HOW DOES A FISCAL REFORM AFFECT ELASTICITIES OF INCOME TAX REVENUES? THE CASE OF SPAIN, 2003-2008

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Abstract

This paper estimates the extent to which an exogenous change in income affects income tax revenues. We focus on the case of Spain over the period 2003-2008, as income tax there underwent a substantial reform in 2007. Using both an analytical method and a numerical simulation, we find a significant increase in aggregate income tax elasticities from 1.4 for 2003-2003 to around 1.8 for 2007-2008. The sensitivity of results to the presence of housing tax credits, non-equiproportional variations in income, changes in income inequality and fiscal drag is also considered.

Keywords: income tax elasticity, progressivity, tax rates, tax credits

JEL Code: H20, H24

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1. INTRODUCTION

The observation of simple data may sometimes lead to misleading conclusions. In its 2002 Annual Report on Tax Revenues the Spanish National Tax Agency (hereafter referred to by its Spanish acronym "AT") showed a negative elasticity of income tax revenues with respect to GDP growth in 1999. The simple ratio between the growth rate in income tax revenues and the growth rate in GDP led to this conclusion in a year when a tax cutting fiscal reform took place. On this basis, elasticities below 1 would also be expected in years such as 1998, 2000 and 2007. However, these two facts are in conflict with the standard characterization of income tax as a progressive tax, through which increases in income result in more than proportionate increases in tax revenues, that is, in income tax elasticities higher than unity.

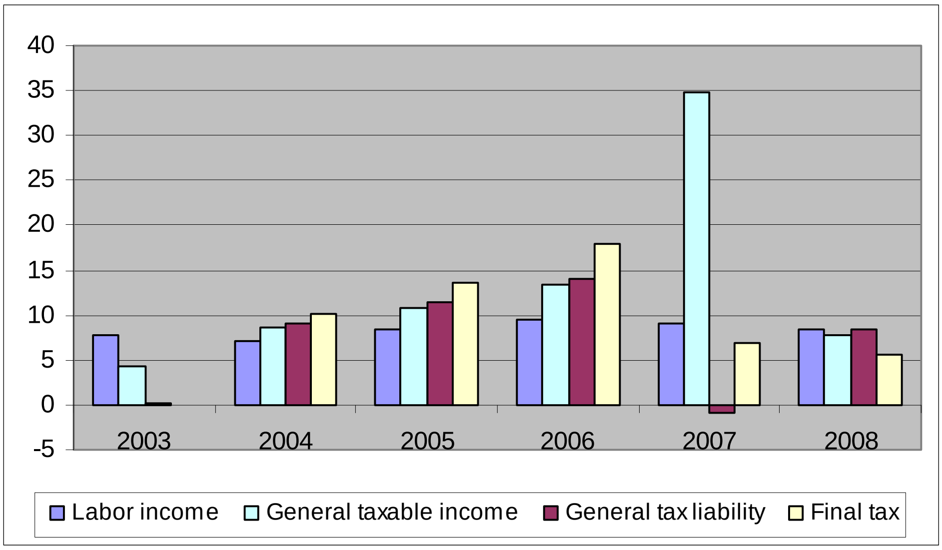
Another example is offered by the behavior of income tax bases and revenues over the period 2003 to 2008. Figure 1 shows the annual growth rates of labour incomes, general taxable income, general tax liability and final tax[1]. For years 2004, 2005 and 2006, the conventional view of a progressive income tax is confirmed: a given growth rate of labour income leads to higher growth rates for general taxable income and, most importantly, for tax liability and final tax in a sequential fashion. But for the years in which fiscal reforms were implemented (2003 and 2007) there is no a clear pattern for modelling growth in income tax revenue. Moreover, in 2008 general taxable income grew by 7.7%, but the final amount paid by taxpayers increased at a lower rate of 5.5%[2]. In this context, the simple ratio between growth rates cannot be used as a proxy of income tax elasticity, unless a

[1] As an indication of how representative these figures are, note that labour incomes are about 80% of total net income, general taxable income is 90% of total taxable income and general tax liability is almost 91% of total tax liability. The term "general" is used by the Spanish tax system to refer to all issues related to non-capital incomes.

[2] The situation is even more striking if the tax credit of €400 set up by the government for working and self-employed taxpayers is considered, as final tax would fall by almost 3%. On the other hand, notice that when only the "general" part of tax liability is taken into account, tax revenues increase by 8.4%, which results in an elasticity –according to the method used by the Spanish tax authorities- of 1.09. In any event, this is far from the figures reported in the relevant literature.

substantially lower (or even negative) sensitivity of tax revenues to changes in income is accepted, which would be counter to the traditional view of income tax as a progressive tax.

Figure 1. Labour incomes and some tax variables (growth rates). Spain, 2003-2008



Source: Spanish National Tax Agency.

Consequently, a different, more complex approach must be considered if the elasticity of income tax with respect to income increases is to be computed. Indeed, it is clear that tax revenues are affected not only by that elasticity but also by changes in tax policy, the dynamics of tax bases and taxpayers themselves and, finally, tax evasion. The issue is, therefore, to isolate income tax elasticity from the other three factors.

In this context, this paper aims to determine the following: given a tax function, to what extent can changes in income tax revenues be explained by exogenous changes in income? We focus on the case of Spain over the period 2003-2008, as income tax there underwent a substantial reform in 2007. The general framework within which this paper is located is that used by Hutton and Lambert (1980), Fries et al. (1982) and Creedy and Gemmell (2002, 2003).

