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How do taxable income responses to marginal tax rates differ by sex, marital status and age? Evidence from Spanish dual income tax

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Abstract
The aim of this paper is to analyze how Spanish taxpayers have responded to the introduction of the dual personal income tax model in 2007. The authors estimate the elasticity of taxable income (ETI) with respect to the marginal net tax rate for different groups of taxpayers by sex, marital status and age, separating the substitution effect from the income effect. For the empirical analysis, they use microdata from the Spanish personal income tax return panel disseminated by the Spanish Institute of Fiscal Studies. The main results show that the 2007 tax reform resulted in a range of elasticity values from 0.41 to 0.43, while the estimated income effect yields a negative value of -0.18. The results for the different taxpayer groups are as follows: the removal of retired people from the sample significantly reduces the ETI; elasticity is higher for women than for men; single people have a considerably higher elasticity than married taxpayers; and the ETI decreases with age. Additionally, the authors find that the marginal cost of public funds increased after the reform, and the top marginal tax rate is above optimal.

JEL H21, H24, H31
Keywords Elasticity of taxable income (ETI); tax reforms; dual income tax; marginal cost of public funds; optimal tax rates
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1 Introduction

The concept of the elasticity of taxable income (ETI) with respect to the marginal net-of-tax rate is a key tool for analyzing taxpayer behavior in the field of the economics of taxation. As opposed to the traditional approach based on labor supply, the calculation of this elasticity can capture overall responses to income taxation, such as income shifting, the choice of different asset types, tax evasion or labor changes. Additionally, the ETI can estimate other important concepts, such as the deadweight loss of income taxation, the marginal cost of public funds and the optimal tax rate. Nevertheless, the previous literature has tended to overlook these issues.

Feldstein (1995) was the first to estimate ETI in a seminal paper applying a single difference-in-differences (DID) estimation for United States panel data after the tax reform implemented in 1986[1]. Since then, the literature studying the ETI has grown continuously as a result of the development different toolkits for estimating tax rate changes (Auten and Carroll, 1999; Moffitt and Wilhelm, 2000; Gruber and Saez, 2002). Giertz (2004) and Saez et al. (2012) surveyed the methodologies, database and empirical analysis of the ETI. Against this backdrop, there is a growing literature on estimated elasticities addressing many unanswered questions regarding income shifting, changing tax avoidance behavior and so on.

Since the pioneering research by Feldstein (1995), the ETI literature has traditionally focused on the United States of America (Austen and Carroll, 1999; Moffitt and Wilhelm, 2000; Gruber and Saez, 2002; Saez, 2001, 2003; Kopczuk, 2005; Giertz, 2007 and Heim, 2009). However, literature addressing other countries, such as Canada (Sillamaa and Veall, 2001; Saez and Veall, 2005), Denmark (Kleven and Schultz, 2013), Finland (Pirttilä and Selin, 2011), Germany (Gottfried and Witczark, 2009), Hungary (Bakos et al., 2008; Kiss and Mosberger, 2015), New Zealand (Claus et al., 2012; Creedy and Gemmell, 2013), Norway (Aarbu and Thoresen, 2001), Spain (Badenes, 2001; Díaz, 2004, Sanmartín, 2007; Onrubia and Sanz, 2009, Arrazola et al. 2014; Sanz-Sanz et al. 2015); and Sweden (Ljunge and Ragan, 2006; Hansson, 2007; Holmlund and Söderström, 2007; Blomquist and Selin, 2010) is growing.

[1] Previously, Lindsey (1987) had estimated the United States' ETI for 1982 and 1984, although this proposal had some methodological limitations.

The literature has identified two main problems with regard to the estimation of ETI: (i) the control of the mean reversion phenomenon and of the changes in income distribution, which are both normally solved in the literature using a logarithm of initial income or spline functions; and (ii) the endogeneity problem of the marginal tax rate, where the usual procedure is to include an instrument for the variable. As shown in Section 3, we apply both approaches in order to calculate the ETI. In the literature, the results of the ETI estimation range from 0.1 to 1.5, depending on both the methodological approach and the specific content of the tax reform. However, there are fewer papers that analyze the deadweight loss (Feldstein 1999), the marginal cost of public funds (Creedy, 2010) and the optimal tax rates for personal income taxes (Saez 2001, Gruber and Saez, 2002, Saez et al, 2012).

Thus, the latest reform of the Spanish personal income tax (PIT) structure provides an appropriate context for calculating ETI. In fact, the structure of Spanish PIT has, since 2007, been semi-dual, with two different bases: the general base taxed according to a progressive schedule, and the savings base taxed at a flat tax rate of 18%. This reform altered the progressive tax schedule, raising the top marginal income tax rate to 45% (from 43%) and increasing the minimum marginal tax rate from 15% to 25%. Other changes, such as the definition and the amount of personal and family allowances and other deduction parameters, were also introduced with the reform. Nevertheless, this semi-dual PIT differs from the pure Nordic dual model on some points. Firstly, not all capital income is taxed at a flat tax rate (i.e., rental income and royalties). Secondly, all income from business and professional activities is included in the general base, and no distinction is made between self-employed salary and capital income in respect of return on business investment.

Hence, the aim of this paper is to analyze taxpayers' behavioral responses to the above PIT reform. To do this, we apply the econometric framework proposed by Gruber and Saez (2002), although we introduce some methodological variants to make a distinction between the substitution and income effects. Spanish personal income tax return panel microdata for the years 2006 and 2007 have been used in the empirical analysis. These data were collected by the Spanish Tax Administration Agency (AEAT) and are made available by the Spanish Institute of Fiscal Studies (IEF). This database represents the entire Spanish taxpayer population in each tax year, providing key economic information from the tax return, as well as a set of socio-personal and family variables.

This paper makes three contributions to the existing literature. Firstly, we compute and provide a detailed analysis of the ETI for the semi-dual income tax structure after the Spanish PIT reform. Secondly, thanks to the wide range of ETI for different taxpayer groups output by the above calculation, we control our estimations by gender, age and marital status. Then, based on the ETI, we estimate the deadweight loss and the marginal cost of public funds caused by the reform. Finally, we calculate the optimal marginal tax rates according to the elasticities estimated for the population as a whole. Based on these findings, we can assess the impact on efficiency costs of the introduction of the semi-dual income tax in Spain.

