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Income Tax Revenue Elasticities in Spain: Individual and Aggregate Measures

By

John Creedy and José Félix Sanz-Sanz[1]

Abstract

This paper derives analytical expressions for the revenue elasticity of the Spanish personal income tax system, as applied to tax units and in aggregate. This is complicated by the schedular nature of the system, and the role of central and regional governments, along with the existence of a range of tax credits and eligible expenditures and deductions. Empirical estimates are obtained using a cross-sectional dataset which enables a number of important ancillary elasticities (relating to allowances and tax credits, and different income sources) to be estimated. It was found that there is considerable variation among tax units in the revenue elasticity, with highly (positively) skewed distributions. The nature of the distributions varies among regions of Spain, and the aggregate elasticities for each region were found to display some variation associated with income distribution differences. The national aggregate is found to be around 1.3.

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1 Introduction

An important characteristic of any personal income tax structure is the elasticity of income tax revenue with respect to changes in gross income, when there are no adjustments to income thresholds or other discretionary changes to the tax structure. The revenue elasticity provides, at individual and aggregate levels, a measure of 'fiscal drag' arising from the failure to adjust income tax thresholds when incomes increase. Fiscal drag, or 'built-in flexibility', has implications for both the revenue and redistributive effects of taxation over the business cycle.[2] This measure is also useful when considering the 'automatic stabilisation' properties of the tax system.[3] The aim of this paper is to estimate the revenue elasticity properties of the Spanish personal income tax structure. Although the focus of attention is the Spanish structure, the methods used are more widely applicable.

The Spanish tax system differs from that of many other countries and has undergone significant reforms, in additional to the type of base-broadening and rate-reducing changes which have been common in many other countries.[4] In particular, income taxation (since 2002) is shared between Central and Regional Governments, consisting of 15 autonomous regions within the Common Territory. In addition, different tax rates and thresholds, and other rules influencing the difference between gross and taxable income, apply to a range of income sources: this involves the use of a multi-schedular tax structure. There are numerous deductions, allowances and tax credits (at central and regional levels) which apply at various stages. A number of these elements depend on non-income as well as income characteristics of tax units. This complexity means that extensions need to be made to standard methods of obtaining revenue elasticities.[5]

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[2] The revenue elasticity is closely linked to one of the measures of progressivity proposed by Musgrave and Thin (1948), and the link with progressivity is examined further in Podder (1997). On a possible relationship between the elasticity and government expenditure, see Craig and Heins (1980) and Misiolek and Elder (1988).

[3] On automatic stabilisation aspects of revenue elasticity, see Pohjola (1985), van den Noord (2000) and Mabbett (2004). A reduced importance was predicted to follow the 'death of inflation', by Heinemann (2001).

[4] On the recent reforms, see OECD (2006).

[5] Alternative methods include times series regressions and simulation. An early study of the US is Greytak and Thursby (1979). Important contributions were made in a series of papers by Hutton (1980) and Hutton and Lambert (1980, 1982a, 1982b, 1983, 1989). See also Caminada and Goudswaard (1996). For a survey of analytical properties, see Creedy and Gemmell (2002, 2006).

The approach followed here is to derive an analytical expression for the revenue elasticity of tax units, with respect to changes in gross income. This is shown to depend on a number of 'ancillary elasticities' which affect the way in which eligible expenditures and deductions, and tax credits, vary with unit income, along with the relative movements of each income source. A large cross-sectional sample of Spanish tax units is then used to estimate values of the ancillary elasticities, allowing for a substantial degree of heterogeneity whereby the elasticities differ according to total tax unit income, the demographic composition of the unit, the location (automonous region) and the income source. The aggregate revenue elasticity for each region and for the country as a whole is then obtained as a tax-share weighted sum of tax unit revenue elasticities, where the weights depend on the way in which each tax unit's income changes when total income changes.

Section 2 provides a description of the Spanish personal income tax system and formulates analytical expressions for the tax liability of each tax unit. Revenue elasticities relating to each tax unit are derived in Section 3, which also provides some numerical illustrations of their variation with tax unit income. Section 4 turns to the empirical estimation of revenue elasticities. First it obtains the distribution over tax units, using the ancillary elasticity estimates. Second, aggregate revenue elasticities for each region are reported. Section 4 also considers the potential implications of alternative income dynamic processes which allow 'regression' away from or towards the geometric mean income. Brief conclusions are given in Section 5.

2 The Tax Structure

This section describes the main elements of the personal income tax structure in Spain. The accounting period is the tax year, which corresponds to the calendar year. Subsection 2.1 provides a basic description of the structure as it applies to an individual tax unit, where the unit may consist of single individuals or married couples who decide to file jointly. In view of the operation of tax credits, several special cases need to be distinguished, as discussed in subsection 2.2.

2.1 Income Taxation of a Tax Unit

Let y_{hi} denote the gross income of tax unit *h* from source $i = 1,...,I$. In transforming from gross to taxable income, there are tax-deductible expenditures and non-income allowances. Let E_{hi} denote the tax-deductible expenditure for unit *h* relating to source *i*. In general these expenditures are expected to be a function of gross income: this is examined in more detail below. Non-income allowances for tax unit *h* relating to source *i* are denoted A_{hi}. Taxable income, x_{hi} is given by:

$$x_{hi} = \max\{0, y_{hi} - E_{hi} - A_{hi}\} \tag{1}$$

If the sum of actual tax-deductible expenditures and non-income allowances exceeds gross income for any income source, the unit effectively has 'losses' associated with that source.[6] A distinction can therefore be drawn between actual expenditures and those which are claimed in a year: in the following discussion, E_{hi} refers to actual expenditures. A complication is that any 'losses' can be carried forward for a period of four years, to be deducted against future income for the same source. However, no allowance is made for this dynamic element on the grounds that the losses form a very small component of income.[7]

The income tax structure has marginal tax rates t_{ki} and thresholds a_{ki} for $k = 1,...,K$, where t_{ki} applies between a_{ki} and $a_{k+1,i}$ (with $a_{K+1,i} = \infty$).[8] In addition, as mentioned above, separate rates are imposed at the central and regional government levels, although the income thresholds are common. Letting superscripts *C* and *R* refer to central and regional rates respectively:

$$t_{ki} = t_{ki}^{C} + t_{ki}^{R} \tag{2}$$

For a multi-step tax structure with *K* steps, $T(x) = 0$ for $a_0 = 0 < x < a_1$, $T(x) = t_1(x - a_1)$ for $a_1 < x < a_2$, and $T(x) = t_1(a_2 - a_1) + t_2(x - a_2)$ for $a_2 < x < a_3$, and so on. Then in general, if $a_k < x < a_{k+1}$, Creedy and Gemmell (2006, p. 25) show that:

$$T(x) = t_k(x - a'_k) \tag{3}$$

where:

$$a'_k = \frac{1}{t_k}\sum_{j=1}^{k} a_j(t_j - t_{j-1}) \tag{4}$$

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[6] This creates a tax asymmetry similar to that associated with corporation taxation, where its role is much more significant.

[7] The amount of negative taxable income generated each tax year is well below 1 per cent. Furthermore, the amount of carried-forward taxable income from the last four years to offset against current taxable income is even less relevant in relative terms, being well below 0.1 per cent. As with corporation losses, many losses are not used by the taxpayers and becoming 'stranded'. Hence, the loss asymmetry in the tax function is of little relevance in determining the aggregate tax liability.

[8] From 2007, there is an exception in that Madrid has a slightly different tax structure from that of the other regions. This minor difference is neglected here.

Hence in the present context, if $a_{ki} < x_{hi} < a_{k+1,i}$, unit *h* is in the *k*th tax bracket for source *i* and the following expressions describe income taxation at central and regional levels.

$$T_i^C\left(y_{hi} \middle| a_{ki} < x_{hi} < a_{k+1,i}\right) = t_{kih}^C\left(x_{hi} - a'^C_{kih}\right) \quad (5)$$

$$T_i^R\left(y_{hi} \middle| a_{ki} < x_{hi} < a_{k+1,i}\right) = t_{kih}^R\left(x_{hi} - a'^R_{kih}\right) \quad (6)$$

The terms a'^C_{ki} and a'^R_{ki} are the corresponding thresholds such that tax liability in a multi-threshold tax structure can be expressed in terms of an equivalent single-rate structure. In writing the expressions (5) and (6) the marginal tax rate terms, *t*, along with the effective thresholds, a', need the *h* subscripts, in order to clarify the point that the tax rates and thresholds indicated are those that apply to the tax unit in question, depending on the tax bracket into which the unit falls.

In addition, there are central and regional government non-refundable tax credits of C_C and C_R. Total tax paid by unit *h* is expressed as:

$$T(\sum_i y_{hi}) = \max\left\{ 0, \sum_{i=1}^{I} T_i^C(y_{hi}) - C_C \right\} + \max\left\{ 0, \sum_{i=1}^{I} T_i^R(y_{hi}) - C_R \right\} \quad (7)$$

In addition, there are refundable tax credits, unrelated to income. However, it is argued that such refundable credits, since they can in principle be administered by a separate authority and their cost is unrelated to the income tax structure, should not be included where – as here – emphasis is on the revenue elasticity from the point of view of revenue growth and fiscal drag. This issue is discussed further in Appendix A.

