	− 0.003
		(0.040)	(0.262)
10	(3) and (6)	0.532***	14.541***
		(0.035)	(0.356)
11	(3) and (7)	0.519***	14.670***
		(0.035)	(0.356)

Table reports the estimated ETI using Eq. (13) with various income controls on our preferred estimates. Column (1) is for the general base and column (2) is for the savings base. Splines refer to 5-piece splines. Row 2 of the savings base refers to the logarithm of the base-year income. Standard errors clustered by the taxpayer are in parentheses. ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$

lagged value of the dependent variable. Therefore, neither of the two income controls is sensitive to the inclusion of nonlinearities. The last four specifications allow for different combinations of the base-year income and the lagged value of the dependent variable with the splines. These combinations highlight the importance of using lags in income controls. Combining the base-year income with a lagged specification reduces the estimated elasticity from 1.009 to 0.234 and 0.225, whereas combining the lagged value of the dependent variable with a lagged specification has no effect, from 0.537 to 0.532 and 0.519.

The savings tax base reports a high sensitivity to each specification in Table 4. This can be explained by two features that make this base a special case. First, the less variation in the marginal tax rates. For example, in some years this tax base has only

one tax bracket, see Table 1. Second, there is a high concentration of taxpayers in the first bracket. For example, in 2011, the proportion of taxpayers in the first bracket was 84.48%, and in the second, 15.52%. Therefore, when estimating the elasticity for the savings tax base, the explanatory variable has less variance than in the general tax base and, consequently, we have less precise estimates. In addition, the change in the log real taxable income is more dispersed in the savings tax base than in the general tax base, see Table 2. For these reasons, the magnitude of the standard errors in Table 3 (panel B) is larger than those in Table 3 (panel A). The same occurs in Tables 4 and 5. Given these considerations, the estimated elasticities in this base should be interpreted with caution.

5.3 Heterogeneity of behavioural responses

In addition to the average estimates of the ETI displayed in Table 3, in this subsection, we examine heterogeneous responses across six groups of taxpayers. The ETI literature emphasises the necessity of providing estimates on the heterogeneity of taxpayers' responses. The ETI is not a fixed parameter and can vary across the population, as some taxpayers have a higher ability to respond to taxation than others. Previous studies (Almunia and López-Rodríguez 2019; Arrazola et al. 2019; Sanz-Sanz et al. 2015) have demonstrated that in the Spanish PIT, factors other than income influence individuals' tax liability, such as their personal circumstances.

Table 5 shows the sensitivity of the ETI to six groups of taxpayers. We use the method of Weber (2014) for the general base, and for the savings base, we use the method of Gruber and Saez (2002). In terms of gender, women exhibit greater responsiveness to changes in marginal tax rates compared to men. This finding is evident in the general base, but not in the savings base; therefore, caution should be exercised in interpreting this result. Women being more sensitive to taxes than men is a recurring finding in the literature (Pillay 2020; Bosch et al. 2020; Paetzold 2019), attributed to the fact that women are more likely to be second or part-time earners, which gives them greater flexibility in the choice of working hours and income decisions. Married couples tend to exhibit greater responsiveness to taxation than their counterparts, given that they likely report higher earnings (not only from labour) and, therefore, have more room for strategic behaviour.[9] This hypothesis is supported in the savings base, where married couples have a higher ETI than single taxpayers, but not in the general base. However, the finding of unmarried taxpayers being more responsive than married couples in the general base has been previously documented for Spain by Gamarra Rondinel et al. (2022), Díaz-Caro and Onrubia (2018) and Arrazola et al. (2014). Finally, Table 5 shows that joint filers are less responsive than separate tax filers. Consistent with previous studies for Spain (Sanz-Sanz et al. 2015), this result aligns with the lower income variation among those who file their tax return jointly.

[9] Around 27% of men are located in the upper tail of the income distribution (quintiles 4th and 5th), whereas only 19% of women are located in these quintiles. This is also the case for married couples (26%) and separate tax filers (24%) compared to single taxpayers (20%) and joint tax filers (22%). Less income-constrained taxpayers may have greater opportunities to adjust their taxable income.

Table 5 Elasticity of Taxable Income, by population group

	Men	Women	Married	Single	Separate tax filers	Joint tax filers
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: General tax base						
$\Delta(1-t)$	0.539***	0.773***	0.459***	0.757***	0.952***	0.571***
	(0.092)	(0.053)	(0.078)	(0.056)	(0.033)	(0.164)
N	747,123	385,696	780,865	351,954	878,253	254,566
Panel B: Savings tax base						
$\Delta(1-t)$	0.759**	0.848*	1.313***	0.753	1.312***	0.176
	(0.347)	(0.480)	(0.329)	(0.949)	(0.317)	(0.692)
N	388,871	207,832	425,228	171,475	471,602	125,101
Partial R^2						
General	0.021	0.146	0.023	0.132	0.126	0.023
Savings	0.288	0.304	0.289	0.200	0.305	0.249
F on excluded instruments						
General	8,027	14,644	11,340	29,458	70,115	2,623
Savings	53,122	22,672	56,642	5,647	64,605	12,452

Table reports the estimated ETI for men (column 1), women (column 2), married taxpayers (column 3), single taxpayers (column 4), separate tax filers (column 5) and joint tax filers (column 6). Single taxpayers include unmarried, widowed and divorced taxpayers. Panel A reports the ETI estimates using the method of Weber (2014), with lags in the instrument and a five-piece cubic spline of the lagged value of the dependent variable. Panel B reports the estimates using the method of Gruber and Saez (2002), with no lags in the instrument, a control for log base-year income and a five-piece cubic spline of base-year income. All specifications include regional and year-fixed effects as well as controls for marital status, tax filing status, age, age squared, gender and indicators for taxpayers' main source of income (wages self-employment and savings). In all regressions, we use two-year differences. Observations in all regressions are weighted by population (except in Panel B). Standard errors clustered by the taxpayer are in parentheses. $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$

This is attributed to the fact that these taxpayers primarily represent households with a single breadwinner, where income fluctuations tend to be less pronounced[10,11].

5.4 Sources of income shifting

The Spanish PIT is a dual-income tax with two tax bases, the general base and the savings base, as described in Sect. 3. Both bases are taxed according to a stepwise schedule with increasing marginal rates, where $\tau_k(\text{savings}) < \tau_k(\text{general})$, see Table 1.

[10] The non-significant elasticities for single and joint filers can be explained because these groups are less represented in the savings base, 68.39% of taxpayers in this base are married and only 20.12% file jointly, see Table 2. Also, the distribution of these groups among brackets is concentrated in the first bracket. For instance, in 2011, 84.60% and 87.05% of joint filers and single taxpayers were in the first bracket.

[11] We also estimated the ETI by income quartiles, the elasticity is 0.593 for the first quartile, 2.875 for the second, 2.147 for the third and 1.256 for the fourth. The ETI is higher for middle and high-income earners. All estimates are significant at 1%.

The difference in marginal tax rates between both tax bases gives incentives to taxpayers to shift a fraction s of their income from the general base to the savings base to benefit from the lower tax rate. Previous studies for Spain have examined the dual nature of the PIT. López-Laborda et al. (2018) studied how the dual nature of the Spanish PIT causes income shifting from the general tax base to the savings tax base. This study finds the existence of income shifting from the general base to different forms of savings, especially from movable assets into capital gains. The groups responsible of this income shifting are the highest-income earners and the self-employed. Also, Sanz-Sanz et al. (2015) and Díaz-Caro and Onrubia (2018) exploit the modification of the definition of tax bases in 2007. Until 2006, the savings tax base included only long-term capital gains (assets held for more than 1 year). The 2007 tax reform incorporated capital gains of any type and any form of income derived from financial savings, into the savings tax base. Sanz-Sanz et al. (2015) estimate an elasticity of gross income between 0.55 and 0.68, and Díaz-Caro and Onrubia (2018) estimate an ETI between 0.41 and 0.43. These elasticities suggest the existence of important efficiency costs probably due to income-shifting responses.

There is a range of possibilities to shift income from the general base to the savings base. Here, we provide three examples. Firstly, when employees receive payment in the form of company shares, within a specified threshold, this non-monetary compensation is exempt from PIT, and any future returns from these shares will be treated as savings income for taxation purposes. Secondly, sole entrepreneurs have the option to finance investments using external resources instead of their own capital. By doing so, they can deduct the financial costs incurred, thereby reducing their overall taxable income. Subsequently, they can then invest their own funds in savings income, which is subject to lower tax rates. Lastly, individuals opting to invest in financial assets, as opposed to tangible ones, benefit from lower tax rates on their savings income, as determined by a tax schedule designed with reduced rates.

Following Harju and Matikka (2016) and Lefebvre et al. (2022), income shifting is an increasing function of the difference between the general and the savings tax rates, i.e., $(\tau^g - \tau^s)$. This relationship is depicted in Fig. 3, illustrating the magnitude of savings taxable income concerning this variance among individuals experiencing no difference ($(\tau^g - \tau^s) = 0$), a positive difference ($(\tau^g - \tau^s) > 0$) and a negative

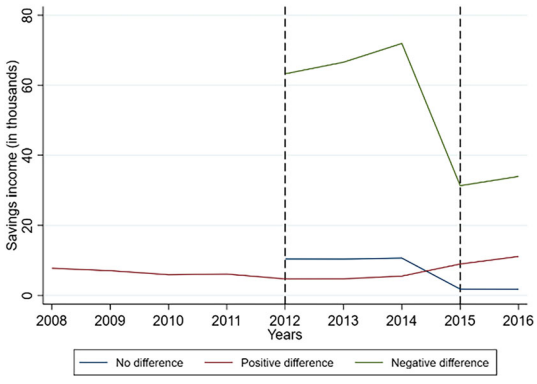

Fig. 3 Income-shifting incentives. *Note*: The estimation sample of this figure is restricted to individuals with positive income in both tax bases during the whole period, eliminates the extreme values in terms of annual variation of savings income and keeps individuals with significant savings income

difference in tax rates ($(\tau^g - \tau^s) < 0$). Before 2012, the data consistently demonstrate positive outcomes, indicating a lack of change in the magnitude of the savings tax base despite the implementation of higher tax rates following the 2012 reform. However, when comparing savings taxable income before and after the 2015 tax reform, we observe a consistent evolution in line with the predictions of income-shifting models. Savings taxable income increased among those facing a positive difference and decreased among those facing a negative difference. In line with López-Laborda et al. (2018), we find that the taxpayers who modify their savings income the most when facing a negative difference are the self-employed. Figure 3 is descriptive evidence—no causality can be claimed from this—that taxpayers responded to the 2015 tax reform according to changes in tax incentives.