Section 2 reports the structure of the Spanish PIT and the main features of the dual reform introduced in 2007. Section 3 shows the theoretical framework and the methodological approach for calculating the ETI, deadweight loss, marginal cost of public funds and optimal tax rates. Section 4 describes the database and discusses the results of the ETI for all taxpayers and each of the different groups mentioned above. Finally, Section 5 concludes with a brief summary of the major findings.

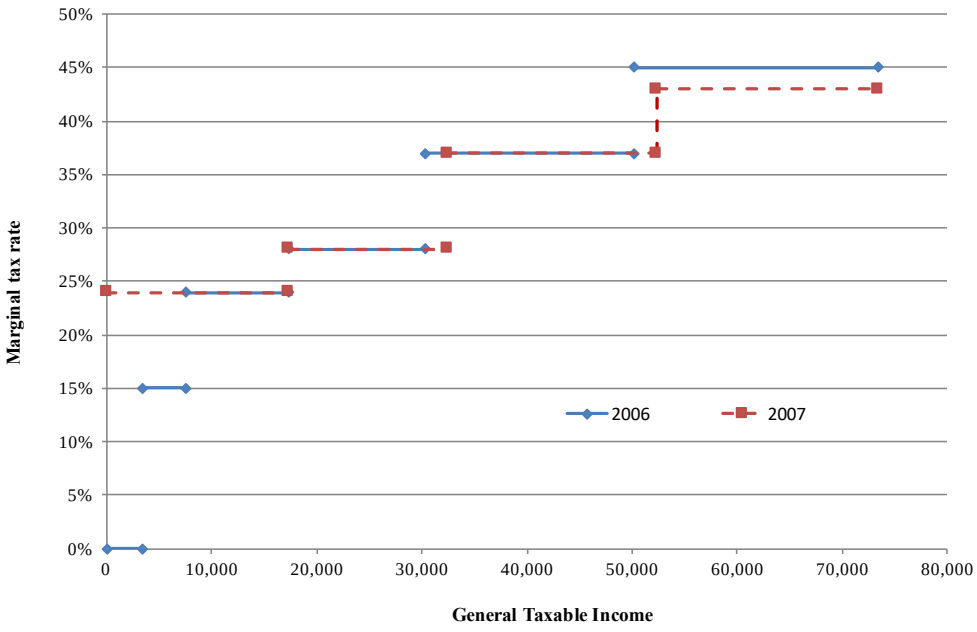
2 The 2007 Spanish Personal Income Tax Reform

Pursuant to what was the most important fiscal reform since 1999, a semi-dual model of personal income taxation was introduced in 2007 (Law 35/2006) in Spain. This semi-dual model differs from the pure Nordic dual model on several points. Note that the previous PIT structure was not strictly a synthetic base model. Therefore, some long-term capital gains, included in the so-called special base, were taxed at a flat rate of 15%. Even so, the reform applies a new flat tax rate of 18% for most of the capital income in the savings base, whereas the capital income for non-financial capital (like real estate income, royalties, intellectual and industrial property income, and winnings from competitions, games and gambling) is classed in the general base and taxed according to a progressive tax schedule together with earned income, pensions, unemployment benefits, self-employment and business income.

Prior to the reform, the special base for net capital gains (or losses) from assets held for a period longer than one year was subject to a tax rate of 15%, whereas other income was classed in the general base and taxed according to five marginal tax rates ranging from

15% to 45%. The top marginal rate in the progressive tax schedule was then reduced to 43%, and the number of tax brackets was decreased to four. Figure 1 describes the marginal tax rates for the respective brackets of "general" taxable income in 2006 and 2007. The new PIT model also changed the treatment of both personal and family circumstances, which it transformed into non-refundable tax credits (in 2006 they were treated as tax allowances). Besides, the reform included several changes to the definition of the amounts and parameters for reductions, exemptions and deductions used to calculate the two new taxable bases. Tables A.1 and A.2 in the Appendix show the differences between the structure and main parameters before and after the PIT reform.

Figure 1: **Spanish PIT marginal tax rates for the years 2006 and 2007**



Source: own elaboration.

3 Theoretical framework

In this section, we explain the methodology applied to estimate the ETI, as well as the approach used to calculate the deadweight loss, the marginal cost of public funds and the optimal tax rate for different brackets.

3.1 Elasticity of taxable income

The ETI is calculated according to the econometric framework proposed by Gruber and Saez (2002). Nevertheless, as shown in Equation 1, we implemented an extended version following Bakos et al. (2008) to derive the income effect[2]:

$$\Delta \log y = \beta^C \Delta \log(1-\tau) + \eta \Delta \log(1-t) \quad (1)$$

where β^C is the ETI with respect to the marginal tax (τ) and (η) is the income effect yielded by the change in the logarithm of the net average tax rate $\Delta \log(1-t)$. However, the estimation of the ETI from Equation 1 is troublesome in two respects. Firstly, endogeneity is an issue to be taken into account because the variations in the marginal tax rate and the average tax rate may be caused not only by legal modifications, that is, exogenous changes, but also by variations in taxable income, that is, endogenous changes. To rule out an inconsistent estimation of both the marginal and average tax rates, we include an instrument for both parameters. Particularly, the synthetic marginal tax rate $\Delta \log(1-\tau') = \log\big(1-\tau_2(\tilde{y}_1)\big) - \log\big(1-\tau_1(y_1)\big)$ and the synthetic average tax rate $\Delta \log(1-t') = \log\big(1-t_2(\tilde{y}_1)\big) - \log\big(1-t_1(y_1)\big)$ are calculated for each taxpayer applying the new tax schedule to the pre-reform taxable income (i.e., 2006 taxable income), adjusted for inflation ($\tilde{y}_1$). In this way, the synthetic parameters only include the exogenous changes and are estimated using a two-stage instrumental regression.

