MELBOURNE INSTITUTE
Applied Economic & Social Research

Working Paper Series

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Working Paper No. 05/23
April 2023

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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 (ETI). Applying these to the Spanish income tax demonstrates that 49.46% (58.49%) of the taxpaying population in the non-savings tax base (savings tax base) is on the "prohibitive" side ("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.

JEL classification: H24, H21, H26, H31

Keywords: personal income tax, Laffer curve, tax revenue, elasticity of taxable income

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 five years, and higher in countries such as Italy (145%), Spain (110%), and the US (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 toward 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 neutrality 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. Thus, in Spain,

[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.

it is confirmed that if the impact of marginal personal income tax rates on the collection of these other taxes and costs is omitted, the "normal" zone of the Laffer curve and the potential revenue-raising power of the tax system are overestimated. Specifically, if all these other revenue effects are considered, the actual revenue-maximising tax rates in the Spanish PIT fall sharply 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. Saez et al. 2012; 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 demonstrates that 49.46% of the taxpaying population in the non-savings tax base were on the "prohibitive" side of the Laffer curve, while 58.49% in the savings tax base were on the "normal" side of the curve. On average, taxpayers in the non-savings base were 6.59 points above the maximum of the Laffer curve, while taxpayers in the savings base were 24.73 points below it. This result indicates that the increase in the marginal tax rates in 2012 resulted in a revenue loss for half of the taxpaying population. As a matter of fact, 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. 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.

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 presents the microdata and the ETI employed in the empirical application. This section also offers a simulation exercise. Finally, Section 4 presents the results, and Section 5 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]

[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).

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 $\Lambda^b = (a_1^b, \dots, a_k^b)$ and marginal tax rates $\zeta^b = (\tau_1^b, .., \tau_k^b)$, 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, m_i^b.[3] 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 $\hat{a}_k^b$ denotes the corresponding effective thresholds defined by $\hat{a}_k^b = \frac{1}{\tau_k^b} \cdot \sum_{j=1}^{K} a_j^b \cdot (\tau_j^b - \tau_{j-1}^b)$.[4] 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. Eq. (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:

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

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) 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,

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

[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.

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

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.

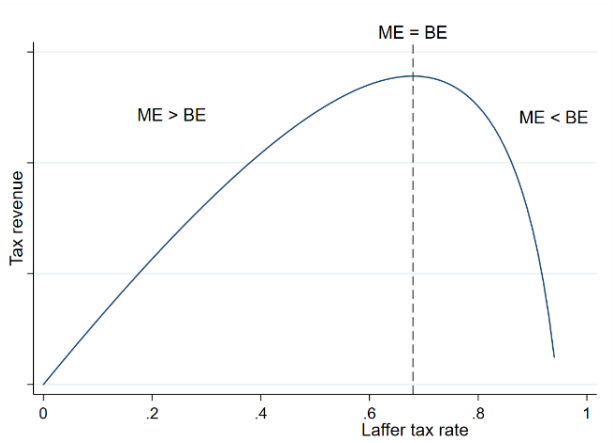

Fig. 1. Laffer curve

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 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 $dR_i/d\tau_h^b = 0$ is met. From $dR_i/d\tau_h^b = 0$, we obtain the following expressions for the individual Laffer rates and the individual Laffer elasticities:

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

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

where, ME_i^b captures the *within* and *outside* MEs associated with taxable income and allowances.[5] Note that $\tau_i^{b^*}$ 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).

[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.

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

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

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

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

Using Eqs. (2) and (3) yields

$$\frac{dR_h}{d\tau_h^b} = \left[\left(\left(\bar{y}_h^b - s \cdot \bar{y}_h^b\right) - a_h^b\right) \cdot N_h^b + \left(a_{h+1}^b - a_h^b\right) \cdot N_h^{b^+}\right) - \left(\left(\bar{m}_h^b - a_h^b\right) \cdot M_h^b + \left(a_{h+1}^b - a_h^b\right) \cdot M_h^{b^+}\right)\right] - \left[\left(\frac{\tau_h^b}{1-\tau_h^b}\right) \cdot \bar{e}_h^b \cdot \bar{y}_h^b \cdot (1-s) \cdot N_h^b\right] \tag{10}$$

where $\bar{e}_h^b$ denotes the average ETI in h (weighted by income), and $\bar{y}_h^b$ and $\bar{m}_h^b$ 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 $dR_h/d\tau_h^b = 0$, we obtain the following expressions for the aggregate Laffer tax rate and the aggregate Laffer elasticity:

