Divide and Rule: Redistribution in a Model with Differentiated Candidates

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Abstract

In many democracies - despite the fact that poor voters constitute a majority - greater income inequality does not lead to greater redistribution. We try to explain this paradox of democratic politics by studying an electoral competition model in which each voter is characterized by income level and non-economic characteristics (ethnicity, religion, culture, etc.) and where two vote share maximizing candidates, with fixed non-economic characteristics (differentiated candidates), strategically promise a level of redistribution. Apart from the *group-size* effect (the larger an income group, the larger its influence on equilibrium tax rate) and the *income* effect (poor voters are more responsive to a redistributive transfer), which obviously push towards greater redistribution, our analysis uncovers a third, and potentially dominant over the other two, effect on equilibrium redistribution: the *within-group homogeneity* effect (the degree to which voters of the same income group have similar non-economic characteristics). This effect a) drags redistribution towards the preferred level of redistribution of the more homogeneous, in terms of non-economic characteristics, income group and b) is proved to be much stronger than the other two effects. That is, if in a society the large group of poor voters is "divided" as far as non-economic characteristics are concerned and the small group of rich voters is relatively more homogeneous in that respect, the equilibrium level of redistribution will be extremely low.

Keywords: redistributive politics, inequality, taxation, differentiated candidates, ethnic heterogeneity, identity.

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"... and the result which follows in democracies is that the poor are more sovereign than the rich, for they are in a majority, and the will of the majority is sovereign."

Aristotle (Politics VI.2, 1317a40)

1 Introduction

Over the past three decades, as income inequality has steadily risen in many democracies (Fig. 1) and the middle class has become relatively poorer (Piketty and Saez 2003; Atkinson et al. 2011), many observers suggest that there appears to be a significant *representation gap* (Bonica et al. 2013). In contrast with the predictions of economic theory of democracy (Downs 1957) that as more people demand redistribution their preferences will eventually be reflected via the democratic process, rich voters' preferences for less redistribution seem to be better represented. That is, despite the fact that the majority of voters is becoming poorer (in relative terms), one does not observe majority's preferences over taxation and redistribution being met by politicians (Fig. 2 and Fig. 3).[1] But how is it possible that democratic politics end up in such representation gaps? Since politicians compete for votes why is it not the case that they converge to promising the level of redistribution that the majority of voters prefers?

[Insert Figures 1, 2 and 3 about here]

Standard models of redistributive politics (Meltzer and Richard 1981; Cox and McCubbins 1986; Alesina and Rodrik 1994; Persson and Tabellini 2001) cannot explain the empirical puzzle described above as they predict median-preferred equilibrium levels of redistribution. In all those models, the relative size of poor versus rich voters drives the result as politicians will always pander to the relatively larger group - we call this the *group-size* effect. Models of special interest politics, on the other hand, consider that parties use redistribution in order to "woo those voters who are relatively more responsive to generous transfers" (Dixit and Londregan 1996). Thus, in the words of Cox (2009): "The Dixit–Londregan model also predicts that parties should target poor voters because their votes should be cheaper to buy." We call this the *income* effect. Thus, both these groups of models result in predicting that the equilibrium redistribution level will be high, reflecting the preferences of poor voters. In the opposite direction, models assuming that rich voters are more involved in politics or finance candidates' campaigns (e.g., Campante 2011) may indeed explain part of the phenomenon but they cannot fully account for the sharp decline in redistribution (taxation) that is observed as the income share of most of the engaged voters is decreasing

[1] For more evidence from European countries on this representation gap see also Rosset et al. (2013).

as well.[2]