The other concern in the econometric specification is the well-known regression to mean. This phenomenon occurs with respect to taxpayers whose income is high (by chance) in one period and drops in the following period, thus leading to problems caused by changes in income distribution. The existence of mean reversion produces biased estimates, being necessary therefore to control it. Following Auten and Carroll (1999) and Moffitt and Wilhelm (2000), we include the logarithm of initial incomes to solve the problem[3].

Finally, Equation 2 includes a set of non-time varying socioeconomic variables $\big(x_j\big)$, such as age, gender, marital status, etc. that we think may influence the dependent variable, and where u_i is the error term:

[2] Kiss and Mosberger (2015) apply this approach to estimate the ETI for high earners in Hungary.
[3] Other authors include quantile splines, but this does not improve the continuity of the distribution of taxable income.

$$\Delta \log y_i = \rho + \beta^C \Delta \log(1 - \hat{\tau}_i) + \eta \Delta \log(1 - \hat{t}_i) + \gamma \log y_{i_1} + \sum_j \delta_j x_{j_i} + u_i \qquad (2)$$

3.2 Deadweight loss and the marginal cost of public funds

The deadweight loss (*DWL*) for each taxpayer is calculated based on the proposal by Feldstein (1999) after previously estimating ETI:

$$DWL = \frac{1}{2} \frac{\tau^2}{(1-\tau)} \beta^C y \qquad (3)$$

Likewise, the marginal excess burden (*MEB*) can be calculated in marginal terms, following Creedy *(*2010). Thus, *MEB* corresponds to the maximum marginal tax rate (τ_m) and is applied to personal income that exceeds a threshold z_{τ_m}. Therefore, it would be determined by the following expression:

$$MEB = N_{\tau_m} \left(\bar{z}_{\tau_m} - z_{\tau_m} \right) \beta^C \alpha_{\tau_m} \left(\frac{\tau_m}{1-\tau_m} \right) \qquad (4)$$

where $\bar{z}_{\tau_m}$ represents the average income of all N_{τ_m} individuals whose income is higher than z_{τ_m}, where $\alpha_{\tau_m} = \bar{z}_{\tau_m} / \left(\bar{z}_{\tau_m} - z_{\tau_m} \right)$.

Thus, *MEB* can be used to determine the marginal welfare cost (*MWC*) by merely dividing Equation 4 by the change in tax revenue as a result of taxing these incomes at the tax rate τ_m:

$$MWC = \frac{\beta^C \tau_m \alpha_{\tau_m}}{1 - \tau_m - \beta^C \tau_m \alpha_{\tau_m}} \qquad (5)$$

Thus, the marginal cost of public funds (*MCPF*) for the Spanish Personal Income Tax application to the last tax bracket would be written as follows[4]:

$$MCPF = 1 + \frac{\beta^C \tau_m \alpha_{\tau_m}}{1 - \tau_m - \beta^C \tau_m \alpha_{\tau_m}} \qquad (6)$$

Besides, the above *MEB* approach can be applied for any bracket *k* of the tax scale:

$$MEB_k = N_k (\bar{z}_k - z_k) \frac{\beta_k^C \tau_k \alpha_{\tau_k}}{1 - \tau_k} \qquad (7)$$

[4] *MCPF* is defined in the literature as the welfare cost, in monetary terms, of raising an additional euro of tax revenue, $MCPF = 1 + MEB$, (Browning, 1976, 1987). However, there are different ways of measuring *MCPF* depending on how the deadweight loss is calculated (basically whether the prices before or after the change in the amounts of tax are taken into account). Dahlby (2008) offers an extensive discussion of *MCPF* measurement.

where N_k is the number of taxpayers classed according to their income in the tax bracket *k*, $\bar{z}_k$ is the average net tax base of taxpayers up to tax bracket *k*, z_k is the threshold related to bracket *k*, τ_k is the marginal tax rate applicable to bracket *k*, where β_k^C is the compensated (taxable income-net marginal tax rate) elasticity estimated for taxpayers within bracket *k* of the net tax base. Likewise, if $\alpha_{\tau_k} = \bar{z}_k/(\bar{z}_k - z_k)$, the expression denoting the marginal welfare cost for taxpayers affected by the marginal tax rate τ_k would be as specified in Equation 8:

$$MWC_k = \frac{\beta_k^C \tau_k \alpha_{\tau_k}}{1-\tau_k-\beta_k^C \tau_k \alpha_{\tau_k}+D_k} \quad (8)$$

where[5],

$$D_k = \frac{N_{k+1}}{N_k}\left(\frac{\alpha_{\tau_{k+1}}-\alpha_{\tau_k}}{\bar{z}_k-\alpha_{\tau_k}}\right)(1-\tau_k) \quad (9)$$

Therefore, the marginal cost of public funds paid by taxpayers within bracket *k* can be expressed as denoted in Equation 10 below:

$$MCPF_k = 1 + \frac{\beta_k^C \tau_k \alpha_{\tau_k}}{1-\tau_k-\beta_k^C \tau_k \alpha_{\tau_k}+D_k} \quad (10)$$

3.3 Optimal marginal tax rates

Finally, we estimate the marginal tax rates that minimize the deadweight loss caused by the Spanish dual PIT reform. According to Gruber and Saez (2002), the optimal marginal tax rate (τ^*), which, if applied, maximizes the potential tax revenue raised by considering a single tax rate, can be written as shown in Equation 11:

$$\tau^* = (1+\beta^C)^{-1} \quad (11)$$

where β^C represents the average compensated ETI of all taxpayers.

Considering a PIT with *k* marginal tax rates, the optimal marginal tax rate applicable to each one of the brackets of the net tax base (τ_k^*) would be:

$$\tau_k^* = \left(1+\beta_k^C \alpha_{\tau_k}\right)^{-1} \quad (12)$$

[5] Note, in particular, that the maximum marginal tax rate, e.g. $\alpha_{\tau_{k+1}} = \infty$, and therefore $D_k = 0$ should be taken into account.