Table 11 in Appendix B provides evidence of income-shifting responses. Column (1) shows the estimate for the savings income *cross* elasticity with respect to the general income net-of-tax rate and column (2) shows the estimate for the *direct* elasticity of savings income with respect to their own net-of-tax rate. The estimates are obtained using Eq. (1) in Appendix B and by 2SLS using the same specification for savings in Table 2 (column 3) *à* la Gruber and Saez (2002), with no lags in the instrument and the income control. Estimations are robust to the absence of nonlinearities. The cross elasticity of savings income is − 0.802. The sign of this elasticity is in line with the predictions from income-shifting models (see Lefebvre et al. 2022; Harju and Matikka 2016). A decrease in the savings marginal tax rate, which implies an increase in the net-of-tax rate on savings income, induces taxpayers to shift their income from the general base to the savings base. This, in turn, increases savings income and decreases general income. Thereby, our finding of a negative cross elasticity of savings income is consistent with the existence of significant income-shifting responses following a tax modification.

6 A simulation

The Laffer effect is essentially an individual matter, i.e., each taxpayer has its own curve. Therefore, in any tax year, there will be as many Laffer curves as taxpayers in that year (e.g., in the 2017 Spanish PIT would be about 14,460,354 individual Laffer curves). We hence carry out an illustrative exercise applying Eqs. (7) and (8) to a *virtual* (average) taxpayer. This exercise is sufficient to illustrate how the study of the Laffer curve from a microeconomic perspective has significant consequences for analysing the revenue capacity of a tax system, as previous studies have pointed out (Sanz-Sanz 2016a, b, 2022). We simulate a slight change in the tax rate in the general base ($d\tau^g = 0.01$) and in the savings base ($d\tau^s = 0.005$). We report our calculations using the 2011 Spanish tax schedule (see Table 1) and the estimated ETIs in Table 3, columns 3 and 5 for the savings and the general base, respectively. We also assume taxpayers shift a fraction ($s = 0, 0.1, 0.2, 0.3$) of their non-savings income towards the savings tax base.

Figures 4 and 5 illustrate the individual Laffer and Fullerton curves derived from the simulations run on a linear schedule (panels A and C) and a stepwise schedule (panels B and D) for 2011. This simulation exercise illustrates how the tax structure

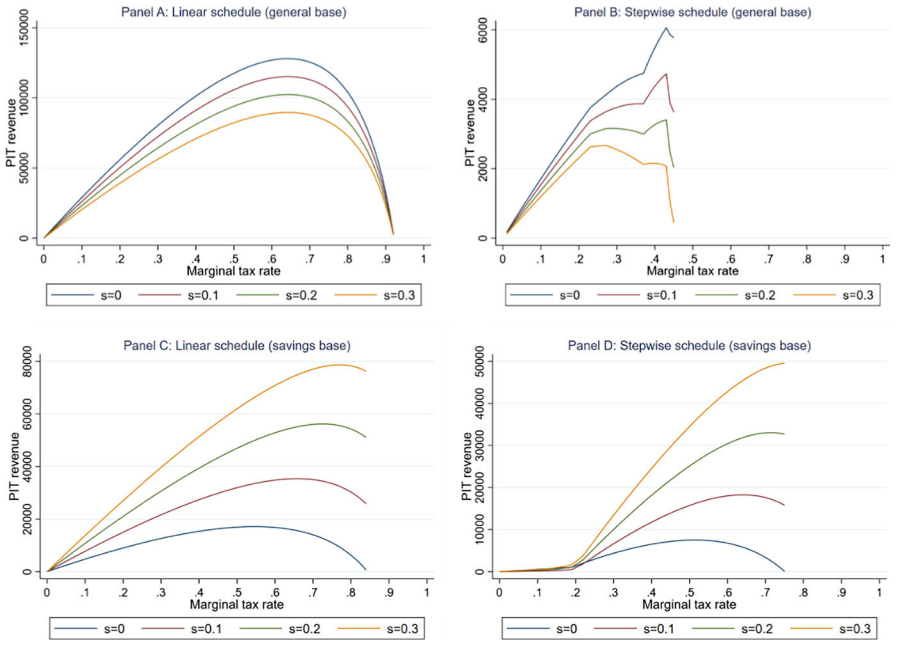

Fig. 4 Laffer curves, linear schedule versus stepwise schedule. *Note:* Laffer curves in Panel D close to the origin raise tax revenue but in small quantities, i.e., PIT revenue > 0

and the presence of income shifting affect the magnitude of the revenue-maximising tax rate and the revenue-maximising elasticity and, consequently, the profile of the Laffer and Fullerton curves. These figures show that stepwise schedules significantly limit the collection capacity of a tax rate increase. For instance, in the absence of income shifting ($s = 0$), Laffer curves under a stepwise schedule are narrower than under a linear schedule. As a result, the revenue-maximising tax rates in a stepwise schedule are lower than in a linear schedule: 0.430 versus 0.640 (general base) and 0.515 versus 0.545 (savings base), see Table 6 (columns 1–4). Figures 4 and 5 also show that the smoothness of the curves in the linear schedule disappears in the stepwise schedule. The kinks detected in Panels B and D along the curves represent the discrete jump of marginal tax rates at bracket cut-offs. The introduction of income-shifting responses also modifies the form of the Laffer curve. Independently of the type of tax schedule, income shifting reduces the PIT revenue obtained in the general base, while it increases the PIT revenue obtained in the savings base. Underlying this result is the notion of fiscal externalities; we will return to this in Sect. 7.

7 Results

Using the analytical expressions derived in Eqs. (7) and (8), this section evaluates the impact on revenue of a change in taxes, provides estimates of the individual revenue-maximising tax rates and elasticities, and locates the position of each taxpayer on the Laffer curve. We use a sample of 2,036,186 tax returns representing a population of

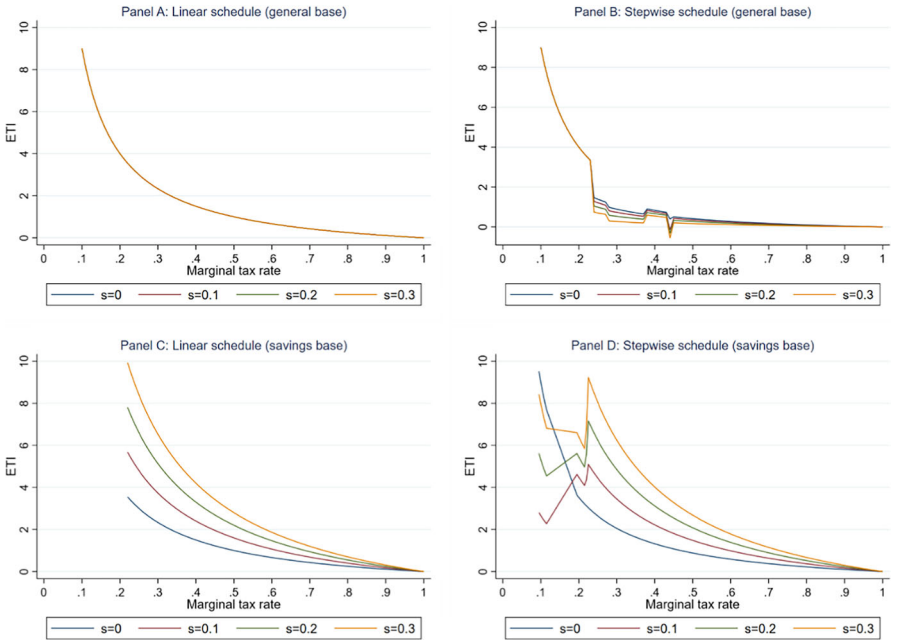

Fig. 5 Fullerton curves, linear schedule vs stepwise schedule. *Note:* Laffer curves in Panel A are the same with and without income shifting, as income shifting does not affect revenue-maximising elasticities in a linear tax schedule, i.e., $e_i^{g*} = 1 - \tau_k^g / \tau_k^g$

Table 6 PIT: Linear vs stepwise

Income shifting	Revenue-maximising tax rates				Revenue-maximising elasticities			
	Linear schedule		Stepwise schedule		Linear schedule		Stepwise schedule	
	General	Savings	General	Savings	General	Savings	General	Savings
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$s = 0$	0.640	0.545	0.430	0.515	0.563	0.835	0.736	0.829
$s = 0.10$	0.640	0.660	0.430	0.640	0.563	0.824	0.670	0.833
$s = 0.20$	0.640	0.725	0.430	0.715	0.563	0.834	0.588	0.829
$s = 0.30$	0.640	0.770	0.270	0.765	0.563	0.836	0.632	0.823

19,467,623 tax returns for 2011. All monetary variables are adjusted for inflation. For the ETI, we use the estimates in Table 3, columns 3 and 5 for the savings and the general base, respectively. We assume these ETIs take a uniform value across brackets but not across tax bases. All the calculations report the situation in the pre-reform year 2011.

7.1 Evaluation of the impact on revenue of the 2012 tax reform

Table 7 shows the net impact on revenue of the reform disaggregated into its two components: mechanical and behavioural.[12] Column (1) reports the absolute revenue gain (in euros) derived from each tax bracket, column (2) reports the percentage of revenue gain as a proportion of the revenue gain in the whole population, and column (3) reports the fraction of tax revenue lost through behavioural responses. Considering only the mechanical effect (ME), the expected revenue of the reform is 5.208 billion euros (4.330 billion from the general base and 877 million from the savings base)[13,14]. However, when considering the behavioural effect (BE), the effective gain in revenue from the reform is reduced by half to 2.408 billion euros (1.754 billion from the general base and 653 million from the savings base). That is, the fraction of tax revenue lost through behavioural responses is 53.77% of the mechanical (i.e., ignoring behavioural responses) projected increase in tax revenue. If we analyse the net revenue effect in more detail, Table 7 shows that 94.79% (42.92% + 51.87%) of the total revenue gain achieved by the tax change is explained by the increase of the first and the second marginal rates. Interestingly, in the 4th and 5th brackets, the tax reform has a reverse effect, generating more efficiency costs than gains (a loss of 85.714 million euros). As for the savings base, the second tax bracket is responsible for 73.01% of the total revenue gain achieved by modifying this tax base.