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

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

3. Data, ETI and simulation

3.1 Data

The computation of the individual revenue-maximising rax 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 above. To estimate the ETI, we use a balanced panel dataset for 2007–2016, collected and prepared by the Spanish Institute for Fiscal Studies. 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. Second, we only include taxpayers with a positive taxable income from 2007 to 2016. 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.

3.2 The ETI in Spain

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. 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), wich can be expressed as

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

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.[6]

To estimate the ETI, we use the most significant reform of the PIT implemented during our analysis period, the 2012 tax reform. This reform provides us with a valid identifying variation. It meant a substantial increase in the marginal tax rate for all brackets and the introduction of an additional tax bracket at the top, see Table 1. We also consider other changes in the income tax schedule implemented during 2007-2016 (summarised in 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.[7]

Table 1
Spanish PIT schedule.

Tax bracket	Tax rate	Bracket	Tax rate	Bracket	Tax rate	Bracket	Tax rate
Panel A: General tax base							
2007-2010		2011		2012-2014		2015-2016	

[6] 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.

[7] The regional governments of Navarre and the Basque Country have full legislative capacity over the PIT. For this reason, they are not included in this study.

€	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

Table 2 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 two-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 (wagees, 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 A.1 in the Appendix reports robustness checks for these preferred estimates. Table 2 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 & Lopez 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) is more sensitive to taxation than non-savings income (i.e., labour income, business income and non-financial capital).

Table 2
Elasticity of taxable income, all population.

	OLS	Gruber and Saez		Weber	
	(1)	(2)	(3)	(4)	(5)
Panel A: General tax base					
Δ(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					
Δ(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	39776	39780	16349	5838
Savings	76031	76004		

Note: Table 2 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 (wagees, 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. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Table 3 shows the sensitivity of the ETI to 6 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 the general tax base, the estimates of the ETI indicate that women, single taxpayers, and separate tax filers are more responsive to changes in marginal tax rates than are men, married couples and joint tax filers. In the savings base, these estimates show that women, married taxpayers and separate tax filers are more sensitive to taxation than their counterparts.

Table 3

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						
Δ(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						
Δ(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	8027	14644	11340	29458	70115	2623
Savings	53122	22672	56642	5647	64605	12452

Note: Table 3 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 (wagees, 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. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

3.3 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, 2016b, 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 2, 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 2 and 3 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 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 vs 0.640 (general base) and 0.515 vs 0.545 (savings base), see Table 4 (columns 1-4). Figures 2 and 3 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 Section 4.