4 Data and results

4.1 Data

In this section, we briefly describe the Spanish Personal Income Tax Return panel made available by the Spanish Institute of Fiscal Studies (IEF), which is used to estimate the ETI. This microdata base is an expanded panel that represents the Spanish population of taxpayers of each year. The current panel covers the period from 1999 to 2013. Four characteristics make it suitable for tax/income analysis and microsimulation purposes[6]: method of stratification according to region (Autonomous Community), income level and major income source; minimum variance sampling, which leads to income estimations with an relative sampling error of less than 1‰; size, ranging from 380,000 to 600,000 observations per year; and low attrition.

Specifically, the sample used to estimate ETI consists of a balanced panel that includes all taxpayers fulfilling the condition of having filed their tax return in the years 2006 and 2007. Furthermore, we apply the constraint of unchanged marital status and household type. We ended up with a sample of 494,591 tax returns, which is representative of a population of 17,760,637 taxpayers.

To estimate the compensated ETI, we first define the taxable income from all sources of income, according to the proposal by Onrubia and Picos (2012). Accordingly, the income for both years is homogeneous. As a result, capital gains are not included in taxable income for several reasons. Firstly, due to sporadicity, annual capital gains are highly volatile. Secondly, taxpayers would be able to anticipate capital gains realizations, which would distort their measurement and subsequently the effects of the reform (Burman et al., 1994)[7].

Table 1 shows the description and the main statistics for the variables used. The average change in the taxable income is positive, as is the net marginal tax rate, both of which denote a reduction in the applied marginal tax rate. The average net tax rate suggests that tax revenue increases after the reform. The main characteristics of taxpayers reveal that 70% are married couples, average age is around 48 years, the majority of taxpayers are male, and the average number of descendants is close to one. With respect to the source

[6] For further information about the description and characteristics of the 1999-2013 Spanish Personal Income Tax Return panel, see Onrubia and Picos (2011) and Onrubia et al. (2011).
[7] Díaz-Caro and Crespo (2016) analyze the "lock-in effect" of capital gains for this tax reform.

income structure, we find that 20% of taxpayers are self-employed workers and professionals, and over 80% receive income from investment and savings, 32% from real estate property and 7% declare capital gains. Finally, the main income earners accounted for about 90% of taxable income in 2006.

Table 1: **Description of variables and summary statistics**

Variable	Description	Mean	SD	Min	Max
$\Delta \log y$	Change in the logarithm of taxable income	0.11	0.94	-14.48	18.30
$\Delta \log(1-\tau)$	Change in the logarithm of marginal net tax rate	0.17	0.22	-5.82	4.87
$\Delta \log(1-\tau')$	Change in the logarithm of synthetic marginal net tax rate	0.36	1.23	-10.72	12.64
$\Delta \log(1-t)$	Change in the logarithm of average net tax rate	-0.04	0.58	-10.91	10.47
$\Delta \log(1-t')$	Change in the logarithm of synthetic average net tax rate	0.17	0.23	-3.92	0.57
$\log y_1$	Logarithm of initial income (2006)	14.32	1.40	0.00	23.41
Age	Taxpayer age in 2006	48.41	15.53	0.10	106.11
Gender	Variable whose value is 1 if the taxpayer is male and 0 if the taxpayer is female.	0.72	0.45	0.00	1.00
Number of children	Number of taxpayer children included in the concept of minimum family allowance for descendants.	0.93	0.83	0.00	20.00
Self-employed	Variable whose value is 1 if the taxpayer filed tax returns in relation to economic activities in 2006 and 0 otherwise.	0.20	0.40	0.00	1.00
Income from investments and savings	Variables whose value is 1 if the taxpayer received income from these categories respectively in 2006 and 0 otherwise.	0.88	0.32	0.00	1.00
Income from real estate property		0.32	0.46	0.00	1.00
Capital Gains		0.07	0.26	0.00	1.00
Marital Status	Variable whose value is 0 if the taxpayer is a single, widowed or separated person, with or without minors, and 1 if the taxpayer is married.	0.70	0.45	0.00	1.00
Percentage of income of main income earner	Variable whose value is either 0 or 1 depending on the percentage of the total taxable income of the tax unit accounted for by the income of the main income earner (1 for unmarried individuals and married couples with only one wage earner).	0.90	0.20	0.00	1.00

Note: Values of variables for the 2006 fiscal year.
Source: own elaboration from Spanish Personal Income Tax Return Panel for year 2006 and 2007.

Dual income taxes pose a particular problem with regard to the selection of the marginal tax rate for estimating the ETI. Specifically, taxpayers have two marginal tax rates, referring to the general and the savings base, respectively. Thus, one advantage of calculating this elasticities is that they can take into account the possible shift between the two tax base categories[8]. We take up the idea that the weighted marginal tax rate is relevant for decision making, according to the proposal by Onrubia and Sanz (2009):

$$\bar{\tau} = \frac{z^G}{z}\tau^G + \frac{z^A}{z}\tau^A \tag{13}$$

where superscripts G and A represent the general and savings components of the net tax bases and the respectively applicable marginal tax rates.

4.2 Results

In this section, we report the results of the elasticities estimations for the whole sample and for different groups of taxpayers considered. Also, we include the results for deadweight loss, efficiency cost and optimal tax rate using the calculated compensated ETI.

4.2.1 Elasticity of taxable income

Table 2 reports the main results after estimating the compensated ETI for the total sample according to a two-step procedure using instrumental variables as described in Section 3. As regards the exogeneity conditions $\text{corr}(Z_i, u_i) = 0$ and relevance $\text{corr}(Z_i, u_i) \neq 0$ required for instruments (Z_i) of the respective variables (X_i), we conduct a Sargan-Hansen test to check that they are met, yielding the p-value of the Kleibergen-Paap statistic to verify the null hypothesis that the equation is overidentified. Besides, we performed F-tests, related to the first stage of the econometric estimation, for both instruments. The resulting values are shown in Table 2. Table 2 contains four columns which successively add control variables to the main model (Column 1) that includes only the net marginal tax rate. Column 2 adds the logarithm of the initial income. Column 3 includes the average net-of-tax rate, and, finally, Column 4 adds the socioeconomic control variables.

