E C O N O M I C S B U L L E T I N

POLARIZATION CHARACTERIZATION OF INEQUALITY−NEUTRAL TAX REFORMS

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Abstract

In this article, polarization measurement is presented as a useful tool for characterizing the net transfers of income between individuals caused by a tax reform. The bipolarization measure, which considers just two poles and involves the disappearance of the middle class, may complement inequality measures insofar as it provides an alternative explanation of the distributional impact of inequality neutral tax reforms. Some theoretical implications of an inequality− and revenue−neutral tax reform concerning polarization are examined. We conclude with an empirical application where we carry out a simulation to evaluate the effects on polarization of a potential substitution of the current Spanish tax system for an inequality− and revenue− neutral linear tax.

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1. Introduction

Recent tax system reforms in western economies provide evidence of an international trend towards the flattening of income tax structures. Efficiency gains are considered the main reason to move from a progressive tax system with graduated tax rates to one with a personal allowance and a single marginal tax rate. However, the redistributive pattern of linear tax reforms is complex can be regarded as an application of a set of composite transfers, both progressive and regressive at the lower and higher tails of the initial distribution, respectively. Nevertheless, we consider that not only inequality measurement but also polarization measurement has to be considered as far as the net transfers of these reforms are concerned[1].

Whereas inequality relates to the overall dispersion of the distribution, polarization concentrates on the income distribution on several focal or polar modes. A particular class of polarization is the bipolarization measure, which considers just two poles. Since, linear tax reform benefits both the poor and the rich, at the expense of the middle class, bipolarization measurement appears to be a useful tool for characterizing the net transfers of income between individuals caused by this kind of fiscal reform.

In this paper we analyze the effects of inequality- and revenue-neutral (non-necessarily linear) tax reforms. All possible scenarios of polarization changes are described in order to characterize the possible net transfers of a tax reform. Finally, a fiscal policy simulation is carried out to illustrate the theoretical results of the paper on bipolarization by substituting the Spanish tax system for an equivalent linear tax. We make use of the ECHP data set to carry out the fiscal reform simulations.

2. Polarization versus Inequality

Polarization is a different concept from inequality as it has been formally defined in the literature. According to Wolfson (1994), a more bipolarized income 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 tendency towards bimodality, a clumping of formerly middle level incomes at either higher or lower levels.

Following Rodríguez and Salas (2002) 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:

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

where m is the median, μ is the mean, 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

[1] 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 (2002).

Gini coefficient into between-groups and within-groups contributions.

Furthermore, Rodríguez and Salas (2002) proposed the *extended Wolfson bipolarization measure*: $P(v) = G^B(v) - G^W(v)$ in which the bipolarization measure depends on a sensitivity parameter v associated to the extended Gini coefficient defined by Donaldson and Weymark (1980) and Yitzhaki (1983).[2]

3. Theoretical Scenarios for the bipolarization Impact of a Tax Reform

We consider a tax reform and it is also assumed that behavior is unaltered by the tax system under consideration. As long as we consider a revenue- and inequality-neutral tax reform, polarization is the only variable that can change.

We have shown that polarization and inequality are different concepts from the theoretical point of view. Now, we turn to the nature of the theoretical relationship between polarization and inequality. Unfortunately, we find that this relationship is not unambiguous in that positive or negative correlation between both terms depends on the variance of the within- relative to the between-groups Gini coefficients. Let us illustrate this result.

The covariance between the polarization and the inequality measures is given by:

$$Cov[G(v)P(v)] = E[(G(v) - E(G(v))(P(v) - E(P(v))] \tag{2}$$

If we substitute polarization and inequality indices for the within- and between-groups inequality terms, we obtain:

$$Cov[G(v)P(v)] = E[(G^B(v) + G^W(v))(G^B(v) - G^W(v)) - (G^B(v) - G^W(v))E(G^B(v) + G^W(v)) \tag{3}$$

and after tedious calculation we conclude that:

$$\begin{aligned} Cov[G(v)P(v)] = {} & Var(G^B(v)) - Var(G^W(v)) - (G^B(v) + G^W(v))E(G^B(v) \\ & - G^W(v)) + E(G^B(v) - G^W(v))E(G^B(v) + G^W(v)) \end{aligned} \tag{4}$$

Therefore, polarization can increase, decrease or be constant whenever an inequality-neutral tax reform is considered. We thus identify three possible scenarios. We are going to show that polarization goes along with the between-groups inequality component in this context.

Scenario 1: *Polarization remains unchanged.* Not only do the revenue and inequality measures remain unchanged but also the polarization measure remains unchanged. As $G(v) = G^B(v) + G^W(v)$ and $P(v) = G^B(v) - G^W(v)$, $G^B(v)$ and $G^W(v)$ have to remain constant as well.