There is very little evidence on Spain. To the best of our knowledge, there are only two papers that study this topic, using two different methodologies. The first one –de Castro et al. (2008)- deals only marginally with the elasticities of several Spanish taxes (with respect to GDP growth) because the paper is focused on a different issue: cyclically adjusted budget balances. The values of income tax elasticity found in this paper are around 1.7 for 1986-1992 and less than 1 for 1993-1998. Elasticity increases for 2003-2005, peaking at 1.9 in this last year.

Creedy and Sanz (2010) is an extensive, well-founded paper that provides a set of elasticity estimates for 15 Spanish regions and a country-wide aggregate. The authors use a large cross-sectional database of Spanish taxpayers for 2002 to generate a simulated population for 2007. They work with a broad concept of tax revenue elasticity (with respect to gross income) and distinguish between different sources of income (mainly from labour and capital). Their estimates range from 2.07 to 1.35, with the latter being the most reliable result.

Our paper differs from that of Creedy and Sanz (2010) in a number of ways, in terms of both methods and results. We obtain results from the analytical resolution of the model and from a simulated sample of taxpayers, while Creedy and Sanz (2010) estimate their elasticities on the basis of a sample of actual individuals. The main caveat of their approach is that they have to update the only database available (dating from 2002) in order to use it in 2007, and this process may result in a sample whose basic statistics differ from those of the Spanish AT for that year.

A second difference between the two papers lies in the very concept of income tax elasticity used. As mentioned above, Creedy and Sanz (2010) offer estimates of sensitivity of tax revenues with respect to gross income, while our paper takes taxable income as its reference. Consequently, they need to incorporate a number of ancillary elasticities to follow the complete sequence of schedular Spanish income tax. By contrast, our approach is quite simple because the starting point is taxable income. This considerably simplifies the computations and allows us to make a direct comparison with studies on other countries, where taxable income is widely used.

Our results indicate that income tax elasticity with respect to taxable income is in line with previous estimates for other countries, though perhaps in the upper range. For the early part of the period (2003-2006) values of around 1.4 are found, while for the later part (2007-2008) elasticity increases to around 1.8. This increment in income tax elasticity after the 2007 fiscal reform persists under a number of changes in assumptions, such as non-equiproportional increases in income, different degrees of income inequality in the sample of taxpayers, the use of tax credits and the consideration of the actual inflation rate in the updating of tax thresholds. After such a sensitivity analysis, it is clear that income tax elasticity has increased in Spain since 2007.

The rest of the paper is structured as follows. Section 2 presents the theoretical model. Section 3 introduces the data and the two methods used. Section 4 shows the results. Section 5 concludes and points out some policy implications.

2. THE MODEL

This section is concerned with the theoretical framework used to estimate the revenue elasticities in Spanish taxes. Basically, we follow the general model by Creedy and Gemmell (2002, 2003) adapting it to fit the case of Spain[3]. Principally, we distinguish between individual and aggregate revenue elasticities. Both theoretical approaches consider multi-step income tax functions, which have received considerable attention in earlier literature and also show a reasonable similarity with the real world.

Denote by $T(y_i)$ the income tax paid by an individual *i* with a nominal income of y_i. The revenue elasticity of income tax with respect to a change in income, η_{T_i,y_i}, is defined as follows:

$$\eta_{T_i,y_i} = \frac{dT(y_i)/dy_i}{T(y_i)/y_i}. \tag{1}$$

It can easily be seen that the numerator in (1) is the marginal tax rate (mtr_i) while the denominator is the average tax rate (atr_i). Income tax is usually a progressive tax, $mtr_i > atr_i$, so the elasticity is greater than 1, $\eta_{T_i,y_i} > 1$.

Consider the following multi-step income tax function:

$$\begin{aligned} T(y_i) &= 0 & 0 < y_i \le a_1 \\ &= t_1(y_i - a_1) & a_1 < y_i \le a_2 \\ &= t_1(a_2 - a_1) + t_2(y_i - a_2) & a_2 < y_i \le a_3 \end{aligned} \tag{2}$$

and so on. Setting $a_0 = t_0 = 0$, $T(y_i)$ can be written for *k≥1* as:

[3] In particular, we use an alternative specification of the multi-step tax function allowing for deductions not only in the tax base (as in the usual approach) but also for tax credits, which are quite significant in the Spanish case.

$$T(y_i) = t_k(y_i - a_k) + \sum_{j=0}^{k-1} t_j(a_{j+1} - a_j), \tag{3}$$

for an individual *i* whose income falls into the *k*th tax bracket. It can be easily seen that the expression (3) can be rewritten as:

$$T(y_i) = t_k y_i + \sum_{j=1}^{k} a_j(t_j - t_{j-1}) \tag{4}$$

Therefore,

$$T(y_i) = t_k(y_i - a_k^{'}), \tag{5}$$

where

$$a_k^{'} = a_k - \sum_{j=0}^{k-1}\left(\frac{t_j}{t_k}\right)(a_{j+1} - a_j) = \sum_{j=1}^{k} a_j\left(\frac{t_j - t_{j-1}}{t_k}\right) \tag{6}$$

The interpretation of (5) and (6) is clear. Individual taxpayers face a single marginal tax rate t_k, which is applied to net income in excess of a threshold $a_k^{'}$. This threshold is specific for individuals in the *k*th tax bracket and reflects the structure of progressivity through marginal tax rates.