[8] López-Laborda et al. (2018) have recently analyzed income shifting in the Spanish dual PIT.

Table 2: **Elasticity of taxable income estimates using Spanish PIT 2006 and 2007**

$\Delta \log y$	Model 1	Model 2	Model 3	Model 4
$\Delta \log(1-\tau)$	-0.658***	0.453***	0.427***	0.415***
	(0.006)	(0.006)	(0.006)	(0.006)
$\Delta \log(1-t)$			-0.208***	-0.184***
			(0.004)	(0.004)
$\log y_1$		-0.558***	-0.559***	-0.591***
		(0.002)	(0.002)	(0.002)
Age				0.021***
				(0.000)
Age^2				0.000***
				(0.000)
Gender				0.102***
				(0.002)
Number of children				0.057***
				(0.001)
Self-employed				-0.131***
				(0.002)
Income from investments and savings				0.060***
				(0.003)
Income from real estate property				0.161***
				(0.002)
Capital gains				0.094***
				(0.004)
Marital status				0.036***
				(0.002)
Percentage of income of main taxpayer				-0.074***
				(0.005)
Autonomous Communities				Yes
Constant	0.226***	8.060***	8.069***	8.006***
	(0.002)	(0.031)	(0.031)	(0.030)
Kleibergen-Paap rk statistic	1.30E+05	1.40E+05	1.20E+04	1.20E+04
p-value	(0.000)	(0.000)	(0.000)	(0.000)
Hansen J statistic				
p-value	(0.000)	(0.000)	(0.000)	(0.000)
Marginal tax rate	3,200,000	1,700,000	1,200,000	2,700,000
Average tax rate			5540.51	1512.75
Observations	494.591	494.591	494.591	494.591

Notes: Results of the robust regression instrumental variables. Heteroskedasticity-robust standard errors in parentheses. * Denotes significance at 10% (p<0.10); ** significance at 5% (p<0.05); and *** significance at 1% (p<0.01).
For the regional component, the dummy included a region variable for the number of taxpayers and taxable income, whose baseline is the capital Madrid; they are all negative and statistically significant, except Ceuta and Melilla.
Kleibergen H_0: underidentified model. Hansen J H_0: overidentified model.
Source: own elaboration from Spanish Personal Income Taxpayers Panel for the years 2006 and 2007.

Analyzing the main results, we find that the ETI is negative in the first regression, although it is positive after introducing the 2006 income logarithm. Regression to mean is a phenomenon often reported in the literature and is known to influence this variable in the estimation. On the other hand, when the net average tax rate is included, the ETI is

slightly lower, and all variables are significant at 99%. The coefficient of the net average tax rate indicates that a 1% increase in the actual average tax rate would reduce taxable income by 0.20%. The control variables influence the ETI, leading to a slight decrease from 0.457 to 0.415. According to these results, the compensated ETI for the 2007 Spanish personal income tax reform is from 0.415 to 0.453, which is within the value range reported in the international literature.

Particularly, taxpayer age has a positive, albeit smaller, influence on taxable income in response to the changes in marginal tax rates, although this effect decreases as the age increases (negative effect of age squared). Taxpayer gender shows that males have a bigger influence on the change in taxable income than females, and the number of children has a positive, albeit rather small, effect. Being married also has a positive influence.

On the other hand, self-employment has a noticeable negative effect, for which there are several reasons. These taxpayers may not declare all their income because it is harder to control by the tax administration. Additionally, they have the option of paying tax under the module-based objective estimation system, paying considerably less than under the direct estimation system which is based on accounting records. The sources of taxable income like financial investments and savings, real estate property and capital gains have a significant and positive influence on the change in taxable income, where real estate property has the biggest impact. On the contrary, the percentage of income accounted for the main income earner in the case of married couples has a negative impact. This makes sense, as it indicates that the change in taxable income would be smaller if the family tax unit were more dependent on the main income earner. Finally, the region variable has an influence, albeit rather small, on changes in taxable income.

4.2.2 ETI sensitivity analysis by groups

As mentioned in the introduction, we estimate the ETI for different groups of taxpayers in order to conduct a sensitivity analysis of elasticity estimates. Table 4 shows the ETI estimation for the following groups: the restricted sample (excluding retired and unemployed taxpayers), gender, age, marital status and the taxable income brackets of the progressive tax schedule. The results shown in Table 3 also include the income effect and logarithm of initial income.

Table 3 refers to the restricted sample built according a two-step procedure. Firstly, we remove retired taxpayers from the sample to further investigate the effect that this has and then we also take out unemployed taxpayers. The results show that the exclusion of retired individuals has the effect of lowering ETI, the income effect and the initial income. Therefore, the response of the taxpayer population of working age is lower than the calculated response for all taxpayers. After also removing unemployed individuals from the sample, we again observed a reduction in the ETI. Changes in employment status (employed and unemployed) offer a possible explanation for this phenomenon, causing a high variability in taxable income. With regard to gender, we find that women have a higher ETI and income effect than men, as expected according to the literature.

With regard to marital status, the ETI for single taxpayers is higher than for married taxpayers (0.648 to 0.32) and the sample as a whole. The income effect is somewhat lower for single taxpayers, as expected according to the literature. With respect to age, we consider three representative taxpayer age groups. The ETI clearly decreases by age (from 0.702 to 0.262), that is, there is a lower effect as taxpayer age increases. The ETI of 0.262 for the 65-and-older age group is consistent with the fact that a substantial part of their income is constant due to the pension component. Similarly, note that the ETI of taxpayers aged from 31 to 64 years is similar to the estimated ETI for the sample as a whole.

Combining marital status with gender and age group, we find that the ETI for single, women taxpayers is slightly higher than for single men, whereas the results are inverted for married couples, where women (0.222) have a lower elasticity than men (0.335). With respect to the income effect, it is smaller for single males than for single women, whereas the opposite applies for married taxpayers. With regard to age group, the ETI decreases for both single men and women. Note that the ETI for single women is only higher than for single men within the 31-to-64 years age group and lower in the other two groups. For married taxpayers, the ETI is higher for men by age group. Otherwise, the control variables do not indicate any major changes across different groups of variable estimations. Finally, Table 4 shows that the tax bracket ETI increases for larger incomes, which indicates a higher response for top- than bottom-income bracket taxpayers, as would be expected according to the literature.

