IS AN INEQUALITY-NEUTRAL FLAT TAX REFORM REALLY NEUTRAL?

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ABSTRACT

Let us assume a revenue- and inequality-neutral flat tax reform shifting from a graduated-rate tax. Is this reform really neutral in terms of the income distribution? Traditionally, there has been a bias toward the inequality analysis, forgetting other relevant aspects of the income distribution. This kind of reforms implies a set of composite transfers, both progressive and regressive, even though inequality remains unchanged. This paper shows that polarization is a useful tool for characterizing this set of transfers caused by inequality-neutral tax reforms. A simulation exercise illustrates how polarization can be used to discriminate between two inequality-neutral tax alternatives.

JEL Classification: D39, D63, H30.

Key Words: polarization, inequality, flat tax.

1. INTRODUCTION

Recent tax system reforms in Western economies provide evidence of an international trend towards the flattening of income tax structures (see table 1). Efficiency gains are considered the main motivation for moving from a progressive tax system with graduated tax rates to one with a personal allowance and a single marginal tax rate (see Cassou and Lansing, 2003). However, the redistributive pattern of linear tax reforms is complex and some careful analysis is required. In fact, it can be regarded as an application of a set of composite transfers, both progressive and regressive at the lower and higher ends of the initial distribution, respectively. Hence, a flat tax reform certainly benefits both the highest and the lowest ends of the income distribution, at the expense of middle range incomes (see, for instance, Davies and Hoy, 2002).

Table 1

MAXIMUM AND MINIMUM MARGINAL TAX RATES IN THE OECD

	MAXIMUM TAX RATE			MINIMUM TAX RATE		
	1980	**1990**	**1999**	**1980**	**1990**	**1999**
Germany	56	53	53	22	19	24
Australia	60	47	47	32	21	20
Switzerland	62	50	50	23	10	10
Belgium	72	55	55	24	25	25
Canada	51	48	50	6	17	17
Denmark (2)	73	68	59	20	22	32
Spain	65	56	48	15	25	18
United States	50	45	40	11	15	15
Finland (2)	68	59	55	6	23	23
France	60	57	54	5	5	10
Greece	60	50	45	11	18	5
Netherlands	72	60	60	17	39	36
Ireland	65	53	46	25	30	24
Iceland (1) (2) (3)	39	40	46	19	40	41
Italy	62	50	46	10	10	19
Japan	70	65	65	15	15	15
Korea	67	54	44	7	5	11

(Sigue)

(Continuación)

	MAXIMUM TAX RATE			MINIMUM TAX RATE		
	1980	**1990**	**1999**	**1980**	**1990**	**1999**
Luxemburg	57	56	47	12	10	10
Mexico	55	35	40	3	3	3
Norway	65	45	42	6	20	28
New Zealand	60	33	33	14	24	22
Portugal	—	40	40	—	15	15
United Kingdom	60	40	40	30	25	10
Sweden (2)	75	51	56	4	30	30
Turkey	68	50	40	10	25	15
OECD Average	63	51	48	15	18	17
EU Average	65	54	51	18	20	17

Source: Álvarez, Alonso, Gago y González (2001).

(1) The maximum marginal tax rate does not take into consideration territorial direct taxes in 1980.

(2) The minimum marginal tax rate does not take into consideration territorial direct taxes in 1980.

(3) The data of Iceland is for 1997 instead of 1999.

The general setting is a revenue- and inequality-neutral flat tax reform shifting from a graduated-rate tax. The aim of this paper is to show that polarization is a useful tool for characterizing this set of transfers derived from this inequality-neutral tax reforms. As a consequence, polarization can be used to discriminate between two inequality-neutral tax alternatives.

There are two main aspects dealt with throughout the paper. Firstly, there has traditionally been a bias toward the analysis of the inequality component of the income distribution[1]. However, there are some other relevant aspects (such as polarization, poverty, ...) which have been almost unconsidered. In fact, no relationship has yet been established between polarization and tax reforms (up to our knowledge). Whereas inequality relates to the overall dispersion of the distribution, polarization concentrates on the income distribution in several focal or polar modes.[2] One particular type of polarization we are going to

[1] A huge literature has emerged due to this interest on linear tax and inequality. See, for instance, Davies and Hoy (1995).

[2] Many papers agree on the conceptual difference between polarization and inequality; see for instance, Wolfson (1994, 1997), Esteban and Ray (1994), Esteban, Gradín, and Ray (1999) and Rodríguez and Salas (2003).

contemplate is the bipolarization measure, which considers only two poles. In this context, bipolarization measurement can be used, for instance, as an indicator of an eventual reduction of the middle class.

Secondly, a flat tax reform of the kind described above implies a set of composite transfers, both progressive and regressive, at the lower and higher ends, respectively, even though inequality remains unchanged. In this paper, we show that revenue- and inequality-neutral flat tax reforms are not completely neutral since other properties of the income distribution are altered. We exploit this fact and characterize this set of transfers in terms of polarization. This is a relevant issue: since linear tax reforms benefit both the poor and the rich, at the expense of the middle class, bipolarization measurement can be seen and understood as a useful tool for characterizing the set of transfers caused by this kind of tax reforms. In addition, polarization will complement inequality analysis.