The Spanish PIT is widely influenced by taxpayers' circumstances, such as marital and tax filing status. These circumstances interact with features of the income tax that make tax liabilities differ between groups. Tables 12, 13 and 14 in the Appendix evaluate the effect of the 2012 tax reform on tax revenue for six groups of the population: women, men, married taxpayers, single taxpayers, separate tax filers and joint tax filers. For the ETI, we use the estimates in Table 5. Note that the ETI of the savings base is not significant for joint and single tax filers. Hence, we assume zero behavioural effects for these two cases. Tables 12, 13 and 14 show that men (1.650 billion euros), joint tax filers (457 million euros) and married couples (1.813 billion euros) provide more tax revenue than women (468 million euros), separate tax filers (336 million euros) and single taxpayers (557 million euros). This can be explained because the fraction of total net revenue lost due to behavioural responses is higher for women (71.65%), separate tax filers (91.97%) and single taxpayers (66.21%), than for men (53.58%), joint tax filers (54.92%) and married taxpayers (49.03%). This result shows the implications of the ETI on efficiency and revenue collection. Tax changes have

[12] Note that this evaluation focuses on the impact of a modification in the PIT on income tax revenue alone. We do not account for the potential effect of this tax on revenue collection from other taxes such as consumption taxes and social security contributions. For this latter effect, see Sanz-Sanz (2022).

[13] The expected revenue initially announced by the government for this 2012 reform was 5.406 billion euros (4.230 billion from general taxable income and 1.176 billion from the savings taxable income). However, the revenue increase achieved after implementing the 2012 Budget amounted to 815 million euros, significantly lower than the government's initial estimates. This figure represented an 85% reduction compared to the government's original projections for the revenue gain linked to the 2012 reform.

[14] From a macroeconomic perspective, Gil et al. (2019) compute the ex-ante revenue impact in terms of the GDP of each tax reform adopted in Spain during the period 1986–2015. For the 2012 reform, they estimated that the ex-ante tax revenue impact was 0.50% of GDP.

Table 7 Mechanical, behavioural and net effects of the marginal tax rate increase

Tax bracket	Mechanical effect (ME)		Behavioural effect (BE)		Net effect (ME–BE)		BE/ME
	(1)	(2)	(1)	(2)	(1)	(2)	(3)
Panel A: Income shifting (0%)							
General tax base							
1	875,870,814	20.22	122,817,062	4.77	753,053,752	42.92	14.02
2	1,427,642,512	32.97	517,608,396	20.09	910,034,116	51.87	36.26
3	838,994,060	19.37	689,615,162	26.77	149,378,898	8.51	82.20
4	706,734,557	16.32	785,318,173	30.48	− 78,583,616	− 4.48	111.12
5	146,130,540	3.37	153,261,001	5.95	− 7,130,462	− 0.41	104.88
6	335,403,893	7.74	307,585,516	11.94	27,818,377	1.59	91.71
All	4,330,776,375		2,576,205,310		1,754,571,065		59.49
Savings tax base							
1	211,228,379	24.07	34,828,770	15.54	176,399,609	26.99	16.49
2	666,313,963	75.93	189,229,805	84.46	477,084,158	73.01	28.40
All	877,542,341		224,058,575		653,483,766		25.53
Total	5,208,318,716		2,800,263,885		2,408,054,831		53.77
Panel B: Income shifting (10%)							
General tax base							
1	798,300,602	22.58	130,978,197	6.29	667,322,405	45.96	16.41
2	1,177,740,962	33.32	484,178,835	23.25	693,562,126	47.77	41.11
3	642,816,250	18.19	515,296,040	24.74	127,520,210	8.78	80.16
4	531,917,601	15.05	592,734,757	28.46	− 60,817,156	− 4.19	111.43
5	113,224,162	3.20	116,709,830	5.60	− 3,485,668	− 0.24	103.08
6	270,750,364	7.66	243,020,360	11.67	27,730,004	1.91	89.76
All	3,534,749,940		2,082,918,020		1,451,831,920		58.93
Savings tax base							
1	818,538,879	48.45	33,019,304	7.31	785,519,574	63.45	4.03
2	871,018,687	51.55	418,432,378	92.69	452,586,309	36.55	48.04
All	1,689,557,566		451,451,683		1,238,105,884		26.72
Total	5,224,307,506		2,534,369,703		2,689,937,804		48.51
Panel C: Income shifting (20%)							
General tax base							
1	705,852,313	25.23	138,750,822	8.41	567,101,491	49.41	19.66
2	926,270,834	33.11	423,288,224	25.65	502,982,610	43.83	45.70
3	479,291,990	17.13	381,114,148	23.10	98,177,842	8.55	79.52
4	386,541,541	13.82	431,520,662	26.15	− 44,979,121	− 3.92	111.64
5	85,328,069	3.05	87,420,356	5.30	− 2,092,287	− 0.18	102.45
6	214,346,392	7.66	187,894,273	11.39	26,452,119	2.30	87.66
All	2,797,631,140		1,649,988,484		1,147,642,656		58.98

Table 7 (continued)

Tax bracket	Mechanical effect (ME)		Behavioural effect (BE)		Net effect (ME–BE)		BE/ME
	(1)	(2)	(1)	(2)	(1)	(2)	(3)
Savings tax base							
1	1,260,910,524	47.29	27,813,216	2.52	1,233,097,308	79.00	2.21
2	1,405,601,122	52.71	1,077,880,597	97.48	327,720,525	21.00	76.68
All	2,666,511,646		1,105,693,813		1,560,817,832		41.47
Total	5,464,142,785		2,755,682,297		2,708,460,488		50.43
Panel D: Income shifting (30%)							
General tax base							
1	596,088,004	28.12	144,562,756	11.37	451,525,248	53.23	24.25
2	685,120,937	32.32	344,256,001	27.07	340,864,936	40.19	50.25
3	341,358,839	16.10	282,397,605	22.20	58,961,235	6.95	82.73
4	270,031,598	12.74	295,583,861	23.24	− 25,552,264	− 3.01	109.46
5	62,250,530	2.94	62,206,869	4.89	43,661	0.01	99.93
6	165,246,227	7.79	142,881,473	11.23	22,364,755	2.64	86.47
All	2,120,096,135		1,271,888,565		848,207,571		59.99
Savings tax base							
1	1,526,860,310	39.97	22,112,928	1.21	1,504,747,381	75.32	1.45
2	2,293,027,274	60.03	1,799,928,385	98.79	493,098,889	24.68	78.50
All	3,819,887,584		1,822,041,314		1,997,846,270		47.70
Total	5,939,983,719		3,093,929,879		2,846,053,841		52.09

"All" corresponds to all brackets and "total" corresponds to total taxable income
A positive behavioural effect indicates a decrease in tax revenue

heterogenous revenue effects across the population, as some groups are more sensitive to the tax than others.

The difference in marginal tax rates across tax bases incentivizes taxpayers to transfer a share of their income, denoted as s, from the general base to the savings base in order to take advantage of a more favourable tax. As an exercise, we introduce this income-shifting possibility to examine its impact on the expected revenue collection. We assume taxpayers shift a fraction ($s = 0.1, 0.2, 0.3$) of their non-savings income towards the savings tax base. Accounting for income shifting increases the total tax revenue produced by the reform: 2.408 billion euros ($s = 0$), 2.689 billion euros ($s = 0.1$), 2.708 billion euros ($s = 0.2$) and 2.846 billion euros ($s = 0.3$). The notion of fiscal externality explains this increase. The loss of revenue produced by the shift away from the general base towards the savings base is not entirely lost as the shifted income is still subject to the savings tax rate. Therefore, not all behavioural responses to tax changes are symptoms of inefficiency, some—such as income shifting between tax bases—reduce the efficiency costs of taxation:[15] 2.576 billion euros ($s = 0$), 2.082 billion euros ($s = 0.1$), 1.649 billion euros ($s = 0.2$) and 1.271 billion euros ($s = 0.3$),

[15] Note that we do not assume cross-responses as in Lefebvre et al. (2022).

see Table 7 (BE, column 1). Overall, the fraction of total tax revenue lost through behavioural responses is reduced when accounting for income shifting: 53.77% ($s = 0$), 48.51% ($s = 0.1$), 50.43% ($s = 0.2$) and 52.09% ($s = 0.3$), see Table 7 (column 3).

7.2 Revenue-maximising tax rates and revenue-maximising elasticities

Following the welfare analysis of taxation, this subsection estimates the revenue-maximising tax rates and revenue-maximising elasticities for each taxpayer in the Spanish population in 2011. Tables 8 and 15, 16 and 17 in the Appendix report the pre-reform mean value—weighted by income—of these parameters in each tax bracket ($\overline{\tau}_L, \overline{e}_L$) and their difference from the actual values of the marginal tax rate ($\overline{\tau} - \overline{\tau}_L$) and the elasticity ($\overline{e} - \overline{e}_L$). These differences can be regarded as an indicator of the relative distance from the maximum of the Laffer curve.

Regarding the general tax base, on average, the income tax system was on the "prohibitive" side of the Laffer curve in 2011: $(\overline{\tau} > \overline{\tau}_L) = 0.37 > 0.30$ and $(\overline{e} > \overline{e}_L) = 0.55 > 0.40$, see Table 8 (Panel A). A tax rate above the revenue-maximising tax rate is inefficient because increasing the tax rate would decrease the utility of the affected taxpayers and decrease government revenue. Consistent with the results in Sect. 7.1, we observe that $(\overline{\tau} < \overline{\tau}_L)$ in the lower tax brackets and $(\overline{\tau} > \overline{\tau}_L)$ in the middle and top tax brackets. As for the savings tax base, Table 8 (Panel B) shows that this income tax base was on the “normal” side of the Laffer curve in 2011 as, for the overall population, the actual marginal tax rate was below the revenue-maximising tax rate: $(\overline{\tau} < \overline{\tau}_L) = 0.20 < 0.45$ and $(\overline{e} < \overline{e}_L) = 0.82 < 3.32$. This result also holds when considering each tax bracket separately.