Table 3: **Elasticity of taxable income estimates by groups using Spanish PIT 2006 and 2007**

Taxpayer group		ETI	Income effect	Log initial income
Employment Situation	Without Retired	0.390***	-0.171***	-0.629***
		(-0.008)	(-0.004)	(-0.002)
	Without Retired + Unemployed	0.316***	-0.162***	-0.607***
		(-0.008)	(-0.004)	(-0.002)
Gender	Women	0.470***	-0.200***	-0.551***
		(-0.012)	(-0.007)	-(0.004)
	Men	0.387***	-0.174***	-0.605***
		(-0.008)	(-0.005)	(-0.002)
Marital Status	Single	0.648***	-0.191***	-0.639***
		(-0.014)	-(0.007)	(-0.003)
	Married	0.320***	-0.177***	-0.564***
		(-0.007)	(-0.005)	(-0.002)
Age	30 and under	0.702***	-0.148***	0.769***
		(-0.024)	(-0.009)	(-0.005)
	From 31 to 64	0.353***	-0.176***	-0.6***
		-0.008	-0.005	(-0.002)
	65 and over	0.262***	-0.156***	-0.343***
		(-0.014)	(-0.011)	(-0.007)
Single	Woman	0.663***	-0.22***	-0.595***
		(-0.018)	(-0.011)	(-0.005)
	Woman <30	0.768***	-0.148***	-0.761***
		(-0.038)	(-0.016)	(-0.014
	Woman >31 and <=64	0.737***	-0.244***	-0.58***
		(-0.028)	(-0.018)	(-0.007)
	Woman >64	0.238***	-0.128***	-0.287***
		(-0.028)	(-0.024)	(-0.021)
	Man	0.598***	-0.163***	-0.668***
		(-0.022)	(-0.009)	(-0.004)
	Man <30	0.784***	-0.133***	-0.779***
		(-0.042)	(-0.013)	(-0.007)
	Man >31 and <=64	0.531***	-0.165***	-0.652***
		(-0.032)	(-0.014)	(-0.005)
	Man >64	0.298***	-0.128***	-0.356***
		(-0.040)	(-0.029)	(-0.022)
Married	Woman	0.222***	-0.161***	-0.480***
		(-0.015)	(-0.012)	(-0.007)
	Woman <30	0.337***	-0.231***	-0.743***
		(-0.072)	(-0.042)	(-0.018)
	Woman >31 and <=64	0.179***	-0.147***	-0.481***
		(-0.017)	(-0.011)	(-0.008)
	Woman >64	0.235***	-0.167***	-0.355***
		(-0.049)	(-0.033)	(-0.028)
	Man	0.335***	-0.175***	-0.579***
		(-0.008)	(-0.005)	(-0.002)
	Man <30	0.465***	-0.117***	-0.802***
		(-0.056)	(-0.018)	(-0.010)
	Man >31 and <=64	0.279***	-0.164***	-0.612***
		(-0.011)	(-0.006)	(-0.002)
	Man >64	0.268***	-0.162***	-0.354***
		(-0.018)	(-0.014)	(-0.009)

Notes: Results of the robust regression instrumental variables. Heteroskedasticity-robust standard errors in parentheses.
* Denotes significance at 10% (p<0.10); ** significance at 5% (p<0.05); and *** significance at 1% (p<0.01).
Source: own elaboration from Spanish Personal Income Taxpayers Panel for the years 2006 and 2007.

Table 4: **Elasticity of taxable income estimates by income level (2007 tax bracket) using Spanish PIT 2006 and 2007**

$\Delta \log y$	Coefficient	ETI
$\Delta \log(1-\tau)$	0.370***	0.370
	(0.008)	
$\Delta \log(1-\tau)$ x bracket 2	0.081***	0.451
	(0.006)	
$\Delta \log(1-\tau)$ x bracket 3	0.458***	0.828
	(0.005)	
$\Delta \log(1-\tau)$ x bracket 4	0.853***	1.223
	(0.007)	
$\Delta \log(1-\tau)$ x bracket 5	1.071***	1.441
	(0.022)	
$\Delta \log(1-t)$	-0.080***	
	(0.004)	
$\log y_1$	-0.665***	
	(0.002)	
Age	0.011***	
	(0.000)	
Age^2	-0.000***	
	(0.000)	
Gender	0.081***	
	(0.002)	
Number of children	0.073***	
	(0.001)	
Self-employed	-0.103***	
	(0.003)	
Income from investments and savings	0.035***	
	(0.003)	
Income from real estate property	0.127***	
	(0.002)	
Capital gains	0.051***	
	(0.004)	
Marital status	0.106***	
	(0.003)	
Percentage of income of main taxpayer	0.034***	
	(0.005)	
Autonomous Communities	yes	
Constant	9.022***	
	(0.033)	
Kleibergen-Paap rk statistic	8,113.605	
p-value	(0.000)	
Hansen J statistic		
p-value	(0.000)	
Marginal tax rate	175,000	
Average tax rate	1,267.79	
Observations	494.591	

Notes: Results of the robust regression instrumental variables. Heteroskedasticity-robust standard errors in parentheses.
* Denotes significance at 10% (p<0.10); ** significance at 5% (p<0.05); and *** significance at 1% (p<0.01).
For the regional component, the dummy included a region variable for the number of taxpayers and taxable income, whose baseline is the capital Madrid; they are all negative and statistically significant, except Ceuta and Melilla.
Kleibergen H_0: underidentified model. Hansen J H_0: overidentified model.
Source: own elaboration from Spanish Personal Income Taxpayers Panel for the years 2006 and 2007.

