Flat Tax Reforms: a General Equilibrium Evaluation for Spain*

Marta González — BBVA

Josep Pijoan-Mas — CEMFI and CEPR

November 2005

Abstract

This paper quantifies the aggregate and distributional implications of an array of revenue neutral flat tax reforms for Spain. A standard general equilibrium economy with heterogeneous agents is used to infer the behavioral parameters of individuals and to evaluate the impact of the tax reforms. We find that different flat tax reforms may generate important changes of aggregate allocations in opposite directions. Among all the reforms, we find that a marginal tax equal to 23.11% and a fixed deduction equal to 30% of per capita income will yield increases in aggregate output, aggregate consumption and labor productivity equal to 5.1%, 4.8% and 2.8% respectively. Admittedly, this type of reforms also generate increases in the gini indexes of after tax income and consumption. However, the proposed reform reduces the tax bill of the bottom 60% of the income distribution.

Keywords: income tax; policy reform; heterogeneous agents; general equilibrium.

JEL Classification: H31; E62; D31; C68.

*The authors thank comments by Samuel Bentolila, Manuel Díaz and attendants to seminars held at CEMFI and CREB. Corresponding author: Josep Pijoan-Mas, pijoan@cemfi.es

1 Introduction

Most OECD economies obtain a big share of their government revenues from direct taxation of individual incomes.[1] These personal income tax codes tend to be very sophisticated, with marginal rates increasing with income and an intricate tangle of deductions. However, in recent years the personal income tax code has been particularly affected by discussions in different fronts. For instance, the study by Comision de Expertos (2002) making a forceful defence of a flat tax for Spain got plenty of press headlines. In a series of articles between March and April 2005, the Economist magazine also praised the simplicity, efficiency and even fairness of single-tax schemes. Indeed, it is not uncommon that debates on fundamental tax reforms eventually shape the political agenda. For instance, a flat tax reform of the current personal income tax was proposed during election time by both the center-left in Spain (2004) and the center-right in Germany (2005).[2] Furthermore, these tax schemes are already in use in several Eastern European countries.[3]

In the academia, attention began with the seminal work by Hall and Rabushka (1995) who proposed a unique marginal tax rate to all incomes above an exemption level.[4] The subsequent debate was enriched by authors as Ventura (1999), Altig, Auerbach, Kotlikoff, Smetters, and Walliser (2001) or Díaz-Giménez and Pijoan-Mas (2005), who used model economies to quantify the effects of this type of reforms for the US economy. They found that, in general, revenue neutral flat tax reforms imply productivity and output gains but bring at the same time increases in the inequality statistics of the economy. However, the opposite might also be true. Díaz-Giménez and Pijoan-Mas (2005) were the first to point out that flat tax reforms might indeed be contractionary.

In this paper we provide quantitative measures for the Spanish economy of the gains in terms of efficiency and the losses in terms of inequality that arise from different flat tax reforms. We propose a battery of flat tax reforms yielding the same tax revenues as the current tax code in Spain. This battery ranges from a pure proportional income tax system to a scheme where the fixed deduction equals half of per capita income. Our measurement tool is a general equilibrium heterogenous agents economy calibrated to match some statistics from both aggregate and individual level data. We make sure that the actual distributions of wages and labor income in the model economy with the current tax code resemble those measured in data. Then, we proceed to impose different tax codes and solve for the new steady states. Our analysis is based on comparing aggregate and

[1] In 2001, the share of personal income tax revenue over all government revenue (excluding social security contributions) was 35.6% on average for the OECD countries.

[2] It is worth pointing out that both political formations won those elections. However, none of them have so far pushed forwards these reforms.

[3] Starting in 1994, Estonia and Lithuania were the pioneers of a reform trend that has already reached a country as large as Russia.

[4] Hall and Rabushka (1995) are a bit more specific in the sense that they also consider deductions for savings and the elimination of double taxation of capital.

distributional statistics of the new steady state equilibria to the corresponding one in the benchmark economy. Our work is original in being the first exercise that evaluates the quantitative implications of a tax reform for Spain by use of a fully specified dynamic general equilibrium model of individual behavior.

We find that reforms with a unique marginal tax of 28.2% or below (combined with a fixed deduction of 40% of per capita income or below) generate steady state gains in terms of aggregate allocations. We have productivity increases up to 3.9% and increases in aggregate output and consumption up to 12.6% and 12.3% respectively. Admittedly, these productivity gains do not come cheap. The distributions of after tax income, consumption and wealth are more concentrated. For example, the gini index of the consumption distribution increases from 0.26 for the benchmark economy with the current tax code to between 0.28 and 0.31 for different tax reforms. However, leaving aside reforms with low fixed deductions, the flat tax reforms are not bad for individuals at the lower tail of the income distribution. Starting with tax exemptions equal to 30% of current per capita income and marginal tax rates equal to 23.11%, individuals at the lowest quintiles of the income distribution pay lower taxes. In fact, as highlighted by other authors, these type of reforms in the tax code can be designed to benefit both income rich and income poor households but they end up increasing the tax burden of middle classes. Nevertheless, in our preferred reform with a fixed deduction equal to 30 percent of current income and a marginal tax equal to 23.11%, there is a reduction of the tax burden on the poorest 60% of the economy.

Regarding productivity, a flat tax reform with a low tax rate and a low deduction has potentially good and bad effects. On the one hand, the marginal tax rate faced by high income workers is lower and therefore there are efficiency gains from smaller tax wedges for the most productive workers. On the other hand, with the flat tax code the distribution of after tax income tends to be more unequal and therefore income uncertainty larger. As highlighted by Pijoan-Mas (2003), in absence of markets to insure against income risk, individuals use work effort to smooth income fluctuations and end up working longer hours when their wages are low. This reduces the efficiency per hour worked. One important result we find is that, for the range of flat tax reforms between purely proportional and a fixed deduction equal to 15% of average income, the latter effect dominates in the allocation of work effort. Precisely, the average efficiency of hours worked in this type of economies is lower than in the economy with the benchmark tax system because people use work effort as a self-insurance mechanism. In spite of this, the higher capital accumulation under the flat tax codes generates productivity gains up to 3.9%.

There is an interesting literature evaluating reforms of the income tax code for Spain. The aforementioned Comision de Expertos (2002) analyzes a possible general reform of the Spanish income tax. Their proposal is a three steps marginal tax function, with rates equal to 0%, 27% and 41%. Castañer and Sanz (2002) run a static simulation exercise to find the flat tax that would generate the same tax procedures and income redistribution as the actual code in Spain in 2001. The linear equivalent tax would consist of a deduction equal to half the per capita net national income and a 34.4% flat tax. A similar work is done by Díaz and Sebastián (2004). These authors conclude that an exemption level equal to 48% of per capita net national income, and a marginal tax equal to 30% would yield the same revenues and the same progressivity as the tax system in 2003. All these papers are very detailed in the characterization of the current tax code. However, they assume that households do not respond to the changed economic atmosphere: the tax bases are fixed and therefore independent from the tax code. This is unfortunate since there is ample evidence of tax changes generating important changes in the tax bases. For instance, for Spain, Díaz (2004) shows that the elasticity of the tax bases to changes in marginal taxes from the mid 1980's to 1994 is in the order of 0.35.

In contrast to this previous literature, we use a very stylized description of the income tax code. This simplicity lets us model individual behavior and therefore we let economic agents adjust their decisions as we change the tax code. In addition, as agents change their individual behavior, aggregate allocations and therefore prices will also change. We take all this into account to provide a general picture of the Spanish economy under different tax scenarios. When solving for the reforms that these authors propose, we find that they fail to be revenue neutral (they collect less taxes than the current system) and that there are important output losses. The first problem is likely to be more our fault: we cannot get rid off the ample net of deductions of the current tax system whereas they can. Therefore, their reforms can afford lower tax rates. However, the second difference is due to the main shortcoming of the so-called arithmetic approach: by definition, aggregate allocations do not change. We find that too large a unique tax rate can discourage saving and labor supply to such an extent that aggregate output may fall.

The remainder of the paper is organized as follows. In section 2 we describe the model economy to be used for the policy analysis. Section 3 shows how we choose parameters such that the model economy resembles the actual Spanish economy at both aggregate and individual level. Then section 4 describes the policy experiments and section 5 presents the main results. In section 6 we discuss the strengths and weaknesses of the approach we have followed and compare the results to the existent literature for Spain. Finally, section 7 concludes.

2 The model economy

The economy analyzed in this paper is a standard growth economy with production, populated by a measure one of individuals (or dynasties) that live forever. We will only look at steady states.