In this paper, we provide an alternative explanation to this paradox by the means of a two-dimensional electoral competition model with differentiated candidates:[3] voters are characterized by income and a fixed non-economic characteristic (which can be thought of as ethnicity, religion or cultural identity) and two candidates with also fixed non-economic characteristics strategically choose balanced-budget redistribution schemes in order to maximize their expected vote shares. In our model both described effects (the group-size effect and the income effect) are present but a third - and potentially dominant over the other two - factor appears: the *within-group homogeneity* effect. Consider a simple example in which voters of two income groups (poor and rich) have preferences over a unidimensional non-economic issue: for example, the darkness of the skin of the candidate.[4] If poor voters are many but divided in this dimension (say half prefer darker skins to paler ones and half prefer paler skins to darker), if rich voters are few but homogeneous and moderate in this dimension and one candidate is very dark while the other candidate is very pale then the following force appears: the dark candidate knows that by offering a redistribution scheme slightly less generous than the pale candidate makes all rich voters vote for her (since rich voters do not have strong preferences about skin color) at the cost of losing the votes of very few poor voters (since poor voters have very strong feelings about the color - a marginal difference between the proposed redistribution schemes is not enough to make them switch their votes). This *within-group homogeneity* effect drives the equilibrium level of redistribution closer to the preferences of the more homogeneous group which is, in this example, the rich voters' group despite the fact that poor voters constitute a majority.

By focusing in Meltzer and Richard (1981) balanced-budget redistribution schemes we initially show that when candidates' fixed non-economic characteristics are identical then the *group-size* effect is dominant: consistent with previous literature (e.g., Cox and McCubbins 1986) candidates pander to the interests of the majority. This implies that redistribution will be high (low) when the majority of the society is poor (rich). We further show that when candidates are sufficiently differentiated in the non-economic dimension and when the degree of within-group homogeneity in the non-economic dimension is identical across income groups, a representation gap appears in favor of the poor voters: independently of the size of the group of poor voters, candidates promise a large level of redistribution. In this case the

[2] Lower voter turnout amongst the very poor voters (bottom quintile) cannot alone account for this paradox as *all* - but the top - quintiles have seen their relative income shares constantly shrinking over the last four decades (US Census Bureau 2012; see Fig. 2). That is, the demand for redistribution should have been higher even among those "upper-middle" class voters (third and fourth quintile) who also tend to be more involved into politics.

[3] For a general presentation of differentiated candidates' models one is referred to Krasa and Polborn (2010a, 2010b, 2012) and Dziubinski and Roy (2011).

[4] Anesi and De Donder (2009) consider an analogous voter set-up, where "... voters differ in their exogenous income and in their ideological views, with racism as an illustration."

income effect is dominant.

But more importantly and perhaps even more strikingly, we find that the direction of the representation gap can be quickly reversed in favor of the rich group when poor voters become more heterogeneous in the non-economic dimension. That is, by maintaining the assumption of sufficient candidate differentiation, we show that even if poor voters are only slightly more heterogeneous than the rich ones in the non-economic dimension, the equilibrium redistribution scheme will better reflect the interests of the rich. Candidates in general are found to pander to the interests of the most homogenous group, as the relative ratio of the densities of the swing voters of the two income groups on the non-economic dimension is found to be more relevant in determining equilibrium redistribution than the ratio of the sizes of these groups. Hence, the *within-group homogeneity* effect is much stronger than the other two and presents itself as a possible explanation for the representation gap paradox that we described in the beginning.

Real world observations seem to back up the existence of this *within-group homogeneity* effect. In the U.S., for example, there appears to be a negative relationship between the observed level of redistribution and the degree of heterogeneity on non-economic issues among poor and middle class voters. In particular, as far as the non-economic dimension of ethnic identity is concerned, we observe not only that the rich are more homogeneous than the poor and the middle class, but moreover that the differences across these income groups grow over time (Fig. 4).[5] In general, the degree of polarization in the U.S. on a series of non-economic matters (e.g., ethnicity, religion, culture and social ideology) has been documented to have risen - both at the political elite level, especially across parties and candidates in Congress (Poole and Rosenthal 1984, 1985, 2000; McCarty et al. 2006) and also among voters (Abramowitz and Saunders 2008; Harbridge and Malhotra 2011; Krasa and Polborn 2014).[6] Such an increase in non-economic polarization may intensify the representation gap by further shifting the axis of political competition from class to identity. It is exactly this interplay between increased candidate differentiation and greater within-poor