The values of the ETI for each tax bracket shown in the last column of the Table 4 are calculated as follows. For the bracket 1, the value of the elasticity coincides with the value of the estimated coefficient (0.370), while for each of the remaining brackets, the elasticity is the sum of that first coefficient plus the coefficient of the corresponding tax bracket (so, for the bracket 2, the ETI is 0.451, that is to say, 0.370 plus 0.451, and for bracket 3, the ETI is 0.828, that is to say, 0.37 plus 0.458, and so on).

4.2.3 Deadweight loss and marginal cost of public funds

In this section, we report the results after estimating the ETI values for different tax brackets of taxable income (see Table 5) in order to achieve the deadweight loss and marginal cost of public funds related to the 2007 Spanish PIT reform. Table 5 shows the marginal excess burden (*MEB*) and the marginal welfare cost (*MWC*) for 2006 and 2007, as well as the variations in each case. Note that the biggest increase occurred in tax bracket 1, which increased from a marginal cost of 0.08 (2006) to 0.33 (2007) euros. This is equivalent to a cost increase of 0.25 euros for each additional euro of tax revenue. As far as the other four brackets are concerned, the increase in welfare costs is considerably lower (0.03 for tax bracket 2, 0.04 for tax bracket 3 and 0.01 for tax brackets 4 and 5). The increment in bracket 1 can be explained by the significant change in the minimum marginal tax rate (from 15% to 24%) and the changes in the treatment of personal and family circumstances (non-refundable tax credits instead of a reduction in taxable income).

4.2.4 Optimal tax rates

Finally, Table 6 shows the optimal tax rates for the whole sample and the different tax brackets, providing a comprehensive analysis of the tax reform. The optimal marginal tax rate for tax bracket 1 would be between 71% and 77%, where the compensated ETI in this bracket is 0.36. These optimal tax rates are above the marginal tax rate of 24% applied in 2007 and the weighted marginal tax rate of 23.46%. Therefore, the ETI in tax bracket 2 is 0.44 and the optimal marginal tax rate is around the 61% to 66%, again above the marginal tax rate (24%) and the weighted tax rate (23.73%). The situation for tax bracket 3 is similar to tax bracket 2, whereas both tax brackets 4 and 5 have an optimal tax rate (24% to 26% and 27% to 29%, respectively), lower than the applied marginal tax rate (37% and 43%) and the respective weighted marginal tax rate (36% and 40%). On the other hand, looking at the overall compensated elasticity of 0.43, we find that the

weighted marginal tax rate would be significantly below the optimal marginal tax rate of 45%, given that the maximum marginal tax rate for the general bases is set at 43% and the savings bases at 18%.

According to Figure 1, the situation with regard to optimal marginal tax rates is unaffected by the readjustment of the marginal tax rates generated by the 2007 reform. Hence, the first three tax rates established for the 2006 general bases (15%, 24% and 28%) are below optimum, whereas the marginal tax rates of 37% and 45% are also considerably above the optimal marginal tax rate of 29%. In light of these results, it is reasonable to assume that a process whereby marginal tax rates are restructured, including a decrease in the top marginal tax rate, could maintain tax revenues and, at the same time, optimize welfare costs.

5 Conclusions

The elasticity of taxable income has evolved into a basic tool for evaluating the optimal tax rate and efficiency cost of tax reforms to the detriment of the traditional approach based on labor supply. This paper analyzes the ETI of the dual income taxation system introduced by the 2007 Spanish tax reform in order to account for as many taxpayer behaviors as possible: income shifting, the choice of different asset types, tax evasion and labor changes, etc. Accordingly, this paper contributes to the literature by reporting the ETI estimations for different taxpayer groups. From these results, we calculate the deadweight loss, the efficiency cost and the optimal marginal tax rate for the dual income tax reform.

Although quiet similar in structure to the original model, with two types of taxable income and two tax schedules, the semi-dual model deployed by the reform differs from the pure Nordic dual income taxation on a number of points. We believe that the reform establishes an incentive for taxpayers to vary their taxable income. For empirical purposes, we used the Spanish Personal Income Tax Return panel for the 2006 and 2007 tax years. In particular, we build a balanced panel database including taxpayers who filed in both years.

Table 5: **Deadweight loss and marginal cost of public funds for Spanish PIT in 2006 and 2007 (average value in euros)**

			2006				2007				2006 - 2007
Bracket	**Elasticity**	**Taxpayers**	$\bar{y}$	**Tax Liability**	**MEB**	**MWC**	$\bar{y}$	**Tax Liability**	**MEB**	**MWC**	**ΔMWC**
1	0.370	6,006,369	12,295.99	663.29	51.27	0.08	17,832.88	1,636.11	533.97	0.33	0.25
2	0.451	5,902,355	18,841.72	2,165.11	307.31	0.14	21,190.23	2,059.57	344.70	0.17	0.03
3	0.828	3,568,102	29,933.39	5,245.82	1,181.60	0.23	32,417.21	4,876.24	1,276.64	0.27	0.04
4	1.223	1,742,285	46,329.70	10,461.24	5,855.52	0.57	49,406.57	10,743.79	6,227.88	0.58	0.01
5	1.441	763,355	106,000.00	34,479.11	25,927.83	0.75	113,000.00	35,699.64	27,370.66	0.76	0.01
All	0.415	17.982.469									

Source: own elaboration from Spanish Personal Income Taxpayers panel for the years 2006 and 2007.