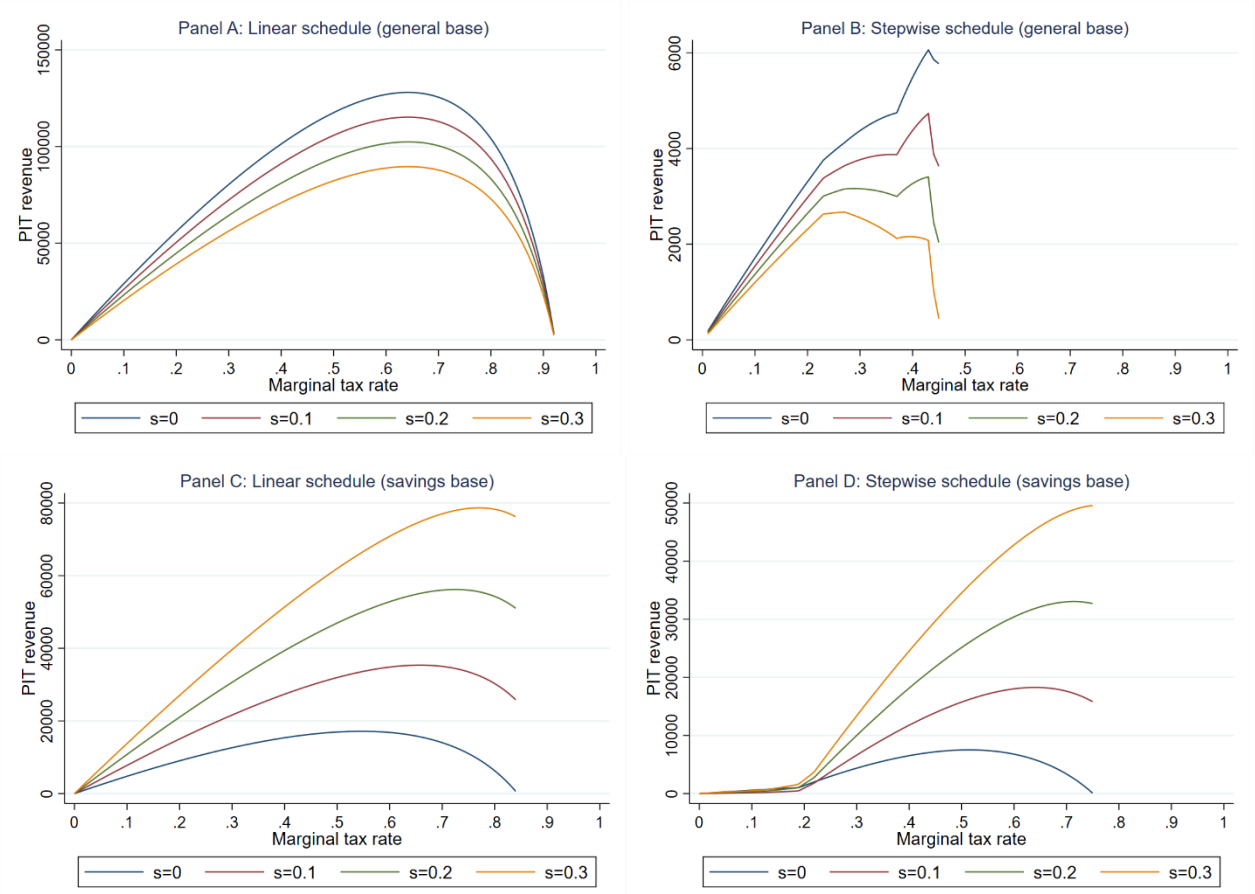

Fig. 2. Laffer curves, linear schedule vs stepwise schedule

Note: Laffer curves in Panel D close to the origin raise tax revenue but in small quantities, i.e., PIT revenue>0.