Beyond the aim of this paper, the feasibility of these kinds of reforms can be justified, on political grounds, on the basis of the median voter model (see for example, Romer, 1975). However, we consider that, given inequality, polarization measurements can be use to judge tax reforms. Both criteria, although based on different principles, are not fully independent, since -as we are going to show- polarization changes depend on the transfers in the middle range of the income distribution, that determine the size of the middle class[3].

In this paper we analyze the effects of inequality- and revenue-neutral (non-necessarily linear) tax reforms. In Section 2, we present inequality and polarization as different concepts. In Section 3, relevant scenarios of polarization changes are described in order to characterize the possible net transfers of a tax reform. Section 4 illustrates the effects for the case of a flat tax reform and explores its relationship with net transfers occurring between the two polar groups. Finally, in section 5, fiscal policy simulations are carried out to illustrate the theoretical results of the paper on bipolarization by replacing the Spanish tax system with an equivalent linear tax. We make use of the European Countries Household Panel (ECHP) data set to develop the fiscal reform simulations.

2. POLARIZATION VERSUS INEQUALITY

As a concept, polarization differs from the formal definition of inequality found in the literature. According to Wolfson (1994), a more bipolarized income

[3] Hence, polarization changes and the median voter model results are somehow related. This issue is the subject of an ongoing research project.

distribution is one that is more spread out from the middle, so there are fewer individuals or families with middle level incomes. In addition, there is a sense that this spreading out is also associated with a tendency towards bimodality, a clumping of formerly middle level incomes at either higher or lower levels.

Following Rodríguez and Salas's (2003) approach, the Wolfson bipolarization index can be obtained by subtracting the within-groups from the between-groups Gini coefficients, computed for groups separated by the median value:

$$P(F) = \frac{2\mu}{m}\left[G^B(F) - G^W(F)\right] \qquad (1)$$

where m is the median, μ is the mean, F is the distribution function, G^B is the between-groups Gini coefficient and G^W is the within-groups Gini coefficient, computed for groups separated by the median value. Notice that the subgroup income ranges do not overlap, and therefore there is an exact decomposition of the Gini coefficient into between-groups and within-groups contributions. The conceptual advantage of this approach is that inequality and polarization can be viewed within the same framework, with addition and subtraction of the within-groups component corresponding to inequality and polarization, respectively[4].

Furthermore, Rodríguez and Salas (2003) propose the *extended Wolfson bipolarization measure*:

$$P(F;v) = \frac{2\mu}{m}\left[G^B(F;v) - G^W(F;v)\right]$$

in which the bipolarization measure depends on a sensitivity parameter *v* associated with the extended Gini coefficient, which is defined by Donaldson and Weymark (1980) and Yitzhaki (1983)[5] [6].

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[4] This is a well-known result, see, for instance, Wolfson (1994, 1997) and Esteban and Ray (1994), that polarization is not consistent with the *principle of transfers*, the basic assumption in inequality measurement. Nonetheless, polarization is consistent with the principle of transfers between polar groups. This fact can be appreciated easily in expression (1).

[5] Note that the proposed extension by Rodriguez and Salas (2003) actually was $P(F;v) = G^B(F;v) - G^W(F;v)$ in a context of median-preserving transfers. Otherwise, in a wider context, we should multiply it by the ratio $2\mu/m$.

[6] In Rodriguez and Salas (2003) is proved that given a particular income distribution X, the extended Wolfson bi-polarization measure, $P(F;v)$, is consistent with the *second polarization curve* if $v \in [2, 3]$. The second polarization curve plays a similar role in the context of bipolarization to that played by the Lorenz curve in the context of inequality (see Foster and Wolfson, 1992). A bipolarization index is consistent with the second polarization curve if a progressive median-preserving transfer within (between) polar subgroups never reduces (increases) polarization.

3. THEORETICAL SCENARIOS FOR THE BIPOLARIZATION IMPACT OF A TAX REFORM

Under a revenue- and inequality-neutral tax reform, even if behavior is altered, polarization can increase, decrease or remain constant[7]. We can identify three relevant scenarios under certain conditions. We are going to show that polarization parallels the between-groups inequality component under a revenue- and inequality-neutral tax reform, whenever the mean-median ratio does not change significantly enough. We establish the following proposition.

Proposition 1: Under a $G(F;v)$-neutral distributional change (for instance, due to a tax reform):

$$\text{Sign}(dP(F;v)) = \text{Sign}\left(dG^B(F;v)\right) \Leftrightarrow \left|\frac{d(\mu/m)}{(\mu/m)}\right| \le \left|\frac{d(G^B(F;v) - G^W(F;v))}{G^B(F;v) - G^W(F;v)}\right|$$

Proof: Given the identity $\frac{dP(F;v)}{P(F;v)} \equiv \frac{d(\mu/m)}{(\mu/m)} + \frac{d(G^B(F;v) - G^W(F;v))}{G^B(F;v) - G^W(F;v)}$, the fact that under an inequality-neutral distributional change, $dG(F;v) = 0$, and taking into account that $G(F;v) = G^B(F;v) + G^W(F;v)$ (see Rodríguez and Salas, 2003), so that $dG^B(F;v) = -dG^W(F;v)$.