[5] In the literature, a standard way of measuring heterogeneity, or else fragmentation, of a group of individuals is to compute the inverse of the Herfindahl-Hirschman index defined as $1/\sum_{i \in X} v_i^2$ where v_i is the share of the group which consists of individuals with characteristic i. In Fig. 4.a we present such computations for three income groups for the years 1979-2010 (data retrieved from from the Current Population Survey conducted by the US Census Bureau and for older surveys data were retrieved from the NBER archive) considering that, within each group, individuals may differ in ethnic identity. In specific we have that *X={white (non-hispanic), african-american, hispanic, others}*. Computed like this the index takes the value one when the group is perfectly homogeneous while a value of two (three etc.) means that it is as if the group is divided in two (three etc.) sub-groups of equal size. Any other popular alternative measure of heterogeneity or fragmentation would end up in similar findings (poor are more heterogeneous than the rich and this difference grows over time). To see that these findings are not just a consequence of the increase in the fragmentation of the non-white population we present in Fig. 4.b the roughest possible measure of within-group homogeneity that one could come up with in this context - the percentage of white (non-hispanic) voters within each income group - and we observe that the cross-group differences and the over time trends remain identical.

[6] According to the American National Election Survey, which records voters' own ideological position on a scale from 1 (very liberal) to 7 (very conservative), the number of respondents who report one of the extreme positions (1,2, 6 and 7) has grown from 21 percent in 1976 to 31 percent in 2008.

heterogeneity that incentivizes parties to pander to the relatively more rich voters and disadvantages the poor voters, as in the absence of any of those two elements redistribution would have been higher according to our model's predictions.

[Insert Figure 4 about here]

Finally, our results can contribute to the literature of ethnic politics by supplementing recent empirical findings (Alesina et al. 2001; Alesina and Glaeser 2004) which suggest that there is more redistribution in ethnically more homogenous societies than in more heterogeneous ones despite the fact that in the latter inequality - and the number of poor voters - might be larger. Our findings add to this discussion by offering a new insight that future empirical research should explore in greater detail: the evolution of relative ethnic heterogeneity within different income groups can potentially be a more important determinant of redistribution than the aggregate country-level degree of heterogeneity.[7]

In terms of modeling assumptions there are two papers which are very close to ours. The first one is Lindbeck and Weibull (1987). In the standard text-book redistribution problem in which two candidates are free to propose any balanced budget redistribution scheme – even ones that upset the income ordering of citizens - no equilibria exist: for each redistribution scheme there is another one which is preferred by a majority. In the framework of this problem Lindbeck and Weibull (1987) make the following seminal observation: if voters care not only about the redistribution scheme but also about other characteristics of candidates and if candidates are sufficiently uncertain about how each voter evaluates their other characteristics, then an equilibrium may exist. This equilibrium, whose existence is subject to very stringent conditions, is such that the less politically biased income group receives transfers from all other income groups. That is, not only could it be the case that there is redistribution in favor of the rich – something which is at odds with bare-eye empirical observations – but it could further be that the total redistribution in favor of the rich in a case in which rich are the less biased group exceeds the total redistribution in favor of the poor in a case in which the poor are the less biased group. Thereafter, no

[7]For example, according to the US Census Bureau, in 2005 the ethnic/racial composition of the US was: 75% were self-identified as white, 12% as black, 10% as hispanic and 3% as asian. Among the poorest voters (bottom quintile) white were roughly 67% while black, hispanic and asian were 18%, 12% and 3% respectively. Nevertheless, among the richest voters (top quantile) whites constituted an overwhelming majority (85%) while the remaining three groups were roughly 5% each. Similarly, in the UK (2005) white (of British and non-British origin) constituted 90% of the total population while other ethnic/racial groups (Indian, Pakistani, African/Caribbean blacks, Chinese, Bangladeshi and other asian backgrounds) were 1-2% of the population each. Yet, while among the poorest voters (bottom quantile) white were only the 79% and the other four major groups (African/Caribbean blacks, Pakistani, Indian and people with other asian origin) constitute roughly 5% each, among the richest ones (top quantile) whites stood at a staggering 95% with all other groups being negligible (less than 1% each). That is, it is clear that the poor are more heterogenous in the non-economic (in this case ethnic and racial) dimension. Moreover, this trend of greater within-poor ethnic and social heterogeneity has been increasing over time, as the same evidence seem to suggest.

clear inference may be drawn from these results regarding the relationship between voters' preferences on non-economic issues and total equilibrium redistribution.