When we account for heterogeneity, we find that the Laffer curve is different for each subgroup. Tables 15, 16 and 17 in the Appendix shows that the revenue-maximising rates are higher for men (0.31), joint tax filers (0.28) and married couples (0.33) than

Table 8 Revenue-maximising tax rates and elasticities in 2011 (pre-tax reform)

Tax bracket	$\overline{\tau}$	$\overline{\tau}_L$	$\overline{\tau} - \overline{\tau}_L$	$\overline{e}$	$\overline{e}_L$	$\overline{e} - \overline{e}_L$
Panel A: General tax base						
1	0.24	0.35	− 11.16	0.55	0.54	0.27
2	0.28	0.31	− 2.91	0.55	0.72	− 17.14
3	0.37	0.23	14.38	0.55	0.47	7.42
4	0.43	0.29	14.05	0.55	0.35	20.08
5	0.44	0.20	23.79	0.55	0.19	35.51
6	0.45	0.42	3.05	0.55	0.59	− 4.18
All brackets	0.37	0.30	6.59	0.55	0.40	14.83
Panel B: Savings tax base						
1	0.19	0.41	− 22.23	0.82	3.60	− 278.07
2	0.21	0.46	− 25.19	0.82	2.38	− 155.67
All brackets	0.20	0.45	− 24.73	0.82	3.32	− 249.36

for women (0.24), separate tax filers (0.21), and single individuals (0.25). That is, the "normal" side of the Laffer curve is flatter for men, married and joint tax filers than for women, single and separate tax filers. The mean difference between ($\overline{\tau}$ and $\overline{\tau}_L$) and ($\overline{e}$ and $\overline{e}_L$) also shows that women, single and separate tax filers are, on average, closer to the maximum of the Laffer curve than are men, married and joint tax filers.

7.3 Distribution of the revenue-maximising tax rates and elasticities within the Laffer curve

This subsection locates each taxpayer on the entire range of the Laffer curve in the year before the reform. Tables 9 and 18, 19, 20, 21, 22 and 23 in the Appendix report ($\overline{\tau}_L, \overline{e}_L$), ($\overline{\tau} - \overline{\tau}_L$), ($\overline{e} - \overline{e}_L$), and the proportion of tax returns, taxable income and tax due involved in each bracket and in the total taxpaying population. The information is presented separately for taxpayers for whom ME > BE (Panel A), ME < BE (Panel B) and ME = BE (Panel C). In what follows, we will focus on Panel B.

Regarding the general tax base, the number of tax returns on the "prohibitive" side of the Laffer curve before the reform was 49.46% of all the reported tax returns (9,628,082 tax returns), which represents 50.88% of the total taxable income accumulated during the tax year and 54.89% of the total tax due. That is, half of the Spanish taxpaying population in 2011 were paying marginal tax rates above the marginal tax rate that would have maximised their tax bills. Regarding the savings tax base, the situation is the opposite: only 19.88% of all the reported tax returns (3,870,734 tax returns) were on the "prohibitive" side of the Laffer curve in 2011, which represents 11.91% of the total taxable income accumulated during the tax year and 2.01% of the total tax due. Panel C shows that 5.82% (in the general base) and 21.63% (in the savings base) of all the reported tax returns were at the maximum point on the Laffer curve before the reform; that is, these taxpayers were paying their revenue-maximising tax rates.

If we disaggregate the analysis by tax brackets, Table 9 (Panel B) shows that the brackets most affected by the reform were the 3rd, 4th, and 5th tax brackets. On average, 89.46%, 86.17% and 100% of the tax returns within these brackets show a behavioural effect more significant than the mechanical effect (ME < BE). This is why the increase in marginal tax rates resulted in a net negative revenue effect in brackets 4 and 5, see Table 7 (Panel A). As a result, the impact in terms of taxable income and tax due is more severe in these brackets.

Tables 18, 19, 20, 21, 22 and 23 (Panel B) in the Appendix show that the proportion of tax returns located on the "prohibitive" side of the Laffer curve is higher for women (58.98%), single (53.34%) and separate tax filers (63.66%) than for men (47.86%), married (47.78%) and joint tax filers (52.67%). As a result, the proportion of taxable income and tax due representing these tax returns located on the descending side of the Laffer curve is also higher for women, single and separate tax filers than for their counterparts. Regarding the savings base, 24.65%, 16.24%, 20.39% and 19.59% of all the reported tax returns for women, men, separate tax filers and married couples were on the "prohibitive" side of the Laffer curve before the reform.

Table 9 Distribution of $(\overline{\tau}, \overline{\tau}_L)$ and $(\overline{e}, \overline{e}_L)$. Location on the Laffer curve of tax returns, taxable income and tax due in 2011 (pre-tax reform)

Tax bracket	$\overline{\tau}$	$\overline{\tau}_L$	$\overline{\tau} - \overline{\tau}_L$	$\overline{e}$	$\overline{e}_L$	$\overline{e} - \overline{e}_L$	Tax returns (%)		Taxable income (%)		Tax due (%)	
							(1)	(2)	(1)	(2)	(1)	(2)
Panel A: ME > BE												
General tax base												
1	0.24	0.47	− 22.64	0.55	1.44	− 89.85	46.16	28.20	73.18	19.59	87.88	10.71
2	0.28	0.39	− 10.64	0.55	0.92	− 37.31	58.12	15.04	65.42	22.47	70.30	21.49
3	0.37	0.39	− 2.06	0.55	0.61	− 6.28	10.54	0.97	13.36	2.70	15.07	3.63
4	0.43	0.47	− 3.70	0.55	0.64	− 9.04	13.83	0.47	19.88	2.67	22.64	4.88
5	0.44	–	–	0.55	–	–	0.00	0.00	0.00	0.00	0.00	0.00
6	0.45	0.57	− 11.78	0.55	0.90	− 35.38	26.69	0.05	52.41	1.70	54.94	4.13
All bracket	0.37	0.43	− 6.08	0.55	0.78	− 23.78		44.72		49.12		44.84
Savings tax base												
1	0.19	0.53	− 34.41	0.82	4.26	− 343.76	57.88	55.50	76.78	22.60	85.18	70.88
2	0.21	0.49	− 27.97	0.82	2.65	− 182.53	72.70	2.99	92.81	65.49	88.03	14.77
All brackets	0.20	0.50	− 30.11	0.82	3.87	− 304.81		58.49		88.09		85.66
Panel B: ME < BE												
General tax base												
1	0.24	0.04	20.18	0.55	0.04	50.83	44.31	27.07	26.82	7.18	9.93	1.21
2	0.28	0.16	11.72	0.55	0.28	26.25	41.88	10.84	34.58	11.88	29.70	9.08
3	0.37	0.20	16.92	0.55	0.34	20.59	89.46	8.22	86.64	17.50	84.93	20.48
4	0.43	0.25	18.46	0.55	0.27	27.51	86.17	2.95	80.12	10.76	77.36	16.69
5	0.44	0.20	23.79	0.55	0.19	35.51	100.00	0.26	100.00	2.01	100.00	4.05

Table 9 (continued)

Tax bracket	$\overline{\tau}$	$\overline{\tau}_L$	$\overline{\tau} - \overline{\tau}_L$	$\overline{e}$	$\overline{e}_L$	$\overline{e} - \overline{e}_L$	Tax returns (%)		Taxable income (%)		Tax due (%)	
							(1)	(2)	(1)	(2)	(1)	(2)
6	0.45	0.26	19.39	0.55	0.26	29.03	73.31	0.13	47.59	1.54	45.06	3.39
All bracket	0.37	0.18	18.82	0.55	0.25	29.46		49.46		50.88		54.89
Savings tax base												
1	0.19	0.01	18.04	0.82	0.00	81.84	19.56	18.76	23.22	6.83	0.01	0.00
2	0.21	0.10	10.69	0.82	0.42	39.91	27.30	1.12	7.19	5.07	11.97	2.01
All bracket	0.20	0.05	15.06	0.82	0.24	58.70		19.88		11.91		2.01
Panel C: ME = BE												
General tax base												
1	0.24	–	–	0.55	–	–	9.53	5.82	0.00	0.00	2.19	0.27
2	0.28	–	–	0.55	–	–	0.00	0.00	0.00	0.00	0.00	0.00
3	0.37	–	–	0.55	–	–	0.00	0.00	0.00	0.00	0.00	0.00
4	0.43	–	–	0.55	–	–	0.00	0.00	0.00	0.00	0.00	0.00
5	0.44	–	–	0.55	–	–	0.00	0.00	0.00	0.00	0.00	0.00
6	0.45	–	–	0.55	–	–	0.00	0.00	0.00	0.00	0.00	0.00
All bracket	0.37	–	–	0.55	–	–		5.82		0.00		0.27
Savings tax base												
1	0.19	–	–	0.82	–	–	22.56	21.63	0.00	0.00	14.82	12.33
2	0.21	–	–	0.82	–	–	0.00	0.00	0.00	0.00	0.00	0.00
All brackets	0.20	–	–	0.82	–	–		21.63		0.00		12.33

(1) In the bracket, (2) in the total

8 Conclusion

This paper has characterised the Laffer curve of each taxpayer in a taxpaying population. This microeconomic approach has enabled us to identify the location of each taxpayer on their own Laffer curve and dissect the effect of some structural and behavioural factors on the profile of the Laffer curve and the locations of the taxpayers on it.

Using microdata from the Spanish Institute for Fiscal Studies, we have calculated the total impact on revenue of the 2012 tax reform. Using the concepts of the mechanical effect and the behavioural effect, we have derived analytical expressions for the revenue-maximising tax rate and the revenue-maximising elasticity in a schedular income tax and in the presence of income shifting. Calculations were performed for the individual taxpayer and the aggregate population. The analysis undertaken in this paper shows that the Laffer curve is not a fixed issue. Because its characterisation depends on a behavioural elasticity (the Elasticity of Taxable Income), the Laffer curve is exposed to behavioural factors such as avoidance channels and taxpayers' circumstances. These factors alter the shape of the Laffer curve and the position of the taxpayers on it. These alterations have important policy implications in the study of the revenue capacity of tax systems, as they can lead to an over-/under-estimation of the magnitude of the revenue gain or loss associated with a change in the tax rates.

Appendix A

See Table 10.