This means that, under an inequality-neutral tax reform, the sign of the polarization change is equal to the sign of the between-groups inequality change, for a sufficiently low $d(\mu/m)$. It is not likely that the ratio μ/m changes significantly enough when a revenue- and inequality-neutral tax reform is adopted, (see empirical evidence in the exercise below and in the Appendix). For a finite sample size, every two-parameters distribution function is fully characterized by the mean and a dispersion value. If the inequality measure we are controlling for is close to the dispersion measurement that characterizes the distribution, the ratio μ/m change will be low enough. In what follows, we assume that μ/m is not high enough.

Scenario 1: *Polarization increases.* The polarization measure increases when $G^B(F;v)$ goes up, $G^W(F;v)$ goes down, or both indices increase and decrease at the same time. However, when the extended Gini coefficient is unchanged, only the last option is possible. Thus, the extended between-groups Gini index increases and the extended within-groups Gini coefficient decreases in this scenario. There exists a sufficiently low $d(\mu/m)$ such that:

[7] Note that, although we follow the standard revenue-constant approach, the main results in this section apply to the more general case where revenue is not constant.

$$dP(F;v) > 0 \Leftrightarrow dG^B(F;v) > 0$$

Scenario 2: *Polarization decreases.* Through similar reasoning, the extended between-groups Gini index decreases and the extended within-groups Gini coefficient increases in this scenario. There exists a sufficiently low $d(\mu / m)$ such that:

$$dP(F;v) < 0 \Leftrightarrow dG^B(F;v) < 0$$

Scenario 3: *Polarization remains unchanged*. Finally, we have the case where the ratio μ/m does not change. Not only do the revenue and inequality measurements remain unchanged but also the polarization measure remains unchanged:

$$dP(F;v) = 0 \Leftrightarrow dG^B(F;v) = 0$$

In this case, $G^W(F;v)$ has to remain constant as well.

4. A THEORETICAL FLAT TAX EXERCISE

We can illustrate the intuition and implications of the results in Section 3 by means of a flat tax exercise. To establish the links between the scenarios and the net transfers, we use a revenue- and inequality-neutral exercise, where behavior is unaltered by this tax reform, which satisfies the condition of Proposition 1. In particular, we assume a system that changes from a piecewise increasing marginal tax rate system T_P to a flat tax T_L reform, defined as:

$$T_L(x) = \begin{cases} (x - m)t & x \geq m \\ 0 & x < m \end{cases} \quad (2)$$

where t is the marginal tax rate and *m* is the personal allowance or the minimum threshold below which tax liability is zero.

Given any inequality index that satisfies continuity and S-convexity (symmetry and the principle of transfers), Davies and Hoy (2002) show that the substitution of the existing graduated tax rate for the proposed flat tax, with revenue and inequality neutrality, guarantees a single crossing of the Lorenz curves associated with the post-tax income distributions. In turn, this generates a unique solution (t^*, m^*) for any S-convex inequality index.

The extended Gini coefficient $G(v)$ that we use in the empirical exercise is consistent, under a single Lorenz intersection, with the $v+1^{th}$ -order inverse stochastic dominance (Zoli, 2000 and Aaberge, 2000). The inverse stochastic dominance was defined by Muliere and Scarsini (1989) as similar to the classical direct dominance, except that successive accumulation is carried out with respect to ordered individuals instead of income. For this reason, this dominance criterion is connected with the principle of positional transfer sensitivity (Zoli 1999) and the rank-dependent Yaari welfare evaluation functions consistent with this principle (Yaari, 1987 and 1988)[8].

We establish the following proposition to set the connections between the scenarios in Section 2 and the net transfers.

Proposition 2: Under any distributional change in F (eventually due to any tax reform):

Sign $\left(dG^{B}(F;v)\right)$ = Sign $(-dL(0,5))$

Proof: Let $G^{B}(F;v)$ be:

$$G^{B}(F;v)=v(v-1)\int_{0}^{1}(1-q)^{v-2}(q-L_{B}(q))dq\,,$$

where q is the corresponding quantile and $L_{B}(q)$ is the between-groups Lorenz curve (see Rodríguez and Salas, 2003)[9]. In this case with two groups, separated by the median value, we can rewrite the above expression as if there were only two households as:

$$G^{B}(F;v)=v(v-1)\int_{0}^{0.5}(1-q)^{v-2}(0.5-L(0.5))dq\,,$$

then Sign $\left(dG^{B}(F;v)\right)$ = Sign $(-dL(0,5))$

This proposition is very general and does not only apply under revenue- and inequality neutral policies. This proposition is important because it helps to link polarization change with the net transfers occurring between the two polar groups through the changes in the G^{B} and $L(0.5)$. Note that the sign of $dL(0.5)$ determines the sign of the net transfers, in the sense that an increase/decrease/constant $L(0.5)$ determines the net transfers to be progressive/ regressive/neutral, as the relative mean income of the poorest group increases/decreases/remains constant. We apply this result to the scenarios under the conditions of Proposition 1.