The second paper whose formal setup is very close to ours is a recent one by Krasa and Polborn (2014). In their paper they consider that candidates, who are differentiated in social ideology, strategically decide a flat tax rate in order to provide a public good. But, in their model candidates are not differentiated only in the social ideology dimension but also in the public good provision technology. Their analysis is of predominant importance for our work as it was the first one that demonstrated that economic policy does not only depend on the distribution of income but also on the distribution of social preferences. Its aim was more to establish the existence of this effect between social preferences and economic outcomes, rather than to investigate the degree to which this effect creates the described representation gap.

There are a number of other papers which also explore the link between voter diversity and redistribution. Roemer (1998), for example, by analyzing a model with two policy-motivated candidates who strategically decide both a level of taxation and a social policy points to the intuitive idea that when the social issue is significantly more important for the voters than the economic issue, candidates policy platforms will converge to the ideal policy of the median of the social issue dimension. To obtain these results though he introduces and applies a non-conventional equilibrium concept since such two-dimensional models rarely admit a Nash equilibrium in pure strategies. Moreover, Austen-Smith and Wallerstein (2006), Lizzeri and Persico (2001, 2004), Levy (2004) and Fernandez and Levy (2008) also explore how diversity among the voters affects the size of government and the type of redistribution. But, in all these papers preference diversity among voters is considered to be of economic nature (some prefer general interest policies while others prefer specialized transfers) and not in relation to some non-economic issue as in this paper or as in Krasa and Polborn (2014).

In what follows we first present the formal model and the results. Then, we further elaborate on the relevance of our findings in unravelling the representation gap paradox. Finally, we discuss potential applications of our theoretical analysis on policy design and its implications for future empirical research.

2 The Model

We model electoral competition between two candidates, A and B, taking place in a two-dimensional space. We name those two dimensions *non-economic characteristics* and *redistribution* respectively. Following the literature of electoral competition between differentiated candidates (Krasa and Polborn 2010a, 2012, 2014; Dziubinski and Roy 2011) we assume that the two candidates have *fixed* non-economic characteristics, while in the second dimension they *strategically* choose a redistribution scheme to maximize expected vote shares. We moreover consider a unit mass of heterogeneous voters that differ both in terms of their non-economic characteristics and also in terms of the wealth that they possess.

We formally denote the platform of a candidate $J \in \{A, B\}$ by $(s_J, t_J) \in \mathbb{R} \times [0, 1]$ where $s_J \in \mathbb{R}$ is the fixed non-economic characteristic of candidate J and $t_J \in [0, 1]$ is a flat tax rate strategically chosen by the vote share maximizing candidate J (without loss of generality we consider that $s_A \leq s_B$). That is, unlike Cox (1982) where candidates could use practically any redistribution scheme, in our setup candidates are allowed to promise only standard balanced-budget redistribution schemes which belong to the class defined by Meltzer and Richard (1981).

Each voter is characterized by her non-economic characteristic, $x \in \mathbb{R}$, and her income $y \in \{m, M\}$, with $0 \leq m < M$. We denote by $q \in (0, 1)$ the mass of poor voters (voters who have income m) and by $(1 - q)$ the mass of rich voters (voters who have income M). The non-economic characteristics of the poor voters are distributed on $\mathbb{R}$ according to an absolutely continuous distribution function F_p with a strictly positive density denoted by f_p while the non-economic characteristics of the rich voters are distributed on $\mathbb{R}$ according to an absolutely continuous distribution function F_r with a strictly positive density denoted by f_r.[8] Each voter votes for the candidate whose platform, once implemented, offers the highest utility. In case of indifference a voter splits her vote. The distribution of income and the distributions of non-economic characteristics for each of the two groups of voters is common information. The utility of a voter with non-economic characteristic $x \in \mathbb{R}$ and income $y \in \{m, M\}$ when the elected candidate has non-economic characteristic $s \in \mathbb{R}$ and implements a flat tax rate $t \in [0, 1]$ is given by:

$$U_{(x,y)}(s, t) = v(|x - s|) + w(y(1 - t) + T(t))$$

where $T(t)$ is the average revenue raised:

$$T(t) = t[qm + (1 - q)M]$$

and in a Meltzer and Richard (1981) redistribution scheme it coincides with the flat individual redistributive transfer.