The existence of non-refundable tax credits means that several cases must be distinguished. These are discussed in the following subsection.

2.2 Special Cases

Consider the most common situation where tax unit *h* is such that $\sum_{i=1}^{I} T_i^C\left(y_{hi}\right) > C_C$ and $\sum_{i=1}^{I} T_i^R\left(y_{hi}\right) > C_R$. The expression given in (7) above for tax liability is thus simplified to:

$$T(\sum_i y_{hi}) = \sum_{i=1}^{I}\left\{T_i^C(y_{hi}) + T_i^R(y_{hi})\right\} - \left(C_R + C_C\right) \quad (8)$$

and:

$$T(\sum_i y_{hi}) = \sum_{i=1}^{I}\left\{t_{kih}x_{hi} - (t_{kih}^C a'^C_{kih} + t_{kih}^R a'^R_{kih})\right\} - \left(C_R + C_C\right) \quad (9)$$

Furthermore, where $x_{hi} > 0$ this becomes:

$$T(\sum_i y_{hi}) = \sum_{i=1}^{I} \left\{ t_{kih} \left(y_{hi} - E_{hi} - A_{hi} \right) - (t_{kih}^C a'^C_{kih} + t_{kih}^R a'^R_{kih}) \right\} - \left(C_R + C_C \right) \qquad (10)$$

A further simplification is available in view of the fact that the central and regional income thresholds are the same. Using the above expression for a'_k, it can be shown that:

$$t_{kih}^C a'^C_{kih} + t_{kih}^R a'^R_{kih} = \sum_{j=1}^{k_{ih}} a_{ji} \left(t_{ji} - t_{j-1,i} \right) \qquad (11)$$

If, alternatively, $\sum_{i=1}^{I} T_i^C \left(y_{hi} \right) > C_C$ but $\sum_{i=1}^{I} T_i^R \left(y_{hi} \right) < C_R$, tax liability is thus:

$$T(\sum_i y_{hi}) = \sum_{i=1}^{I} \left\{ T_i^C (y_{hi}) \right\} - C_C \qquad (12)$$

and if $x_{hi} > 0$ this becomes:

$$T(\sum_i y_{hi}) = \sum_{i=1}^{I} \left\{ t_{kih}^C \left(y_{hi} - E_{hi} - A_{hi} \right) - (t_{kih}^C a'^C_{kih}) \right\} - C_C \qquad (13)$$

with $t_{ki}^C a'^C_{ki} = \sum_{j=1}^{k} a_{ji} \left(t_{ji}^C - t_{j-1,i}^C \right)$. Similarly, if $\sum_{i=1}^{I} T_i^C \left(y_{hi} \right) < C_C$ but $\sum_{i=1}^{I} T_i^R \left(y_{hi} \right) > C_R$, the above expressions apply with *C* replaced by *R*.

3 Individual Revenue Elasticities

This section considers the tax revenue elasticity, measuring the extent to which tax revenue increases when gross income increases, at the level of the tax unit.

Consider the effect on tax paid by a tax unit of a small increase in gross income, arising from changes in each of the sources, which does not take the unit into a higher tax bracket.[9] First, define $T(\sum_i y_{hi}) \equiv T_h$ as the total tax paid by the unit. Furthermore, define $y_h = \sum_i y_{hi}$ as total gross income from all sources.

The change in tax paid by the unit when total gross income changes is given by:

$$\frac{dT_h}{dy_h} = \sum_{i=1}^{I} \frac{\partial T_h}{\partial y_{hi}} \frac{\partial y_{hi}}{\partial y_h} \qquad (14)$$

[9] It is common not to allow for such transitions when using analytical expressions. However, when using a simulation approach which actually computes discrete income and tax changes, considerable care is needed because very large individual values, for a very small number of units, can distort the aggregate results.

Hence:

$$\frac{y_h}{T_h}\frac{dT_h}{dy_h} = \sum_{i=1}^{I}\left(\frac{y_{hi}}{T_h}\frac{\partial T_h}{\partial y_{hi}}\right)\left(\frac{y_h}{y_{hi}}\frac{\partial y_{hi}}{\partial y_h}\right) \tag{15}$$

In general denote the elasticity of A with respect to B using the notation $\eta_{A,B}$. Thus:

$$\eta_{T_h,y_h} = \sum_{i=1}^{I}\eta_{T_h,y_{hi}}\eta_{y_{hi},y_h} \tag{16}$$

The elasticity of total tax paid by unit h therefore depends on the way in which the individual components of income change when the unit's total gross income changes, determined by η_{y_{hi},y_h}.

Consider the component elasticity $\eta_{T_h,y_{hi}}$. Here it is not possible to obtain a component elasticity defined in terms of the revenue from a single source, because the non-refundable tax credits are related to total income tax rather than its components. If it were possible to distinguish revenue from each source, as for example T_{hi}, the elasticity η_{T_h,y_h} could be expressed as a tax-share (T_{hi}/T_h) weighted sum of the product of individual elasticities $\eta_{T_{hi},y_{hi}}$ and η_{y_{hi},y_h}.

For those with positive taxable incomes in excess of the tax credits, and supposing that eligible expenditures and allowances change when income from source q changes:

$$\frac{\partial T_h}{\partial y_{hq}} = t_{kqh}\left(1 - \frac{\partial E_{hq}}{\partial y_{hq}} - \frac{\partial A_{hq}}{\partial y_{hq}}\right) \tag{17}$$

This can be rewritten:

$$\frac{y_{hq}}{T_h}\frac{\partial T_h}{\partial y_{hq}} = \eta_{T_h,y_{hq}} = \frac{t_{kqh}y_{hq}}{T_h}\left(1 - \frac{\partial E_{hq}}{\partial y_{hq}} - \frac{\partial A_{hq}}{\partial y_{hq}}\right) \tag{18}$$

The ratio T_h / y_{hq} is the total tax paid by unit h as a proportion of h's income from source q, which may be denoted by ATR'_{hq}: the prime is added here as it is not the averate rate associated with source q. It can thus be interpreted as a kind of average tax rate: if there were no distinction between income sources, it would be a standard average tax rate. The term $\partial T_h / \partial y_{hq}$ is the marginal tax rate, MTR_{hq}, relating to a change in income source q. The tax revenue elasticity for unit h with respect to a change in income source q is thus the ratio, MTR_{hq} / ATR'_{hq}, as in the standard result.

Then it can be seen that:

$$\eta_{T_h,y_{hq}} = \frac{t_{kqh}y_{hq}}{T_h} - \eta_{E_{hq},y_{hq}}\left(\frac{t_{kqh}E_{hq}}{T_h}\right) - \eta_{A_{hq},y_{hq}}\left(\frac{t_{kqh}A_{hq}}{T_h}\right) \tag{19}$$

The term $t_{kqh}E_{hq}/T_h$ represents the tax 'saved' at the margin from the existence of the deduction, E_{hq}, expressed as a ratio of total tax paid. Denote this by $\theta_{E,hq}$. A similar term, $\theta_{A,hq}$, can be defined relating to allowances. Furthermore, let $t_{kqh} = MITR_{hqh}$, where the subscript *h* is included as a reminder that the appropriate marginal rate depends on the specific situation facing the tax unit. The notation, including 'I', indicates that it is the marginal income tax rate, not the effective marginal tax rate, $\partial T_h / \partial y_{hq}$. The elasticity can therefore be written:

$$\eta_{T_h,y_{hq}} = \frac{MITR_{hq}}{ATR'_{hq}} - \eta_{E_{hq},y_{hq}}\theta_{E,hq} - \eta_{A_{hq},y_{hq}}\theta_{A,hq} \tag{20}$$

In the special case where E_{hq} and A_{hq} are fixed, so that $\theta_{E,hq} = \theta_{A,hq} = 0$, then of course $MITR_{hq} = MTR_{hq} = t_{kq}$.[10]

A further complication arises where the tax credits, C_C and C_R, are not fixed, but depend on household characteristics. These credits are not connected with individual income sources, unlike the expenditures and allowances. Suppose instead that the tax credits depend on total income, y_h. The above elasticity is then further reduced by subtracting the term:

$$\left\{\eta_{C_{Ch},y_h}\left(\frac{C_{Ch}}{T_h}\right) + \eta_{C_{Rh},y_h}\left(\frac{C_{Rh}}{T_h}\right)\right\}\left(\frac{1}{\eta_{y_{hq},y_h}}\right) \tag{21}$$

Using the above property that $\eta_{T_h,y_h} = \sum_{i=1}^{I} \eta_{T_h,y_{hi}}\eta_{y_{hi},y_h}$, defining $ATR_h = T_h / y_h$ as the overall average tax rate facing the unit, and noting that $\eta_{y_{hi},y_h} = \eta_{y_h,y_{hi}}^{-1}$ and, for example, $\eta_{a,b}\eta_{b,c} = \eta_{a,c}$,it can be shown that, for those taxpayers with $C_C > T_h^C$ and $C_R > T_h^R$:

[10] The treatment of the relationship between allowances and income from each source is slightly simplified here and in the following subsection. However, as explained in Section 4, the full details are modelled when obtaining empirical values.