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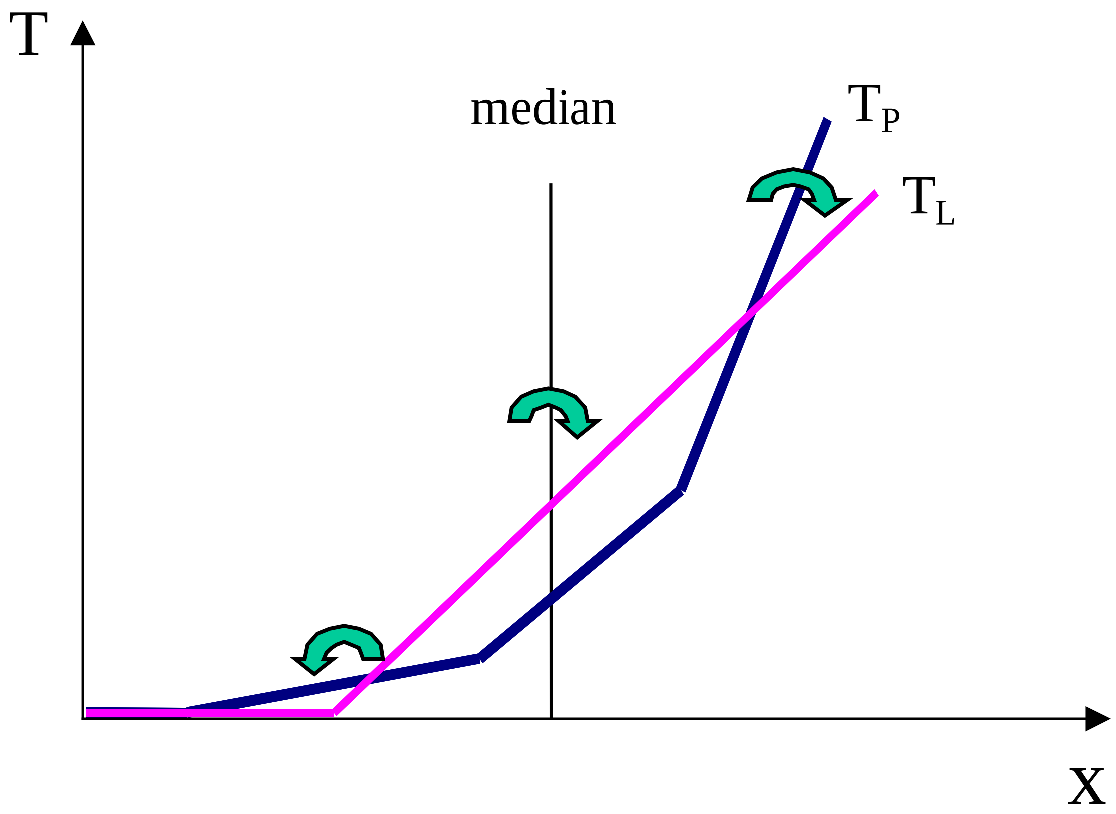
8 We could also apply the well-known result on third-order direct stochastic dominance (Shorrocks and Foster, 1987, Dardanoni and Lambert, 1988 and Davies and Hoy, 1994, 1995). In this case, the rule of thumb is the variance coefficient. This dominance criterion is connected with the principles of diminishing transfer (Kolm, 1976) or transfer sensitivity (Shorrocks and Foster, 1987) and it is consistent with all the expected utility welfare evaluation functions that satisfies monotonicity, concavity and non-decreasing third derivative.

9 We define the between-groups Lorenz curve as the one corresponding to a distribution where the subgroup mean income value is allocated to every household in that subgroup.

The whole population is separated into two groups by the median value, and a piecewise progressive income tax structure (T_P line in figure 1) is substituted by a linear tax system (T_L line). Figure 1 represents the first scenario when polarization increases. There is a regressive net transfer as the relative mean income of the poorest group decreases. The middle class is reduced as income distribution is more spread out from the middle (or polarized). Moreover, the progressive transfer within the poorest income group overcomes the regressive transfer within the richest income group, leading to a reduction in the overall within-groups inequality.