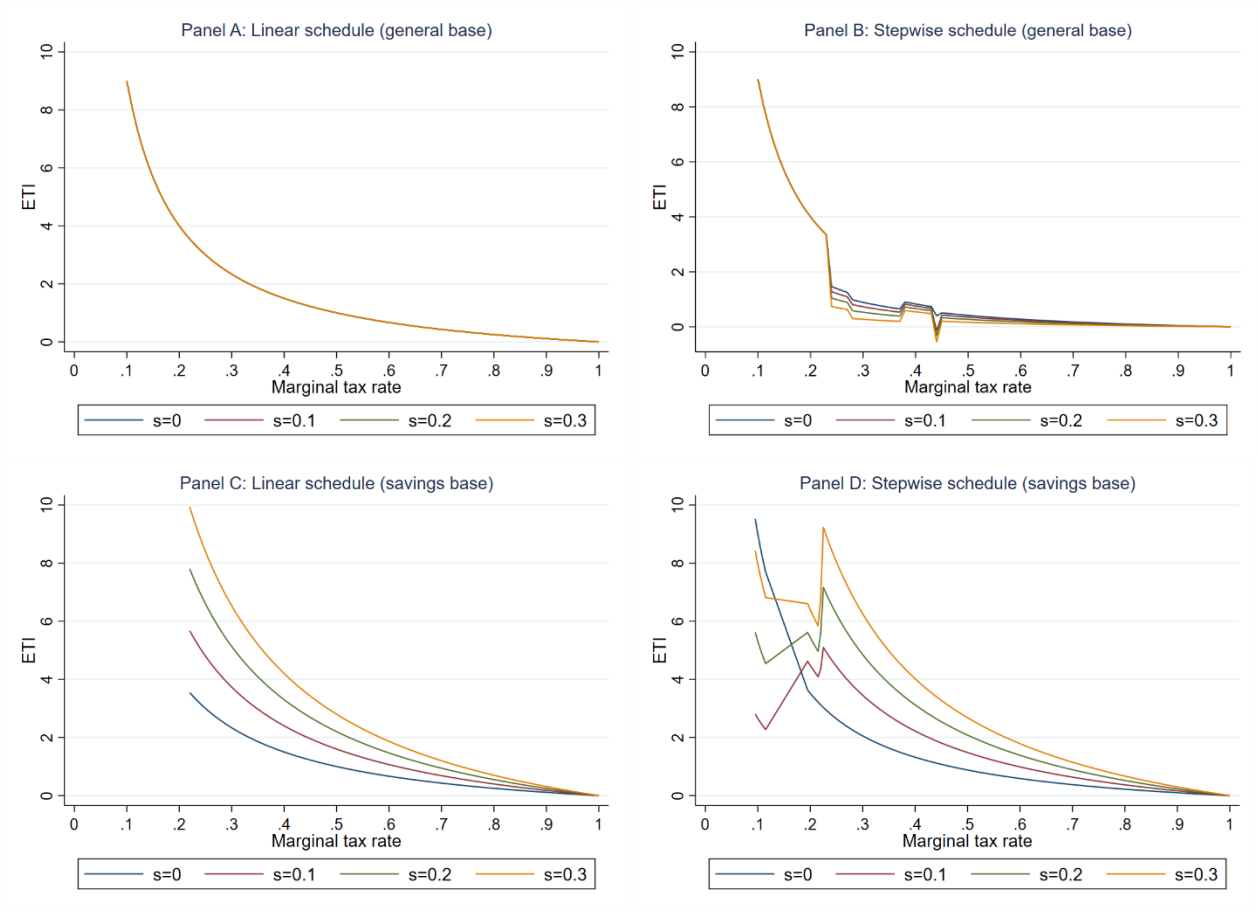

Fig. 3. Fullerton curves, linear schedule vs stepwise schedule

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 4
Linear PIT vs stepwise PIT.

Income shifting	Revenue-maximizing tax rates				Revenue-maximizing 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

4. 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 19,467,623 tax returns for 2011. All monetary variables are adjusted for inflation. For the ETI, we use the estimates in Table 2, 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.

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

Table 5 shows the net impact on revenue of the reform disaggregated into its two components: mechanical and behavioural.[8] 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).[9] 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 5 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 B.1-B.3 in the Appendix evaluate the effect of the 2012 tax reform on tax revenue for 6 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 3. 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 B.1-B.3 shows 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 heterogenous revenue effects across the population, as some groups are more sensitive to the tax than others.

The Spanish PIT is a dual-income tax with two tax bases, the general base and the savings base. The general base includes income from labour, business, movable capital (derived from intellectual and industrial property, technical assistance, renting of movable property, businesses or mines, subletting and leasing image rights), immovable capital, capital gains (not derived from the transfer of assets) and imputed income. The savings base includes income from movable capital (derived from dividends, interest, income from insurance and capitalisation operations) and capital gains (derived from transmissions and reimbursements of assets). Both bases are taxed according to a stepwise schedule with increasing marginal rates, where τ_k(savings) < τ_k(general), see Table 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. 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 toward 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:[10] 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), see Table 5 (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 5 (column 3).

Table 5

[8] 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).

[9] As a matter of fact, when the 2012 tax reform was announced, the government forecast a revenue gain (ignoring behavioural responses) of 5.4 billion euros.