$$\eta_{T_h y_h} = \sum_{i=1}^{I} \frac{t_{kih}}{ATR_h} \times \left[\eta_{y_{hi} y_h} \frac{y_{hi}}{y_h} - \eta_{E_{hi} y_h} \frac{E_{hi}}{y_h} - \eta_{A_{hi} y_h} \frac{A_{hi}}{y_h} - \left\{ \eta_{C_{Ch}, y_h} \frac{C_{Ch}}{y_h} + \eta_{C_{Rh}, y_h} \frac{C_{Rh}}{y_h} \right\} \frac{1}{t_{kih}} \right] \quad (22)$$

This can also be written as:

$$\eta_{T_h y_h} = \sum_{i=1}^{I} \frac{t_{kih}}{ATR_h} \left(\frac{y_{hi}}{y_h} \right) \eta_{y_{hi} y_h} - \sum_{i=1}^{I} \frac{t_{kih}}{T_h} \left[\left(\eta_{E_{hi} y_h} E_{hi} + \eta_{A_{hi} y_h} A_{hi} \right) + \left(\eta_{C_{Ch}, y_h} C_{Ch} + \eta_{C_{Rh}, y_h} C_{Rh} \right) \frac{1}{t_{kih}} \right] \quad (23)$$

If there were only one income source, then $y_{hi} / y_h = \eta_{y_{hi}, y_h} = 1$ and the first term above would be simply the ratio of the marginal tax rate to the average tax rate facing the unit: this is the standard expression for the revenue elasticity. The second term shows the modifications arising from the eligible expenditures and allowances, which are involved in the transformation from gross to taxable income, and the central and regional tax credits. Special cases of this result apply for situations where tax credits are greater or equal than the tax liability after the application of the tax schedule.

3.1 Illustrative Examples

This subsection illustrates the way in which the tax revenue elasticity varies for individuals in Spain. Following the Spanish tax code operating in 2007, attention is concentrated on just two sources of income and on the effects of varying eligible expenditures, allowances and tax credits as gross income increases. The first income source includes: labour income; alimony; self employment income; income from property and income applications to shareholders coming from Corporations under the *fiscal transparency regime* (similar to S-Corporations in the USA). The second income source includes: capital gains and any form of income derived from financial savings such as interest rates from bank accounts and deposits, share dividends, bond interest or any other type of yield earned from debt saving instruments. Incomes include both monetary compensations and fringe benefits.

The allowable tax deductions, E, are income related specific deductions which generally include a shortlist of necessary expenditures incurred in order to earn the relevant income. Good examples of this are the employee Social Security contributions and union membership fees for labour income, loan interest payments, maintenance costs or economic depreciation in the case of property income, or a restricted list of some operating expenses from savings or entrepreneurship. Together with this, E entails the existence of a fixed labour-specific tax deduction of 4,000 € for earnings less than or equal to 9,000 €. Notwithstanding, this tax deduction turns out to be income-decreasing for earnings between 9,000 € and 13,000 € and becoming fixed again at a reduced amount of 2,600 € for earnings of 13,000 € and above.

Allowances, A, incorporate non-specific tax allowances and deductions. This includes paid palimony, contributions to Pension Schemes and personal and family allowances. Examples of the latter are the allowances recognized for special circumstances such as age, disability or the existence of dependants (ancestors and/or descendants). These non-specific income allowances are normally capped and present some limitations for its application in terms of the taxpayer's income level and type of income. Finally, tax credits include all non-refundable tax relief enjoyed by the taxpayers in order to compute the final tax due after applying the tax schedules. For a detailed description of the specific quantities applied in year 2007 see Agencia Tributaria (2008), and for an evolution of all these concepts through time in the Spanish case, see Romero and Sanz-Sanz (2007).

The marginal rates and thresholds for the first income source are shown in Table 1. For the second source, tax is paid at fixed central and regional (marginal and average) rates of 0.111 and 0.069.

Table 1 Tax Structure for Income Source 1

Income Threshold (€s)	Central Govt MTR	Regional Govt MTR	Total MTR
0	0.1566	0.0834	0.24
17,360	0.1827	0.0973	0.28
32,360	0.2414	0.1286	0.37
52,360	0.2713	0.1587	0.43

Four different cases, for parameters listed in Table 2, are illustrated. In each case a fixed ratio of income from the two sources is assumed, whereby source two is 10 per cent of source one. Case 1 takes the (unrealistic) extreme of fixed eligible expenses, allowances and credits. The following cases gradually introduce elasticities, assumed to be constant, so that Case 4 allows all deductions and credits to vary as income varies. For example, in obtaining the values of expenditures, and so on, the following specification was thus used:

$$E_{hi} = E_0 y_{hi}^{\eta_{E_i,y_i}} \tag{24}$$

The various elasticities, such as η_{E_i,y_i}, are referred to here as ‘ancillary elasticities’, and their estimation for Spain is described in the following Section. For estimation purposes, a major aim was to allow for as much population heterogeneity as possible. For present illustrative purposes the parameters in Table 2 are imposed, based on orders of magnitude obtained for the estimates.

Table 2 Alternative Parameters for Four Cases

	Case 1	Case 2	Case 3	Case 4
Source 1				
E_0	3500	98	98	98
Elasticity	0	0.4	0.4	0.4
A_0	5000	5000	7000	7000
Elasticity	0	0	0.005	0.005
Source 2				
E_0	35	0.3	0.3	0.3
Elasticity	0	0.8	0.8	0.8
A_0	5000	5000	4750	4750
Elasticity	0	0	0.05	0.05
Credits				
C_{C0}	1200	1200	1200	800
Elasticity	0	0	0	0.05
C_{R0}	550	550	550	13
Elasticity	0	0	0	0.4

The resulting variations in individual revenue elasticities are shown in Figures 1 to 4. Clearly the highest elasticity values are obtained when expenditures, deductions and credits are fixed. Tax unit elasticities can become extremely high where income is just above the tax threshold where units begin to pay tax: in the limit – right at the threshold – the elasticity is of course infinitely high because the denominator (the initial tax paid) is zero. This property influences the distribution of elasticities discussed in the following Section.

From Figure 1, no tax is paid until total income reaches approximately 16,775 €, when income from the first source becomes subject to the regional government rate of 0.0834 and income from the second source is taxed at the regional government rate of 0.069. At these levels, just above the threshold when the individual begins to pay tax, the revenue elasticity is very high. It then falls, until a total income of about 17,875 € is reached. At this point, the individual’s incomes from both sources are taxed at both the central government and regional rates, so that the marginal tax rates applying to sources one and two are 0.24 and 0.18 respectively. On crossing into the higher marginal tax rate brackets, the revenue elasticity shoots up again, after which it declines steadily until reaching the next threshold.

When total income is about 28600 €, the marginal tax rate applied to income from the first source becomes 0.28 (the combined central and regional rates), and a smaller jump in the revenue elasticity is observed. The next income threshold is about 45,100 € when income from the first source begins to be taxed at a combined rate of 0.37. The effect is that the pattern of revenue elasticities displays the familiar 'saw tooth' pattern.

Case 2, where positive ancillary elasticities are introduced for eligible expenditures, the pattern is similar to that for Case 1, although of course the effective income thresholds are different. Thus initially only regional government taxes are paid in relation to both income sources, then another threshold is reached where central government tax rates are also applied. The individual then gradually moves into the higher tax brackets relating to the first income source. Similar characteristics apply when, in Case 3, ancillary elasticities for allowances are also positive.

Figure 1 Variation in Individual Revenue Elasticity with Total Gross Income: Case 1

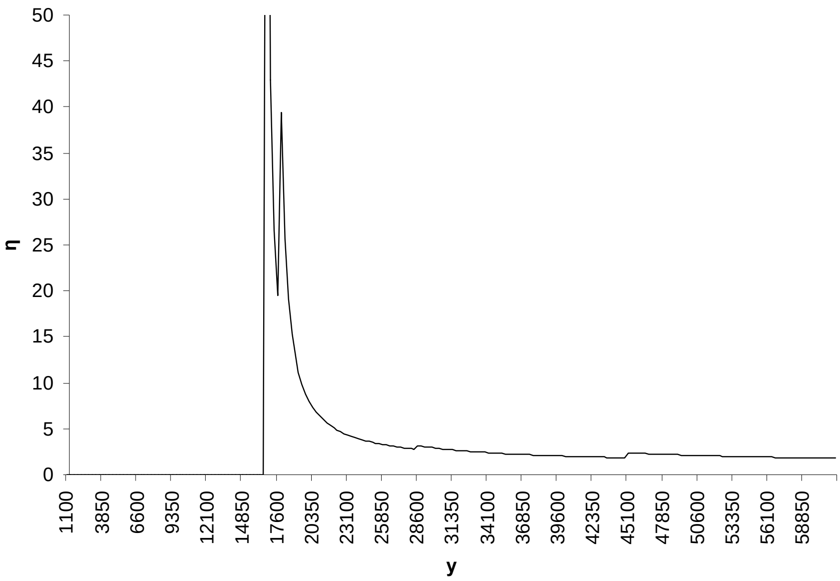


Figure 2 Variation in Individual Revenue Elasticity with Total Gross Income: Case 2