Differentiation of (5) gives the change in the taxes paid by individual *i* when his/her income increases exogenously by 1 per cent:

$$\eta_{T_i, y_i} = \frac{1 - da_k^{'}/dy_i}{1 - a_k^{'}/y_i} \tag{7}$$

It is easy to show that if the term $da_k^{'}/dy_i$ equals 0, the above expression becomes:

$$\eta_{T_i, y_i} = 1 + \frac{a_k^{'}}{y_i - a_k^{'}} \tag{8}$$

The assumption $da_k^{'}/dy_i = 0$ means that an increase in y_i does not affect the level of effective deductions $a_k^{'}$. This is a strong hypothesis, not only in the context of income taxation but also for taxes on consumption (Fries et al. 1982). However, in our empirical analysis below, the treatment of effective deductions other than thresholds can be ignored; indeed, starting from the concept of taxable income, where both tax-deductible expenditures and non-income allowances are already taken into account, avoids having to deal with methodological problems concerned with estimating responses of such as deductions with respect to income[4].

Additionally, individual income tax elasticity with a multi-step income tax function can be decomposed as the change in the tax base as a result of a change in income (η_{B,y_i}) and the change in tax payments when the tax base is affected ($\eta_{T_i,B}$):

$$\eta_{T_i,y_i} = \eta_{T_i,B} \cdot \eta_{B,y_i} = \eta_{B,y_i} , \tag{9}$$

where the last equality comes from the fact that $\eta_{T_i,B} = \frac{t}{t} = 1$.

An issue which becomes relevant in tax systems such as that of Spain is the presence of tax credits. The expressions above and below need to be arranged so as to take this feature into account. Formula (5) maintains the same formal appearance but $a_k^{'}$ must be rewritten:

$$a_k^{'} = a_k - \sum_{j=0}^{k-1}\left(\frac{t_j}{t_k}\right)\left(a_{j+1} - a_j\right) + \frac{b_i}{t_k} = \sum_{j=1}^{k} a_j\left(\frac{t_j - t_{j-1}}{t_k}\right) + \frac{b_i}{t_k}, \tag{10}$$

where b_i is the amount of tax credit. Expression (7) now becomes $\eta_{T_i,y_i} = \dfrac{1 - da_k^{'} / dy_i}{1 - a_k^{'} / y_i - b/t_k y_i}$.

So far the analysis has focused on individual elasticity, but for policy purposes it is the aggregate response to changes in income that is of most interest. Assume now that there are N individuals with incomes $y_1, y_2, ..., y_N$ so that total income Y is $\sum_{i=1}^{N} y_i$ and total income tax revenue is $T_y = \sum_{i=1}^{N} T(y_i)$. With a multi-step income tax function, and after some algebra manipulation, total differentiation of T_y gives the following:

$$dT_y = \sum_{i=1}^{N} \frac{\partial T(y_i, a_k^{'})}{\partial y_i} dy_i = \sum_{i=1}^{N} \eta_{T_i,y_i} T(y_i, a_k^{'}) \frac{dy_i}{y_i} . \tag{11}$$

[4] Creedy and Gemmell (2003) obtain such elasticities for the UK using simple regression analyses, which probably suffer from econometric problems (see their Appendix B); Creedy and Sanz (2010), with a better econometric approach, report notably high results for Spain (see their Appendix D), which are far from the reference values of Creedy and Gemmell (2003), who give figures which are positive but below 1 for these elasticities.

Note that to compute the elasticity of aggregate tax revenue with respect to changes in aggregate income requires information on the distribution of income changes across the N individuals. In other words, a change in total income Y may affect each individual i differently; consequently, some scenarios concerned with the behaviour of $\frac{dy_i}{y_i}$ must be defined.

2.1 Equiproportional income changes

It is assumed firstly that all individuals experience an identical, proportionate increase in their incomes. Therefore $\frac{dy_i}{y_i} = \frac{dY}{Y}$ and expression (11) allows a highly intuitive formula for aggregate elasticity to be obtained:

$$\eta_{T,y} = \frac{dT_y}{dY}\frac{y}{T_y} = \sum_{i=1}^{N} \eta_{T_i,y_i} \frac{T\left(y_i, a_k^{'}\right)}{T_y} \tag{12}$$

Under this simple assumption, aggregate elasticity is a weighted average of individual elasticities, where the weights are given by the amount of tax paid by each taxpayer as a proportion of total revenue.

2.2 The multi-step income tax function

Consider again the income tax function specified in (2), with $K+1$ tax brackets and $a_{K+1} = \infty$. For the sake of simplicity, a continuous income distribution function $F(y)$ is established so that the expression for aggregate revenue elasticity can be expressed as:

$$\eta_{T,y} = \frac{\int_0^{\infty} yT^{'}(y)dF(y)}{\int_0^{\infty} T(y)dF(y)}. \tag{13}$$

Using (5), total tax revenue can be rewritten under this continuous case as:

$$T_y = N\bar{y}\sum_{k=1}^{K}\left[t_k \int_{a_k}^{a_{k+1}} \left(y_i - a_k^{'}\right)dF(y)\right], \tag{14}$$

where $\bar{y}$ is the arithmetic mean income. Denoting by $F_1(.)$ the first moment distribution function such that $F_1(y)$ is the proportion of total income obtained by those individuals with income less than or equal to y, expression (14) is rewritten as:

$$T_y = N\bar{y}\sum_{k=1}^{K} t_k G_k(a_k), \tag{15}$$

where $G_k(a_k) = [F_1(a_{k+1}) - F_1(a_k)] - \frac{a_k^{'}}{\bar{y}}[F_1(a_{k+1}) - F_1(a_k)]$. Expression (15) is the denominator of (13). To obtain the numerator of (13), we have $N\bar{y}\sum_{k=1}^{K}[t_k F_1(a_{k+1}) - F_1(a_{k+1})]$. Hence, after some algebraic manipulations, aggregate revenue elasticity is given by:

$$\eta_{T,y} = \frac{\bar{y}}{\bar{y} - a^*} = 1 + \frac{a^*}{\bar{y} - a^*}, \tag{16}$$

where a^* is the effective aggregate allowance:

$$a^* = \frac{\sum_{k=1}^{K} t_k a_k^{'}[F(a_{k+1}) - F(a_k)]}{\sum_{k=1}^{K} t_k [F_1(a_{k+1}) - F_1(a_k)]} \tag{17}$$