[10] Note that we do not assume cross-responses as in Lefebvre et al. (2022). That is, we assume income shifting is only possible from the general base to the savings base, not vice versa. Therefore, the Behavioural Effect from the general base is directly affected by these responses, while the Behavioural Effect from the savings base is only affected by structural factors.

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 brackets	€ 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 brackets	€ 877,542,341		€ 224,058,575		€ 653,483,766		25.53
Total taxable income	€ 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 brackets	€ 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 brackets	€ 1,689,557,566		€ 451,451,683		€ 1,238,105,884		26.72
Total taxable income	€ 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 brackets	€ 2,797,631,140		€ 1,649,988,484		€ 1,147,642,656		58.98
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 brackets	€ 2,666,511,646		€ 1,105,693,813		€ 1,560,817,832		41.47
Total taxable income	€ 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 brackets	€ 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 brackets	€ 3,819,887,584		€ 1,822,041,314		€ 1,997,846,270		47.70
Total taxable income	€ 5,939,983,719		€ 3,093,929,879		€ 2,846,053,841		52.09

Note: A positive behavioural effect indicates a decrease in tax revenue.

4.2 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 6 and C.1-C.3 in the Appendix report the pre-reform mean value – weighted by income – of these parameters in each tax bracket ($\bar{\tau}_L, \bar{e}_L$), and their difference from the actual values of the marginal tax rate $(\bar{\tau} - \bar{\tau}_L)$ and the elasticity $(\bar{e} - \bar{e}_L)$. 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: $(\bar{\tau} > \bar{\tau}_L) = 0.37 > 0.30$ and $(\bar{e} > \bar{e}_L) = 0.55 > 0.40$, see Table 6 (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 Section 4.1, we observe that $(\bar{\tau} < \bar{\tau}_L)$ in the lower tax brackets and $(\bar{\tau} > \bar{\tau}_L)$ in the middle and top tax brackets. As for the savings tax base, Table 6 (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: $(\bar{\tau} < \bar{\tau}_L) = 0.20 < 0.45$ and $(\bar{e} < \bar{e}_L) = 0.82 < 3.32$. 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 C.1-C.3 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 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 ($\bar{\tau}$ and $\bar{\tau}_L$) and ($\bar{e}$ and $\bar{e}_L$) 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.

Table 6
Revenue-maximising tax rates and elasticities in 2011 (pre-tax reform).

Tax bracket	$\bar{\tau}$	$\bar{\tau}_L$	$\bar{\tau} - \bar{\tau}_L$	$\bar{e}$	$\bar{e}_L$	$\bar{e} - \bar{e}_L$
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

4.3 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 7 and D.1-D.6 in the Appendix report $(\bar{\tau}_L, \bar{e}_L)$, $(\bar{\tau} - \bar{\tau}_L)$, $(\bar{e} - \bar{e}_L)$, 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 7 (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 5 (Panel A). As a result, the impact in terms of taxable income and tax due is more severe in these brackets.

Tables D.1-D.6 (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 7
Distribution of $(\bar{\tau}, \bar{\tau}_L)$ and $(\bar{e}, \bar{e}_L)$. Location on the Laffer curve of tax returns, taxable income, and tax due in 2011 (pre-tax reform).

Tax bracket	$\bar{\tau}$	$\bar{\tau}_L$	$\bar{\tau} - \bar{\tau}_L$	$\bar{e}$	$\bar{e}_L$	$\bar{e} - \bar{e}_L$	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 brackets	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
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 brackets	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 brackets	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 brackets	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

Note: (1) In the bracket, (2) in the total.