Table 10 Robustness checks: ETI

	General base (1)	Savings base (2)
Panel A: No exclusion		
$\Delta(1-t)$	0.822***	0.868***
	(0.106)	(0.275)
N	1,159,632	639,126
Panel B: Drop gross income < €5,000		
$\Delta(1-t)$	0.562***	0.885***
	(0.104)	(0.286)
N	1,144,212	605,732
Panel C: Drop gross income < €10,000		

Table 10 (continued)

	General base (1)	Savings base (2)
$\Delta(1-t)$	0.074	0.828***
	(0.103)	(0.291)
N	1,089,281	571,922
Panel D: Exclude taxpayers who change residence from year1 to year2		
$\Delta(1-t)$	0.786***	0.991***
	(0.107)	(0.283)
N	1,130,100	622,944
Panel E: Exclude taxpayers who change marital status from year1 to year2		
$\Delta(1-t)$	0.825***	1.348***
	(0.113)	(0.285)
N	1,014,324	569,454
Panel F: Exclude taxpayers who change tax filing status from year1 to year2		
$\Delta(1-t)$	− 0.027	1.292***
	(0.107)	(0.317)
N	793,278	451,968
Partial R^2*:*		
No exclusion	0.0155	0.296
Drop gross income < €5,000	0.0148	0.293
Drop gross income < €10,000	0.0117	0.294
Exclude taxpayers who change marital status	0.0157	0.296
Exclude taxpayers who change tax filing status	0.0189	0.302
Exclude taxpayers who change residence	0.0156	0.294
F on excluded instruments:		
No exclusion	6,377	82,638
Drop gross income < €5,000	6,128	76,818
Drop gross income < €10,000	4,864	74,443
Exclude taxpayers who change marital status	5,471	76,312
Exclude taxpayers who change tax filing status	4,651	58,990
Exclude taxpayers who change residence	6,171	78,949

Appendix B: Cross and direct savings elasticities

To estimate the *cross* elasticity of savings income with respect to the net-of-tax rate on general income and the *direct* elasticity of savings income with respect to its own nex-of-tax rate, we estimate the following equation:

Table 11 Cross and direct savings elasticities

	$\partial \log y^s \partial \log 1-\tau^g$	$\frac{\partial \log y^s}{\partial \log(1-\tau^s)}$
	(1)	(2)
	− 0.802***	1.297***
	(0.143)	(0.264)
N	553,800	553,800
Partial R^2	0.0802	0.0802
F on excluded instruments	34,541	34,542

Table reports the cross and direct elasticities estimates of Eq. (14). Standard errors clustered by the taxpayer are in parentheses. ***$p <$ 0.01, **$p < 0.05$, *$p < 0.1$

$$\Delta \log y^s_{i,t} = \beta_0 + \beta_1 \Delta \log\left(1-\tau^g_{k_{i,t}}\right) + \beta_2 \Delta \log\left(1-\tau^s_{k_{i,t}}\right) + \beta_3 f\left(y^s_{i,t}\right) + \beta_4 X'_{it} + u_{it} \tag{14}$$

where,$\Delta \log y^s_{i,t}$ is the log change in savings income between the year $t+2$ and the benchmark year t, $\Delta \log\left(1-\tau^g_{k_{i,t}}\right)$ is the instrumented net-of-tax rate on general income, and $\Delta \log\left(1-\tau^s_{k_{i,t}}\right)$ is the instrumented net-of-tax rate on savings income. Thus, β_1 is the cross elasticity and β_2 is the direct elasticity of savings.

Following Gruber and Saez (2002), we use no lags in the instruments. To control for unobserved heterogeneity in income growth, we include a five-piece of base-year savings income spline and a base-year savings income control.[16] We also include regional and year-fixed effects. We estimate the model using the 2SLS method. We rely on the same estimation sample used in the estimation of the ETI (savings) in Sect. 5, except that in Table 11 we restrict to taxpayers with income in both tax bases during the entire period.

Appendix C

See Tables 12, 13 and 14.

[16] We perform robustness checks on this specification. These checks are available from the authors upon request.

Table 12 Gender: Mechanical, behavioural and net effects of the marginal tax rate increase

Tax	Mechanical effect (ME)		Behavioural effect (BE)		Net effect (ME–BE)		BE/ME
	(1)	(2)	(1)	(2)	(1)	(2)	(3)
Panel A: Women							
General base							
1	333,859,199	25.76	75,758,134	6.97	258,101,064	123.71	22.69
2	500,014,682	38.58	272,710,349	25.08	227,304,333	108.95	54.54
3	251,466,563	19.40	346,442,243	31.86	− 94,975,680	− 45.52	137.77
4	155,082,374	11.96	300,855,247	27.66	− 145,772,873	− 69.87	194.00
5	22,615,378	1.74	39,109,121	3.60	− 16,493,744	− 7.91	172.93
6	33,129,286	2.56	52,665,405	4.84	− 19,536,119	− 9.36	158.97
All	1,296,167,481		1,087,540,499		208,626,982		83.90
Savings base							
1	82,333,190	23.14	15,609,166	16.24	66,724,024	25.69	18.96
2	273,518,694	76.86	80,533,541	83.76	192,985,153	74.31	29.44
All	355,851,883		96,142,707		259,709,176		27.02
Total	1,652,019,365		1,183,683,207		468,336,158		71.65
Panel B: Men							
General base							
1	542,011,615	17.86	68,417,598	3.83	473,594,018	37.89	12.62
2	927,627,831	30.57	320,815,998	17.97	606,811,832	48.55	34.58
3	587,527,497	19.36	439,205,523	24.61	148,321,974	11.87	74.75
4	551,652,182	18.18	565,468,616	31.68	− 13,816,434	− 1.11	102.50
5	123,515,162	4.07	124,025,972	6.95	− 510,810	− 0.04	100.41
6	302,274,607	9.96	266,919,390	14.95	35,355,217	2.83	88.30
All	3,034,608,894		1,784,853,097		1,249,755,797		58.82
Savings base							
1	128,895,189	24.71	18,149,395	15.05	110,745,794	27.61	14.08
2	392,795,269	75.29	102,433,164	84.95	290,362,104	72.39	26.08
All	521,690,458		120,582,560		401,107,898		23.11
Total	3,556,299,352		1,905,435,656		1,650,863,695		53.58

"All" corresponds to all brackets and "total" corresponds to total taxable income

Table 13 Tax filing: Mechanical, behavioural and net effects of the marginal tax rate increase

Tax	Mechanical effect (ME)		Behavioural effect (BE)		Net effect (ME–BE)		BE/ME
	(1)	(2)	(1)	(2)	(1)	(2)	(3)
Panel A: Separate tax filers							
General base							
1	726,026,632	20.96	161,829,172	4.54	564,197,460	− 569.96	22.29
2	1,151,937,744	33.26	714,088,423	20.04	437,849,321	− 442.32	61.99
3	676,557,223	19.53	989,384,612	27.77	− 312,827,389	316.02	146.24
4	551,980,493	15.94	1,097,802,303	30.82	− 545,821,809	551.39	198.88
5	108,487,000	3.13	204,209,516	5.73	− 95,722,516	96.70	188.23
6	248,518,362	7.18	395,182,864	11.09	− 146,664,502	148.16	159.02
All	3,463,507,454		3,562,496,890		− 98,989,436		102.86
Savings base							
1	164,213,671	22.50	42,046,243	14.29	122,167,427	28.05	25.60
2	565,577,827	77.50	252,234,508	85.71	313,343,318	71.95	44.60
All	729,791,497		294,280,752		435,510,746		40.32
Total	4,193,298,951		3,856,777,641		336,521,310		91.97
Panel B: Joint tax filers							
General base							
1	149,844,182	17.28	31,377,049	5.63	118,467,134	38.23	20.94
2	275,704,769	31.79	113,005,382	20.27	162,699,387	52.51	40.99
3	162,436,837	18.73	127,768,039	22.92	34,668,798	11.19	78.66
4	154,754,063	17.84	162,825,217	29.21	− 8,071,154	− 2.60	105.22
5	37,643,539	4.34	37,795,638	6.78	− 152,099	− 0.05	100.40
6	86,885,531	10.02	84,642,405	15.18	2,243,125	0.72	97.42
All	867,268,921		557,413,730		309,855,191		64.27
Savings base							
1	47,014,708	31.82	0	–	47,014,708	31.82	–
2	100,736,136	68.18	0	–	100,736,136	68.18	–
All	147,750,844		0		147,750,844		–
Total	1,015,019,765		557,413,730		457,606,035		54.92

"All" corresponds to all brackets and "total" corresponds to total taxable income

Table 14 Marital status: Mechanical, behavioural and net effects of the marginal tax rate increase

Tax bracket	Mechanical effect (ME)		Behavioural effect (BE)		Net effect (ME–BE)		BE/ME
	(1)	(2)	(1)	(2)	(1)	(2)	(3)
Panel A:Single							
General base							
1	371,430,612	27.14	74,646,428	6.83	296,784,184	107.52	20.10
2	489,532,355	35.77	284,984,656	26.08	204,547,699	74.10	58.22
3	241,473,082	17.64	306,907,274	28.09	− 65,434,193	− 23.71	127.10
4	170,084,331	12.43	294,483,467	26.95	− 124,399,136	− 45.07	173.14
5	30,183,069	2.21	47,896,561	4.38	− 17,713,492	− 6.42	158.69
6	65,899,259	4.82	83,656,577	7.66	− 17,757,318	− 6.43	126.95
All	1,368,602,707		1,092,574,963		276,027,745		79.83
Savings base							
1	70,376,961	25.00	0	–	70,376,961	25.00	–
2	211,132,302	75.00	0	–	211,132,302	75.00	–
All	281,509,263		0		281,509,263		–
Total	1,650,111,971		1,092,574,963		557,537,008		66.21
Panel B: Married							
General base							
1	504,440,202	17.03	57,986,134	3.86	446,454,068	30.60	11.50
2	938,110,158	31.67	262,334,502	17.45	675,775,655	46.32	27.96
3	597,520,978	20.17	393,641,015	26.19	203,879,963	13.97	65.88
4	536,650,226	18.12	481,627,704	32.04	55,022,522	3.77	89.75
5	115,947,471	3.91	99,798,651	6.64	16,148,820	1.11	86.07
6	269,504,634	9.10	207,850,236	13.83	61,654,397	4.23	77.12
All	2,962,173,668		1,503,238,242		1,458,935,425		50.75
Savings base							
1	140,851,417	23.63	36,253,783	15.03	104,597,635	29.48	25.74
2	455,181,661	76.37	204,985,002	84.97	250,196,658	70.52	45.03
All	596,033,078		241,238,785		354,794,293		40.47
Total	3,558,206,746		1,744,477,027		1,813,729,719		49.03

"All" corresponds to all brackets and "total" corresponds to total taxable income

Appendix D

See Tables 15, 16 and 17.