Table 6: **Optimal marginal tax rates (average values in euros and percentages)**

Bracket	Z_k	$\bar{y}$	**Weighted Marginal tax rate***	**Range of compensated ETI (0.1 to 2.0)**																		
				0.1	**0.2**	**0.3**	**0.4**	**0.5**	**0.6**	**0.7**	**0.8**	**0.9**	**1**	**1.1**	**1.2**	**1.3**	**1.4**	**1.5**	**1.6**	**1.7**	**1.8**	**1.9**	**2.0**
1	0.00	9,773.40	23.46%	91%	83%	77%	71%	67%	63%	59%	56%	53%	50%	48%	45%	43%	42%	40%	38%	37%	36%	34%	33%
2	4,161.60	18,687.11	23.73%	89%	80%	72%	66%	61%	56%	53%	49%	46%	44%	41%	39%	37%	36%	34%	33%	31%	30%	29%	28%
3	14,357.52	29,931.50	27.55%	84%	72%	63%	57%	51%	46%	43%	39%	37%	34%	32%	30%	29%	27%	26%	25%	23%	22%	21%	21%
4	26,842.32	46,325.92	36.01%	81%	68%	58%	51%	46%	41%	38%	34%	32%	30%	28%	26%	24%	23%	22%	21%	20%	19%	18%	17%
5	46,818.00	106,000.00	40.13%	85%	74%	65%	58%	53%	48%	44%	41%	38%	36%	34%	32%	30%	29%	27%	26%	25%	24%	23%	22%
All	14,357.52	24,316.28	------	80%	67%	58%	51%	45%	41%	37%	34%	31%	29%	27%	25%	24%	23%	21%	20%	19%	19%	18%	17%

NOTE: * Weighted marginal tax rates calculated proportionally to the general and savings tax bases for each bracket

Source: own elaboration from Spanish personal income taxpayers panel for the years 2006 and 2007.

The highlighted results reveal that the 2007 PIT reform led to several relevant changes in taxpayer behavior. Specifically, the value of the compensated ETI ranges from 0.41 to 0.43 for the whole sample. The income effect, which is measured based on the change in average net tax rates, leads to a negative value of -0.18, indicating an increase in the effective average tax rate due to the reform. Several socio-personal and family variables have been identified as having a positive influence on the intensity of the change in taxable income, such as taxpayer age, gender, the number of dependent children, and the declaration of financial capital gains or rental income. On the contrary, variables that have a negative influence on the change in taxable income are age squared, the declaration of income from self-employment and being the main income earner in a married couple. We have also identified a slight, albeit non-significant, variability in the responses depending on the Autonomous Community of residence.

Furthermore, we calculate the compensated ETI for different taxpayer groups to conduct a sensitivity analysis. From the results, we reached the following conclusions: the removal of retired people from the sample significantly reduces the ETI; elasticity is higher for women than for men; single people have a considerably higher elasticity than married taxpayers; and the ETI decreases with age. Besides, if we use the ETI value to estimate the deadweight loss and the marginal cost of public funds, we find that the cost is higher than with the previous design. Therefore, the welfare cost increases with the taxpayer's income bracket. This increase is mainly due to the sizable change in the marginal tax rate of Bracket 1. Finally, we estimate the optimal marginal tax rate based on the ETI for different tax brackets. These estimations show that the optimal marginal tax rate is below the top two marginal tax rates established by the reform. Therefore, the marginal tax rate could be readjusted according to the actual tax schedule to minimize the efficiency cost.

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Appendix

Table A.1
Structure of Spanish Personal Income Tax, years 2006 and 2007

Concept	2006 Spanish PIT	2007 Spanish PIT
Computation of gross income	Different types of income: labor income, savings income, self-employment income and business income, spousal support, rental income, imputed income for non-rented houses, income attributions, and capital gains and losses	
Reductions (applied for calculating incomes)	Rental income deduction and irregular income reduction	Earned income deduction, rental income deduction and irregular income reduction
Income classification (applied for calculating adjusted gross income and taxable income)	*General base*: Labor income, savings income, self-employment income, spousal support, rental income, imputed income for non-rented houses, income attributions, and capital gains and losses≤1 year *Special base*: Capital gains and losses> 1 year	*General base*: Labor income, self-employment income, spousal support, rental income, imputed income for non-rented houses, income attributions, and capital gains and losses *Savings base*: Income from savings, and capital gains and losses
Adjusted gross income	Sum of incomes minus personal and descendant allowances	Sum of incomes
Taxable income	Adjusted gross income minus earned income deduction, ascendant, age and disability allowances, spousal support and pension schemes allowances	Taxable income minus allowances for joint taxation, spousal support and pension schemes allowances
Gross tax liability	Results of applying respectively the general and special schedule to general and special taxable income	Results of applying respectively the general and savings schedule to the general and savings taxable income, minus the result of applying tax schedules to the sum of personal and family allowances
	The general and special (savings) schedules are divided into state and regional parts	
Final tax liability	Gross tax liability minus state and regional tax credits	
Refundable tax credits	For maternity (applying to working mothers)	For maternity and childbirth (applying to working mothers)

Source: Onrubia et al. (2014) and own elaboration.

Table A.2

Main parameters of the Spanish Personal Income Tax, years 2006 and 2007 (euros)

Concepts	2006 PIT	2007 PIT
Reduction for irregular income	40%	40%
Reduction for earned income	2,400 - 3,500	2,600 - 4,000
Increment for disability	+2,800 /+6,200	+2,800 /+6,200
Late retirement and geographical mobility	+100% for either concept	+100% for either concept
Rental income deduction (for landlord)	-50%	-50%/-100%
Personal allowances General Single-parent family Joint taxation	 3,400 5,550 6,800	 5,050
Increment for age	+800 /+1,800	+900 /+ 2,000
Allowance for joint taxation Single-parent family Married couples		 3,400 [a] 2,150 [a]
Descendants allowances	1,400 / -2,300	1,800 / -4,100
Increment for age	+1,200 per child < 3 years	+2,200 < 3 years
Ascendant allowances	800 /1,800	900 /2,000
Disability allowances	2,000 / -7,000	2,270 / - 9,170
General tax schedules (State + Autonomous Community)	15% - 24% - 28% - 37% - 45%	24% - 28% - 37% -43%
Limits for pension scheme reductions	8,000 / 24,250	10,000 / 12,500 30%/50% (b+c)
Tax rate for special or savings base	15%	18%
Tax credit on housing investment	15% / 25%	15%
Tax credit for maternity	100 per month (from birth to 3 years old)	100 per month (from birth to 3 years old)
Tax credit for childbirth or adoption	-	2,500 per child

NOTES: (a) Applied as taxable income reduction, the other reductions are applicable as tax credits; (b) net labor income; (c) self-employment income and business income.
Source: Onrubia et al., (2014) and own elaboration.