Figure 1

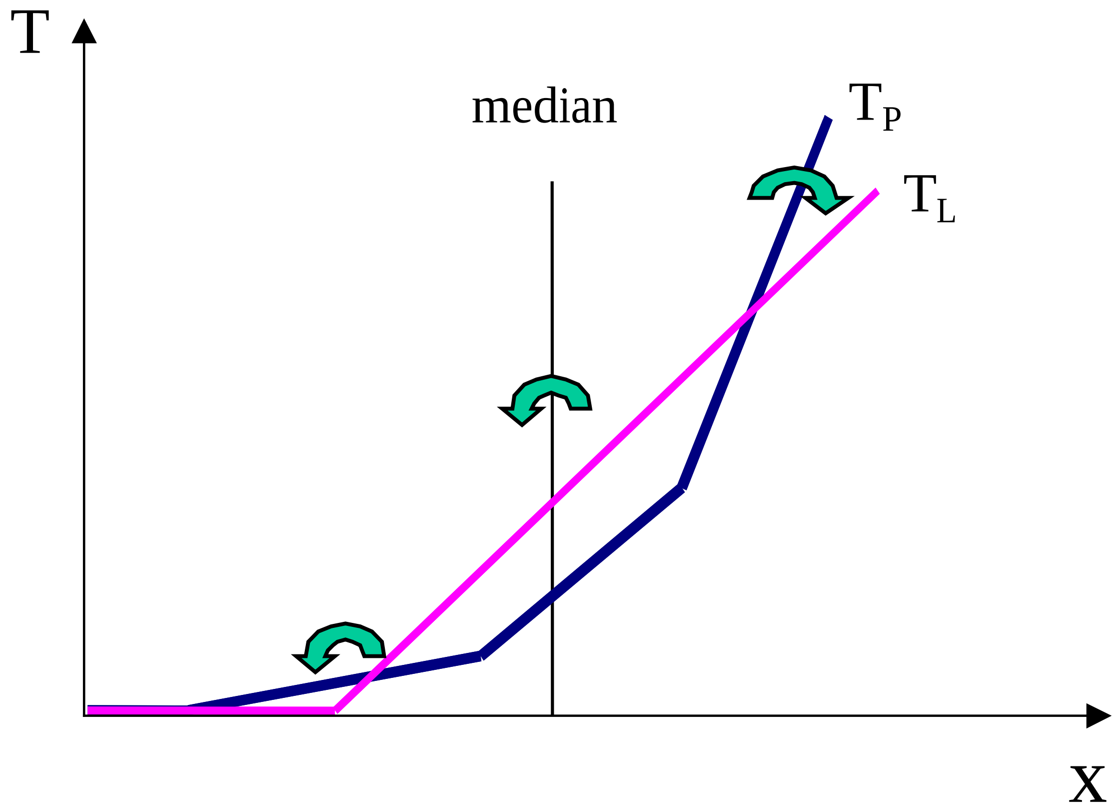
SCENARIO 1: POLARIZATION INCREASES



In figure 2 (scenario 2) there is a progressive net transfer as the relative mean income of the poorest group increases. In this case, the middle class increases. Moreover, the regressive transfer within the richest income group overcomes the progressive transfer within the poorest income group to lead an increase in the overall within-groups inequality.