Individuals value consumption and leisure in all periods of time. Current consumption is denoted by c and current leisure by l. Future utilities are discounted at the rate $\beta \in (0,1)$. We write the per period utility as $u(c,l)$, and total expected utility at time τ as $E_\tau \sum_{t=\tau}^{\infty} \beta^{t-\tau} u(c_t, l_t)$. Individuals differ in their labor market productivity. We decompose the productivity endowments in a fixed component $\alpha \in \{\alpha_1, \ldots, \alpha_{n_\alpha}\}$ and a time changing stochastic component $\varepsilon \in \{\varepsilon_1, \ldots, \varepsilon_{n_\varepsilon}\}$. This stochastic component is Markov with transition matrix Γ, with any element $\Gamma_{\varepsilon\varepsilon'}$ stating $Pr\left(\varepsilon_{t+1} = \varepsilon' | \varepsilon_t = \varepsilon\right)$. The sum $\alpha + \varepsilon$ represent the log of the total amount of efficiency units of labor per unit of time that the worker can sell in the market in exchange of a wage rate w.

Aggregate output Y is produced according to an aggregate neoclassical production function $F(K, L)$ that takes as inputs capital K and efficient units of labor L. The aggregate labor input comes from aggregation over all agents' efficiency units of labor worked. Aggregate capital results from aggregation of all assets. Capital depreciates at an exogenous rate $\delta \in (0,1]$. We will work with an incomplete markets setting. By incomplete markets we mean that there are no state contingent markets for the household specific shock ε. [5] Individuals hold assets $a \in A \equiv [\underline{a}, \infty)$ that pay an interest rate r. We assume that individuals are restricted by a lower bound on their assets holdings $\underline{a}$.[6]

The individual state variables are the two labor market endowments α and ε and the stock of assets a.[7] The problem that the individual solves is:

$$v(\alpha, \varepsilon, a) = \max_{c,l,a'} \left\{ u(c,l) + \beta \sum_{\varepsilon'} \Gamma_{\varepsilon\varepsilon'} v\left(\alpha, \varepsilon', a'\right) \right\} \tag{1}$$

s.t.:

$$c + a' = we^{\alpha+\varepsilon}(1-l) + (1 + r(1-\tau_k))\,a - T\left[we^{\alpha+\varepsilon}(1-l) + r(1-\tau_k)\,a\right] \tag{2}$$

$$c \geq 0, \quad 1 \geq l \geq 0 \quad \text{and} \quad a' \geq \underline{a}$$

The tax function $T(\cdot)$ does not distinguish different sources of income. Note that this formulation accounts for the double taxation of capital income. To be consistent with the Spanish personal income tax, we establish a function by brackets as follows. We consider M different brackets subject to M different tax rates τ_1, τ_2, ..., τ_M. The brackets are defined by the series of thresholds $\bar{y}_1$, $\bar{y}_2$, ..., $\bar{y}_{M-1}$. Then, an income $y \in (\bar{y}_i, \bar{y}_{i+1}]$ is subject to the tax payment

$$T(y) = \tau_1(\bar{y}_2 - \bar{y}_1) + \tau_2(\bar{y}_3 - \bar{y}_2) + \cdots + \tau_i(y - \bar{y}_i)$$

The solution to the individual problem is given by the policy functions $a' = g^a(\alpha, \varepsilon, a)$, $c = g^c(\alpha, \varepsilon, a)$ and $l = g^l(\alpha, \varepsilon, a)$. There is an endogenous upper bound on asset holdings,

[5] Nor for the fixed term α.

[6] This lower bound may arise endogenously as the quantity that ensures that the household is capable of repaying its debt in all states of the world or we can just set it exogenously as a borrowing constraint. See Huggett (1993) and Aiyagari (1994) for details.

[7] Since there is no aggregate uncertainty and since we only look at steady states, there are no aggregate state variables.

$\bar{a}$ such that $\bar{a} \geq g^a(\alpha, \varepsilon, a) \geq \underline{a}$ for all $\alpha \in \{\alpha_1, \ldots, \alpha_{n_\alpha}\}$, all $\varepsilon \in \{\varepsilon_1, \ldots, \varepsilon_{n_\varepsilon}\}$ and all $a \in [\underline{a}, \bar{a}]$.[8] Hereafter we will also use the more compact notation $s \equiv \{\alpha, \varepsilon, a\}$ and $\mathbf{S} \equiv \{\alpha_1, \ldots, \alpha_{n_\alpha}\} \times \{\varepsilon_1, \ldots, \varepsilon_{n_\varepsilon}\} \times [\underline{a}, \bar{a}]$. Let $\mathcal{S}$ be the σ-algebra generated in $\mathbf{S}$ by, say, its open intervals. A probability measure μ over $\mathcal{S}$ exhaustively describes the economy by stating how many households are of each type. Let $Q(s, S)$ denote the probability that a type s has of becoming of a type in $S \subset \mathcal{S}$. We can express Q as:

$$Q(s, S) = \sum_{\varepsilon' \in S_\varepsilon} \Gamma_{\varepsilon\varepsilon'} \mathbf{I}_{g^a(s) \in S_a} \mathbf{I}_{\alpha \in S_\alpha}$$

where $\mathbf{I}$ is an indicator function that takes value 1 if its argument is true and 0 otherwise, S_α is the projection of S in $\{\alpha_1, \ldots, \alpha_{n_\alpha}\}$, S_ε is the projection of S in $\{\varepsilon_1, \ldots, \varepsilon_{n_\varepsilon}\}$ and S_a is the projection of S in $[\underline{a}, \bar{a}]$. The function Q describes how the economy moves over time by generating a probability measure for tomorrow μ' given a probability measure μ today:

$$\mu'(S) = \int_{\mathbf{S}} Q(s, S)\ d\mu \tag{3}$$

In equilibrium this measure μ is unique.[9]

Finally, the government is a passive actor in this economy. Since we do not model the role of public expenditure and we concentrate in revenue neutral tax reforms, public expenditure G is wasted.[10]

Definition 1 *A steady state equilibrium for the incomplete markets economy is a set of functions $\{v, g^a, g^c, g^l\}$, a probability measure μ, and a pair of prices $\{w, r\}$ such that: (1) given a pair of prices $\{w, r\}$, the functions $\{v, g^a, g^c, g^l\}$ solve the individual decision problem; (2) prices are given by marginal productivities, $w = F_L(K/L)$ and $r = F_K(K/L) - \delta$; (3) factor inputs are obtained aggregating over individuals, $L = \int e^{\alpha+\varepsilon}\left(1 - g^l(s)\right) d\mu$ and $K = \int g^a(s) d\mu$; (4) the measure of individuals is stationary, $\mu(S) = \int_{\mathbf{S}} Q(s, S) d\mu$; and (5) the government budget constraint is in balance, $\int \tau_k r a\, d\mu + \int T\left[w e^{\alpha+\varepsilon}(1-l) + r(1-\tau_k) a\right] d\mu = G$.*

3 Calibration

The calibration strategy we pursue is the following. Given an exogenous process for the efficiency endowment $\alpha + \varepsilon$ and given the actual income tax code of Spain, we choose the model parameters such that in the steady state equilibrium the model economy matches some characteristics of both aggregate and individual level data. This implies solving for

[8] See Huggett (1993) for details.

[9] See Hopenhayn and Prescott (1992) for a proof.

[10] Alternatively, we may consider that G enters the individuals utility function in a separable manner. However, since G will be kept constant across economies, it plays no role.

the equilibrium as many times as needed until the statistics from data are matched.[11] In a sense, this calibration strategy can be seen as an exactly identified generalized method of moments estimation. Then, given these parameters, economies with alternative tax systems are solved. One important decision to be made is the length of the model period. We set it equal to one year since this is also the length of a tax period and the length of the data collection period of our individual level data set.

3.1 The process for individual wages

The market productivity has two components. A fixed term $\alpha \in \{\alpha_1, \ldots, \alpha_{n_\alpha}\}$ that makes households different forever and a temporary and (possibly) persistent shock ε. The process for ε is determined by an $n_\varepsilon \times 1$ vector of endowments $\{\varepsilon_1, \ldots, \varepsilon_{n_\varepsilon}\}$ and an $n_\varepsilon \times n_\varepsilon$ transition matrix Γ. The first step for the calibration is to give values to the parameters of this process by looking at data on wages.