Table 15 Gender: Revenue-maximising tax rates and revenue-maximising elasticities in 2011 (pre-tax reform)

Tax bracket	$\overline{\tau}$	$\overline{\tau}_L$	$\overline{\tau} - \overline{\tau}_L$	$\overline{e}$	$\overline{e}_L$	$\overline{e} - \overline{e}_L$
Panel A: Women						
General tax base						
1	0.24	0.28	− 3.86	0.77	0.45	31.98
2	0.28	0.24	3.53	0.77	0.72	5.26
3	0.37	0.17	20.18	0.77	0.45	31.89
4	0.43	0.21	21.92	0.77	0.32	45.63
5	0.44	0.15	28.81	0.77	0.19	58.53
6	0.45	0.30	14.76	0.77	0.48	29.09
All brackets	0.37	0.24	13.16	0.77	0.36	41.02
Savings tax base						
1	0.19	0.37	− 18.06	0.85	3.46	− 261.15
2	0.21	0.45	− 24.38	0.85	2.35	− 150.42
All brackets	0.20	0.43	− 22.84	0.85	3.22	− 237.53
Panel B: Men						
General tax base						
1	0.24	0.36	− 12.31	0.54	0.63	− 8.76
2	0.28	0.31	− 3.12	0.54	0.72	− 17.69
3	0.37	0.23	13.72	0.54	0.48	6.04
4	0.43	0.30	13.01	0.54	0.36	18.37
5	0.44	0.20	23.52	0.54	0.19	34.74
6	0.45	0.43	2.09	0.54	0.60	− 6.31
All brackets	0.37	0.31	6.01	0.54	0.41	12.97
Savings tax base						
1	0.19	0.46	− 26.67	0.76	3.65	− 289.45
2	0.21	0.48	− 27.16	0.76	2.39	− 162.88
All brackets	0.20	0.47	− 27.45	0.76	3.35	− 258.87

Table 16 Tax filing: Revenue-maximising tax rates and revenue-maximising elasticities in 2011 (pre-tax reform)

Tax bracket	$\overline{\tau}$	$\overline{\tau}_L$	$\overline{\tau} - \overline{\tau}_L$	$\overline{e}$	$\overline{e}_L$	$\overline{e} - \overline{e}_L$
Panel A: Separate						
General tax base						
1	0.24	0.27	− 3.05	0.95	0.55	40.44
2	0.28	0.21	6.97	0.95	0.73	22.56
3	0.37	0.15	22.29	0.95	0.46	49.52
4	0.43	0.20	23.50	0.95	0.34	60.74
5	0.44	0.13	31.05	0.95	0.19	76.28
6	0.45	0.31	14.19	0.95	0.59	36.32
All brackets	0.37	0.21	15.66	0.95	0.39	55.99
Savings tax base						
1	0.19	0.33	− 13.53	1.31	3.61	− 230.19
2	0.21	0.36	− 15.09	1.31	2.42	− 110.85
All brackets	0.20	0.35	− 15.11	1.31	3.33	− 201.59
Panel B: Joint						
General tax base						
1	0.24	0.27	− 3.40	0.57	0.53	3.95
2	0.28	0.30	− 1.64	0.57	0.70	− 12.87
3	0.37	0.23	14.38	0.57	0.50	7.24
4	0.43	0.29	14.06	0.57	0.35	22.35
5	0.44	0.20	24.04	0.57	0.20	37.53
6	0.45	0.41	4.19	0.57	0.59	− 1.46
All brackets	0.37	0.28	8.92	0.57	0.41	15.71
Savings tax base						
1	0.19	–	–	–	–	–
2	0.21	–	–	–	–	–
All brackets	0.20	–	–	–	–	–

Table 17 Marital status: Revenue-maximising tax rates and revenue-maximising elasticities in 2011 (pre-tax reform)

Tax bracket	$\overline{\tau}$	$\overline{\tau}_L$	$\overline{\tau} - \overline{\tau}_L$	$\overline{e}$	$\overline{e}_L$	$\overline{e} - \overline{e}_L$
Panel A: Single						
General tax base						
1	0.24	0.32	− 7.65	0.76	0.54	21.33
2	0.28	0.24	3.82	0.76	0.70	6.05
3	0.37	0.17	19.74	0.76	0.45	30.30
4	0.43	0.22	21.03	0.76	0.33	42.67
5	0.44	0.16	28.33	0.76	0.19	56.69
6	0.45	0.35	10.06	0.76	0.60	15.86
All brackets	0.37	0.25	11.62	0.76	0.39	36.48
Savings tax base						
1	0.19	–	–	–	–	–
2	0.21	–	–	–	–	–
All brackets	0.20	–	–	–	–	–
Panel B: Married						
General tax base						
1	0.24	0.36	− 12.15	0.46	0.54	− 8.40
2	0.28	0.35	− 6.92	0.46	0.73	- 26.84
3	0.37	0.26	11.17	0.46	0.48	− 1.87
4	0.43	0.33	10.14	0.46	0.35	10.86
5	0.44	0.23	21.04	0.46	0.19	26.78
6	0.45	0.46	− 0.71	0.46	0.59	− 12.63
All brackets	0.37	0.33	3.76	0.46	0.40	5.94
Savings tax base						
1	0.19	0.33	− 14.18	1.31	3.68	− 236.46
2	0.21	0.36	− 14.73	1.31	2.37	− 105.35
All brackets	0.20	0.35	− 15.00	1.31	3.36	− 204.91

Appendix E

See Tables 18, 19, 20, 21, 22 and 23.

Table 18 Women: Distribution of $(\overline{\tau}, \overline{\tau}_L)$ and $(\overline{e}, \overline{e}_L)$. Location on the Laffer curve of tax returns, taxable income and tax due in 2011 (pre-tax reform)

Tax bracket	$\overline{\tau}$	$\overline{\tau}_L$	$\overline{\tau} - \overline{\tau}_L$	$\overline{e}$	$\overline{e}_L$	$\overline{e} - \overline{e}_L$	Tax returns (%)		Taxable income (%)		Tax due (%)	
							(1)	(2)	(1)	(2)	(1)	(2)
Panel A: ME > BE												
General tax base												
1	0.24	0.39	− 15.35	0.77	1.51	− 73.74	38.42	25.89	66.51	21.54	81.51	13.19
2	0.28	0.33	− 5.15	0.77	1.01	− 23.51	39.39	8.87	46.88	16.64	51.25	17.99
3	0.37	–	–	0.77	–	–	0.00	0.00	0.00	0.00	0.00	0.00
4	0.43	–	–	0.77	–	–	0.00	0.00	0.00	0.00	0.00	0.00
5	0.44	–	–	0.77	–	–	0.00	0.00	0.00	0.00	0.00	0.00
6	0.45	0.50	− 5.47	0.77	0.98	− 20.76	8.20	0.00	24.10	0.26	26.94	0.75
All bracket	0.37	0.37	0.09	0.77	1.24	− 46.59		34.76		38.45		31.93
Savings tax base												
1	0.19	0.52	− 33.04	0.85	4.26	− 341.01	54.79	52.57	70.60	21.55	86.40	73.52
2	0.21	0.48	− 27.10	0.85	2.63	− 177.88	73.38	2.97	92.82	64.49	87.91	13.10
All bracket	0.20	0.49	− 29.09	0.85	3.89	− 304.13		55.54		86.04		86.62
Panel B: ME < BE												
General tax base												
1	0.24	0.05	18.96	0.77	0.06	71.60	52.30	35.24	33.49	10.85	16.06	2.60
2	0.28	0.17	11.18	0.77	0.42	35.57	60.61	13.64	53.12	18.86	48.75	17.12
3	0.37	0.17	20.18	0.77	0.45	31.89	100.00	7.69	100.00	19.91	100.00	25.93
4	0.43	0.21	21.92	0.77	0.32	45.63	100.00	2.24	100.00	10.10	100.00	17.76

Table 18 (continued)

Tax bracket	$\overline{\tau}$	$\overline{\tau}_L$	$\overline{\tau} - \overline{\tau}_L$	$\overline{e}$	$\overline{e}_L$	$\overline{e} - \overline{e}_L$	Tax returns (%)		Taxable income (%)		Tax due (%)	
							(1)	(2)	(1)	(2)	(1)	(2)
5	0.44	0.15	28.81	0.77	0.19	58.53	100.00	0.11	100.00	1.01	100.00	2.23
6	0.45	0.24	21.19	0.77	0.33	44.40	91.80	0.05	75.90	0.82	73.06	2.04
All brackets	0.37	0.16	21.32	0.77	0.30	47.20		58.98		61.55		67.67
Savings tax base												
1	0.19	0.01	17.91	0.85	0.00	84.34	24.57	23.58	29.40	8.97	0.01	0.01
2	0.21	0.10	10.79	0.85	0.43	41.61	26.62	1.08	7.18	4.99	12.09	1.80
All bracket	0.20	0.04	15.65	0.85	0.15	69.73		24.65		13.96		1.81
Panel C: ME = BE												
General tax base												
1	0.24	–	–	0.77	–	–	9.29	6.26	0.00	0.00	2.43	0.39
2	0.28	–	–	0.77	–	–	0.00	0.00	0.00	0.00	0.00	0.00
3	0.37	–	–	0.77	–	–	0.00	0.00	0.00	0.00	0.00	0.00
4	0.43	–	–	0.77	–	–	0.00	0.00	0.00	0.00	0.00	0.00
5	0.44	–	–	0.77	–	–	0.00	0.00	0.00	0.00	0.00	0.00
6	0.45	–	–	0.77	–	–	0.00	0.00	0.00	0.00	0.00	0.00
All bracket	0.37	–	–	0.77	–	–		6.26		0.00		0.39
Savings tax base												
1	0.19	–	–	0.85	–	–	20.64	19.80	0.00	0.00	13.59	11.57
2	0.21	–	–	0.85	–	–	0.00	0.00	0.00	0.00	0.00	0.00
All brackets	0.20	–	–	0.85	–	–		19.80		0.00		11.57