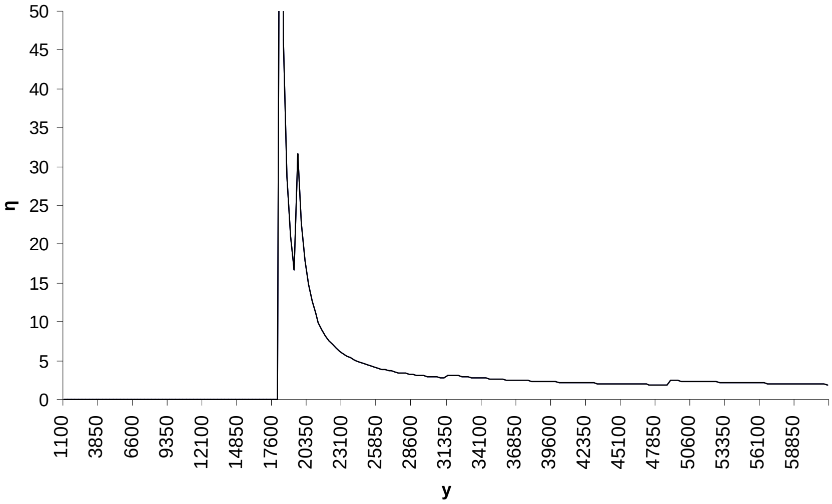


Figure 3 Variation in Individual Revenue Elasticity with Total Gross Income: Case 3

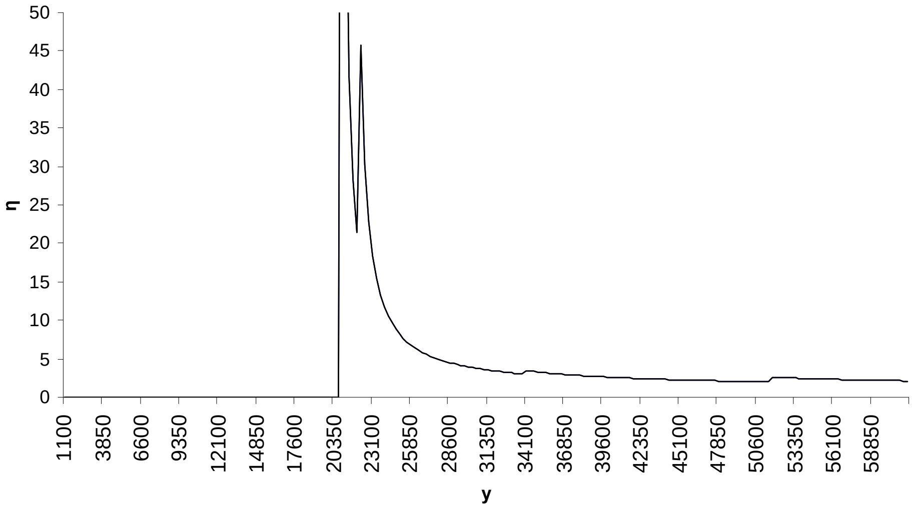
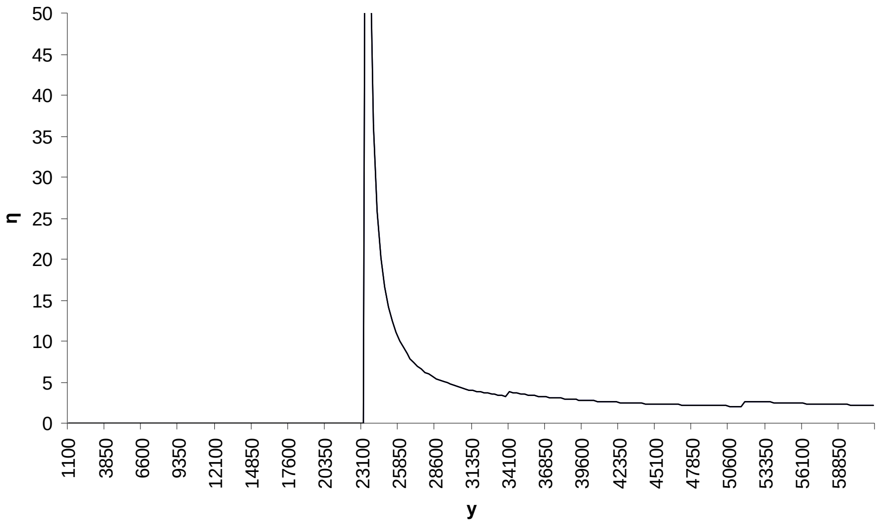


Figure 4 Variation in Individual Revenue Elasticity with Total Gross Income: Case 4



Case 4, where all ancillary elasticities are positive, gives rise to a slightly different pattern. In this case the income level, of about 23,375 €, at which the individual begins to pay tax involves paying only the central government rates of 0.1566 and 0.111 for the first and second income source respectively. Very soon after this, at the level of 23,650 €, the individual pays tax on both income sources at the combined central and regional rates of 0.24 and 0.18 for the two sources. A kink, or 'tooth' arises in the revenue elasticity curve at the income of 34,100 €, when income source one attracts the higher combined marginal tax rate of 0.28. Then at 51,700 €, the individual moves into the next tax bracket for this source, with a marginal rate of 0.37. Movement to the top marginal tax bracket is not shown in the diagram.

4 Empirical Estimates

This section presents estimated values of the individual revenue elasticity as defined in equation (23). Results were obtained using the Personal Income Tax information reported for a sample of 896,390 Spanish tax units. The original dataset comes from a cross-sectional dataset from the Spanish Tax Agency for year 2002. The data were adjusted to tax year 2007 and the simulated personal income tax is the one that came into force in January 2007. Appendix C reports some basic summary statistics for relevant variables, both for the whole country and for each of the Autonomous Communities (regions).

The first step was to compute the ancillary elasticities relating to the variation in expenditures and allowances. An important priority was to allow for as much heterogeneity as possible. For each of the 15 Autonomous Communities, the sample was split into subsamples according to 5 quantiles of total gross income, and within each quantile by the size of the tax unit. In the latter case three categories were used consisting of: one member; two members; and three or more members. Therefore, the total sample was divided into 225 subsamples ($15 \times 5 \times 3$), and for each of these 225 subsamples the ancillary elasticities were obtained by running the following Tobit regression (where the sampling weight of each tax unit was taken into account):

$$\log z_h = \alpha + \eta_{z,y} \log y_h + \gamma \log Q_h + \varepsilon \qquad (25)$$

Where z is the relevant variable for which the constant elasticity, $\eta_{z,y}$, with respect to total gross income is required (that is, $y_1, y_2, E_1, E_2, A_1, C_C$ and C_R), and the matrix Q represents a set of dummy variables capturing the type of tax-return (joint or separate filing), marital status (four categories) and type of main source of income (three categories).[11] As a consequence of the procedure described above 1,575 estimations were run (seven ancillary elasticities for each of the 225 subgroups). Clearly there are too many values to be reported here.

To compute the remaining terms in equation (23) for each tax unit, the 2007 tax structure was applied to each tax unit in the sample. For each tax unit the appropriate values of y_1, y_2, y_t, A_1, A_2, C_C, C_r and the marginal tax rates levied on each income source, t_{kih}, as well as the weighted total marginal tax rate, $\frac{y_1}{y_h} t_{k1h} + \frac{y_2}{y_h} t_{k2h}$, and the average tax rate (ATR). All the ingredients of $\eta_{T_h\, y_h}$ were thus available for each tax unit, and Summary measures of the distribution of individual elasticities are reported in Table 3 for each region.

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[11] For the case of $\eta_{A_2 y_h}$ the procedure was slightly different, as follows. The values of A_2 are positive only if the magnitude of A_1 has not been entirely absorbed by the first income source y_1. In those cases, the excess of A_1 can be transferred as an allowance to reduce the second source of income y_2. Thus A_2 is positive only for tax units for whom y_1 is sufficiently small not to absorb all its entitled A_1. In other words, tax units which are rich in income from source 1 will not enjoy any transfer and as a result they will have $A_2 = 0$.

Table 3 Quartiles of Individual Revenue Elasticities by Region and for The Whole Country

	Lower quartile	Median	Upper quartile
National	1.1214	1.4082	1.7761
Andalucia	0.9673	1.3004	1.6172
Aragon	1.1128	1.3819	1.8037
Asturias	1.1414	1.4731	1.9418
Baleares	1.0127	1.3865	1.9085
Canarias	1.0207	1.3504	1.7578
Cantabria	1.2341	1.5071	1.8395
Castilla-Leon	1.0710	1.3829	1.7248
Castilla-LaMancha	1.0553	1.3905	1.7490
Cataluña	1.1874	1.3660	1.6667
Valencia	1.0806	1.3706	1.8863
Extremadura	0.9384	1.3016	1.6013
Galicia	0.9480	1.3297	1.8183
Madrid	1.2896	1.5507	1.8279
Murcia	1.1164	1.4429	1.9578
Rioja	1.1214	1.4082	1.7761

The distribution of individual revenue elasticities is of course highly skewed because those individuals who are just above an income threshold have very high revenue elasticities, as discussed in the previous Section.