We set up the following process for the time t individual i logarithm of the real hourly wage $\omega_{i,t}$:

$$\omega_{i,t} = \alpha_i + \varepsilon_{i,t}$$

where $\alpha_i \sim N\left(0, \sigma_\alpha^2\right)$ and the stochastic component $\varepsilon_{i,t}$ follows an autoregressive process:

$$\varepsilon_{i,t} = \rho\varepsilon_{i,t-1} + \eta_{i,t} \quad \text{with } \eta_{i,t} \sim N\left(0, \sigma_\eta^2\right)$$

Fernández (2004) estimates a process like this for Spain by use of the European Community Household Panel (ECHP). He also considers a white noise term in the wage equation, a component which is normally regarded as measurement error. Fernández finds the following estimates $\left\{\rho, \sigma_\eta^2, \sigma_\alpha^2\right\} = \{0.95, 0.0148, 0.0988\}$. These numbers are not very different from what has been estimated by use of a similar specification in other countries. For example, Fernández (2004) reports that for the U.S. Flodén and Lindé (2001) find estimates like $\{0.91, 0.0426, 0.1175\}$ and French (2003) obtain $\{0.97, 0.0141, \cdot\}$. The first one implies a higher weight of the fixed effect component and lower persistence of the stochastic term whereas the second one does not allow for fixed heterogeneity and therefore obtains higher persistence for the stochastic component.[12]

We parameterize the process for ε by discretizing the autoregressive component into a seven-state markov chain following the methodology described by Tauchen (1986). The fixed heterogeneity term is set up with two different points α_1 and α_2 such that the mean is zero, the variance equals its estimate above and the process is symmetric.[13] This process

[11] Other recent articles that follow a similar calibration strategy in a similar context are Castañeda, Díaz-Giménez, and Ríos-Rull (2003), Heathcote, Storesletten, and Violante (2004) and Pijoan-Mas (2003).

[12] These are not the only studies estimating a process for the idiosyncratic and stochastic component of wages by use of PSID data. Earlier work by Card (1991) provides a less persistent process with $\rho = 0.89$. Heathcote, Storesletten, and Violante (2004) obtain $\rho = 0.94$.

[13] Therefore, we end up working with a 14-state Markov chain with appropriate zeros in the transition matrix in order to account for the fixed heterogeneity.

generates a coefficient of variation for wages equal to 0.69, which equals its counterpart in data as measured in the 1999 cross section of the ECHP.

3.2 Functional forms

The production function is the standard Cobb-Douglas, which is consistent with the non-trended factor shares:

$$F(K, L) = BK^{1-\theta}L^{\theta}$$

The chosen utility function is:

$$u(c, l) = \frac{c^{1-\sigma} - 1}{1-\sigma} + \lambda \frac{l^{1-\nu} - 1}{1-\nu}$$

It gives enough parameters to have distinct intertemporal elasticities of substitution for consumption and leisure which let us match observed individual behavior.[14] With this utility function, the intertemporal elasticity of substitution of consumption is given by $\frac{1}{\sigma}$, the intertemporal elasticity of substitution of leisure by $\frac{1}{\nu}$ and the intertemporal elasticity of substitution of labor by $\frac{l}{\nu(1-l)}$.

3.3 The tax code

We choose to replicate the personal income tax code of 1999, which corresponds to the last big reform of the Spanish income tax. In order to make the model units consistent with the progressivity embedded in the actual tax code, we normalize the brackets by the per capita net national income of 1999. Table 1 reports the brackets and the tax codes that apply. We have added an extra untaxed bracket to account for the personal fixed deduction.[15]

We also need to parameterize the capital income tax. In Spain, corporations are subject to a flat 35% rate with some minor deductions.[16] In our model economy we do not distinguish between corporate capital and other types of capital (as non corporate businesses or real estate), whose incomes are exempt from the capital income tax. Therefore we need to abstract from the portfolio choice of households and assume that all agents in

[14] Notice however that $\sigma \neq 1$ is inconsistent with balanced growth path in a representative agent economy with positive growth.

[15] Admittedly, this is an extremely stylized description of the actual income tax code. In particular, in addition to some asymmetries in the treatment of labor income and capital income, there are important deductions to both the tax base and the final tax bill. The two most important deductions are for investment in owner occupied housing and for investment in private pension plans. To account for these two types of deduction we would need to set up a model with three assets: real estate, pension funds and other assets. To account for the pension funds we would also need to add a life-cycle dimension to the model. We think that these are important elements for an analysis of tax reforms but they are well beyond the scope of this paper. See section 6 for a discussion on the type of bias that this omission may introduce.

[16] Although according to Díaz and Sebastián (2004), once the deductions are taken into account the effective rate that Spanish corporations pay is around 27%.

Table 1: **Personal Income Tax, 1999.**

Income Bracket 1999 euros	*Relative Bracket* $\bar{y}_i$	*Marginal Tax* τ_i
0.00	0.00	00.00
3,305.57	0.27	18.00
6,911.64	0.56	24.00
15,026.82	1.30	28.30
27,946.82	2.28	37.20
42,971.65	3.50	45.00
69,416.90	5.65	48.00

Source: Agencia Española de Administración Tributaria

the economy hold the market portfolio. Then, τ_k, the effective marginal tax on capital income, is set as the product of the nominal tax on corporate income and the share of corporate capital in the economy. We can obtain τ_k through two different routes. First, obtain a measurement of the share of corporate capital in the economy and multiply it by 35%. Second, use actual data of total revenues from the capital income tax. We choose this latter route. Let's call T_k the total government revenue from the capital income tax. Using the Cobb-Douglas production function this can be written as,

$$\frac{T_k}{Y} = \tau_k \left((1-\theta) - \delta \frac{K}{Y} \right)$$

In 1999 the ratio $\frac{T_k}{Y}$ was 2.588%. Given the actual choices for parameters δ and θ and the measurement of $\frac{K}{Y}$ (see section 3.4 below) this implies an effective tax on total capital income equal to 17.35%.

When put into the model, this tax code will generate in equilibrium a total amount of revenue for the government that we call G. Then, in our tax reforms we keep fixed this amount of tax revenue G.

3.4 The calibration in equilibrium

There are 7 parameters we need to pin down: the preference parameters β, σ, ν, λ, the technology parameters θ and δ and the level constant B for the production function.[17] We pick $\delta = 0.0851$ and set the labor share θ equal to 0.65. These values are reported by Puch and Licandro (1997) by use of the Spanish National Accounts. The rest of parameters are calibrated in equilibrium such that the benchmark economy with the actual tax code matches some statistics from data. We need to pick five calibration targets and we will be taking two targets from aggregate data and three targets from household survey data.

[17] The lower level on asset holdings $\underline{a}$ is set equal to zero. Since in this model there are no transfers and labor income depends on hours supplied, zero is the only possible value if we do not want to add a theory of financial markets and unsecured credit.

Table 2: **Calibration targets and model parameters.**

parameter	*target*	*value*
β	$K/Y = 2.36$	0.950
B	$Y - \delta K = 1.00$	1.769
λ	$H = 0.33$	1.433
σ	$corr(h, \varepsilon) = -0.05$	1.230
ν	$cv(h) = 0.26$	1.188

The level constant B is normally irrelevant since this type of economies are neutral in size. However, once we add progressive taxation size does matter. Therefore, we need to scale the economy such that the level of progressivity given by the tax function is comparable to the one faced by Spanish households. Since we have normalized the brackets of the Spanish income tax by the net national income, we choose to set the model national income equal to one. The second target from aggregate data is the total amount of wealth of the economy. Puch and Licandro (1997) report a capital to output ratio equal to 2.36.

To be consistent with the estimates of the process for wages, we use the ECHP to compute individual level statistics.[18] First, we choose the average number of hours worked in the sample which is roughly 1/3 of available time. Second, we use the cross-sectional correlation between hourly wages and hours worked. This correlation turns out to be -0.05.[19] Third, we target the volatility of hours worked. The coefficient of variation of hours worked is 0.26. All these statistics are computed for 1999.

Table 2 contains the parameter values consistent with a steady state equilibrium displaying these five properties from data.[20] We find the curvature of consumption equal to 1.23. This is in line with many empirical studies.[21] The curvature of leisure is equal to 1.19, which implies a Frisch elasticity of labor supply equal to 1.25 (when measured at the average amount of hours worked). There is a lot of controversy about how large this elasticity *should* be. For instance, the micro estimates quoted in Blundell and MaCurdy (1999) are one order of magnitude smaller. However, these estimates are typically obtained for prime aged male actively engaged in the labor market. Elasticities for females are much larger.[22] Furthermore, once we also consider the extensive margin they might even be larger. Nobel laureate Edward Prescott defends a Frisch elasticity of 1.50 for

[18]See appendix A for details.

[19]Heathcote, Storesletten, and Violante (2004) report a value of 0.02 for the U.S. during the period 1967-1996 using PSID data. Pijoan-Mas (2003) also reports a value of 0.02 for the U.S. using CPS data.

[20]Notice that since the parameters are calibrated to equilibrium statistics, all of them affects all calibration targets. However, in the text we highlight the statistic that is most influenced by each parameter.

[21]In the macro literature values between 1 and 3 are deemed as reasonable. Recent calibration exercises show very similar findings. For example, for the U.S. Heathcote, Storesletten, and Violante (2004) find 1.44 and Pijoan-Mas (2003) finds 1.46.

[22]See Kumar (2005) for references.

the aggregate labor supply.[23] Our value is closer to the aggregate elasticity defended by Prescott for models with a stand-in consumer than to the micro estimates for prime aged males.