Table 19 Men: Distribution of $(\overline{\tau}, \overline{\tau}_L)$ and $(\overline{e}, \overline{e}_L)$. Location on the Laffer curve of tax returns, taxable income and tax due in 2011 (pre-tax reform)

Tax bracket	$\overline{\tau}$	$\overline{\tau}_L$	$\overline{\tau} - \overline{\tau}_L$	$\overline{e}$	$\overline{e}_L$	$\overline{e} - \overline{e}_L$	Tax returns (%)		Taxable income (%)		Tax due (%)	
							(1)	(2)	(1)	(2)	(1)	(2)
Panel A: ME > BE												
General tax base												
1	0.24	0.47	23.02	0.54	1.45	− 91.45	49.93	28.14	75.07	17.72	90.68	9.28
2	0.28	0.39	10.92	0.54	0.91	− 37.57	58.09	16.49	65.38	22.03	70.63	20.02
3	0.37	0.39	2.23	0.54	0.61	− 6.78	12.22	1.26	15.36	3.13	17.24	4.00
4	0.43	0.47	3.91	0.54	0.63	− 9.45	15.96	0.69	22.56	3.45	25.54	5.99
5	0.44	0.00	− 44.00	0.54	0.00	53.90	0.00	0.00	0.00	0.00	0.00	0.00
6	0.45	0.57	12.15	0.54	0.90	− 36.27	28.23	0.07	54.56	2.42	56.98	5.60
All bracket	0.37	0.43	6.52	0.54	0.77	− 23.24		46.65		48.76		44.89
Savings tax base												
1	0.19	0.56	− 36.81	0.76	4.26	− 350.24	60.19	57.68	81.56	23.37	84.56	69.59
2	0.21	0.51	− 29.89	0.76	2.64	− 187.64	73.98	3.08	93.30	66.57	89.04	15.76
All bracket	0.20	0.52	− 32.17	0.76	3.86	− 309.84		60.76		89.94		85.35
Panel B: ME < BE												
General tax base												
1	0.24	0.04	− 19.92	0.54	0.04	49.53	40.33	22.73	24.93	5.88	7.33	0.75
2	0.28	0.16	− 11.61	0.54	0.28	25.93	41.91	11.90	34.62	11.67	29.37	8.33
3	0.37	0.20	− 16.62	0.54	0.34	20.15	87.78	9.05	84.64	17.24	82.76	19.22
4	0.43	0.25	− 17.94	0.54	0.27	26.65	84.04	3.62	77.44	11.86	74.46	17.45

Table 19 (continued)

Tax bracket	$\overline{\tau}$	$\overline{\tau}_L$	$\overline{\tau} - \overline{\tau}_L$	$\overline{e}$	$\overline{e}_L$	$\overline{e} - \overline{e}_L$	Tax returns (%)		Taxable income (%)		Tax due (%)	
							(1)	(2)	(1)	(2)	(1)	(2)
5	0.44	0.20	− 23.52	0.54	0.19	34.74	100.00	0.37	100.00	2.58	100.00	4.94
6	0.45	0.26	− 19.19	0.54	0.26	28.38	71.77	0.19	45.44	2.02	43.02	4.23
All bracket	0.37	0.19	− 17.93	0.54	0.25	28.42		47.86		51.24		54.91
Savings tax base												
1	0.19	0.01	18.19	0.76	0.00	75.47	15.82	15.16	18.44	5.28	0.00	0.00
2	0.21	0.10	10.89	0.76	0.39	36.79	26.02	1.08	6.70	4.78	10.96	1.94
All bracket	0.20	0.05	14.77	0.76	0.26	49.83		16.24		10.06		1.94
Panel C: ME = BE												
General tax base												
1	0.24	–	–	0.77	–	–	9.74	5.49	0.00	0.00	2.00	0.20
2	0.28	–	–	0.77	–	–	0.00	0.00	0.00	0.00	0.00	0.00
3	0.37	–	–	0.77	–	–	0.00	0.00	0.00	0.00	0.00	0.00
4	0.43	–	–	0.77	–	–	0.00	0.00	0.00	0.00	0.00	0.00
5	0.44	–	–	0.77	–	–	0.00	0.00	0.00	0.00	0.00	0.00
6	0.45	–	–	0.77	–	–	0.00	0.00	0.00	0.00	0.00	0.00
All bracket	0.37	–	–	0.77	–	–		5.49		0.00		0.20
Savings tax base												
1	0.19	–	–	0.85	–	–	23.99	23.00	0.00	0.00	15.44	12.70
2	0.21	–	–	0.85	–	–	0.00	0.00	0.00	0.00	0.00	0.00
All brackets	0.20	–	–	0.85	–	–		23.00		0.00		12.70

Table 20 Separate tax filers: Distribution of $(\overline{\tau}, \overline{\tau}_L)$ and $(\overline{e}, \overline{e}_L)$. Location on the Laffer curve of tax returns, taxable income and tax due in 2011 (pre-tax reform)

Tax bracket	$\overline{\tau}$	$\overline{\tau}_L$	$\overline{\tau} - \overline{\tau}_L$	$\overline{e}$	$\overline{e}_L$	$\overline{e} - \overline{e}_L$	Tax returns (%)		Taxable income (%)		Tax due (%)	
							(1)	(2)	(1)	(2)	(1)	(2)
Panel A: ME > BE												
General tax base												
1	0.24	0.36	− 11.97	0.95	1.62	− 67.29	42.01	25.20	69.69	17.91	83.03	10.27
2	0.28	0.30	− 2.48	0.95	1.08	− 12.89	22.90	6.03	28.78	9.94	32.34	9.94
3	0.37	–	–	0.95	–	–	0.00	0.00	0.00	0.00	0.00	0.00
4	0.43	–	–	0.95	–	–	0.00	0.00	0.00	0.00	0.00	0.00
5	0.44	–	–	0.95	–	–	0.00	0.00	0.00	0.00	0.00	0.00
6	0.45	0.49	− 3.63	0.95	1.11	− 15.38	4.41	0.01	23.36	0.71	24.80	1.70
All brackets	0.37	0.34	2.46	0.95	1.27	− 31.43		31.23		28.55		21.91
Savings tax base												
1	0.19	0.42	− 23.29	1.31	4.26	− 294.93	59.13	56.62	76.06	20.86	85.23	70.98
2	0.21	0.39	− 17.89	1.31	2.84	− 152.57	61.89	2.62	89.80	65.18	81.51	13.63
All brackets	0.20	0.40	− 19.71	1.31	3.93	− 262.12		59.25		86.03		84.61
Panel B: ME < BE												
General tax base												
1	0.24	0.07	17.46	0.95	0.09	86.38	49.47	29.66	30.31	7.79	14.93	1.85
2	0.28	0.17	10.79	0.95	0.54	41.16	77.10	20.30	71.22	24.59	67.66	20.79
3	0.37	0.15	22.29	0.95	0.46	49.52	100.00	9.74	100.00	21.12	100.00	24.73
4	0.43	0.20	23.50	0.95	0.34	60.74	100.00	3.54	100.00	13.68	100.00	21.44

Table 20 (continued)

Tax bracket	$\overline{\tau}$	$\overline{\tau}_L$	$\overline{\tau} - \overline{\tau}_L$	$\overline{e}$	$\overline{e}_L$	$\overline{e} - \overline{e}_L$	Tax returns (%)		Taxable income (%)		Tax due (%)	
							(1)	(2)	(1)	(2)	(1)	(2)
5	0.44	0.13	31.05	0.95	0.19	76.28	100.00	0.26	100.00	1.95	100.00	3.86
6	0.45	0.25	19.62	0.95	0.44	51.31	95.59	0.16	76.64	2.32	75.20	5.17
All bracket	0.37	0.16	20.94	0.95	0.34	61.14		63.66		71.45		77.84
Savings tax base												
1	0.19	0.02	17.48	1.31	0.01	130.04	19.60	18.77	23.94	6.56	0.01	0.01
2	0.21	0.11	9.57	1.31	0.69	61.95	38.11	1.62	10.20	7.40	18.49	3.09
All bracket	0.20	0.07	13.23	1.31	0.46	84.94		20.39		13.97		3.10
Panel C: ME = BE												
General tax base												
1	0.24	–	–	0.77	–	–	8.52	5.11	0.00	0.00	2.04	0.25
2	0.28	–	–	0.77	–	–	0.00	0.00	0.00	0.00	0.00	0.00
3	0.37	–	–	0.77	–	–	0.00	0.00	0.00	0.00	0.00	0.00
4	0.43	–	–	0.77	–	–	0.00	0.00	0.00	0.00	0.00	0.00
5	0.44	–	–	0.77	–	–	0.00	0.00	0.00	0.00	0.00	0.00
6	0.45	–	–	0.77	–	–	0.00	0.00	0.00	0.00	0.00	0.00
All brackets	0.37	–	–	0.77	–	–		5.11		0.00		0.25
Savings tax base												
1	0.19	–	–	0.85	–	–	21.27	20.37	0.00	0.00	14.76	12.29
2	0.21	–	–	0.85	–	–	0.00	0.00	0.00	0.00	0.00	0.00
All brackets	0.20	–	–	0.85	–	–		20.37		0.00		12.29

Table 21 Joint tax filers: Distribution of $(\overline{\tau}, \overline{\tau}_L)$ and $(\overline{e}, \overline{e}_L)$. Location on the Laffer curve of tax returns, taxable income and tax due in 2011 (pre-tax reform)