Further details regarding the distribution of individual elasticities can be illustrated using 'box plots', as in Figures 5 to 7, which provide a graphical representation of the main characteristics of a given distribution. A box plot is formed by a box, two 'whiskers' and two 'fences', as follows. The right border of the box is the upper quartile; the left border is the lower quartile; and the line inside the box is the median. Hence the width of the box shows the inter-quartile range. The whiskers are the two horizontal lines to the left and right of the box which end in two vertical lines known as the fences. The right fence shows the highest value of the distribution that is smaller than or equal to the third quartile plus 1.5 times the inter-quartile range. The left fence shows the lowest value of the distribution that is greater than or equal to the first quartile minus 1.5 times the inter-quartile range. The box therefore indicates the dispersion and the skewness of the distribution.

Figure 5 Distribution of Individual Elasticities by Income Quintile and Size of Tax Unit: All Regions

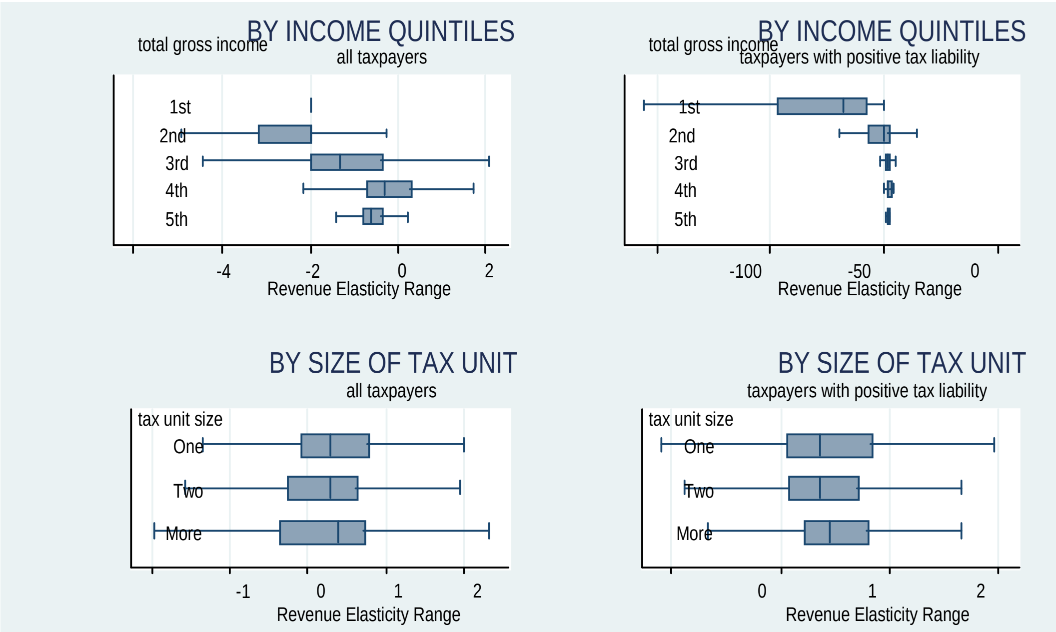


Figure 6 Distribution of Individual Elasticities by Main Income and Marital Status: All Regions

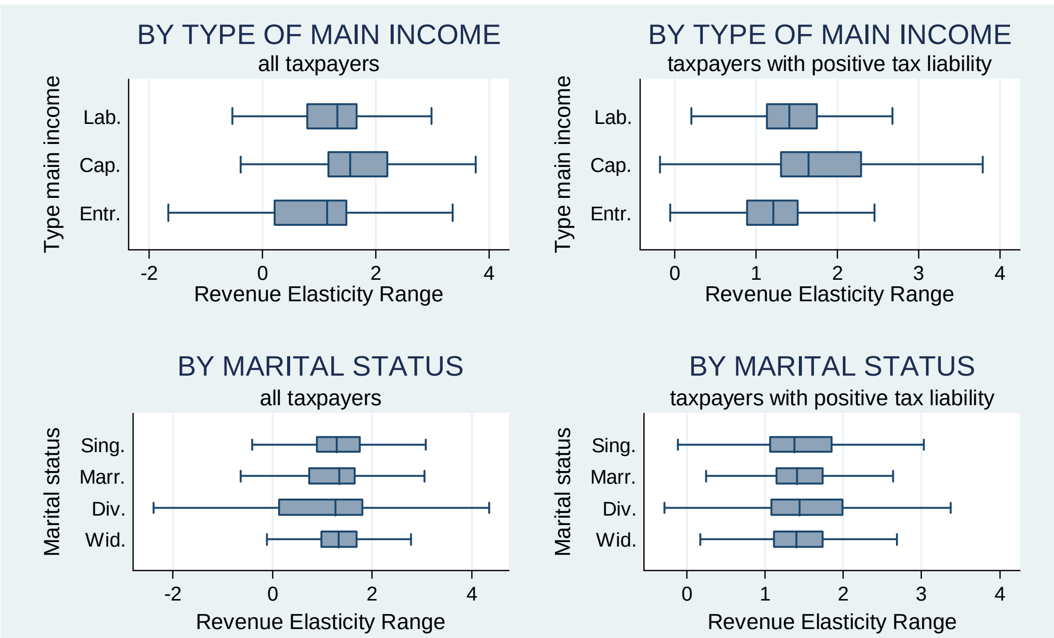
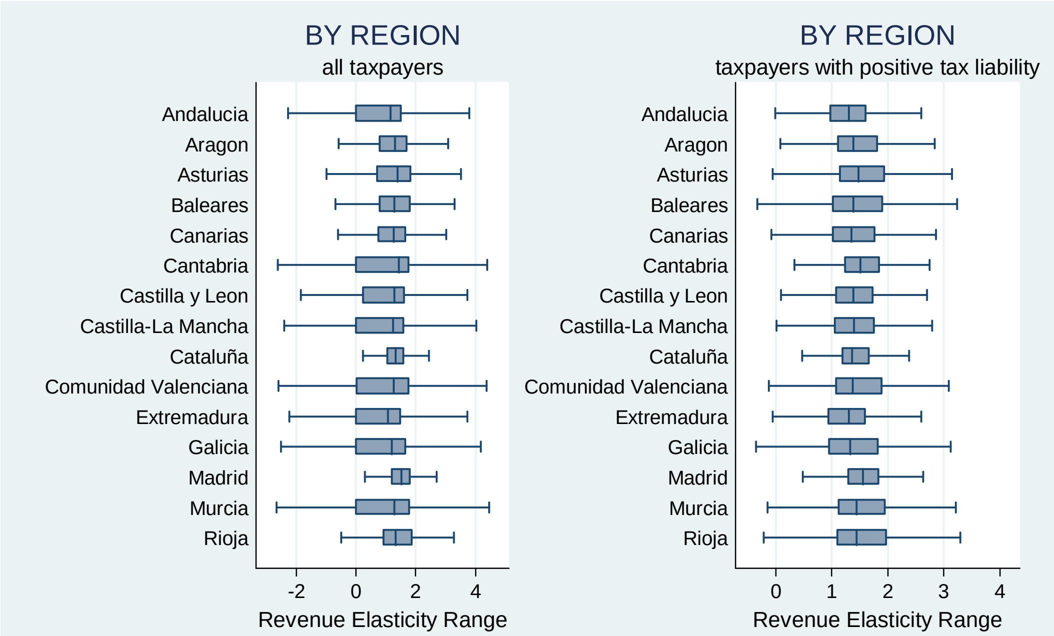


Figure 7 Distribution of Individual Elasticities by Autonomous Community in Common Territory



The boxes on the left hand side of each figure refer to all tax units, and thus include all those with a zero tax liability. When the elasticities are classified by income quintiles, it can be seen that there are nurerous negative elasticities, many of which are large in absolute terms. These negative elasticities are associated mainly with tax units who pay small amounts of personal income tax but have low incomes and ancillary elasticities which are greater than unity; thus (some of) the eligible expenditures, allowances and tax credits increase by more than gross income. The dispersion is substantially affected by whether all tax units are included, or whether attention is restricted to those who pay positive amounts of personal income tax.

When classified by tax unit size, there is little variation in the dispersion of individual revenue elasticities. Those whose main source of income is entrepreneurial income have a lower dispersion when only taxpayers are included, compared with the population of all tax units. This result is affected by the great ability of such tax units to claim substantial amounts of eligible expenditure and allowances.

4.1 The Aggregate Revenue Elasticity

Consider next the aggregate tax revenue elasticity, over H tax units. Define $Y=\sum_{h=1}^{H} y_h$ and $T=\sum_{h=1}^{H} T_h$ as aggregate income and tax revenue respectively. Then:

$$\frac{dT}{dY}\frac{Y}{T}=\sum_{h=1}^{H}\left(\frac{\partial T_h}{\partial y_h}\frac{y_h}{T_h}\right)\left(\frac{\partial y_h}{\partial Y}\frac{Y}{y_h}\right)\left(\frac{T_h}{T}\right) \tag{26}$$

and:

$$\eta_{T,Y}=\sum_{h=1}^{H}\eta_{T_h,y_h}\eta_{y_h,Y}\left(\frac{T_h}{T}\right) \tag{27}$$

The elasticity of aggregate revenue with respect to aggregate income is thus a tax-share weighted average of the product of individual revenue elasticities and the elasticity of individual income with respect to total income. Hence it depends not only the tax structure but on the extent to which individual incomes change when aggregate income changes. And, as shown above, the individual revenue elasticities depend on the extent to which the components of individuals' incomes change as each individual's income changes.