The calculations involved in (17) require the use of convenient relationships between the moment distributions, which are usually assumed to be lognormal in type.

2.3 Non-equiproportional income changes

A realistic situation can be given by $\frac{dy_i}{y_i} \neq \frac{dY}{Y}$, i.e. the increase in individual incomes is not the same for all members of the population. The key variable is then the elasticity of individual income with respect to aggregate income, which we denote by $\eta_{y_i,Y}$. Rewritting expression (12) as:

$$\eta_{T,y} = \frac{\sum_{i=1}^{N} y_i T^{'}(y_i)}{\sum_{i=1}^{N} T(y_i)}, \tag{18}$$

the elasticity of total revenues with respect to changes in total income is then given by

$$\eta_{T,y} = \frac{\sum_{i=1}^{N} y_i \eta_{y_i,Y} T^{'}(y_i)}{\sum_{i=1}^{N} T(y_i)}, \tag{19}$$

where $\sum_{i=1}^{N} \eta_{y_i,Y} = 1$ holds. One way of learning the value of the new variable $\eta_{y_i,Y}$ is to regress it on $1 - \beta(\log y_i - \mu)$, where μ is the mean of the logarithms of income (see Lambert (1993) for a further discussion of the non-equiproportional case).

3. Methods and data

This paper provides results for income tax elasticities using two different approaches. Given the previous theoretical framework, the first method computes the values of elasticities by analytically evaluating the above formulae. The second method obtains aggregate revenue elasticities on the basis of a numerical simulation for a large enough sample of taxpayers. The latter procedure has a number of advantages over the former, namely the treatment of non-equiproportional changes in income and the selected use of tax credits in the simulations.

The analytical method consists of evaluating expressions (16) and (17). Obviously, when the presence of tax credits is considered, $a_k^{'}$ must be evaluated using expression (10). In any event, an assumption on income distribution must first be made. In line with mainstream research, we assume that incomes are lognormally distributed as $\Omega(\mu, \sigma^2)$, where μ and σ^2 are the mean and the variance of the logarithms of income respectively. To make it easier to evaluate such expressions, we take the simple relationships between the moment distributions in the case of lognormal distribution from Hart (1975). Particularly, it can be proved that $\Omega_r(\mu, \sigma^2) = \Omega(\mu + r\sigma, \sigma^2)$, where $\Omega_r(.)$ is the *r*th moment distribution function.

Although (to best of our knowledge) there are no studies dealing with the distribution of Spanish taxpayers for 2003-2008, there are some indications that lognormal distribution is an appropriate assumption. First, Sanz et al (2009) provide empirical evidence that both the net income from labour (which is the main basis for the concept of general taxable income used here) and the tax credits linked to mortgage payments (which are considered below) followed a lognormal distribution in 2002[5]. Further support for the lognormal assumption is given by the fact that the arithmetic mean of general taxable income computed from data is found to be very close to the arithmetic mean calculated from the simulated sample.

The income tax thresholds, the arithmetic mean of income and the mean of tax credits for all 10 income groups into which taxpayers are sorted (data from Income

[5] See Figures 2 and 6 in their Chapter 2.

Taxpayer Statistics of the AT) are available for each year. Since the number of thresholds is not the same as the number of taxpayer deciles, we group the amounts of tax credits to fit them to the thresholds; the reasonably good match between the groups of taxpayers according to general taxable income and the 10 income groups used in the statistics made this task easier (and increased the confidence level). The only tax credit considered in this paper is that for money invested in the purchase or rehabilitation of housing[6].

A common value of 0.5 is taken as the variance of the log of income for the whole period; this is the figure used by Creedy and Gemmell (2002) in their numerical exercises and is very close to those used by Creedy and Gemmell (2003) for the UK in the nineties. In any event, a sensitivity analysis of our estimates of aggregate elasticity with respect to changes in the variance of log of income σ^2 was carried out on the basis of analytical methods. The results are discussed below.

The above theoretical model also allows the aggregate effective marginal and average tax rates to be computed. Defining the former as $\sum_{i=1}^{N}\left(\frac{y_i}{Y}\right)T'(y_i)$, i.e. as an income-share weighted average of individual marginal tax rates, the aggregate effective average tax rate is obtained on the basis of expression $\eta_{T,y} = \frac{MTR}{ATR}$, where the capital letters refer to aggregate concepts. Obviously, in the continuous case, summation of individuals must be replaced by an integral and the weighted average is computed using the moment distribution functions evaluated at threshold values.

Additionally, we applied an alternative method based on generating a simulated population of taxpayers who pay their taxes and, hence, give individual values of mtr_i and atr_i. When their individual elasticities are conveniently weighted, a value for aggregate elasticity is obtained. The details of this simulation method are explained below.