We consider that $v : [0, +\infty) \to \mathbb{R}$ is twice differentiable, strictly decreasing, strictly concave everywhere with $v(0) = v'(0) = 0$, $\lim_{x \to +\infty} v'(x) = -\infty$ and $\lim_{x \to +\infty} v''(x) - v''(x - c) \neq \pm\infty$ for a fixed $c \in \mathbb{R}$.[9] That is, a voter has symmetric and single-peaked preferences on the non-economic dimension; the more similar the elected candidate's non-economic characteristic to hers, the better. As far as the

[8] This assumption is made only for simplicity. All our general results hold if the densities of these distributions are strictly positive in a non-degenerate open interval which contains $\frac{s_A + s_B}{2}$.

[9] This is a very mild assumption of only technical nature which simply states that changes in the degree of concavity of v should not be unbounded.

economic dimension is concerned we assume that $w : [0, +\infty) \to \mathbb{R}$ is a twice differentiable, strictly increasing, strictly concave function with $w(0) = 0$.

We consider a voting game with three stages. All information is publicly available and known *ex ante* to all agents. The equilibrium solution concept we employ is Nash equilibrium. The three stages of the game are as follows:

Stage 1: Candidates announce simultaneously their *platforms* (s_A, t_A) and (s_B, t_B) which become common information.

Stage 2: Each voter votes for the candidate whose platform, once implemented, offers the highest utility.

Stage 3: Each candidate $J \in \{A, B\}$ receives her payoffs which coincide with her vote share.

Given that the behavior of voters is trivial in such two-candidate voting games (they vote for the platform they prefer) we focus on the two-player game between the candidates. To do that we first need to investigate voters' optimal behavior when candidates announce platforms (s_A, t_A) and (s_B, t_B).

For any fixed $s_A < s_B$ our assumptions regarding $v(\bullet)$ imply that there exists a single-valued, continuous and twice-differentiable $i_p(t_A, t_B) : [0, 1]^2 \to \mathbb{R}$ which denotes the indifferent poor voter when candidates choose $(t_A, t_B) \in [0, 1]$ and it is such that:[10]

$$v(|i_p(t_A, t_B) - s_A|) + w(m(1 - t_A) + T(t_A)) = v(|i_p(t_A, t_B) - s_B|) + w(m(1 - t_B) + T(t_B))$$

which can be written as:

$$v(|i_p(t_A, t_B) - s_A|) - v(|i_p(t_A, t_B) - s_B|) = w(m(1 - t_B) + T(t_B)) - w(m(1 - t_A) + T(t_A))$$

Obviously, when $t_A = t_B$ monotonicity of $v(\bullet)$ implies that $i_p(t_A, t_B) = \frac{s_A + s_B}{2}$. When $t_A > t_B$ we observe that $i_p(t_A, t_B) > \frac{s_A + s_B}{2}$ and when $t_A < t_B$ we have that $i_p(t_A, t_B) < \frac{s_A + s_B}{2}$.

Equivalently, there exists a single-valued, continuous and twice-differentiable $i_r(t_A, t_B) : [0, 1]^2 \to \mathbb{R}$ which denotes the indifferent rich voter when candidates choose $(t_A, t_B) \in [0, 1]$ and it is such that:

$$v(|i_r(t_A, t_B) - s_A|) + w(M(1 - t_A) + T(t_A)) = v(|i_r(t_A, t_B) - s_B|) + w(M(1 - t_B) + T(t_B))$$

which can be written as:

$$v(|i_r(t_A, t_B) - s_A|) - v(|i_r(t_A, t_B) - s_B|) = w(M(1 - t_B) + T(t_B)) - w(M(1 - t_A) + T(t_A)).$$

[10] See Groseclose (2001) and Aragonès and Xefteris (2012).

When $t_A = t_B$ monotonicity of $v(\bullet)$ implies that $i_r(t_A, t_B) = \frac{s_A+s_B}{2}$. When $t_A > t_B$ we have that $i_r(t_A, t_B) < \frac{s_A+s_B}{2}$ and when $t_A < t_B$ we have that $i_r(t_A, t_B) > \frac{s_A+s_B}{2}$.