5. 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

Table A.1
Robustness checks: ETI

	General base (1)	Savings base (2)

Panel A: No exclusion		
Δ(1-t)	0.822***	0.868***
	(0.106)	(0.275)
N	1,159,632	639,126
Panel B: Drop gross income < €5,000		
	0.562***	0.885***
	(0.104)	(0.286)
N	1,144,212	605,732
Panel C: Drop gross income < €10,000		
Δ(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		
Δ(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		
	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		
Δ(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	6377	82638
Drop gross income < €5,000	6128	76818
Drop gross income < €10,000	4864	74443
Exclude taxpayers who change marital status	5471	76312
Exclude taxpayers who change tax filing status	4651	58990
Exclude taxpayers who change residence	6171	78949

Appendix B

Table B.1

Gender: 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: 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 brackets	€ 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 brackets	€ 355,851,883		€ 96,142,707		€ 259,709,176		27.02
Total taxable income	€ 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 brackets	€ 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 brackets	€ 521,690,458		€ 120,582,560		€ 401,107,898		23.11
Total taxable income	€ 3,556,299,352		€ 1,905,435,656		€ 1,650,863,695		53.58

Table B.2
Tax filing: 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: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 brackets	€ 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 brackets	€ 729,791,497		€ 294,280,752		€ 435,510,746		40.32
Total taxable income	€ 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 brackets	€	867,268,921		€	557,413,730		€	309,855,191		64.27
Savings base										
1	€	47,014,708.25	31.82	€	0	-	€	47,014,708.25	31.82	-
2	€	100,736,135.78	68.18	€	0	-	€	100,736,135.78	68.18	-
All brackets	€	147,750,844.03		€	0		€	147,750,844.03		-
Total taxable income	€	1,015,019,765		€	557,413,730		€	457,606,035		54.92

Table B.3
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 brackets	€ 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 brackets	€ 281,509,263		€ 0		€ 281,509,263		-
Total taxable income	€ 1,650,111,971		€ 1,092,574,962.80		€ 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 brackets	€ 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 brackets	€ 596,033,078		€ 241,238,785		€ 354,794,293		40.47
Total taxable income	€ 3,558,206,746		€ 1,744,477,027		€ 1,813,729,719		49.03

Appendix C

Table C.1
Gender: Revenue-maximising tax rates and revenue-maxisiming elasticities in 2011 (pre-tax reform).

Tax bracket	$\bar{\tau}$	$\bar{\tau}_L$	$\bar{\tau} - \bar{\tau}_L$	$\bar{e}$	$\bar{e}_L$	$\bar{e} - \bar{e}_L$

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 C.2
Tax filing: Revenue-maximising tax rates and revenue-maxisiming elasticities in 2011 (pre-tax reform).

Tax bracket	$\bar{\tau}$	$\bar{\tau}_L$	$\bar{\tau} - \bar{\tau}_L$	$\bar{e}$	$\bar{e}_L$	$\bar{e} - \bar{e}_L$
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 C.3
Marital status: Revenue-maximising tax rates and revenue-maxisiming elasticities in 2011 (pre-tax reform).

Tax bracket	$\bar{\tau}$	$\bar{\tau}_L$	$\bar{\tau} - \bar{\tau}_L$	$\bar{e}$	$\bar{e}_L$	$\bar{e} - \bar{e}_L$
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 D

Table D.1
Women: Distribution of $(\bar{\tau}, \bar{\tau}_L)$ and $(\bar{e}, \bar{e}_L)$. Location on the Laffer curve of tax returns, taxable income, and tax due in 2011 (pre-tax reform).

Tax bracket	$\bar{\tau}$	$\bar{\tau}_L$	$\bar{\tau} - \bar{\tau}_L$	$\bar{e}$	$\bar{e}_L$	$\bar{e} - \bar{e}_L$	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 brackets	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 brackets	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
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 brackets	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 brackets	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 D.2

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

Tax bracket	$\bar{\tau}$	$\bar{\tau}_L$	$\bar{\tau} - \bar{\tau}_L$	$\bar{e}$	$\bar{e}_L$	$\bar{e} - \bar{e}_L$	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 brackets	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 brackets	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
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 brackets	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 brackets	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 brackets	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 D.3

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

Tax bracket	$\bar{\tau}$	$\bar{\tau}_L$	$\bar{\tau} - \bar{\tau}_L$	$\bar{e}$	$\bar{e}_L$	$\bar{e} - \bar{e}_L$	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
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 brackets	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 brackets	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 D.4

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

Tax bracket	$\bar{\tau}$	$\bar{\tau}_L$	$\bar{\tau} - \bar{\tau}_L$	$\bar{e}$	$\bar{e}_L$	$\bar{e} - \bar{e}_L$	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												
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 D.5