Table 3: **Distributional statistics.**

variable	cv	$gini$	q_1	q_2	q_3	q_4	q_5
wages							
data	0.68	0.31	8.6%	12.8%	16.3%	22.2%	40.1%
model	0.69	0.35	6.7%	11.4%	16.3%	23.4%	42.1%
earnings							
data	0.77	0.34	7.2%	12.8%	16.5%	22.4%	41.2%
model	0.72	0.37	5.8%	11.3%	16.2%	23.8%	43.0%
hours							
data	0.26	0.13	0.21	0.32	0.34	0.34	0.44
model	0.26	0.14	0.19	0.31	0.36	0.38	0.41

Note: cv refers to coefficient of variation. $q_1, ..., q_5$ refer, for wages and earnings, to the share held by all people in the corresponding quintile with respect to the total. However, for hours it is the average fraction of time endowment actually worked by people in the corresponding quintile. Data statistics from the ECHP99.

As an illustration of the model economy, in table 3 we display some distributional statistics and compare them to data from the 1999 wave of the ECHP. We find that the model captures very well the cross-sectional properties of the distributions of wages, labor income and hours worked. The overall inequality, as measured by the gini index, is slightly larger in the model than in data. The pictures for wages and labor income are quite similar.[24] The model understates the share earned by the bottom quintile (although less than two percentage points in both distributions) and the second quintile (less than one and a half percentage point in each case). The smaller wages and earnings generated by the model in the lower tail are made up by slightly larger shares of wages and income in the top quintile (again, less than two percentage points of difference between the model and the data). Regarding hours worked, the gini indexes are almost identical. The model understates the fraction of time worked by the bottom quintile (two percent of available time) and the top quintile (three percent of available time), with the difference compensated by the third and fourth quintiles.

4 The policy experiments

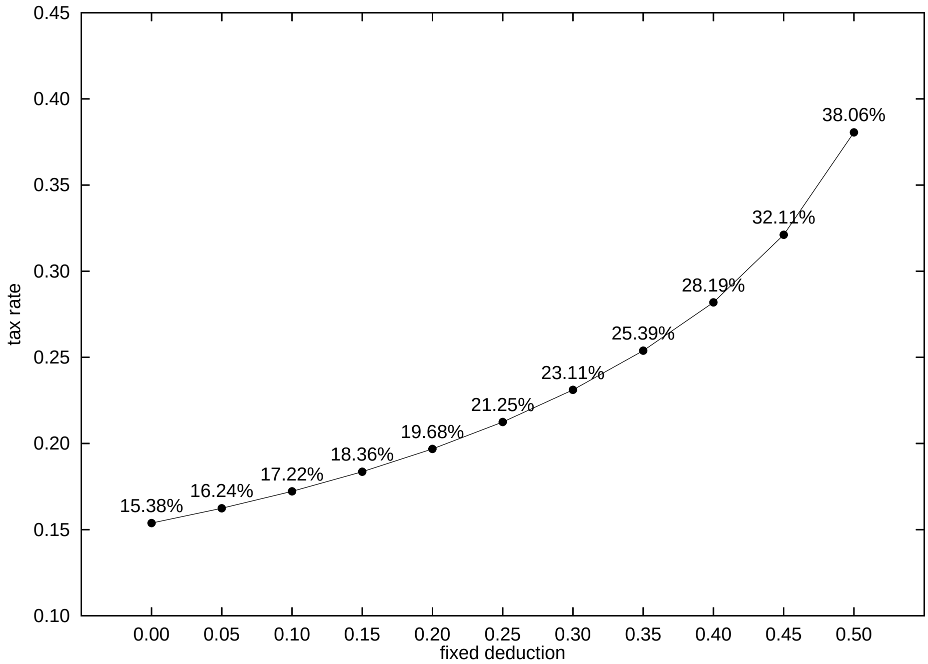
In our policy experiments we substitute the personal income tax of 1999 described in table 1 by a flat tax schedule in which a unique constant marginal tax applies to all

[23]See Prescott (2004) for example.

[24]Of course, the overall level of dispersion of the three distributions cannot be very far from data. The dispersion of wages and hours have been calibrated and the dispersion of labor earnings obtains since we have also calibrated the correlation between hours and wages. Therefore, the interest of table 3 resides in the shares by quintile, which have not been targeted at all.

personal income levels over a certain threshold. Therefore, we replace the seven brackets of the current code by a much simpler two-bracket system. We will concentrate in revenue neutral tax reforms: that is to say, the proposed tax schedules will be constrained to raise the same revenues for the government as the benchmark tax code. Therefore, for a given tax deduction we have to solve for the tax rate that in a steady state equilibrium yields the same amount of tax revenue as the benchmark economy with the current tax code. Note that this leaves us with one free parameter, the fixed deduction. There is a continuum of combinations of fixed deduction and marginal tax that yield the same aggregate tax revenue. We choose to compute the new steady state equilibrium for eleven cases: the fixed deduction is set as a percentage of average household income in the benchmark case and we pick values from 0% to 50%, in 5% steps. Then, we compute the flat tax that generates the same income tax proceeds in the new steady state equilibrium for each possible fixed deduction. Exemption levels and their corresponding tax rates are shown in figure 1.[25]

Figure 1: **Revenue neutral flat tax reforms.**



Note: combinations of fixed deductions and tax rate that generate steady state equilibria with the same tax revenue as in the benchmark case.

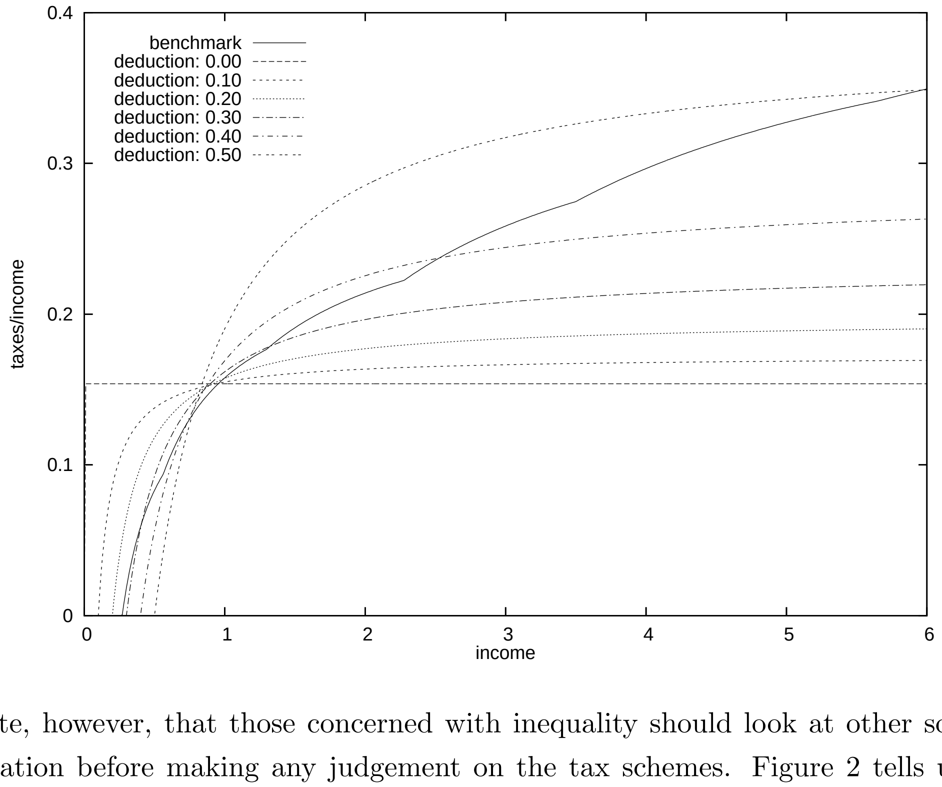
Figure 1 shows that the tax rate grows more than linearly as we increase the exemption level. There are two reasons for this. First, as we reduce the fixed deduction we decrease the tax base and therefore we need higher tax rates to raise revenues. Second, higher taxes distort the agents' labour and capital decisions. For every 5% increase in the fixed

[25]By *corresponding tax rate* we mean the one that lies in the increasing part of the Laffer curve. There will always be a larger tax rate consistent with the same government revenue in the decreasing part of the Laffer curve.

deduction, the flat tax has to be higher each time in order to reach the same aggregate tax proceeds. Moreover, if we tried to pull the exemption level above 60% of mean income, there would be no fixed tax rate that could generate the same tax proceeds, implying that we would fall into the right hand side of the Laffer curve.

The simple structure of fixed deduction plus a flat tax rate generates a tax scheme that is progressive in the classical sense: the average tax is increasing with income. Our different combinations of tax rate and fixed deduction generate tax schemes with different degrees of progressivity. In figure 2 we show the average tax implied by the benchmark tax code compared to 6 of our tax reforms. By definition, the case with no fixed deduction is a proportional system. As we increase the fixed deduction we have to increase the tax rate in order to keep the same revenue and the level of progressivity of the system increases. Of course, the benchmark case, with its 48% marginal tax rate for the highest incomes embeds a higher level of progressivity.