That is, for fixed $s_A < s_B$ and candidates choosing $(t_A, t_B) \in [0, 1]$ we have that all the poor voters with non-economic characteristics to the left of $i_p(t_A, t_B)$ vote for A and all poor voters with non-economic characteristics to the right of $i_p(t_A, t_B)$ vote for B. Equivalently, all the rich voters with non-economic characteristics to the left of $i_r(t_A, t_B)$ vote for A and all rich voters with non-economic characteristics to the right of $i_r(t_A, t_B)$ vote for B.

That is, the payoff functions of the two candidates when $s_A < s_B$ are given by:

$$\pi_A(t_A, t_B) = q \times F_p(i_p(t_A, t_B)) + (1 - q) \times F_r(i_r(t_A, t_B))$$

and

$$\pi_B(t_A, t_B) = q \times [1 - F_p(i_p(t_A, t_B))] + (1 - q) \times [1 - F_r(i_r(t_A, t_B))]$$

When $s_A = s_B$ the payoff functions of the two-candidates are:

$$\pi_A(t_A, t_B) = 1 - \pi_B(t_A, t_B) = \begin{cases} q \text{ if } t_A > t_B \\ \frac{1}{2} \text{ if } t_A = t_B \\ (1 - q) \text{ if } t_A < t_B \end{cases}$$

3 Analysis

We start by providing two general formal results which offer a solid foundation to our subsequent, more detailed, analysis.

Proposition 1 *For every $q \in (0, 1)$, every $m \in [0, M)$, every $M > 0$, every admissible F_p and F_r and every $s_A < s_B$ the game admits an equilibrium in mixed strategies.*[11]

This trivially follows form the fact that when $s_A < s_B$ we have that $i_p(t_A, t_B)$ and $i_r(t_A, t_B)$ are continuous in every $(t_A, t_B) \in [0, 1]^2$ and hence, $\pi_A(t_A, t_B)$ and $\pi_B(t_A, t_B)$ are continuous in every $(t_A, t_B) \in [0, 1]^2$. Therefore, the two conditions of Glicksberg (1952) are satisfied (compactness of the strategy space and continuity of the payoff function in own strategies) and an equilibrium in mixed strategies exists. Next we provide the most general formal result of the paper.

Proposition 2 *For every $q \in (0, 1)$, every $m \in [0, M)$, every $M > 0$ and for every admissible F_p and F_r the game admits an equilibrium in pure strategies if candidates are sufficiently differentiated, that is,*

[11] All proofs can be found in the appendix.

if $s_B - s_A$ is sufficiently large. This equilibrium is unique, symmetric, that is, $t_A = t_B = t^*$, and it is such that a) $t^* = 1$ when $f_p(\frac{s_A+s_B}{2}) \geq f_r(\frac{s_A+s_B}{2})$, b) $t^* < 1$ when $f_p(\frac{s_A+s_B}{2}) < f_r(\frac{s_A+s_B}{2})$ and c) $\frac{\Delta t^*}{\Delta q} \geq 0$, $\frac{\Delta t^*}{\Delta f_p(\frac{s_A+s_B}{2})} \geq 0$, $\frac{\Delta t^*}{\Delta f_r(\frac{s_A+s_B}{2})} \leq 0$ and $\frac{\Delta t^*}{\Delta(s_B - s_A)} = 0$ for $\Delta(s_B - s_A)$ sufficiently small.

This proposition states that a unique equilibrium tax rate is guaranteed to exist as long as candidates are sufficiently differentiated. No restrictions on voters' utility functions or on all other parameters of the model were necessary to obtain this result. That is, unlike Lindbeck and Weibull (1987) whose equilibrium existence conditions are very difficult to be satisfied and unlike Krasa and Polborn (2014) who focus only on local equilibria,[12] our framework allows us to establish existence of a unique Nash equilibrium under very general assumptions. Moreover we were able to retrieve important qualitative features of this unique equilibrium tax rate even in the general case: the equilibrium tax rate is increasing in the size of the group of poor voters (group-size effect), it becomes one when the densities of the swing voters of both income groups are the same (income effect) and it is increasing in the ratio of the density of the poor swing voters over the density of rich swing voters (within-group homogeneity effect). Finally, we show that the degree of candidate differentiation in the non-economic issue, despite it being an important determinant of whether an equilibrium exists or not, does not affect equilibrium tax rate once an equilibrium exists.