In order to show the relevance of taking into account the schedular design of the tax as well as the rules that affect the definition of the taxable income and the final tax due, it is of interest to consider alternative measures of the aggregate revenue elasticity. Allowing for progressively more flexibility or endogeneity of deductions and allowances, the following terms are used for the individual elasticities:

$$\eta_{1h}=\sum_{i=1}^{I}\frac{t_{kih}}{ATR_h}\left(\frac{y_{hi}}{y_h}\right) \tag{28}$$

$$\eta_{2h}=\sum_{i=1}^{I}\frac{t_{kih}}{ATR_h}\left(\frac{y_{hi}}{y_h}\right)\eta_{y_{hi}y_h} \tag{29}$$

$$\eta_{3h}=\sum_{i=1}^{I}\frac{t_{kih}}{ATR_h}\left(\frac{y_{hi}}{y_h}\right)\eta_{y_{hi}y_h}-\sum_{i=1}^{I}\left(\frac{t_{kih}}{T_h}\right)\left[\left(\eta_{E_{hi}y_h}E_{hi}+\eta_{A_{hi}y_h}A_{hi}\right)\right] \tag{30}$$

Along with (23), which gives, say, η_{4h}.

Table 4 Aggregate Revenue Elasticities: $\eta_{y_h,Y} = 1$

	η_1	η_2	η_3	η_4
National	2.0732	2.1010	1.6238	1.3516
Andalucía	2.2403	2.2444	1.6813	1.2231
Aragón	2.1577	2.0983	1.5823	1.3266
Asturias	2.1926	2.2358	1.7334	1.4369
Baleares	2.0425	2.0047	1.5878	1.3282
Canarias	2.1566	2.1250	1.6885	1.3235
Cantabria	2.1645	2.1011	1.5900	1.3164
Castilla-León	2.2493	2.2275	1.5390	1.2051
Castilla-La Mancha	2.3570	2.3310	1.7721	1.2842
Cataluña	1.9944	1.9501	1.5615	1.3668
Valencia	2.1714	2.1569	1.6281	1.3026
Extremadura	2.3600	2.2622	1.6661	1.0762
Galicia	2.1924	2.1721	1.6028	1.1985
Madrid	1.8614	2.0515	1.6300	1.5057
Murcia	2.2954	2.2725	1.8047	1.3189
Rioja	2.1905	2.1212	1.6275	1.3665

In obtaining results reported here, the assumption was made that $\eta_{y_h,Y}$ is unity; that is, all incomes move in the same proportion.The resulting aggregate elasticities are shown in Table 4. The elasticity η_1 assumes not only that all deductions and credits are fixed irrespective of income, but that the two sources of income remain in fixed proportions for all individuals. The second elasticity, η_2, uses information about the (cross-sectional) variation in income proportions to attribute an elasticity η_{y_{hi},y_h} to each tax unit's income source. This has a relatively small effect on the revenue elasticity estimates. Larger effects are observed where eligible expenditures and deductions, and then tax credits, vary with tax unit income: in each case the aggregate revenue elasticity falls when the ancillary elasticities are used.

The revenue elasticities in the final column of Table 4 vary from just over 1.0 to about 1.5. The variation across regions arises from regional differences in gross incomes, since all regions face similar tax structures.

In general, the aggregate values are similar to those reported for a number of other countries. On the US, see Fries *et al*. (1982), Dye and McGuire (1991) and Ram(1991). UK results are reported in Johnson and Lambert (1989) and Creedy and Gemmell (2004a, 2006, pp. 113). Canadian estimates are given by King and McMorran (2002)[12], and for New Zealand see Creedy and Gemmell (2004b, 2006, p.171). Lower elasticities of around 1, using time series methods, are given for Turkey by Kuştepeli and Şapçi (2006).

In considering the revenue elasticities reported above, it should be remembered that they relate to revenue changes associated with changes in gross incomes. Many empirical studies actually begin not from gross income but from taxable income; that is, measured income has already been adjusted for eligible expenditures and allowances, so that the tax function can be applied directly as a function of taxable income.

In the case of a single income source, where *x* and *y* are, as above, taxable and gross income, and tax paid is $T\left(x\left(y\right)\right)$, then the revenue elasticity is $\eta_{T,y} = \left(\eta_{T,x}\right)\left(\eta_{x,y}\right)$. Furthermore, writing $x = y - D$, where *D* refers to all allowances and deductions, it can be shown that:

$$\eta_{x,y} = \left(1 - \frac{D}{y}\right)^{-1}\left(1 - \frac{D}{y}\eta_{D,y}\right) \tag{31}$$

Where $\eta_{D,y}$ is the elasticity of deductions with respect to gross income. It is clear from (33) that if $\eta_{D,y} < 1$, then $\eta_{x,y} > 1$ and the revenue elasticity with respect to gross income exceeds the revenue elasticity with respect to taxable income.

4.2 Income Dynamics

The above estimates, in common with most studies, are obtained on the assumption that all incomes move together, so that $\eta_{y_h,Y}$ is equal to unity. In the absence of direct information on the dynamic process of relative income changes from year to year, it is possible to consider the sensitivity of results to an assumed degree of regression towards, or away from, the geometric mean. Following Creedy and Gemmell (2006), suppose income dynamics can be described by the relationship:

$$\eta_{y_h,Y} = 1 - \left(1 - \beta\right)\left(\log y_h - E\left(\log y\right)\right) \tag{32}$$

where $E\left(\log y\right)$ is the mean log-income, or equivalently the logarithm of geometric mean income. The coefficient, β, therefore governs systematic movements within the income distribution. If

[12] They found a large variation between 1994 and 1998 of between 1.8 and 2.9, but judged the 'underlying' value to be 1.4. For medium term revenue forecasting, they proposed values in the range 1 to 1.3.

$\beta < 1$ there are systematic equalising relative movements whereby those below the geometric mean income experience relative larger increases than those above the geometric mean, when total income increases. A value of $\beta > 1$ implies systematic disequalising income movements. The effects on aggregate revenue elasticities of differential income changes are shown in Tables 5 and 6, which may be compared with Table 4.

Table 5 Aggregate Elasticities: $\beta = 0.9$

	η_1	η_2	η_3	η_4
National	1.9480	1.9712	1.5054	1.2198
Andalucia	2.1274	2.1296	1.5763	1.0999
Aragon	2.0504	1.9930	1.4908	1.2216
Asturias	2.0856	2.1240	1.6314	1.3162
Baleares	1.9115	1.8804	1.4735	1.1989
Canarias	2.0382	2.0046	1.5786	1.2075
Cantabria	2.0536	1.9801	1.4814	1.1933
Castilla-Leon	2.1476	2.1293	1.4575	1.1062
Castilla-LaMancha	2.2517	2.2303	1.6850	1.1769
Cataluña	1.8706	1.8327	1.4545	1.2495
Valencia	2.0523	2.0371	1.5170	1.1748
Extremadura	2.2580	2.1673	1.5848	0.9714
Galicia	2.0775	2.0660	1.5045	1.0815
Madrid	1.7203	1.8873	1.4778	1.3467
Murcia	2.1804	2.1536	1.6966	1.1882
Rioja	2.0842	2.0290	1.5471	1.2705

Table 6 Aggregate Elasticities: $\beta = 1.1$

	η_1	η_2	η_3	η_4
Nacional	2.1984	2.2309	1.7422	1.4834
Andalucia	2.3532	2.3593	1.7862	1.3462
Aragon	2.2650	2.2037	1.6737	1.4317
Asturias	2.2995	2.3477	1.8353	1.5577
Baleares	2.1735	2.1290	1.7022	1.4575
Canarias	2.2750	2.2455	1.7985	1.4396
Cantabria	2.2755	2.2222	1.6986	1.4395
Castilla-Leon	2.3510	2.3257	1.6205	1.3040
Castilla-LaMancha	2.4623	2.4318	1.8592	1.3914
Cataluña	2.1181	2.0675	1.6686	1.4841
Valencia	2.2905	2.2766	1.7392	1.4305
Extremadura	2.4620	2.3570	1.7474	1.1810
Galicia	2.3074	2.2783	1.7011	1.3154
Madrid	2.0024	2.2157	1.7822	1.6647
Murcia	2.4103	2.3914	1.9128	1.4496
Rioja	2.2968	2.2134	1.7080	1.4625

It can be shown that the elasticity varies linearly with β, as can be seen by substituting (31) into (27), whereby:

$$\eta_{T,Y} = \sum_{h=1}^{H} \eta_{T_h, y_h} \left(\frac{T_h}{T} \right) - (1-\beta) \sum_{h=1}^{H} \eta_{T_h, y_h} \left(\frac{T_h}{T} \right) \left(\log y_h - E\left(\log y\right) \right) \tag{33}$$

Although no direct evidence is available here, it is unlikely that β deviates far from unity. For example, a value of $\beta = 0.9$ would be considered low, implying for example that if total income were to increase by 10 per cent, the lower quartile would increase by about 14 per cent whereas the upper quartile would increase by only about 3 per cent. This implies considerable 'regression towards the (geometric) mean'.[13]

The increase in the revenue elasticity as β increases is associated with the resulting rise in income inequality as those below the geometric mean experience relatively smaller percentage income increases. The larger proportion of the population just above the lower income thresholds implies an increase in the number of tax units having larger revenue elasticities. The decline in the elasticities associated with the higher income groups is relatively small, as can be seen from the shapes of the elasticity profiles shown above. Hence, in aggregate the revenue elasticity increases with β.