Figure 2

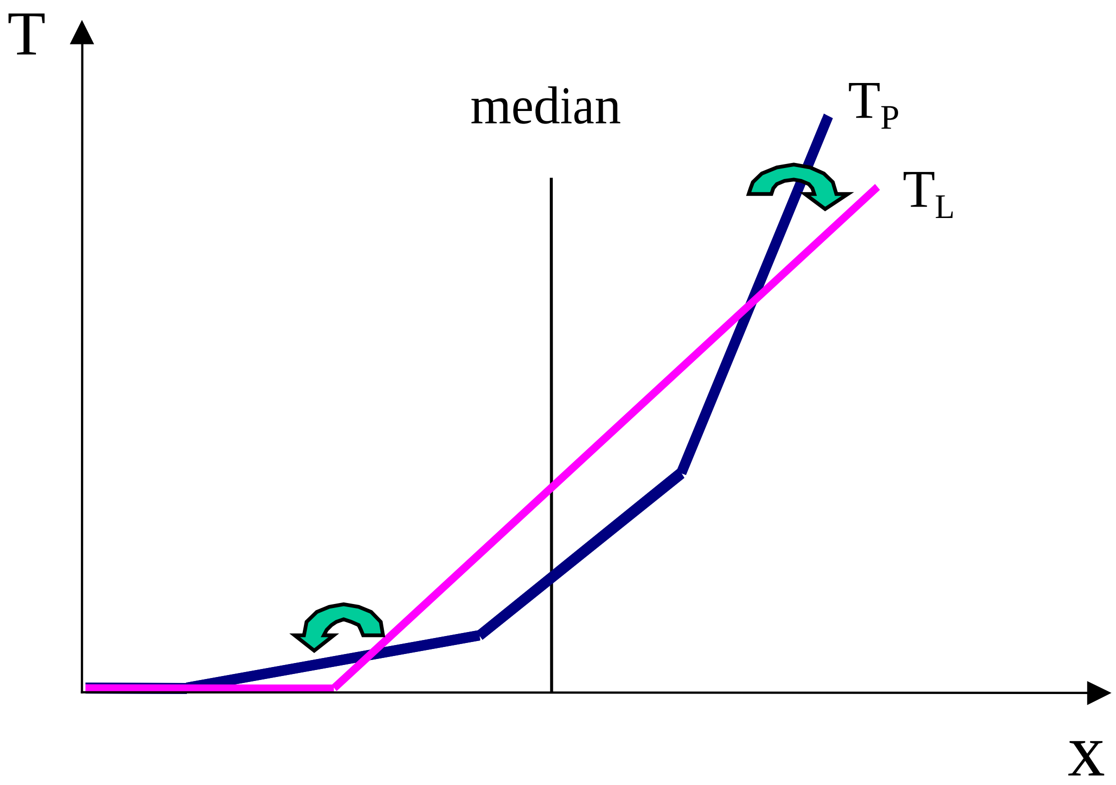
SCENARIO 2: POLARIZATION DECREASES



Finally, in the third scenario there cannot be net transfers between both groups since the extended between-groups Gini coefficient, $G^B(F;v)$, has to remain constant. In this case, there are no net transfers between groups because the mean income value of each group does not change. On the other hand, a linear tax reform benefits both the poor and the rich, at the expense of the middle class, as can be observed in figure 3. This means that two sorts of income transfers within the groups are occurring at the same time: a progressive income transfer within the poorest group and a regressive income transfer within the richest group. Moreover, in order to obtain an unchanged extended within-groups Gini coefficient, $G^W(F;v)$, the progressive and the regressive transfers have to exactly compensate to each other (null net transfers).

Figure 3

SCENARIO 3: POLARIZATION UNCHANGED



Therefore, the analysis of a revenue- and inequality-neutral tax reform on its effects on polarization allow us to characterize, in a very simple way, the different sort of net transfers that occur between and within the income groups, under the conditions of Proposition 1.

5. A FLAT TAX SIMULATION EXERCISE

In this section we carry out two simulation exercises in order to evaluate the empirical effects on polarization of replacing the Spanish tax system with a revenue- and inequality-equivalent flat tax in equation (2). This exercise illustrates the utility of scenarios under Propositions 1 and 2 for policy-makers to evaluate the impact of eventual tax reforms on polarization.

We use micro-data drawn from the ECHP panel database for 1997. The sample comprises 13,705 individuals. The equivalent income Y^e is computed using the Buhmann *et al.* (1988) and Coulter *et al.* (1992) parametric equivalence scale

$$Y^e = \frac{Y}{N^\alpha}$$

where N is the household size and α is the equivalent scale parameter in the household. All observations are weighted according to the number of persons in the household. In this illustration we do not consider the statistical inference problems dealt with in Davidson and Duclos (2000). We also ignore the measurement errors due to contaminated data dealt with in Cowell and Victoria-Feser (1996).

The effects on polarization change resulting from this flat tax reform are unknown even in this simple exercise. Two different simulations are carried out with different impacts on polarization change, each of them corresponds to Scenarios 1 and 2 of the theoretical sections 2 and 3. Therefore, we can link these results with the set of the net transfers involved in either case.

On top of that, one important aspect related to such a reform arises. The design of the threshold matters. In the baseline simulation exercise, a constant individual nominal threshold (CINT) is imposed. For example, if we establish CINT = 1,000 euros, the household allowance will then be m = 1,000N.

The alternative exercise assumes a constant individual equivalent threshold (CIET). The individual equivalent threshold is constant for all individuals, in equivalent-income terms, regardless of the household size. If we set CIET = 1,000 euros, the household allowance will be $m = 1{,}000N^{\alpha}$ euros. This is an interesting exercise, as it does not incorporate any source of horizontal inequity due to the threshold.

Results under the baseline simulation are presented in table 2, where marginal tax rates and income thresholds (t*, m*) are shown for different equivalent scales and different extended Gini inequality aversion parameters.

Table 2

LINEAR TAX SIMULATION UNDER CONSTANT REVENUE AND VERTICAL REDISTRIBUTION

	1997 Tax System		Baseline simulation		
	S-Gini Coefficients	Bipolarization	Threshold CINT (Euros)	Marginal Tax Rate	Bipolarization
$\alpha = 0.25$					
v = 1.5	0.2142	0.1215	4194.54	30.4698	0.1703
v = 2.0	0.3291	0.2922	4031.05	29.2389	0.3306
v = 2.5	0.4035	0.4287	3978.05	28.8407	0.4622
v = 3.0	0.4568	0.5236	3982.35	28.8722	0.5533
$\alpha = 0.50$					
v = 1.5	0.2093	0.1139	3890.47	28.2063	0.1562
v = 2.0	0.3210	0.2792	3680.92	26.7430	0.2986
v = 2.5	0.3932	0.4115	3570.96	26.0069	0.4217
v = 3.0	0.4451	0.5032	3507.99	25.5967	0.5089

(Sigue)

(Continuación)

	1997 Tax System		Baseline simulation		
	S-Gini Coefficients	**Bipolarization**	**Threshold CINT** (Euros)	**Marginal Tax Rate**	**Bipolarization**
$\alpha = 0.75$					
v = 1.5	0.2121	0.1074	3636.90	26.4452	0.1127
v = 2.0	0.3235	0.2741	3388.63	24.8405	0.2563
v = 2.5	0.3951	0.4085	3229.20	23.8673	0.3834
v = 3.0	0.4466	0.5017	3112.15	23.1800	0.4712

Source: ECHP database 1997. Sample size (N): 5427 households (13705 individuals).