In the analysis that follows we elaborate on these qualitative features of our equilibrium a) by offering a few more general results and b) by discussing in more detail some representative parametrizations of our general model that will allow us to assess in an analytical way the relative prevalence of each one of those three forces. In the last part of our analysis section we also argue that these qualitative findings are robust to taking into account efficiency costs of taxation.

3.1 Group-size Effect Dominance

As we saw above when candidates are sufficiently differentiated a unique equilibrium exists and it is such that $\frac{\Delta t^*}{\Delta q} \geq 0$. This means that the groups' relative sizes reflect on the equilibrium tax rate. We will now argue that when candidates are similar this group-size effect is further amplified. In particular we will show that it becomes the predominant determinant of the equilibrium tax rate when candidates are not differentiated at all.

Proposition 3 *For every $q \in (0,1) - \{\frac{1}{2}\}$, every $m \in [0, M)$, every $M > 0$, every admissible F_p and F_r and $s_A = s_B$ the game admits a unique equilibrium which is $(t_A, t_B) = (0, 0)$ when $q < \frac{1}{2}$ and*

[12] A local equilibrium, (θ_1, θ_2), of a two-player game in the unit square (each player's strategy set is the segment $[0,1]$) is a Nash equilibrium of the variant of this game in which the only admissible strategy profiles are the ones contained in $(x-\varepsilon, x+\varepsilon) \times (y-\varepsilon, y+\varepsilon)$ for $\varepsilon > 0$ sufficiently small. Hence, such strategy profiles guarantee stability if players are allowed to make only tiny deviations away from a posited strategy and not if players are allowed to move away to any other strategy.

$(t_A, t_B) = (1, 1)$ *when* $q > \frac{1}{2}$. *When* $q = \frac{1}{2}$ *any strategy profile is an equilibrium.*

Naturally, in this case, as candidates are not differentiated in the non-economic dimension the only relevant policy for all voters is redistribution. Then, the resulting utility of income of a poor voter, given tax rate $t \in (0, 1)$ is given by:

$$w\left(m(1-t) + qmt + (1-q)Mt\right) = w\left(m + (1-q)(M-m)t\right) > w(m)$$

whereas, for a rich one it is:

$$w(M(1-t) + qmt + (1-q)Mt) = w(M - q(M-m)t) < w(M)$$

By monotonicity of $w(\bullet)$ it follows that a poor voter strictly prefers a flat tax rate $\hat{t}$ to another flat tax rate $\dot{t}$ if and only if $\hat{t} > \dot{t}$. On the contrary, a rich voter strictly prefers a flat tax rate $\hat{t}$ to another flat tax rate $\dot{t}$ if and only if $\hat{t} < \dot{t}$.[13] These dynamics trivially lead to the above result. Here, the only relevant factors for the determination of the equilibrium tax rate are the relative sizes of the two income groups: the group-size effect is the dominant force.

But how does the importance of this effect varies as a function of the degree of candidates' differentiation? As we have just seen when candidates are not differentiated relative group size is the only thing that matters for the determination of equilibrium tax rate. Moreover by Proposition 2 we know that when candidates are sufficiently differentiated and a pure strategy Nash equilibrium exists it is true that the equilibrium tax rate does not depend on the exact degree of candidate differentiation and that factors other than group-sizes affect equilibrium tax rate. Hence the importance of the group-size effect is constant but not predominant when candidates are sufficiently differentiated and becomes predominant when candidas are not differentiated. This implies that this effect should be increasing in the intermediate cases; as candidates become less differentiated the importance of the group-size effect becomes greater.

3.2 Income Effect Dominance

Proposition 2 also pointed to another feature of the equilibrium tax rate when candidates are sufficiently differentiated; it tends to favor the poor voters. In particular, when the distributions of the non-economic characteristics of the two income groups coincide (that is when $F_p = F_r$)[14] it is the case that $t^* = 1$

[13] This formulation of preferences, within each group, is exactly equivalent to Groseclose's (2007) "one-and-a-half dimensional" preferences where "alternatives are described by two characteristics: their position in a spatial dimension, and their position in a good-bad [high-low tax rate] dimension, over which voters [of the same group] have identical preferences."