Figure 2: **Average tax.**



Note, however, that those concerned with inequality should look at other sources of information before making any judgement on the tax schemes. Figure 2 tells us about the ability of different tax codes to redistribute income for a given income distribution. However, as we change the tax codes both incentives and equilibrium prices change and so do the chosen levels of income, consumption and wealth. The final distribution of any variable of interest may present different degrees of concentration not necessarily related to the progressivity of the tax code. In the next section we study the aggregate and distributional consequences of the different flat tax reforms.

5 Results

The essence of the results can be summarized as follows. The flat tax reforms, for not too large fixed deductions, generate steady state equilibria with higher output and consumption but also with higher values of the inequality statistics of the distributions of wealth, after tax income and consumption. Figures 3 and 4 illustrate these results. Starting from zero, as we increase the fixed deduction our simulated economy falls in size and sees the inequality measures fall as well. Compared to the benchmark economy with the current tax code, tax reforms with a flat rate of 28.19% (and a fixed deduction of 0.40) or below yield higher aggregate output and higher aggregate consumption. As it is clear in figure 3 and also in table 4, these output gains come from higher amounts of both aggregate capital and aggregate labor. The output and consumption gains are not small. Output increases range from 12.6% in the proportional system to 0.6% in the tax code with deduction equal to 0.40, whereas consumption increases range from 12.3% to 0.4%. Additionally, and as it will be shown below, the flat tax alternatives yield important productivity increases. Looking at the ratio between output and work effort, we observe increases ranging from 0.5% to 3.9% (see table 5).

Maybe it is even more important to highlight the results for the tax reforms with high tax rates and high fixed deductions. Both figure 3 and table 4 show that flat tax reforms with a tax rate of 32.11% (and a fixed deduction of 0.45) or above may depress the economy. Therefore, it cannot be taken for granted that flat tax reforms are always expansionary. For the most progressive reform considered, tax rate equal to 38.06% and fixed deduction of half the average income, output losses are as big as 2%. On the good side, this type of reform ensures a more even distributions of after tax income and consumption.

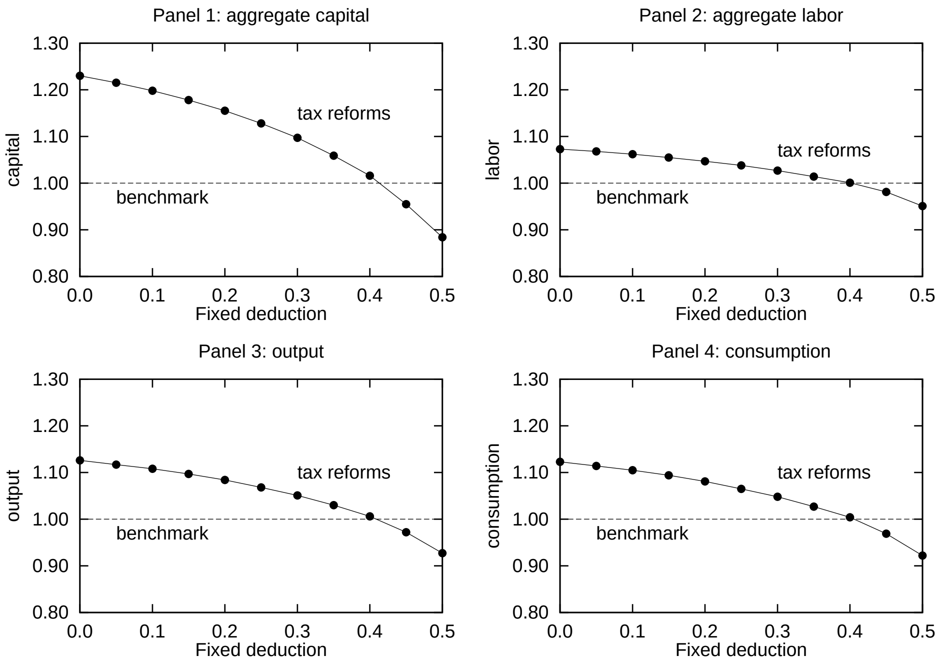
Table 4: **Aggregate variables.**

tax scheme	K	L	Y	C
0.00	23.0%	7.3%	12.6%	12.3%
0.05	21.5%	6.8%	11.7%	11.4%
0.10	19.8%	6.2%	10.8%	10.5%
0.15	17.8%	5.5%	9.7%	9.4%
0.20	15.5%	4.7%	8.4%	8.1%
0.25	12.8%	3.8%	6.8%	6.5%
0.30	9.7%	2.7%	5.1%	4.8%
0.35	5.9%	1.4%	3.0%	2.7%
0.40	1.6%	0.1%	0.6%	0.4%
0.45	−4.5%	−1.9%	−2.8%	−3.1%
0.50	−11.6%	−4.9%	−7.3%	−7.8%

Note: Percentage changes with respect to the benchmark economy.

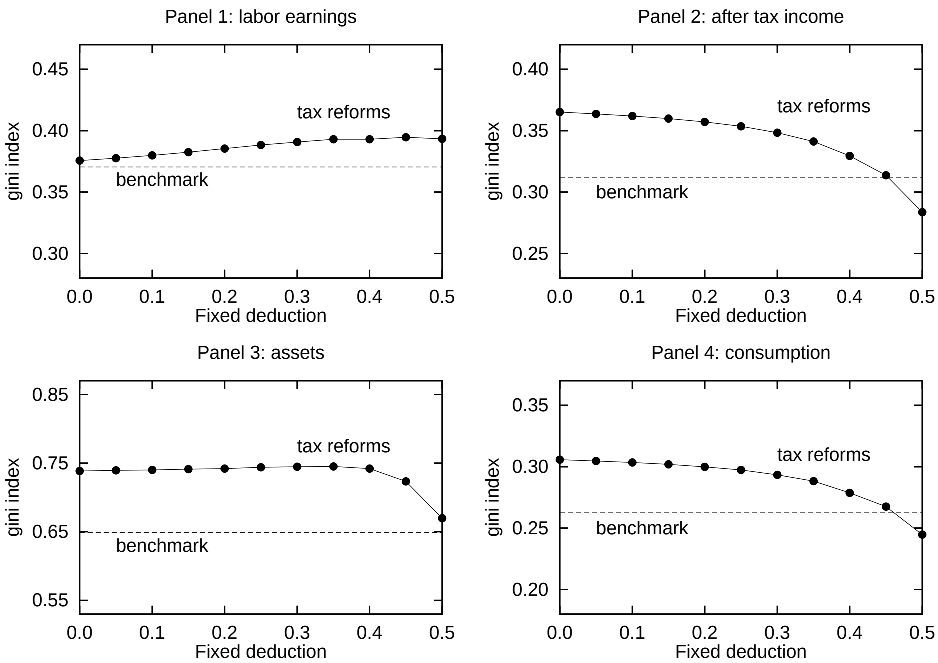
Figure 4 shows that for the tax reforms with output gains the gini indexes of the after

Figure 3: **Aggregate allocations**



Note: The graphs display the levels of aggregate variables in the reformed economies relative to the corresponding value in the benchmark economy.

Figure 4: **Inequality indexes**



Note: The graphs display the actual value of the gini index of the distribution of the corresponding variable.

tax income, consumption and wealth distributions increase compared to the benchmark case. This is the trade off between efficiency and equality: we can increase the efficiency of the economy by diminishing the tax distortions but we will face more unequal distributions of the resources of the economy.

We find the gini index of consumption the most informative. We might have an increase in the inequality measures of the after-tax income or wealth distribution just because households allocate their work effort in a more efficient way, working hard when most productive and buying leisure when less. This would generate an increase in the inequality measures of income and wealth but not necessarily an increase in inequality of consumption. It would be hard to argue that these increases in inequality imply a reduction in equality of the distribution of permanent well-being. The fact that the gini index of consumption increases tells us that, at least part of the increase of inequality in wealth and after tax income are permanent. The gini indexes of the consumption distribution range from 0.31 in the proportional system to 0.24 in the case with the larger deduction. Except in this last case, all reforms produce consumption distributions that are more concentrated than the one in the benchmark economy.

To sum up, aggregate gains are potentially large. However, the bigger they are, the bigger the gini index of the consumption distribution. Aggregate gains completely disappear in reforms with a fixed deduction above 40% and marginal tax equal to 28.11% or above. At this point, the inequality measures are below the ones in the benchmark economy. Now, we proceed to analyze the results in greater detail.