It can be observed that in the baseline linear tax reform bipolarization increases (except from α = 0.75 and v ≥ 2). Therefore, this simulation agrees with Scenario 1, where between-groups inequality is increased and within-groups inequality is reduced (see Figure 1). Note that the change in the component between/within-groups is the main factor explaining the change in polarization (see Table 4A in the Appendix).

However, polarization change is different under the alternative simulation. Indeed polarization decreases as can be seen in table 3 (except from α = 0.5 and *v* = 1.5). Therefore, Scenario 2 is the relevant one. From the theoretical framework there must be a progressive transfer from upper-middle to lower-middle class. Again the change in the component between/within-groups is the main factor explaining the change in polarization (see Table 4B in the Appendix).

Table 3

ALTERNATIVE LINEAR TAX SIMULATION

	Alternative simulation		
	Threshold CIET (Euros)	**Marginal Tax Rate**	**Bipolarization**
$\alpha = 0.25$			
v = 1.5	8693.64	26.5887	0.1045
v = 2.0	7990.27	24.7031	0.2455
v = 2.5	7545.27	23.5858	0.3826
v = 3.0	7227.76	22.8245	0.4792
$\alpha = 0.50$			
v = 1.5	6588.04	26.9170	0.1151
v = 2.0	6103.79	25.1168	0.2502
v = 2.5	5799.85	24.0530	0.3733
v = 3.0	5576.71	23.3079	0.4591

(Sigue)

(Continuación)

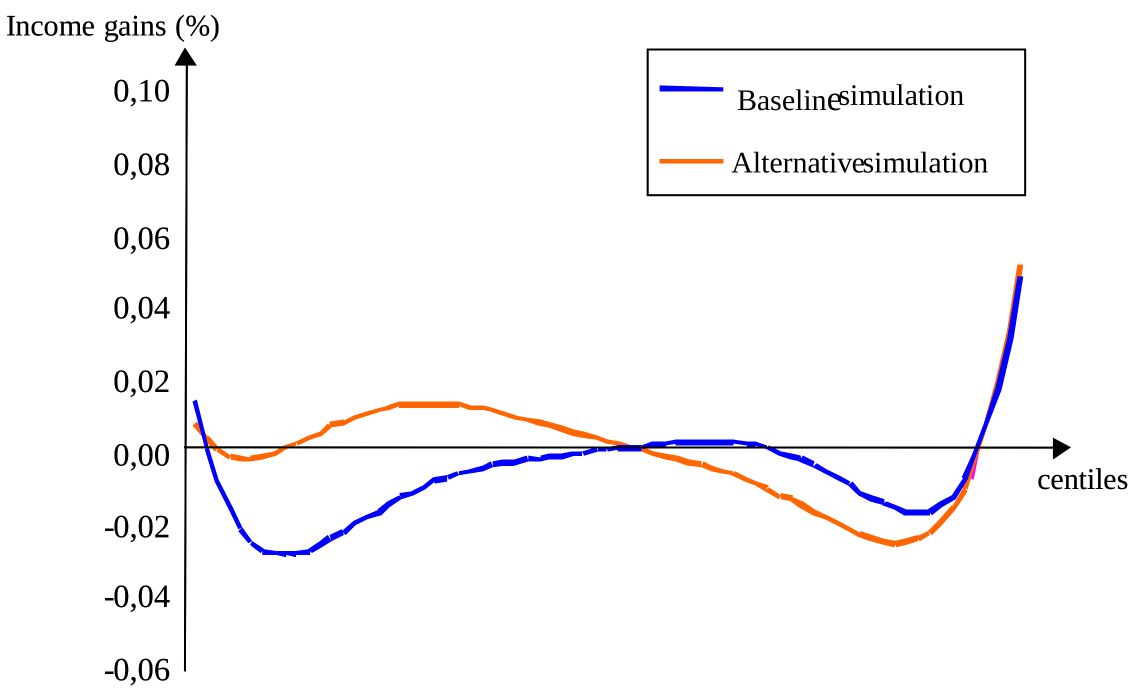
	Alternative simulation		
	Threshold CIET (Euros)	**Marginal Tax Rate**	**Bipolarization**
α=0.75			
v=1.5	4879.77	26.6528	0.1025
v=2.0	4526.65	24.8926	0.2331
v=2.5	4308.43	23.8654	0.3600
v=3.0	4150.71	23.1533	0.4578

Source: ECHP database 1997. Sample size (N): 5427 households (13705 individuals).