First, we generate annual samples of 20,000 individuals, assuming a lognormal distribution of income, whose arithmetic mean incomes and variance of log of incomes are the same as in the analytical case. Each of these samples contains both taxpayers who are entitled to use tax credits related to investment in housing and taxpayers who are not; the

[6] They affect a range of between 36% and 46% of total taxpayers. Remaining tax credits are not very significant in terms of beneficiaries.

proportions of each type of individuals are given by the data from the Income Taxpayer Statistics of the AT. Second, each individual faces the corresponding tax rates and thresholds of income tax, defining individual marginal and average tax rates; the distribution of tax credits across entitled taxpayers also follows the information from the Income Taxpayer Statistics. By contrast with the analytical case, this simulation approach allows for a better match between the official data, which are grouped in 10 income brackets as mentioned above, and the assignment of different tax credits to different individuals. Finally, individual tax rates are weighted to give the aggregate tax rates, which lead to the estimates of revenue elasticities.

Moreover, with the simulation method income tax elasticities can be computed assuming that changes in individual incomes are non-equiproportional, i.e. $\frac{dy_i}{y_i} \neq \frac{dY}{Y}$. In this sense, we study what happens to the aggregate revenue elasticity for each year if the poorest taxpayers increase their incomes more (or less) than the richest ones. The poverty line is set at the first threshold (e.g. €13,800 of taxable income in 2003); people below this threshold are considered as poor. The parameter modified to take this issue into account is $\eta_{y_i,Y}$ in expression (19). Equalising (disequalising) changes mean a value of this elasticity of more (less) than 1 for poor taxpayers; given the constraint that $\sum_{i=1}^{N} \eta_{y_i,Y} = 1$, the values for rich individuals will be just the opposite, and their magnitudes will also depend on the proportion of taxpayers below the poverty line.

A few words must be said about the 2007 Spanish income tax reform. We focus here on the main changes related to the estimates of tax revenue elasticity under the simple theoretical model that we use as our framework:

- The tax scale applicable to the general component of taxable income was reduced from five brackets to four.
- The highest marginal tax rate was decreased from 45% to 43%. The rest of marginal tax rates remain unchanged at 24%, 28% and 37%.
- Personal and family allowances were increased. Since 2007 they have been included as general rule in the first income bracket, which is taxed at a zero rate. Similarly, given the findings by Sanz et al. (2009), the new treatment of these personal and minimum allowances can be seen as a credit tax of

24% (the minimum tax rate) of the amount of such allowances[7]. Until 2007, they were deducted from the tax base, which decreased the progressivity of taxation.

- Additionally, in order to support household purchasing power, an additional tax credit of €400 was granted to working and self-employed taxpayers in 2008.

The extent of the thresholds were modified every year –except in 2004- to take the effect of inflation on nominal magnitudes into account, according to government forecasts of price increases (which were usually lower than the actual increases). Table 1 reports the thresholds and marginal tax rates in place in 2003-2008 for levying general taxable income. Finally, it is worth noting that both the methodological approaches used take into account the presence of a housing tax credit, which consists –as a general rule- of a credit of 15% of the amount invested in acquiring or refurbishing the taxpayer's habitual residence, up to a maximum level[8].

Table 1: Income tax structure, 2003-2008

	Income tax thresholds					Marginal tax rates				
	a_1	a_2	a_3	a_4	a_5	t_1	t_2	t_3	t_4	t_5
2003	1	4000	13800	25800	45000	0.15	0.24	0.28	0.37	0.45
2004	1	4000	13800	25800	45000	0.15	0.24	0.28	0.37	0.45
2005	1	4080	14076	26316	45900	0.15	0.24	0.28	0.37	0.45
2006	1	4161	14357	26842	46818	0.15	0.24	0.28	0.37	0.45
2007	1	17360	32360	52360	-	0.24	0.28	0.37	0.43	-
2008	1	17707	33007	53407	-	0.24	0.28	0.37	0.43	-

Note: Decimal values have been ignored in the case of thresholds. Source: Spanish National Tax Administration.

Table 2 shows the mean income figures and the tax credits linked to housing investments by tax brackets. As mentioned above, official statistics give information on all tax variables by deciles of net income. Consequently, both these tax credits and the personal

[7] Sanz et al. (2009) find that for 99.22% of income tax returns the minimum allowance replicates a fixed tax credit of 24% on the amount of the allowance.

and family allowances shown below in Table 3 are grouped to match the corresponding thresholds.

Table 2: Basic statistics on income and housing tax credits (by tax brackets)

	Mean income	Housing tax credits 1st threshold	Housing tax credits 2nd threshold	Housing tax credits 3rd threshold	Housing tax credits 4th threshold	Housing tax credits 5th threshold
2003	14050	648	705	871	1059	1390
2004	14548	651	702	861	1045	1313
2005	15282	679	726	872	1050	1314
2006	16206	730	773	908	1076	1382
2007	18067	663	822	910	1051	-
2008	18765	713	849	932	1131	-

Note: Decimal values have been ignored. Source: Spanish National Tax Administration

Table 3: Personal and family allowances (by tax brackets)

	Personal and family allowances. 1st threshold	Personal and family allowances. 2nd threshold	Personal and family allowances. 3rd threshold	Personal and family allowances. 4th threshold
2007	966	1599	1610	1625
2008	976	1626	1640	1672

Note: Decimal values have been ignored. Source: Spanish National Tax Administration

4. Results

Given the two methodological approaches described above, a set of estimates of tax revenue elasticities are reported here that distinguish whether tax credits are considered or not. Table 4 shows the aggregate income tax elasticities estimated under different assumptions and methods. The two first columns refer to a situation in which no taxpayers have access to tax credits related to housing purchases; the next two columns deal exclusively with individuals who benefit from such tax credits; finally, column (V) reports the results of the simulation in which both types of taxpayer are taken into account, in a proportion equal to their weights as per real-world data.