5.1 Understanding the changes in aggregate variables

As discussed above, aggregate capital and labour in the economy increase when we replace the tax schedule in 1999 by any flat tax with exemption level equal to or below 40%. Table 4 shows that capital increases derived from the new tax schedules range from the 23% in the proportional tax system to the 1.6% increase in the case with fixed deduction equal to 40% of mean income. Furthermore, the increase in aggregate capital falls monotonically with the pair fixed deduction / marginal tax. These capital increases come from two sources. First, with the flat tax reforms the top marginal tax is decreased, which increases the after tax returns to savings for households in the upper tail of the income distribution. At the same time, the marginal tax to mid income households increases. However, asset rich households are more responsive to interest rate changes because the precautionary motive is very weak for them.[26] Second, as it will be shown in the next section, the distribution of after tax income is more unequal for reforms with low fixed deduction and low marginal rate. In particular, the lower tail of the income distribution pay higher taxes. This worsens the income situations of those households with low productivity

[26] See Aiyagari (1994).

endowment, which generates the need for higher precautionary savings. Therefore, we have both efficiency and uncertainty motives pushing aggregate savings upwards in the flat tax economies, with the increase in savings being larger the smaller the pair of fixed deduction and marginal tax. In general equilibrium economies, as the ones analyzed here, this increase in aggregate savings generates a fall in the interest rate that partially offsets the increase in aggregate capital.

Regarding aggregate labor, we observe increases ranging from 7.3% in the proportional tax economy to 0.1% in the economy with a fixed deduction equal to 40% of mean income. The increase in labor effort may be understood as the result of three elements. First, the increase in capital implies an increase in the market wage rate. Second, with larger economies the average tax rate will have to be lower in order to sustain the same amount of government revenue. And third, reducing the top marginal taxes increases the incentives to work for the most productive individuals of the economy.

There is an additional and important issue regarding labor supply. For the reforms with a 0.15 fixed deduction and below, these increases in aggregate labor are smaller than the increases in aggregate hours. Not reported in the tables, the increases in aggregate hours range from 8.4% to 5.6%. The reason behind is that for these tax reforms there is a fall in the correlation between wages and work effort. As shown in section 3, the benchmark economy has been calibrated to replicate the -0.05 correlation found in data. For the flat tax reforms with a 0.15 fixed deduction and below this correlation falls slightly up to -0.09, whereas it increases for the rest. This makes the ratio between aggregate labor and aggregate hours fall in the economies with low fixed deductions. Following Pijoan-Mas (2003) we interpret this fall as an increase in the use of work effort as a consumption smoothing mechanism. A progressive tax code diminishes the uncertainty in income faced by households. When we replace the benchmark tax function by the simpler flat tax schemes the amount of progressivity diminishes (see figure 2 above). This generates the need for increasing self-insurance. Households have two costly margins of adjustment: they can increase their precautionary savings and they can modify their work effort such that they work longer hours when the wage is very low (and the marginal utility of consumption very high) and enjoy leisure when the wage is high. As it turns out, they end up doing both things. With the tax reforms, there is potential for a better allocation of work effort. However, due to the use of hours as a self-insurance mechanism, the increased uncertainty of the less progressive reforms dominates the reduced distortions and we end up with a less efficient allocation of work effort.

Finally, we can decompose the productivity gains according to their components: (a) the increase in capital stock relative to labor and (b) the increase in efficiency of labor. As discussed in the previous paragraph, for a range of reforms we actually have a fall in labor efficiency due to the increase in uncertainty. Therefore, in those reforms all the productivity gains come from capital deepening. Table 5 shows precisely this. The ratio

Table 5: **Productivity gains.**

tax scheme	Y/H	K/L	L/H
0.00	3.9%	14.6%	−1.0%
0.05	3.8%	13.8%	−0.7%
0.10	3.8%	12.8%	−0.4%
0.15	3.8%	11.7%	−0.1%
0.20	3.7%	10.3%	0.2%
0.25	3.4%	8.7%	0.4%
0.30	2.8%	6.8%	0.4%
0.35	2.0%	4.4%	0.5%
0.40	0.5%	1.4%	0.0%
0.45	−0.7%	−2.6%	0.2%
0.50	−2.1%	−7.1%	0.4%

Note: Percentage changes with respect to the benchmark economy.

between capital and aggregate labor is larger than in the benchmark case for all tax reforms with fixed deduction equal to or below 0.40. In addition, the increases in the capital to labor ratios are much larger than the increases in the aggregate labor to hours ratios. We conclude that the main reason behind the large productivity increases are the better incentives for capital accumulation. Indeed, moving to less distortionary tax codes does not necessarily imply a better allocation of work effort. In fact, in some case we have the contrary taking place.

5.2 Inequality increases

In figure 4 we have seen that the bulk of the proposed tax reforms generate increases in the inequality statistics of the distributions of interest. Precisely, figure 4 shows the gini indexes for labor earnings, after tax income, assets and consumption. The distributions of both labor earnings and assets become more concentrated with all the reforms. The same is true for the distributions of after tax income and consumption, with the exception of the reform with a fixed deduction of 0.5. For this reform, the distributions of after tax income and consumption become less concentrated than under the benchmark economy.

For example, the gini index for the distribution of wealth is around 0.74 with the flat tax reforms, a figure much higher than the 0.65 value found in the benchmark economy. The differences are not so big once we look at the distribution of consumption. For instance, in the benchmark economy the gini index of the consumption distribution is 0.26 and in the flat tax economies it takes a maximum value of 0.31 in the case of a pure proportional tax scheme and falls steadily up to 0.34 for the economy with a fixed deduction equal to 0.50. However, it is difficult to summarize an infinitely dimensional object as a distribution with a single statistic. Besides, inequality statistics may be of limited importance compared to the actual levels of the variables of interest at different points of the distribution. Therefore, in this section we will look at more dimensions of the distributions in order to assess the distributional implications of the tax reforms.

Table 6: **Average taxes paid by income quintile.**

tax scheme	$q1$	$q2$	$q3$	$q4$	$q5$
0.00	4.1%	3.3%	1.8%	-0.7%	-8.5%
0.05	3.5%	2.9%	1.5%	-0.5%	-7.4%
0.10	2.9%	2.4%	1.2%	-0.3%	-6.2%
0.15	2.1%	1.9%	1.0%	-0.2%	-4.8%
0.20	1.2%	1.3%	0.7%	-0.1%	-3.1%
0.25	0.3%	0.5%	0.3%	0.1%	-1.1%
0.30	-0.6%	-0.5%	-0.2%	0.2%	1.0%
0.35	-1.2%	-1.8%	-0.8%	0.2%	3.6%
0.40	-1.5%	-3.4%	-1.7%	0.1%	6.5%
0.45	-1.5%	-4.7%	-3.1%	-0.4%	9.8%
0.50	-1.1%	-4.7%	-5.5%	-1.8%	13.2%

Note: Within quintile average of the differences of taxes paid with respect to the benchmark economy. Values reported as a percentage of per capita income in the benchmark economy, which is calibrated to one. Since we are comparing revenue neutral tax reforms, rows must add up to one (in some case they do not due to rounding).

To start, we may want to look at the distribution of the tax burden. Table 6 reports the difference, between the benchmark case and each possible tax reform, of total taxes paid by individuals in each income quintile. The values are reported as percentage of average income in the benchmark economy. Compared to the benchmark economy, we find that individuals in the top quintile of the income distribution pay less taxes than in the reformed economies with a fixed deduction of 0.25 or less (which correspond to a tax rate equal or below 21.25%). In contrast, they pay more taxes for reforms with higher fixed deduction and higher tax rate. The pattern for the first, second and third income quintiles is exactly the opposite. Households in the bottom 60% of the income distribution benefit, in terms of the final tax bill, of reforms with fixed deduction above 0.25 (and tax rate above 21.25%). This accords with what we observe in figure 2: for high incomes, the reforms with high tax exemption and high marginal tax imply higher tax burdens, whereas the opposite is true for low incomes. Households in the fourth quintile pay more taxes as we increase the deduction and the tax rate until we reach the reform with a deduction equal to 0.35. From here on the increase in the deduction outweighs the increase in the tax rate. Therefore, we conclude that increasing the progressivity of the flat tax scheme implies shifting the tax burden from the poorest 60% to the top 20% of the income distribution.