5 Conclusions

The aim of this paper was to derive analytical expressions for the revenue elasticity of the Spanish personal income tax system as applied to tax units and in aggregate. This was considerably complicated by the schedular nature of the system, the role of central and regional governments, along with the existence of a range of tax credits and eligible expenditures and deductions.

Empirical estimates of revenue elasticities were obtained using a large cross-sectional data set which enabled a number of important ancillary elasticities (relating to allowances and tax credits, and different income sources) to be estimated. The functional relationship between gross income and personal income taxation was examined, rather than starting from a given distribution of taxable income.

[13] Random variations in proportional income changes, in addition to the systematic regression, can – if sufficiently large – lead to an increase in overall inequality; see Creedy (1985).

It was found that there is considerable variation among tax units in the revenue elasticity, with highly (positively) skewed distributions. Similarly, the aggregate elasticities for each region were found to vary, associated with variations in the income distributions. Variations were around a value of about 1.3.

Appendix A. The Treatment of Allowances

This appendix considers refundable and non-refundable tax allowances. Suppose there is a simple tax structure with a marginal rate of t applied to income, y in excess of a, and there is a 'refundable tax credit' of b. The term 'refundable' means that if income tax is less than b, the individual receives a payment (pays negative tax). The net tax paid is

$$T(y) = t(y-a) - b \qquad \text{(B1)}$$

The total expenditure on the refundable tax credit b remains fixed, so long as the population size is fixed. Those with incomes between a and $a+b/t$ pay some income tax but face an overall negative average tax rate.

For taxpayers, net income is $y(1-t)+at+b$ and the tax-free threshold can be regarded as giving rise to a kind of tax credit worth at. This is a 'non-refundable tax credit', such that those with $y<a$ receive nothing.

The non-refundable credit is intimately connected with the income tax structure. It determines who pays a zero marginal income tax rate, and the size of the 'non-refundable credit' is determined by the tax rate as well as a. The total 'tax expenditure' associated with the threshold a varies as the tax rate and the income distribution changes: it increases as the number of people above the threshold increases.

Consider only values of income for which tax, net of b, is positive. The average tax rate is:

$$ATR = t\left(1-\frac{a}{y}\right) - \frac{b}{y} \qquad \text{(B2)}$$

The individual revenue elasticity is given by *MTR/ATR* and is thus:

$$\eta = \frac{MTR}{ATR} = \left(1-\frac{a+b/t}{y}\right)^{-1} \qquad \text{(B3)}$$

Hence for those with positive net average tax rates, the elasticity is higher when b is included (essentially because it lowers their average tax rate). A higher value of the refundable tax credit b has the effect of raising the revenue elasticity.

Alternatively, it is possible simply to think of the two components of the structure separately. It could be said to combine an income tax with a tax-free threshold, and an unconditional transfer payment that is unrelated to income. Indeed, the refundable tax credit could be administered, without any change in net incomes, by an entirely separate agency and could be given a name (such as a 'basic income', or 'grant') that is unrelated to income taxation. In contrast, it would not be possible to separate the non-refundable tax credit from the income tax system.

Considering only the income tax system, the individual revenue elasticity is then:

$$\eta = \left(1 - \frac{a}{y}\right)^{-1} = 1 + \left(\frac{a}{y-a}\right) \qquad \text{(B4)}$$

as conventionally obtained.

If interest is in using the revenue elasticity at a given income level as an indication of overall progressivity of taxes and transfers, then the refundable tax credit clearly increases progressivity of the tax and transfer system as a whole. Perhaps it is then desirable to include both components.[14] But if concern is with the effect on tax revenue of inflation – fiscal drag – then it can be argued that allowance should be made only for non-refundable tax credits, and not refundable credits which, as suggested above, can be entirely separated from the income tax system, both conceptually and administratively.

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[14] However, measures of progressivity based on the Gini measure, such as Kakwani's measure of disproportionality, could not be produced because the Gini is not defined for negative values

Appendix B. Summary Statistics for Spanish Regions

Table 7 Basic Statistics for Key Tax Variables for Whole Country and for each Autonomous Community

WHOLE COUNTRY

	Mean	Std_Dev	Max
t_{k1h}	0.2938	0.0771	0.43
t_{k2h}	0.1527	0.0646	0.18
$t_{kh\,(weighted)}$	0.2871	0.0712	0.43
ATR_h	0.1235	0.0923	0.43
$ATR\_TI_h^{*}$	0.1503	0.1012	0.43
y_{h1}/y_h	0.9259	0.1902	1
y_{h2}/y_h	0.0716	0.1846	1
E_{h1}/y_h	0.2588	0.1665	1
E_{h2}/y_h	0.0038	0.0262	1
A_{h1}/y_h	0.0604	0.1084	1
A_{h2}/y_h	0.0087	0.0858	1
C_{Ch}/y_h	0.0615	0.0302	0.2612
C_{Rh}/y_h	0.0325	0.0161	0.1293

1.ANDALUCIA

	Mean	Std_Dev	Max
t_{k1h}	0.2818	0.0712	0.43
t_{k2h}	0.1424	0.0731	0.18
$t_{kh\,(weighted)}$	0.2775	0.0656	0.43
ATR_h	0.1040	0.0878	0.43
$ATR\_TI_h^{*}$	0.1277	0.0979	0.43
y_{h1}/y_h	0.9374	0.1841	1
y_{h2}/y_h	0.0587	0.1744	1
E_{h1}/y_h	0.2720	0.1776	1
E_{h2}/y_h	0.0021	0.0221	1
A_{h1}/y_h	0.0783	0.1228	1
A_{h2}/y_h	0.0095	0.0898	1
C_{Ch}/y_h	0.0640	0.0303	0.1566
C_{Rh}/y_h	0.0339	0.0162	0.0834

2.ARAGÓN

	Mean	Std_Dev	Max
t_{k1h}	0.2862	0.0721	0.43
t_{k2h}	0.1658	0.0485	0.18
$t_{kh\,(weighted)}$	0.2788	0.0657	0.43
ATR_h	0.1161	0.0820	0.42
$ATR\_TI_h^{*}$	0.1443	0.0922	0.42
y_{h1}/y_h	0.9048	0.2055	1
y_{h2}/y_h	0.0941	0.2034	1
E_{h1}/y_h	0.2519	0.1627	1
E_{h2}/y_h	0.0066	0.0323	1
A_{h1}/y_h	0.0540	0.0992	1
A_{h2}/y_h	0.0114	0.0980	1
C_{Ch}/y_h	0.0613	0.0300	0.1566
C_{Rh}/y_h	0.0324	0.0160	0.0834

3.ASTURIAS

	Mean	Std_Dev	Max
t_{k1h}	0.2853	0.0712	0.43
t_{k2h}	0.1544	0.0629	0.18
$t_{kh\,(weighted)}$	0.2803	0.0650	0.43
ATR_h	0.1136	0.0835	0.42
$ATR\_TI_h^{*}$	0.1427	0.0935	0.42
y_{h1}/y_h	0.9236	0.1982	1
y_{h2}/y_h	0.0736	0.1921	1
E_{h1}/y_h	0.2668	0.1812	1
E_{h2}/y_h	0.0041	0.0252	1
A_{h1}/y_h	0.0593	0.1044	1
A_{h2}/y_h	0.0115	0.0988	1
C_{Ch}/y_h	0.0598	0.0311	0.1566
C_{Rh}/y_h	0.0318	0.0167	0.0834

* ATR_TI_h stands for the ratio of total tax due to total taxable income (TI) i.e. $ATR\_TI_h = TI_h / y_h$

Table 8 Basic Statistics for Key Tax Variables for Whole Country and for each Autonomous Community *(Continued)*