[2] In Rodriguez and Salas (2003) is proved that given a particular income distribution X, the extended Wolfson bi-polarization measure, $P(v)$, is consistent with the second polarization curve if $v \in [2, 3]$. A bipolarization index is consistent with the second polarization curve if a progressive median-preserving transfer within (between) polar subgroups never reduces (increases) polarization.

Scenario 2: *Polarization increases.* The polarization measure increases when $G^B(v)$ goes up, $G^W(v)$ 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.

Scenario 3: *Polarization decreases.* By similar reasoning, the extended between-groups Gini index decreases and the extended within-groups Gini coefficient increases under this scenario.

Proposition: Let consider an inequality-neutral tax reform, then polarization changes along with the between-groups inequality component:

$$\Delta P(v) > 0 \Leftrightarrow \Delta G^B(v) > 0 \quad (5)$$
$$\Delta P(v) = 0 \Leftrightarrow \Delta G^B(v) = 0 \quad (6)$$

We can illustrate the intuitions and implications of this result with the following exercise. Let consider a revenue- inequality-neutral exercise that changes from a piecewise increasing marginal tax rate system T_P to a linear tax T_L reform, defined as:

$$T_L(x) = \begin{cases} (x - A)t & x \geq A \\ 0 & x < A \end{cases} \quad (7)$$

where t is the marginal tax rate and A is the personal allowance or the minimum threshold below which tax liability is zero (similar as in Davies and Hoy, 2002).

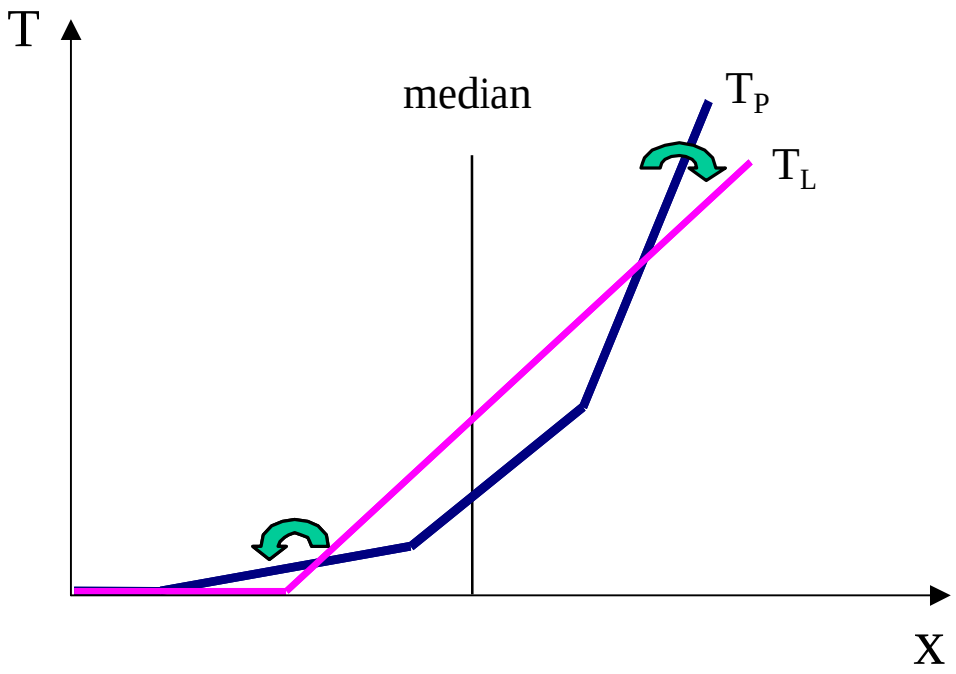

Figure 1. Scenario 1: polarization unchanged

The whole population is separated into two groups by the median value and a piecewise progressive income tax structure (blue line in Figure 1) is substituted by a linear tax system (pink line). On the one hand, there cannot be any transfer between both groups when the extended between-groups Gini coefficient, $G^B(v)$, has to remain constant. On the other hand, it has been pointed out by Davies and Hoy (2002) that a linear tax reform benefits both the poor and the rich, at the expense of the middle class, as can be observed in the Figure 1. 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 unchanged extended within-groups Gini coefficient, $G^W(v)$, the progressive and the regressive transfers have to exactly compensate to each other.

Figure 2 represents the second scenario when polarization increases. The income transfer between both groups is regressive and the progressive transfer within the poorest income group overcomes the regressive transfer within the richest income group.