Furthermore, in figure 4, we present the relative income gains by centiles derived from the reform under consideration for $v = 2$ and $\alpha = 0.5$[10]. In the baseline simulation, it is observed that losses are concentrated on two polar nodes of the income distribution, corresponding to the lower-middle and to the upper-middle classes. Winners are concentrated in both extremes of the income distribution. Therefore polarization is increased. The alternative simulation confirms the net progressive transfer from the upper-middle and to the lower-middle class, as there are also winners in the lower-middle range of the distribution.

Figure 4

RELATIVE INCOME GAINS DUE TO THE TAX REFORM BY CENTILES



[10] A polynomial smoothing is applied in figure 4 to clarify main trends.

Thus, real-data results confirm the theoretical result regarding the net transfers within the middle-class income levels highlighted in Section 4 and summarized by the idea underlying Figures 1 and 2. As a conclusion of this section, it can be said that the simulated flat tax reform generates two different outcomes, associated with an increase or a reduction, respectively, of the middle class consistent with our theoretical results, depending on whether there is a regressive or a progressive net transfer between the two polar groups.

6. CONCLUDING REMARKS

This paper evaluates the distributional effects of inequality- and revenue-neutral flat tax reforms shifting from a graduated-rate tax system. If polarization is borne in mind, we will be able to identify the composite set of transfers that will take place along the whole range of the income distribution. Polarization becomes an important feature of the income distribution and the analysis of its changes is an important question, specially in the case that inequality remains constant.

The net transfers caused by a flat tax reform are characterized. Using the *extended Wolfson bipolarization measure*, relevant theoretical polarization scenarios are identified. Under certain conditions, an important result is that bipolarization changes along with between-groups inequality: bipolarization goes up or down if and only if between-groups inequality goes up or down. These conditions are satisfied in empirical terms.

The change from a graduated marginal tax rate to a flat tax benefits both the highest and the lowest ends of the income distribution, at the expense of middle range incomes (see for example, Davis and Hoy, 2002). However, we show how a flat tax reform may, in a counterintuitive way, decrease polarization. The reform may contribute to narrow the distance between the two polar groups separated by the median value, and therefore, to increase the size of the middle class.

We have carried out two simulations that had opposite results on polarization. Nevertheless, both cases match very well with our theoretical framework. Hence, the proposed theoretical scenarios can be used to anticipate the distributive effects of a tax reform with minimum information requirements. This illustrates how important the polarization measurement can be in discriminating between two alternative inequality-neutral linear tax reforms. In the same way, these results can be extended to many other examples such as public utility pricing reforms or more general inequality-neutral public policy reforms.

A by-product result of the specific linear tax reform under consideration is that the design of the thresholds matters, from the distributive point of view, even if we consider an inequality-neutral tax reform.

A future line of research may be the study of the feasibility of these tax reforms, on political grounds, in terms of the median voter model. This issue is directly related with the size of the middle-class, the main focus of this paper.

APPENDIX

We show that the condition in Proposition1:

$$\left|\frac{d(\mu/m)}{(\mu/m)}\right| \leq \left|\frac{d(G^B - G^W)}{G^B - G^W}\right|$$

is verified in our simulations.

Table 4A

POLARIZATION CHANGE BY COMPONENTS

	Baseline simulation		
	Polarization change (%)	**Change in G^B-G^W (%)**	**Change in μ/m (%)**
$\alpha = 0.25$			
v=1.5	40.1	42.5	-1.7
v=2.0	13.1	15.1	-1.7
v=2.5	7.8	9.5	-1,6
v=3.0	5.7	7.4	-1.6
$\alpha = 0.50$			
v=1.5	37.1	39.7	-1.8
v=2.0	6.9	8.1	-1.1
v=2.5	2.5	3.3	-0.8
v=3.0	1.1	1.7	-0.5
$\alpha = 0.75$			
v=1.5	5.0	5.9	-0.9
v=2.0	-6.5	-6.6	0.1
v=2.5	-6.1	-6.7	0.6
v=3.0	-6.1	-7.0	1.0

Source: ECHP database 1997. Sample size (N): 5427 households (13705 individuals).

Table 4B

POLARIZATION CHANGE BY COMPONENTS

	Alternative simulation		
	Polarization change (%)	Change in G^B-G^W (%)	Change in μ/m (%)
$\alpha=0.25$			
v=1.5	-14.0	-13.5	-0.6
v=2.0	-16.0	-16.5	0.6
v=2.5	-10.8	-11.8	1.2
v=3.0	-8.5	-10.0	1.6
$\alpha=0.50$			
v=1.5	1.1	1.9	-0.8
v=2.0	-10.4	-10.7	0.3
v=2.5	-9.3	-10.2	1.0
v=3.0	-8.8	-10.0	1.4
$\alpha=0.75$			
v=1.5	-4.5	-4.1	-0.5
v=2.0	-15.0	-15.5	0.6
v=2.5	-11.9	-12.9	1.2
v=3.0	-8.8	-10.2	1.6

Source: ECHP database 1997. Sample size (N): 5427 households (13705 individuals).

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