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

Tax bracket	$\bar{\tau}$	$\bar{\tau}_L$	$\bar{\tau} - \bar{\tau}_L$	$\bar{e}$	$\bar{e}_L$	$\bar{e} - \bar{e}_L$	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 brackets	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												
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 D.6

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

Tax bracket	$\bar{\tau}$	$\bar{\tau}_L$	$\bar{\tau} - \bar{\tau}_L$	$\bar{e}$	$\bar{e}_L$	$\bar{e} - \bar{e}_L$	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 brackets	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
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 brackets	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 brackets	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

Declarations of competing interest The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgements The authors thank the Instituto de Estudios Fiscales (IEF) for providing access to the administrative tax-return data. The authors also thank Prof. James Hines for his comments.

Funding This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

References

Almunia, M. & López-Rodríguez, D. (2019). The elasticity of taxable income in Spain: 1999-2014. *SERIEs, 10,* 281-320.

Arrazola, M., Hevia, J., Sanz-Sanz, J.F. & Romero, D. (2019). Assessing tax reforms through the elasticity of reported income: an empirical analysis for Spain. *Applied Economics, 51,* 6040-6053.

Auten, G., & R. Carroll. (1999). The Effect of Income Taxes on Household Behaviour. *Review of Economics and Statistics 81 (4),* 681–693.

Creedy, J. & Gemmell N. (2006). *Modelling Tax Revenue Growth*. Edward Elgar, Cheltenham, England.

Creedy, J. & Gemmell N. (2013). "Measuring revenue responses to tax rate changes in multi-rate income tax systems: behavioural and structural factors". *International Tax and Public Finance, 20 (6),* 974-991.

Creedy, J. & Gemmell, N. (2014). "Measuring Revenue-Maximising Elasticities of Taxable Income: Evidence for the US Income Tax". *Victoria University of Wellington Working Papers in Public Finance*, No. 02/2014.

Creedy, J. & Gemmell, N. (2015). "Revenue-maximising elasticities tax rates and elasticities of taxable income in New Zealand". *New Zealand Economic Papers. 49 (2),*189-206.

Creedy, J. (2015). The elasticity of taxable income, welfare changes and optimal tax rates. *New Zealand Economic Papers, 49 (3),* 227-248.

Creedy, J. (2022). *The Elasticity of Taxable Income. Theory and Estimation.* Edward Elgar, Cheltenham, England.

Fullerton D. (1982). On the possibility of an inverse relationship between tax rates and government revenues. *Journal of Public Economics 19*, 3-22.

Gruber, J. & Saez, E. (2002). The Elasticity of Taxable Income: Evidence and Implications. *Journal of Public Economics, 84*, 1-32.

IMF (2022). Fiscal Monitor: Helping People Bounce Back. Washington, DC: IMF, October.

Lefebvre, M., Lehmann, E. & Sicsic, M. (2022). Estimating the Laffer Tax Rate on Capital Income: Cross-Base Responses Matter!, *CESifo Working Paper Series 9879*, CESifo.

Saez, E., Slemrod, J. & Giertz, S. H. (2012). The Elasticity of Taxable Income with Respect to Marginal Tax Rates: A critical review. *Journal of Economic Literature, 50*, 3-50.

Sanz-Sanz, J.F. (2016a). The Laffer curve in schedular multi-rate income taxes with non-genuine allowances: An application to Spain. *Economic Modelling*, *55*, 42-56.

Sanz-Sanz J.F. (2016b). Revenue-Maximising Tax Rates in Personal Income Taxation in the Presence of Consumption Taxes: A Note. *Applied Economics Letters, 23 (8),* 571-575.

Sanz-Sanz J.F. (2022) "A Full-Fledged Analytical Model for the Laffer Curve in Personal Income Taxation", *Economic Analysis and Policy*, *73*, 795-811.

Weber, C. (2014). Toward obtaining a consistent estimate of the elasticity of taxable income using difference-in-differences. *Journal of Public Economics, 117*, 90-103.


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