[8] Before 2007, this percentage could be higher under certain circumstances, for instance when using mortgages and for the first two years.

Table 4. Aggregate income tax elasticities

	(I)	(II)	(III)	(IV)	(V)
2003	1.2643	1.2630	1.6580	1.6208	1.3809
2004	1.2659	1.2647	1.6377	1.5993	1.3995
2005	1.2673	1.2680	1.6261	1.6024	1.4011
2006	1.2691	1.2677	1.6234	1.5885	1.3978
2007	1.6295	1.6423	2.0578	1.9317	1.7358
2008	1.8305	1.7821	2.4455	2.0850	1.8752

Notes: (I): Analytically without tax credits; (II): Simulation without tax credits; (III): Analytically with tax credits; (IV): Simulation with tax credits; (V): Simulation with and without tax credits.

Whichever family of estimates is considered, it is clear that the 2007 fiscal reform yields a substantial increase in income tax elasticity. For the simulation based on a sample of individuals with and without tax credits[9] -column (V)- the estimates range from around 1.4 for 2003-2006 to between 1.7 and (almost) 1.9 in 2007 and 2008. The main explanation behind this is that from 2007 onwards income tax includes a new tax credit (linked to personal and minimum allowances) which decreases tax liability, as explained above. As a result, although the marginal tax rates are slightly lower (see below) there are major changes in average tax rates, which decrease by more than 20 per cent from 2006 to 2007.

When no tax credits related to housing investments are considered –columns (I) and (II)- the coincidence between the analytical approach and the simulation method is very high until 2007. This feature has previously been pointed out by Creedy and Gemmell (2002, 2003) for other cases. However, after the 2007 fiscal reform slight differences arise due to the fact that the simulation procedure does not consider those taxpayers whose tax liability is negative or zero after tax credits are applied (personal and family allowances and the €400 tax credit in 2008[10]). By contrast, the analytical approach has no way of removing those individuals from the general computation of elasticity.

[9] In a sense, the elasticities reported in column (V) can be considered as the benchmark values and those which are most reliable as long as they are based on a realistic enough composition of the taxpayer sample.
[10] As a result of this deduction of €400, which was not applicable in 2007, the discrepancies between the two methods are greater in 2008.

In the case of elasticities estimated under the assumption that all taxpayers benefit from tax credits linked to housing investments, higher elasticities are obviously obtained. Again, the underlying explanation is the major reduction in the average tax rate which takes place when such tax credits are considered. Also, the wider gap between the two approaches from the 2007 tax income reform onwards is based on the number of individuals who, after facing the tax schedule and applying the corresponding tax credits, show a negative (or null) final tax amount. These taxpayers are ignored in the simulation method but are considered in the analytical one. Given the major importance in quantitative terms of tax credits after 2007, a significant discrepancy between the two procedures is expected (and confirmed) for the last two years.

An indication of the good match between the performance of our simulation and data from the AT comes precisely from the number of individuals whose final tax is negative. The numerical simulation finds that 18 per cent of the 20,000 potential taxpayers in 2008 had to pay no taxes. Data from tax statistics indicate a percentage of about 23 per cent that year. The two figures are relatively close if it is taken into account that they are not directly comparable (the data from the AT include not only the taxes to be paid on labour incomes - as in our exercise- but also those levied on income from capital).

Our estimates can be connected with those found previously by other authors. Creedy and Sanz (2010), using a different approach from ours, obtain a figure of 1.35 taking into account different sources of income, eligible expenditures, allowances and tax credits. When only two sources of income are used, the elasticity of tax revenue with respect to gross income rises to 2.10 in 2007.

A number of similar papers with close results can be quoted for a variety of samples and periods. Dorrington (1974) gives figures of between 2.43 and 2.10 for the UK for 1963-1971. Hutton and Lambert (1980) find elasticities of between 1.91 and 1.83 for the same country in 1973-1978. Also for the UK, Johnson and Lambert (1989) provide estimates ranging between 1.5 and 1.6 for the early eighties. Using cross-section regressions at US state level for 1949, 1959, 1969 and 1979, Ram (1991) estimates elasticities of around 1.6; slightly lower values (1.3-1.4) are obtained when the 1980s are analysed. Creedy and Gemmell (2003) find figures of between 1.2 and 1.4 for the UK for 1989-2000.

Seeking reasons for the substantial difference between income tax elasticities in the periods 2003-2006 and 2007-2008 other than tax policy changes arising from fiscal reform, we noted that the share of taxpayers entitled to benefit from the tax credit for housing investments in 2006 was higher than in 2007 (46 and 37% respectively). A lower proportion of beneficiaries of tax credits means a higher average tax rate, so this change implies a lower income tax elasticity, which is just the opposite to what our results indicate.

Consequently, the increase in estimated elasticity between 2006 and 2007-2008 cannot be attributed to a greater use of housing tax credits. If the elasticity of income tax in 2007 is computed using the same distribution of beneficiaries of tax credits as in 2006, the values obtained are 1.6400 (to be compared to column (II), simulation without tax credits), 1.9400 (column (IV), simulation with tax credits) and 1.7624 (column (V), simulation with and without tax credits).