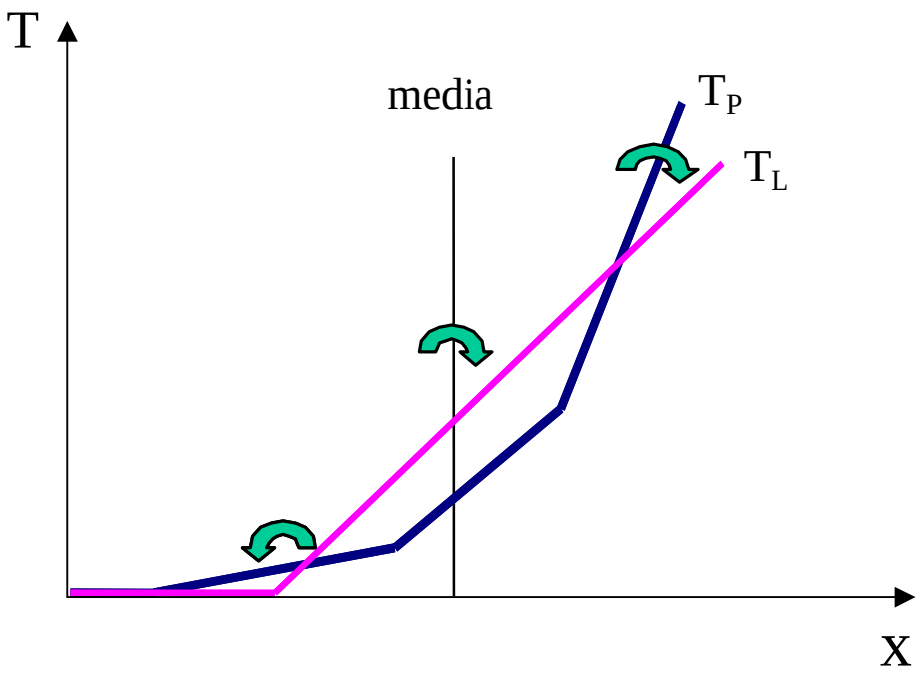

Figure 2. Scenario 2: polarization increases.

In Figure 3 (scenario 3) the income transfer between both groups is progressive and the regressive transfer within the richest income group overcomes the progressive transfer within the poorest income group.

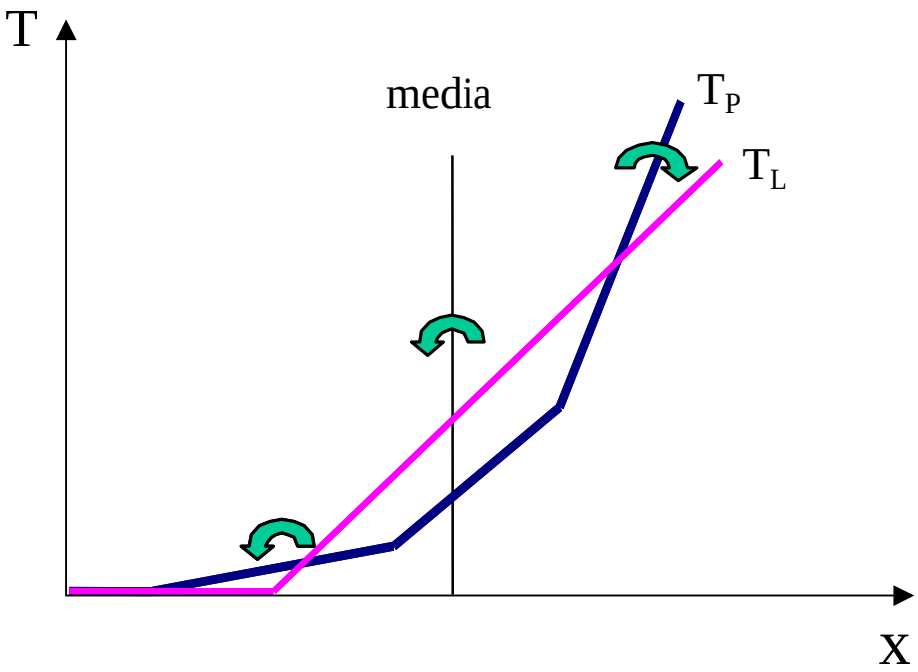

Figure 3. Scenario 3: polarization decreases.

Therefore, the analysis of a revenue- and inequality-neutral linear tax reform through its effects on polarization allow us to characterize in a very simple way the different sort of transfers that occur between and within the income groups. In sum, this approach allows us to evaluate all the income transfers from the upper and lower middle classes.

4. A linear tax simulation exercise

In this section we carry out a simulation exercise in order to evaluate the empirical effects of the substitution of the Spanish tax system for a revenue- and inequality-equivalent linear tax. 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

$$Y^e = \frac{Y}{N^\alpha} \tag{8}$$

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. Results are presented in Table 1, where marginal tax rates and income thresholds (t*, m*) are shown for

different equivalent scales and different extended Gini inequality aversion parameters.