A better picture of the distributional effects of the tax reforms should look into the changes in the distribution of assets and consumption. Table 7 reports the gini index and

Table 7: **Wealth distribution.**

tax scheme	gini	$q1$	$q2$	$q3$	$q4$	$q5$
benchmark	0.649	0.17%	1.97%	8.74%	23.59%	65.53%
0.00	0.738	0.03%	0.55%	4.76%	18.18%	76.49%
0.05	0.739	0.03%	0.53%	4.72%	18.13%	76.60%
0.10	0.740	0.03%	0.51%	4.68%	18.11%	76.67%
0.15	0.741	0.03%	0.49%	4.62%	18.06%	76.80%
0.20	0.742	0.02%	0.48%	4.60%	18.01%	76.89%
0.25	0.744	0.02%	0.44%	4.47%	17.94%	77.14%
0.30	0.745	0.01%	0.42%	4.47%	17.89%	77.22%
0.35	0.745	0.01%	0.45%	4.41%	17.80%	77.32%
0.40	0.742	0.06%	0.60%	4.47%	17.80%	77.08%
0.45	0.723	0.06%	1.38%	5.23%	18.12%	75.20%
0.50	0.670	0.15%	3.27%	7.82%	19.26%	69.49%

Note: $q1 \ldots q5$ refer to share of total wealth held by people in the corresponding quintile

the average share owned by each quintile of the wealth distribution. We observe that the big increases in the gini index of the wealth distribution (from 0.65 as generated by the benchmark economy to around 0.74 for most reforms) are due to the huge increases in the share of wealth held by the top quintile at the expense of the rest of individuals. The top quintile of the wealth distribution increases the share of total wealth by around 10 percentage points.

Table 8: **Average consumption by income quintile.**

tax scheme	$q1$	$q2$	$q3$	$q4$	$q5$
0.00	-0.2%	6.1%	10.2%	12.3%	20.9%
0.05	-0.5%	5.6%	8.7%	12.0%	19.8%
0.10	-1.0%	5.0%	7.4%	11.3%	18.6%
0.15	-1.7%	4.4%	6.3%	10.1%	17.2%
0.20	-1.9%	3.6%	5.0%	8.8%	15.5%
0.25	-2.2%	2.7%	3.4%	7.3%	13.5%
0.30	-1.6%	1.7%	1.7%	5.3%	11.1%
0.35	-0.6%	0.0%	-0.3%	2.8%	8.2%
0.40	2.8%	-1.1%	-2.7%	-0.2%	4.6%
0.45	2.8%	-3.2%	-5.9%	-4.6%	-0.6%
0.50	6.2%	-2.3%	-9.2%	-11.6%	-8.5%

Note: Relative consumption increase with respect to the benchmark economy, by income quintiles.

Finally, we may want to complement the analysis of the tax reforms with an inspection to the levels of consumption for different individuals. We sort the individuals in our economy by the income they obtain and see how the average consumption changes within each quintile. This is what we do in table 8, where we report percentage changes with respect to the benchmark economy. The lowest 20% of the income distribution start to benefit from the reforms with a tax exemption equal to 0.40 and a marginal tax equal to 28.19%. In this case, they consume 2.8% more than under the benchmark economy. The clear winners with this reform are individuals in the top 20% of the income distribution because they increase their consumption by 4.6%. Individuals in the middle lose. Reforms with lower fixed deduction and lower tax rate benefit all individuals except the bottom quintile. However, in some reforms the losses for the bottom quintile are really small, like the 0.2% loss for the pure proportional income tax.

6 Discussion

After seeing the results, there are two important issues that deserve further discussion. First, which are the critical assumptions and choices we have made and what is its likely impact on the results. Second, how these results compare to the rest of work in the literature.

As discussed elsewhere in the paper, the characterization of the personal income tax code is very simple. We are leaving aside an array of deductions according to both different sources and different uses of household income. This simplification is the cost to pay in order to have a dynamic stochastic model for individual behavior with heterogenous agents and general equilibrium. Since we are not considering the tax deductions in the actual code, we think that the tax reforms have to be interpreted as preserving the actual system of deductions. We think that under this view, our numbers are very conservative. There are two reasons for this. First, one of the quantitatively important elements of a flat tax reform is the elimination of all deductions. The reason is that the objective of the flat tax reform, apart from simplicity, is to broaden the tax base as much as possible in order to afford lower marginal taxes. Second, Comision de Expertos (2002) show that the two main deductions in the Spanish personal income tax code, owner occupied housing and private pension funds, are regressive since the amounts deducted increase with household income. Hence, if something, we should expect that an analysis that considers the elimination of these deductions would allow for lower marginal taxes, larger aggregate gains and a more even distribution of after tax income.

The discussion in the previous paragraph is very relevant when we look at the literature of flat tax reforms for the Spanish economy. Previous work is based on static micro-simulations models. This means that by construction households do not react to changes in the tax code and therefore (a) there are no changes in the aggregate allocations of the economy and (b) for the analysis of inequality only the direct impact of taxes on earned incomes matters. In contrast, this body of the literature is very detailed in the description of the actual tax code and most studies eliminate deductions when evaluating flat tax reforms.

Castañer and Sanz (2002) look for the flat tax reform that yields (a) the same government revenue as the personal income tax code in 2001 and (b) the same redistribution of income as measured by the Reynolds-Smolensky index. They find that a unique tax rate of 34.4% and an exemption level equal to 0.5 of per capita net national income satisfies this criterion.[27] Our results say that for fixed deduction of 0.5 to be revenue neutral we would require a 38.08% tax rate. This is about three and a half percentage points more. The results are remarkably similar given the differences in approaches. In addition to the already mentioned differences in the details of the tax code and in the behavioral responses of households, there is another important difference between their and our studies, namely the data set where to measure the distribution of income of the Spanish economy. Castañer and Sanz (2002) use household data from *Panel de Declarantes del Instituto de Estudios Fiscales*, corresponding to the year 1995. This data set is a sample of the actual income tax reports of households.[28] They use this data set for both the level and the dispersion of income. We set the level of income by use of National Accounting and the dispersion by use of a representative sample of the Spanish population given in the ECHP. In an additional tax reform exercise, we have solved for a reform with the two tax parameters of Castañer and Sanz (2002). We find that such a reform is not revenue neutral, it actually loses 5.1% of government revenue. The most important result is that the reform is contractionary, with an output loss equal to 4.6%. In their work, Castañer and Sanz (2002) find that the effective tax rate that households pay in comparison to the benchmark system is larger for deciles 3 and 4 and 9 and 10, and lower for the rest. We find that for such a reform only the top 20% would pay lower taxes.

Díaz and Sebastián (2004) perform a similar analysis (although referred to the year 2000). They also use data from actual tax reports from households. The revenue neutral tax reforms that yields the same progressivity of the income tax code is given by a fixed rate of 30% and a fixed deduction equal to 0.92 of per capita net national income. Note that this result is very different from Castañer and Sanz (2002) and our own results. We deduce from this difference that the fixed deduction in Díaz and Sebastián (2004) refers to the whole household instead of the individual. Therefore, in a two earner household, the fixed deduction per person would be around 0.48. Our results suggest that the revenue neutral tax rate of a code with a fixed deduction such that would be around 35.7%. This is a somewhat larger difference than in the Castañer and Sanz (2002) study. We have also solved for a reform with the two tax parameters of Díaz and Sebastián (2004). We find that such a reform fails to raise 10.5% of current government income and that it yields output losses of 1.5%.

[27]Castañer and Sanz (2002), like the rest of quoted articles, give their fixed deductions in nominal euros of the year of policy evaluation. We choose to transform these amounts to a relative measure of income in order to make all of them comparable.

[28]Note that there is a mismatch between the year they use and the one we use. In addition, in their case the tax year and the year for the income distribution do not coincide.

Finally, Oliver and Spadaro (2004) analyze four different revenue neutral flat tax reforms, with marginal taxes equal to 25%, 30%, 38% and 46%. The corresponding tax-exempt levels are 0.63, 0.78, 0.98 and 1.14 of 1999 per capita net national income. They use also data from the ECHP (although the 1995 wave). They find that the gini index of after tax income is lower in the reforms than in the 1999 economy. The gini index falls as they move to reforms with a higher tax rate and a higher deduction. This pattern is consistent with our findings, although the revenue neutral tax reforms they propose are quite far away from ours.

Our feeling is that the research on tax reforms should try to combine both approaches. Work based on static arithmetic models overlook the likely output losses that arise with high marginal taxes. Our own approach cannot deal with the elimination of the complex web of deductions of the current tax system. If one is to combine these two approaches there is yet an extra problem to tackle. Individual level data from actual tax reports generate an appropriate mapping from individual income to taxes paid. However, due to tax evasion and to the fact that not everybody is obliged to fill in a tax report, this source of individual data is very unlikely to aggregate to national income and will understate the variance of individual incomes. On the other hand, using national accounts and data from a representative panel as the ECHP is likely to overstate the actual tax bases of households. It is not obvious how to combine both sources of data, but it is a challenge worth taking. In this sense, Picos (2005) seems to be a first attempt in the right direction.

7 Conclusions

This paper evaluates quantitatively a series of flat tax reforms for the Spanish economy. Our main finding is that there is not such a thing as *the* flat tax reform. Flat tax reforms have the potential of generating important changes in a given economy in *opposite* directions. Our results show that whenever the chosen pair of tax rate and fixed deduction are low enough, we should expect gains in aggregate output, aggregate consumption and labor productivity. We find that this is the case for reforms with a unique marginal tax equal to 28.2% or below and a fixed deduction equal to 40% of average income or below. These aggregate gains are due to both increases in aggregate capital and aggregate labor. However, when choosing a pair of tax rate and fixed deduction that are large enough, a flat tax reform can generate output losses.