A final comment on Table 4 is that after the 2007 reform the differences between the estimated benchmark elasticity (column (V)) and those estimates using samples with all taxpayers with tax credits in housing or all taxpayers without such tax credits are smaller. The benchmark figures are always higher than those which consider only taxpayers without tax credits and always lower than the estimated elasticities with all individuals using tax credits, but both differences are smaller in 2007 than in 2006. In a sense, the design of the new income tax inserts a convergence force between the two approaches as long as a new tax credit (related to personal and family allowances), which decreases final tax liability, is included in 2007. This is especially true in the model without tax credits linked to housing investments. Nevertheless, the way in which the minimum personal and familiar allowances are taken into account is the same in both models.

Table 5: Elasticities with non-equiproportional changes

	2003	**2004**	**2005**	**2006**	**2007**	**2008**
Equalising changes	1.3675	1.3859	1.3893	1.3865	1.7197	1.8565
Disequalising changes	1.3942	1.4130	1.4130	1.4091	1.7520	1.8939

The above theoretical model allows us to control for the impact on tax revenues of non-equiproportional changes in income. The analytical expression used here is (19), which includes the term $\eta_{y_i,Y}$ to reflect how sensitive individual *i*'s income is to an increase in the aggregate income of country *Y*. As explained in Section 3, the two scenarios (equalising and disequalising) refer to (more than or less than proportional) changes in the income of the group with the lowest incomes; obviously, this change affects the income of the richest taxpayers inversely.

Table 5 provides a synthesis of the results, showing only the estimates of tax elasticities obtained when the poorest individuals see their income increase by 1 per cent more than the aggregate income (equalising), and vice versa (disequalising)[11]. It is clear that income tax elasticity diminishes when an equalising change takes place, and the opposite happens when disequalising movements are considered.

The reason for this lies in the progressivity of income tax. Individuals with higher levels of income face higher marginal tax rates and, consequently, show higher income tax elasticity; hence, when relatively rich taxpayers experience an increase in their income higher than that of the poorest, the taxes that they pay will increase by more than the final tax paid by the poorest. This leads to a greater weight of the higher individual elasticities of the richest taxpayers than the lower values of the poorest. This results in higher aggregate income tax elasticity when disequalising changes take place. This finding is in line with previous references, particularly Creedy and Sanz (2010).

Moreover, we have found that the gap between the benchmark elasticity –the figures in column (V) of table 4- and those from non-equiproportional changes in income widens after the 2007 fiscal reform. Moreover, the differences become greater as the intensity of equalising or disequalising changes increases. That is, the distance between the benchmark elasticity in 2006 (1.39) and the elasticity computed under the equalising assumption (say $\eta_{y_i,Y} = 1.2$) also in 2006 (1.17) is smaller than in 2007 (1.73 versus 1.41, respectively) for the same equalising situation. The same is true in the case of disequalising changes.

Leaving aside non-equiproportional changes in income growth, the issues concerned with income inequality and aggregate income tax elasticity have not been studied on an empirical basis. To the best of our knowledge, the only reference on this point is a paper by Hutton and Lambert (1982), who offer a numerical simulation which has no direct link to

[11] Results obtained with other figures for the intensity of (dis)equalising, e.g. 2 per cent, 5 per cent, 10 per cent and so on, are available upon request.

data from the real world[12]. With the aim of covering this gap at least in part, we compute aggregate income tax elasticities using our analytical approach, taking the empirical information for each year and different values of σ^2.

Table 6: Sensitivity of tax revenue elasticity to income inequality

σ^2	2006	2007	2008
0.2	1.6159	2.1156	2.5332
0.3	1.6256	2.1036	2.5108
0.4	1.6274	2.0830	2.4808
0.5	1.6234	2.0578	2.4455
0.6	1.6156	2.0307	2.4077
0.7	1.6053	2.0032	2.3692
0.8	1.5937	1.9762	2.3310
0.9	1.5812	1.9501	2.2940
1	1.5685	1.9250	2.2584
1.1	1.5556	1.9011	2.2243
1.2	1.5429	1.8785	2.1920
1.3	1.5304	1.8569	2.1613
1.4	1.5183	1.8365	2.1321
1.5	1.5065	1.8172	2.1045

Table 6 shows the results for 2006-2008 taking the model with tax credits linked to housing investment as a reference. In fact, the inverse relationship between income inequality and income tax elasticities found by Hutton and Lambert (1982) is also detected here for the Spanish case[13]. The higher the income inequality, the lower the income tax elasticity. This feature becomes more intense after the 2007 reform and is even increasing in time (see how the ratios between our benchmark value with σ^2 =0.5 and those reported for different σ^2 are lower for 2007 than for 2008).

However, when the model without tax credits linked to housing investments is considered, there is not such a clear pattern as in the case with tax credits. In fact, although the results are not reported here[14], the univocal inverse relationship between income inequality and tax revenue elasticity does not hold for values of σ^2 below 0.5. For higher

[12] Based on an econometric approach, Dye and McGuire (1991) provide evidence which confirms that income inequality is not a trivial issue for estimating income tax elasticities.
[13] Strictly speaking, this is true except for the elasticity computed for 2006 when σ^2 =0.2. According to the above relationship, a higher value for this elasticity would be expected here.
[14] They are, however, available upon request.

levels of inequality, our results are in line, quantitatively and qualitatively, with those found for the model with housing tax credits.

One of the most significant tax policy issues deals with the impact of modifying thresholds to adapt them to inflation. As is well-known, when thresholds are not updated to take price increases into account there is fiscal drag, which has implications for income tax revenues and, consequently, for estimates of tax revenue elasticities.