Tax bracket	$\overline{\tau}$	$\overline{\tau}_L$	$\overline{\tau} - \overline{\tau}_L$	$\overline{e}$	$\overline{e}_L$	$\overline{e} - \overline{e}_L$	Tax returns (%)		Taxable income (%)		Tax due (%)	
							(1)	(2)	(1)	(2)	(1)	(2)
Panel A: ME > BE												
General tax base												
1	0.24	0.42	− 18.22	0.57	1.32	− 74.92	37.89	24.62	60.96	18.73	87.72	10.00
2	0.28	0.38	− 10.00	0.57	0.92	− 35.17	54.82	13.31	62.34	21.01	69.59	20.81
3	0.37	0.39	− 1.53	0.57	0.62	− 4.67	9.06	0.66	11.52	1.94	13.19	2.83
4	0.43	0.46	− 3.20	0.57	0.65	− 8.05	12.86	0.39	18.66	2.34	21.45	4.74
5	0.44	–	–	0.57	–	–	–	–	–	–	–	–
6	0.45	0.56	− 10.68	0.57	0.90	− 32.71	25.58	0.05	50.24	2.01	53.16	5.45
All brackets	0.37	0.41	− 4.09	0.57	0.79	− 22.33		39.03		46.03		43.83
Panel B: ME < BE												
General tax base												
1	0.24	0.04	19.73	0.57	0.05	52.05	49.33	32.05	39.04	12.00	9.39	1.07
2	0.28	0.16	12.19	0.57	0.29	27.94	45.18	10.97	37.66	12.69	30.41	9.09
3	0.37	0.21	16.45	0.57	0.39	18.42	90.94	6.59	88.48	14.88	86.81	18.63
4	0.43	0.25	18.02	0.57	0.28	29.30	87.14	2.62	81.34	10.18	78.55	17.37
5	0.44	0.20	24.04	0.57	0.20	37.53	100.00	0.27	100.00	2.23	100.00	4.88
6	0.45	0.26	19.21	0.57	0.27	30.05	74.42	0.15	49.76	1.99	46.84	4.80
All brackets	0.37	0.17	20.01	0.57	0.26	30.75		52.67		53.97		55.84
Panel C: ME = BE												

Table 21 (continued)

Tax bracket	$\overline{\tau}$	$\overline{\tau}_L$	$\overline{\tau} - \overline{\tau}_L$	$\overline{e}$	$\overline{e}_L$	$\overline{e} - \overline{e}_L$	Tax returns (%)		Taxable income (%)		Tax due (%)	
							(1)	(2)	(1)	(2)	(1)	(2)
General tax base												
1	0.24	–	–	0.77	–	–	12.78	8.31	0.00	0.00	2.89	0.33
2	0.28	–	–	0.77	–	–	0.00	0.00	0.00	0.00	0.00	0.00
3	0.37	–	–	0.77	–	–	0.00	0.00	0.00	0.00	0.00	0.00
4	0.43	–	–	0.77	–	–	0.00	0.00	0.00	0.00	0.00	0.00
5	0.44	–	–	0.77	–	–	0.00	0.00	0.00	0.00	0.00	0.00
6	0.45	–	–	0.77	–	–	0.00	0.00	0.00	0.00	0.00	0.00
All brackets	0.37	–	–	0.77	–	–		8.31		0.00		0.33

Table 22 Single: Distribution of $(\overline{\tau}, \overline{\tau}_L)$ and $(\overline{e}, \overline{e}_L)$. Location on the Laffer curve of tax returns, taxable income and tax due in 2011 (pre-tax reform)

Tax bracket	$\overline{\tau}$	$\overline{\tau}_L$	$\overline{\tau} - \overline{\tau}_L$	$\overline{e}$	$\overline{e}_L$	$\overline{e} - \overline{e}_L$	Tax returns (%)		Taxable income (%)		Tax due (%)	
							(1)	(2)	(1)	(2)	(1)	(2)
Panel A: ME > BE												
General tax base												
1	0.24	0.41	− 17.12	0.76	1.58	− 82.27	44.18	29.23	73.74	23.65	88.34	14.44
2	0.28	0.33	− 5.30	0.76	1.00	− 23.91	38.04	9.29	45.45	16.95	49.97	18.26
3	0.37	–	–	0.76	–	–	0.00	0.00	0.00	0.00	0.00	0.00
4	0.43	–	–	0.76	–	–	0.00	0.00	0.00	0.00	0.00	0.00
5	0.44	–	–	0.76	–	–	0.00	0.00	0.00	0.00	0.00	0.00
6	0.45	0.52	− 7.42	0.76	1.04	− 28.02	11.36	0.01	37.17	0.64	39.87	1.73
All bracket	0.37	0.38	− 1.25	0.76	1.23	− 47.60		38.53		41.24		34.44
Panel B: ME < BE												
General tax base												
1	0.24	0.05	18.95	0.76	0.06	69.55	43.53	28.80	26.26	8.42	9.45	1.54
2	0.28	0.17	11.41	0.76	0.40	35.32	61.96	15.13	54.55	20.34	50.03	18.29
3	0.37	0.17	19.74	0.76	0.45	30.30	100.00	6.98	100.00	17.73	100.00	22.90
4	0.43	0.22	21.03	0.76	0.33	42.67	100.00	2.22	100.00	9.93	100.00	17.14
5	0.44	0.16	28.33	0.76	0.19	56.69	100.00	0.14	100.00	1.24	100.00	2.71
6	0.45	0.25	20.39	0.76	0.34	41.86	88.64	0.07	62.83	1.09	60.13	2.61
All brackets	0.37	0.16	20.66	0.76	0.31	44.70		53.34		58.76		65.20
Panel C: ME = BE												

Table 22 (continued)

Tax bracket	$\overline{\tau}$	$\overline{\tau}_L$	$\overline{\tau} - \overline{\tau}_L$	$\overline{e}$	$\overline{e}_L$	$\overline{e} - \overline{e}_L$	Tax returns (%)		Taxable income (%)		Tax due (%)	
							(1)	(2)	(1)	(2)	(1)	(2)
General tax base												
1	0.24	–	–	0.77	–	–	12.29	8.13	0.00	0.00	2.21	0.36
2	0.28	–	–	0.77	–	–	0.00	0.00	0.00	0.00	0.00	0.00
3	0.37	–	–	0.77	–	–	0.00	0.00	0.00	0.00	0.00	0.00
4	0.43	–	–	0.77	–	–	0.00	0.00	0.00	0.00	0.00	0.00
5	0.44	–	–	0.77	–	–	0.00	0.00	0.00	0.00	0.00	0.00
6	0.45	–	–	0.77	–	–	0.00	0.00	0.00	0.00	0.00	0.00
All brackets	0.37	–	–	0.77	–	–		8.13		0.00		0.36

Table 23 Married: Distribution of $(\overline{\tau}, \overline{\tau}_L)$ and $(\overline{e}, \overline{e}_L)$ Location on the Laffer curve of tax returns, taxable income and tax due in 2011 (pre-tax reform)

Tax bracket	$\overline{\tau}$	$\overline{\tau}_L$	$\overline{\tau} - \overline{\tau}_L$	$\overline{e}$	$\overline{e}_L$	$\overline{e} - \overline{e}_L$	Tax returns (%)		Taxable income (%)		Tax due (%)	
							(1)	(2)	(1)	(2)	(1)	(2)
Panel A: ME > BE												
General tax base												
1	0.24	0.49	− 25.02	0.46	1.36	− 90.35	46.71	26.78	71.78	17.01	86.61	8.71
2	0.28	0.42	− 13.91	0.46	0.89	− 43.27	66.11	17.81	72.74	23.75	77.47	21.31
3	0.37	0.41	− 4.34	0.46	0.58	− 12.54	22.13	2.40	26.91	5.82	29.65	7.33
4	0.43	0.49	− 5.97	0.46	0.59	− 12.96	24.24	1.05	32.33	5.00	36.00	8.58
5	0.44	0.00	44.00	0.46	0.00	45.90	0.00	0.00	0.00	0.00	0.00	0.00
6	0.45	0.59	− 14.29	0.46	0.85	− 38.88	34.81	0.08	59.23	2.43	61.66	5.63
All bracket	0.37	0.46	− 8.69	0.46	0.70	− 23.98		48.12		54.01		51.57
Savings tax base												
1	0.19	0.42	− 23.45	1.31	4.26	− 294.88	60.57	57.67	77.45	22.16	86.59	70.72
2	0.21	0.39	− 17.97	1.31	2.81	− 149.48	57.92	2.77	88.39	63.10	80.07	14.67
All brackets	0.20	0.40	− 19.87	1.31	3.93	− 262.14		60.44		85.26		85.40
Panel B: ME < BE												
General tax base												
1	0.24	0.03	20.61	0.46	0.03	43.19	46.12	26.44	28.22	6.69	11.23	1.13
2	0.28	0.16	11.72	0.46	0.24	22.28	33.89	9.13	27.26	8.90	22.53	6.20
3	0.37	0.20	16.88	0.46	0.27	19.25	77.87	8.43	73.09	15.81	70.35	17.40
4	0.43	0.25	17.84	0.46	0.23	22.52	75.76	3.27	67.67	10.46	64.00	15.25

Table 23 (continued)

Tax bracket	$\overline{\tau}$	$\overline{\tau}_L$	$\overline{\tau} - \overline{\tau}_L$	$\overline{e}$	$\overline{e}_L$	$\overline{e} - \overline{e}_L$	Tax returns (%)		Taxable income (%)		Tax due (%)	
							(1)	(2)	(1)	(2)	(1)	(2)
5	0.44	0.23	21.04	0.46	0.19	26.78	100.00	0.35	100.00	2.46	100.00	4.73
6	0.45	0.26	19.04	0.46	0.22	24.02	65.19	0.16	40.77	1.67	38.34	3.50
All brackets	0.37	0.18	18.38	0.46	0.22	24.07		47.78		45.99		48.21
Savings tax base												
1	0.19	0.01	17.67	1.31	0.01	130.12	18.46	17.58	22.55	6.45	0.01	0.01
2	0.21	0.11	9.89	1.31	0.69	62.22	42.08	2.01	11.61	8.29	19.93	3.65
All bracket	0.20	0.07	13.17	1.31	0.52	79.55		19.59		14.74		3.66
Panel C: ME = BE												
General tax base												
1	0.24	–	–	0.77	–	–	7.16	4.11	0.00	0.00	2.17	0.22
2	0.28	–	–	0.77	–	–	0.00	0.00	0.00	0.00	0.00	0.00
3	0.37	–	–	0.77	–	–	0.00	0.00	0.00	0.00	0.00	0.00
4	0.43	–	–	0.77	–	–	0.00	0.00	0.00	0.00	0.00	0.00
5	0.44	–	–	0.77	–	–	0.00	0.00	0.00	0.00	0.00	0.00
6	0.45	–	–	0.77	–	–	0.00	0.00	0.00	0.00	0.00	0.00
All bracket	0.37	–	–	0.77	–	–		4.11		0.00		0.22
Savings tax base												
1	0.19	–	–	0.85	–	–	20.97	19.97	0.00	0.00	13.40	10.94
2	0.21	–	–	0.85	–	–	0.00	0.00	0.00	0.00	0.00	0.00
All brackets	0.20	–	–	0.85	–	–		19.97		0.00		10.94

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