Table 1: Linear tax simulations under constant revenue and vertical redistribution

	1997 Tax System		Simulation		
	S-Gini Coefficients	Bipolarization	Threshold (Euros)	Marginal Tax Rate	Bipolarization
Alpha=0.25					
v=1.5	0.2142	0.0526	4233.80	30.7759	0.0760
v=2.0	0.3291	0.1263	4155.06	30.1661	0.1467
v=2.5	0.4035	0.1853	4108.09	29.8087	0.2036
v=3.0	0.4568	0.2264	4126.58	29.9488	0.2436
Alpha=0.50					
v=1.5	0.2093	0.0493	4006.79	29.0518	0.0730
v=2.0	0.3210	0.1209	3778.84	27.4169	0.1335
v=2.5	0.3932	0.1781	3670.91	26.6752	0.1869
v=3.0	0.4451	0.2184	3617.38	26.3144	0.2239
Alpha=0.75					
v=1.5	0.2121	0.0460	3738.94	27.1405	0.0545
v=2.0	0.3235	0.1174	3474.10	25.3795	0.1130
v=2.5	0.3951	0.1749	3312.69	24.3722	0.1668
v=3.0	0.4466	0.2149	3198.69	23.6861	0.2034

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

It can be observed that linear tax reform increases bipolarization (except from $\alpha = 0.75$ and $v \geq 2$). Therefore, in this simulation we are in Scenario 2, where between-groups inequality is increased and within-groups inequality is reduced (see Figure 2).

Furthermore, in Figure 4, we present the percentage of losers by income centiles. In general terms, it is observed that the higher the income centile, the higher the percentage of losers, except for the last two centiles where the percentage of losers decrease dramatically. This result is to be expected in that the winners should be concentrated in both extremes of the income distribution.

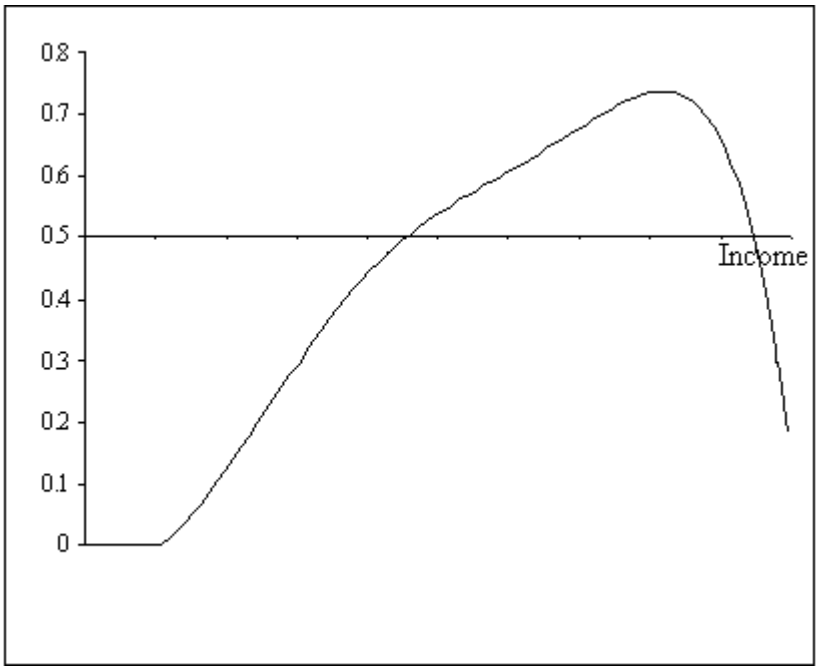

Figure 4. Percentage of losers by centiles.

Thus, real-data results confirm the theoretical result about the net transfers in the middle-class income levels highlighted in Section 3 and summarised by the idea behind Figure 2. In this context, our linear tax reform simulation is, in most of the cases, consistent with a *regressive* net transfer from the low-middle to upper-middle income individuals.

5. Concluding remarks

This article evaluates the polarization effects of inequality- and revenue-neutral tax reforms. Indeed, it can be shown that results are maintained under non revenue-neutrality. The set of net transfers that these fiscal reforms generate is characterized. Using the *extended Wolfson bipolarization measure*, all potential polarization scenarios are identified, from a theoretical point of view, and it allows us to characterize the net transfers that this tax reform would produce. One important result is that bipolarization changes along with between-groups inequality: bipolarization goes up (down) if and only if between-groups inequality goes up (down).

Finally, we illustrate this intuition by making use of graphical analysis applied to 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 neural inequality public policy reforms.

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