In this sense, we analytically compute the elasticities of Spanish income tax in 2008 and 2005 using tax brackets whose amounts are updated according to the inflation which effectively took place. These results are compared in Table 7 to those obtained previously applying a lower growth rate of price increase, particularly that forecast by the government.

Table 7. Tax revenue elasticities with adjustments for inflation

	2005	2005 with real inflation	2008	2008 with real inflation
Without tax credits	1.267	1.266	1.830	1.828
With tax credits	1.626	1.625	2.445	2.442

Although elasticities decrease when thresholds are adapted to real inflation, the differences with the previously estimated figures are insignificant. The discrepancies arise at the level of the third decimal, so it can be concluded here that the impact of fiscal drag on elasticities is negligible. Obviously, in a context with higher inflation rates, strongly discordant with those used by the government for updating tax bracket limits, a decrease in estimated elasticities is to be expected.

This comes from the fact that increasing the thresholds makes it more unlikely that an exogenous increase in income will lead to a higher *mtr* (indeed, the *mtr* will remain unchanged for many taxpayers) whereas the *atr* will be higher when the individual is richer. This is due to the mere presence of thresholds, which make income tax progressive and, consequently, increase the *atr* even within the same tax brackets.

However, using the analytical method can be proved that a tax function where the value of the first threshold substantially deviates from 0 does not yield lower elasticities when the thresholds are updated according to the real inflation rate. This is what would occur in the case of the UK versus what we have found for the Spanish case.

Table 8. Effective marginal and average tax rates

	Effective MTR without tax credits	Effective ATR without tax credits	Effective MTR with tax credits	Effective ATR with tax credits	Effective MTR	Effective ATR
2003	0.2994	0.2371	0.2953	0.1822	0.2978	0.2157
2004	0.3035	0.2400	0.2997	0.1866	0.3023	0.2230
2005	0.3045	0.2401	0.3009	0.1878	0.3028	0.2161
2006	0.3092	0.2439	0.3080	0.1939	0.3086	0.2208
2007	0.3006	0.1830	0.2854	0.1478	0.2949	0.1699
2008	0.2959	0.1661	0.2782	0.1334	0.2896	0.1545

A minor question here, which stems from the computation of income tax elasticities, is the discussion on effective marginal and average tax rates. Strictly speaking, we do not offer the standard effective tax rates used in papers focusing on redistributive implications of fiscal reforms. Rather, we report the underlying tax rates supporting our estimates of tax revenue elasticities (in a similar way to Hutton and Lambert 1980). Recall that we use the concept of taxable labour income (rather than gross income), leaving aside a number of tax credits which may have impact on income inequality and redistribution through taxes.

In general, the 2007 fiscal reform breaks a slight upward trend in both tax rates over the period 2003-2006. This change is especially intense in the case of the average tax rate, which decreases by more than 5 percentage points between 2006 and 2007. The reduction in the marginal tax rate is stronger in the model with tax credits for housing investments while the average tax rate falls especially in the model without such tax credits.

5. Concluding remarks

This paper estimates the elasticities of Spanish income tax in 2003-2008, a period which includes the substantial fiscal reform that took place in 2007. The standard wisdom sees income tax as a progressive tax, with marginal tax rates higher than average tax rates, so that an exogenous increase in income leads to a more than proportionate growth in tax revenues.

However, as long as government resources are influenced by a number of factors, data may hide useful information. This is the case of Spanish income tax revenues, where the official reports by the AT show elasticities below 1 for some recent years.

Our aim here is to isolate the impact of progressivity on tax revenues, excluding other factors such as policy changes, tax evasion and so on. Hence, using two different methods (an analytical approach and a simulation procedure), we compute the extent to which tax revenues increase when taxpayers' income goes up marginally. We take into account some particular features of the Spanish tax system, namely the presence of tax credits for purchasing houses and the implementation of a major fiscal reform, which decreased tax rates and introduced personal and family allowances treated as tax credits, among other things.

Our results show that aggregate income tax elasticities range from 1.4 for 2003-2006 to 1.7-1.8 for 2007 and 2008. Clearly, the 2007 tax reform raised the sensitivity of income tax revenues to exogenous changes in income taxpayers. Obviously, these results vary according to the way in which housing tax credits are considered (higher elasticities when such tax credits are extensively used).

These findings are compared with others obtained by modifying some of the initial assumptions. If non-equiproportional changes in taxpayers' income are considered, equalising changes which increase the income of poor individuals more are seen to reduce aggregate income tax elasticity, and vice versa. Analytically, we also conclude that the higher the income inequality, the lower the income tax elasticity, although this result must be qualified under certain circumstances. Moreover, we show that correcting for fiscal drag from inflation decreases elasticity only insignificantly. These two procedures also allow the average and marginal effective tax rates to be obtained, and confirm that the increase in aggregate income tax elasticity after 2007 is supported by a more intense decrease in average tax rates than in marginal tax rates.

We believe that investigating aggregate tax elasticities is a relevant issue for many developed countries. As is well-known, the need to increase government resources is crucial in current fiscal consolidation processes. In regard to income tax in particular, we know that increasing tax rates may have substantial efficiency costs; and the war against tax evasion must pass a prior cost-benefit analysis whose final result is not evident in many cases.

Hence, the hope of many governments lies in capturing the increase in tax revenues that stems from economic recovery. Therefore, it is crucial to have estimates (which are as precise and robust as possible) of aggregate tax elasticities to draw up credible, realistic plans for cutting budget deficits.

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