4.BALEARES	Mean	Std_Dev	Max	5.CANARIAS	Mean	Std_Dev	Max
t_{k1h}	0.2935	0.0776	0.43	t_{k1h}	0.2924	0.0746	0.43
t_{k2h}	0.1618	0.0543	0.18	t_{k2h}	0.1171	0.0858	0.18
$t_{kh\ (weighted)}$	0.2870	0.0715	0.43	$t_{kh\ (weighted)}$	0.2886	0.0689	0.43
ATR_h	0.1269	0.0936	0.42	ATR_h	0.1188	0.0866	0.42
$ATR\_TI_h^*$	0.1532	0.1019	0.42	$ATR\_TI_h^*$	0.1449	0.0960	0.42
y_{h1}/y_h	0.9323	0.1798	1	y_{h1}/y_h	0.9575	0.1540	1
y_{h2}/y_h	0.0648	0.1728	1	y_{h2}/y_h	0.0396	0.1452	1
E_{h1}/y_h	0.2574	0.1589	1	E_{h1}/y_h	0.2674	0.1665	1
E_{h2}/y_h	0.0027	0.0180	1	E_{h2}/y_h	0.0020	0.0202	1
A_{h1}/y_h	0.0435	0.0907	1	A_{h1}/y_h	0.0591	0.1044	1
A_{h2}/y_h	0.0077	0.0827	1	A_{h2}/y_h	0.0045	0.0622	1
C_{Ch}/y_h	0.0628	0.0300	0.1566	C_{Ch}/y_h	0.0619	0.0293	0.2612
C_{Rh}/y_h	0.0332	0.0160	0.0834	C_{Rh}/y_h	0.0328	0.0156	0.1286
CANTABRIA	Mean	Std_Dev	Max	7. CASTILLA Y LEÓN	Mean	Std_Dev	Max
t_{k1h}	0.2938	0.0771	0.43	t_{k1h}	0.2808	0.0688	0.43
t_{k2h}	0.1527	0.0646	0.18	t_{k2h}	0.1621	0.0539	0.18
$t_{kh\ (weighted)}$	0.2871	0.0712	0.43	$t_{kh\ (weighted)}$	0.2751	0.0634	0.43
ATR_h	0.1235	0.0923	0.43	ATR_h	0.1062	0.0811	0.42
$ATR\_TI_h^*$	0.1503	0.1012	0.43	$ATR\_TI_h^*$	0.1328	0.0921	0.42
y_{h1}/y_h	0.9259	0.1902	1	y_{h1}/y_h	0.9029	0.2126	1
y_{h2}/y_h	0.0716	0.1846	1	y_{h2}/y_h	0.0951	0.2087	1
E_{h1}/y_h	0.2588	0.1665	1	E_{h1}/y_h	0.2507	0.1702	1
E_{h2}/y_h	0.0038	0.0262	1	E_{h2}/y_h	0.0056	0.0299	1
A_{h1}/y_h	0.0604	0.1084	1	A_{h1}/y_h	0.0673	0.1167	1
A_{h2}/y_h	0.0087	0.0858	1	A_{h2}/y_h	0.0121	0.1018	1
C_{Ch}/y_h	0.0615	0.0302	0.2612	C_{Ch}/y_h	0.0638	0.0311	0.1566
C_{Rh}/y_h	0.0325	0.0161	0.1293	C_{Rh}/y_h	0.0337	0.0167	0.0834

* ATR_TI_h stands for the ratio of total tax due to total taxable income (TI) i.e. $ATR\_TI_h = T_h / TI_h$

Table 9 Basic Statistics for Key Tax Variables for Whole Country and for each Autonomous Community *(Continued)*

8.CASTILLA-LA MANCHA

	Mean	Std_Dev	Max
t_{k1h}	0.2754	0.0668	0.43
t_{k2h}	0.1571	0.0600	0.18
$t_{kh\ (weighted)}$	0.2708	0.0614	0.43
ATR_h	0.0943	0.0820	0.41
$ATR\_TI_h^*$	0.1179	0.0935	0.42
y_{h1}/y_h	0.9252	0.1901	1
y_{h2}/y_h	0.0728	0.1857	1
E_{h1}/y_h	0.2638	0.1692	1
E_{h2}/y_h	0.0036	0.0289	1
A_{h1}/y_h	0.0899	0.1381	1
A_{h2}/y_h	0.0120	0.1009	1
C_{Ch}/y_h	0.0650	0.0302	0.1566
C_{Rh}/y_h	0.0343	0.0162	0.0834

9.CATALUÑA

	Mean	Std_Dev	Max
t_{k1h}	0.3021	0.0798	0.43
t_{k2h}	0.1633	0.0522	0.18
$t_{kh\ (weighted)}$	0.2939	0.0736	0.43
ATR_h	0.1361	0.0917	0.43
$ATR\_TI_h^*$	0.1650	0.0998	0.43
y_{h1}/y_h	0.9183	0.1937	1
y_{h2}/y_h	0.0802	0.1905	1
E_{h1}/y_h	0.2453	0.1543	1
E_{h2}/y_h	0.0046	0.0289	1
A_{h1}/y_h	0.0437	0.0872	1
A_{h2}/y_h	0.0079	0.0821	1
C_{Ch}/y_h	0.0594	0.0298	0.1566
C_{Rh}/y_h	0.0313	0.0159	0.0834

10.COMUNIDAD VALENCIANA

	Mean	Std_Dev	Max
t_{k1h}	0.2848	0.0730	0.43
t_{k2h}	0.1502	0.0669	0.18
$t_{kh\ (weighted)}$	0.2779	0.0673	0.43
ATR_h	0.1116	0.0883	0.42
$ATR\_TI_h^*$	0.1370	0.0977	0.42
y_{h1}/y_h	0.9254	0.1860	1
y_{h2}/y_h	0.0723	0.1805	1
E_{h1}/y_h	0.2739	0.1669	1
E_{h2}/y_h	0.0035	0.0251	1
A_{h1}/y_h	0.0583	0.1055	1
A_{h2}/y_h	0.0073	0.0782	1
C_{Ch}/y_h	0.0631	0.0292	0.1938
C_{Rh}/y_h	0.0334	0.0156	0.1090

11. EXTREMADURA

	Mean	Std_Dev	Max
t_{k1h}	0.2729	0.0650	0.43
t_{k2h}	0.1571	0.0600	0.18
$t_{kh\ (weighted)}$	0.2687	0.0613	0.43
ATR_h	0.0907	0.0821	0.40
$ATR\_TI_h^*$	0.1125	0.0938	0.41
y_{h1}/y_h	0.9321	0.1820	1
y_{h2}/y_h	0.0657	0.1765	1
E_{h1}/y_h	0.2786	0.1801	1
E_{h2}/y_h	0.0020	0.0178	1
A_{h1}/y_h	0.0951	0.1435	1
A_{h2}/y_h	0.0108	0.0952	1
C_{Ch}/y_h	0.0645	0.0305	0.1566
C_{Rh}/y_h	0.0342	0.0164	0.0834

* ATR_TI_h stands for the ratio of total tax due to total taxable income (TI) i.e. $ATR\_TI_h = T_h / TI_h$

Table 10 Basic Statistics for Key Tax Variables for Whole Country and for each Autonomous Community *(Continued)*

12.GALICIA	Mean	Std_Dev	Max	13.MADRID	Mean	Std_Dev	Max
t_{k1h}	0.2831	0.0715	0.43	t_{k1h}	0.3167	0.0836	0.43
t_{k2h}	0.1474	0.0693	0.18	t_{k2h}	0.1508	0.0663	0.18
$t_{kh\,(weighted)}$	0.2772	0.0658	0.43	$t_{kh\,(weighted)}$	0.3078	0.0784	0.43
ATR_h	0.1085	0.0864	0.42	ATR_h	0.1558	0.0996	0.43
$ATR\_TI_h{}^*$	0.1342	0.0968	0.42	$ATR\_TI_h{}^*$	0.1849	0.1054	0.43
y_{h1}/y_h	0.9268	0.1911	1	y_{h1}/y_h	0.9300	0.1852	1
y_{h2}/y_h	0.0695	0.1827	1	y_{h2}/y_h	0.0680	0.1803	1
E_{h1}/y_h	0.2693	0.1763	1	E_{h1}/y_h	0.2388	0.1508	1
E_{h2}/y_h	0.0033	0.0269	1	E_{h2}/y_h	0.0042	0.0258	1
A_{h1}/y_h	0.0676	0.1243	1	A_{h1}/y_h	0.0465	0.0880	1
A_{h2}/y_h	0.0089	0.0860	1	A_{h2}/y_h	0.0063	0.0738	1
C_{Ch}/y_h	0.0637	0.0317	0.2248	C_{Ch}/y_h	0.0564	0.0294	0.1612
C_{Rh}/y_h	0.0338	0.0170	0.1293	C_{Rh}/y_h	0.0297	0.0156	0.0834

14.MURCIA	Mean	Std_Dev	Max	15.RIOJA	Mean	Std_Dev	Max
t_{k1h}	0.2805	0.0712	0.43	t_{k1h}	0.2827	0.0714	0.43
t_{k2h}	0.1463	0.0703	0.18	t_{k2h}	0.1653	0.0493	0.18
$t_{kh\,(weighted)}$	0.2758	0.0652	0.43	$t_{kh\,(weighted)}$	0.2748	0.0647	0.43
ATR_h	0.1000	0.0866	0.41	ATR_h	0.1117	0.0818	0.39
$ATR\_TI_h{}^*$	0.1234	0.0970	0.42	$ATR\_TI_h{}^*$	0.1377	0.0913	0.42
y_{h1}/y_h	0.9358	0.1819	1	y_{h1}/y_h	0.8966	0.2168	1
y_{h2}/y_h	0.0615	0.1754	1	y_{h2}/y_h	0.1020	0.2143	1
E_{h1}/y_h	0.2828	0.1795	1	E_{h1}/y_h	0.2474	0.1674	1
E_{h2}/y_h	0.0025	0.0225	1	E_{h2}/y_h	0.0064	0.0316	1
A_{h1}/y_h	0.0680	0.1125	1	A_{h1}/y_h	0.0545	0.1031	1
A_{h2}/y_h	0.0098	0.0900	1	A_{h2}/y_h	0.0126	0.1023	1
C_{Ch}/y_h	0.0647	0.0295	0.1566	C_{Ch}/y_h	0.0629	0.0302	0.1566
C_{Rh}/y_h	0.0343	0.0158	0.0834	C_{Rh}/y_h	0.0332	0.0161	0.0834

* ATR_TI_h stands for the ratio of total tax due to total taxable income (TI) i.e. $ATR\_TI_h = T_h / TI_h$

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