Flat tax schemes are usually attacked on the grounds of embedding little progressivity. This is not necessarily true: just two tax instruments such as a fixed deduction and a marginal tax rate can go a long way in terms of income redistribution. Our results show that both after tax income and consumption might be less concentrated under a flat tax scheme. However, this happens for a reform that requires a pair of tax rate and fixed deduction large enough to generate output losses.

We also show that in spite of having more concentrated after tax income and consumption, some reforms are good for the income poor as well as expansionary. In particular, a tax rate of 23.11% and a fixed deduction equal to 30% of average income generates an output increase of 5% while reducing the tax bill of the bottom 60% of the income distribution.

An important aspect to highlight is that our reforms do not touch the structure of tax deductions present in the current system. Removing the current deductions would afford lower tax rates. Therefore, we see our results on output increases as a lower bound of what could be achieved. Furthermore, to the extent that at least the two most important deductions in the Spanish income tax code (owner-occupied housing and private pensions funds) are regressive, we should also expect a flat tax reform that eliminates the current deductions not to worsen so much the distributions of income, consumption and wealth. Therefore, we see our results on inequality increases as an upper bound.

References

AIYAGARI, S. R. (1994): "Uninsured Idiosyncratic Risk, and Aggregate Saving," *Quarterly Journal of Economics*, 109(3), 659–684.

ALTIG, D., A. J. AUERBACH, L. J. KOTLIKOFF, K. A. SMETTERS, AND J. WALLISER (2001): "Simulating Fundamental Tax Reform in the United States," *American Economic Review*, 91(3), 574–595.

BLUNDELL, R., AND T. MACURDY (1999): "Labor Supply of Men: A Review of Alternative Approaches," in *Handbook of Labor Economics*, ed. by O. Ashenfelter, and D. Card, vol. 3. Elsevier Science Publishers.

CARD, D. (1991): "Intertemporal Labor Supply: an Assessment," NBER Working Paper 3602.

CASTAÑEDA, A., J. DÍAZ-GIMÉNEZ, AND J.-V. RÍOS-RULL (2003): "Accounting for U.S. Earnigns and Wealth Inequaltiy," *Journal of Political Economy*, 111(4), 818–857.

CASTAÑER, J.-M., AND J.-F. SANZ (2002): "Imposición Lineal sobre la Renta y Equivalencia Distributiva: un Ejercicio de Microsimulación," Papeles de Trabajo del Instituto de Estudios Fiscales, 9/02.

COMISION DE EXPERTOS (2002): *Una Alternativa Fiscal para España.* Fundación Alternativas. Exlibris Economía.

DÍAZ, M. (2004): "La Respuesta de los Contribuyentes ante las Reformas del IRPF, 1987-1994," Tesinas del CEMFI, 0405.

DÍAZ, M., AND M. SEBASTIÁN (2004): "Ideas para una Reforma Fiscal en España," in *Políticas, Mercados e Instituciones Económicas. Estudios en Homenaje a Luis Ángel Rojo.*, ed. by J. Pérez, C. Sebastián, and P. T. de Lorca, vol. 1. Editorial Complutense.

DÍAZ-GIMÉNEZ, J., AND J. PIJOAN-MAS (2005): "Flat Tax Reforms in the U.S.: a Boon for the Income Poor," Unpublished mansucript.

FERNÁNDEZ, J. (2004): "Estimación del Riesgo en un Proceso de Salarios en España," Mimeo, CEMFI.

FLODÉN, M., AND J. LINDÉ (2001): "Idiosyncratic Risk in the United States and Sweden: Is There a Role for Government Insurance?," *Review of Economic Dynamics*, 4, 406–437.

FRENCH, E. (2003): "The Effects of Health, Wealth and Wages on Labor Supply and Retirement Behavior," Mimeo, Federal Reserve Bank of Chicago.

HALL, R., AND A. RABUSHKA (1995): *The Flat Tax.* Hoover Institution Press.

HEATHCOTE, J., K. STORESLETTEN, AND G. VIOLANTE (2004): "The Macroeconomic Implications of Rising Wage Inequality in the US," Mimeo.

HOPENHAYN, H., AND E. C. PRESCOTT (1992): "Stochastic Monotonicity and Stationary Distributions for Dynamic Economies," *Econometrica*, 60(6), 1387–1406.

Huggett, M. (1993): "The Risk Free Rate in Heterogeneous-Agents, Incomplete Insurance Economies," *Journal of Economic Dynamics and Control*, 17(5/6), 953–970.

Kumar, A. (2005): "Lifecycle Consistent Estimation Of Effect Of Taxes On Female Labor Supply In The U.S.: Evidence From Panel Data," Dallas FED Working Paper 0504.

Oliver, X., and A. Spadaro (2004): "Renta Mínima o Mnimo Vital? Un Análisis sobre los Efectos Redistributivos de Posibles Reformas del Sistema Impositivo Español," Unpublished manuscript.

Picos, F. (2005): "Las Rentas de Capital en PHOGUE: Análisis de su Fiabilidad y Corrección Mediante Fusión Estadística," Forthcoming, *Revista de Economía Aplicada.*

Pijoan-Mas, J. (2003): "Precautionary Savings or Working Longer Hours?," CEMFI Working Paper 0311.

Prescott, E. C. (2004): "Why Do Americans Work So Much More Than Europeans?," *Federal Reserve Bank of Minneapolis Quarterly Review*, 28(1), 2–13.

Puch, L., and O. Licandro (1997): "Are There any Special Features in the Spanish Business Cycles?," *Investigaciones Económicas*, 21(2), 361–394.

Tauchen, G. (1986): "Finite State Markov-Chain Approximations to Univariate and Vector Autoregressions," *Economics Letters*, 20(2), 177–181.

Ventura, G. (1999): "Flat Tax Reform: a Quantitative Exploration," *Journal of Economic Dynamics and Control*, 23, 1425–1458.

Appendix

A The ECHP data

In order to obtain measures of dispersion of individual incomes, wages and hours of work we use data from the European Community Household Panel (ECHP), a European-wide survey ran by Eurostat. The survey started in 1994 and followed the same households for 8 years, until 2001. We only look at data for Spain corresponding to 1999 (waves 6).

The ECHP does not report annual hours but weekly hours instead. Therefore, all the variance that arises from the extensive margin within the year is lost. Our measure of labor earnings is given by the question "current wage and salary earnings", which reports labor earnings for the current month. We build the hourly wage as the ratio between monthly earnings and monthly hours (where monthly hours is weekly hours times 4.3). These are the same variable definitions used by Fernández (2004), whose estimates of the wage process we borrow. There is an alternative route to follow. One could go to the 2000 wave were individuals are asked about total annual labor earnings in 1999. By doing this, we would not miss the between month variance of labor earnings. However, this alternative measure would introduce a substantial amount of noise in the hourly wage measure. Since we only observe weekly hours, the measure of annual hours would be much more noisy than the measure of monthly hours and so would be the measure of hourly wage. In addition, there is a lot of attrition in the ECHP. Going to the 2000 wave means losing several individuals. Indeed, when we tried to followed this second route our sample size was reduced to one half.

Regarding sample selection we kept all non self-employed individuals with positive responses for both hours and income. Our final sample consists of $4,463$ individuals. We use the ECHP weights to obtain our population statistics.

B Numerical solution

The solution method used is the same as in Pijoan-Mas (2003). In this appendix we just want to give the general lines.

To solve the household problem we have used the Euler equation. We have approximated the unknown policy function for assets $g^a(s)$ piecewise linearly. For every possible realization of α and ε we have used a grid of 100 points in the assets dimension and interpolated linearly. The policy function for leisure $g^l(s)$ is the implicit function given by the first order condition of labor. Then, given a guess for $g^a(s)$ we have iterated until finding a fixed point.

To find the equilibrium distribution μ we have used a Monte Carlo method. We have created a sample of $50,000$ individuals and simulated each of them for $3,000$ periods. The final approximation to μ is given by the last period distribution of the Monte Carlo experiment.

To find the equilibrium prices we have iterated on the capital to labor ratio K/L until the prices r and w are consistent with the aggregates generated by the individual behavior and the equilibrium distribution μ.

Finally, for the calibration in equilibrium we have written a function that takes as argument our vector of 5 parameters $\{\beta, B, \lambda, \sigma, \nu\}$ and returns the value of the 5 statistics described in table 2. Since we have also five targets from data, this is a (highly non linear) system of 5 equations in 5 unknowns. We have used a standard non linear equation solver to find the exact solution to this system.