[14] The qualitative implications of this subsection's analysis do not limit to the case in which $F_p = F_r$ but directly extend to any case in which $f_p(\frac{s_A+s_B}{2}) \geq f_r(\frac{s_A+s_B}{2})$. In order to conduct though a head-to-head comparison between the group-size effect and the income effect, it is preferable to neutralize all third forces of the model which may influence equilibrium tax rate in one way or another.

independently of what is the exact size of the group of poor voters. The reason behind this equilibrium feature is that, ceteris paribus, poor voters - due to concavity of the component of the utility function which relates to income - are relatively more willing to switch their votes in response to tiny increases in the level of promised redistribution by one of the candidates than rich voters. And since the non-economic characteristics of these two income groups in this case are identical, this income effect becomes dominant.

But how strong is this result? That is, when $F_p = F_r$, is there a $\delta > 0$ such that if $s_B - s_A > \delta$ the equilibrium tax rate is $t^* = 1$ for any $q \in (0, 1)$ (if this is the case, then the income effect finding would prove to be dominant) or is it the case that when $q \to 0$ it must be that $s_B - s_A \to +\infty$ (if this is the case the income effect finding would prove to be weak)? In other words, can we find a degree of candidate differentiation that guarantees that when the non-economic characteristics of both groups are identical, relative group size will not affect equilibrium tax rate and candidates will always pander to the group of poor voters?

In what follows we attempt to provide a positive answer to this last question and hence show that the income effect dominates all others when $F_p = F_r$ and candidates are sufficiently differentiated. To this end we specifically assume that $m = 0$, $M = 1$ and that $v(\xi) = -\xi^2$ and $w(\xi) = \sqrt{\xi}$.[15] For our next result we consider that F_p and F_r are both uniform distributions on $[0, 1]$ and that $s_A \leq \frac{1}{2} \leq s_B = 1 - s_A$.[16]

Proposition 4 *The strategy profile $(t_A, t_B) = (1, 1)$ is the unique Nash equilibrium a) for any $s_A \in [0, \frac{1}{2}]$ when $q > \frac{1}{2}$ and b) for $s_A \in [0, g(q)]$ when $q \leq \frac{1}{2}$, where $g(q) = \frac{-1+2q}{2q} + \frac{1}{2}\sqrt{\frac{1-3q+3q^2-q^3}{q^2}}$. For $q \leq \frac{1}{2}$ and $s_A \in (g(q), \frac{1}{2})$ there is no equilibrium in pure strategies.*

Notice that $g(0) = \frac{1}{4}$ and $g(1/2) = \frac{1}{2}$. That is when $s_A < \frac{1}{4}$ candidates pander to the group of poor voters for any $q \in (0, 1)$, that is, *independently of the size of that group.* As we argued above, the quality of all the above results does not depend on our specific assumptions regarding $v(\bullet)$ and $w(\bullet)$. What is perhaps more important to stress here is that the income effect dominance result qualifies to a case in which there are *more than two income groups*; even for a case in which there is a continuum of income groups. That is, we can relax the assumption that the support of the income distribution consists of only two points, m and M (the choice of $m = 0$ and $M = 1$ is obviously without any loss of generality), and assume instead a continuous distribution of income. For instance, we can construct an example with a uniform distribution of incomes on $[0, 1]$ (as in Krasa and Polborn 2014) considering that the distribution

[15] These assumptions are only made for analytical tractability and they do not endanger loss of generality. Krasa and Polborm (2014), for example, as well as many other papers also consider specific functional forms for $v(\bullet)$ and $w(\bullet)$ that are identical or similar to ours.

[16] Given that a uniform distribution on $[0, 1]$ does not have a strictly positive density at every point in $\mathbb{R}$ an independent proof is formally necessary here. Despite that, we see that none of the qualitative findings of this case stands at any contrast to the general findings of Proposition 2.

of non-economic characteristics of voters of each income level is uniform. In this case one can validate (see Fig. 5) that when candidates are sufficiently differentiated, the strategy profile $(t_A, t_B) = (1, 1)$ is the unique Nash equilibrium of the game.

[Insert Figure 5 about here]

Moreover, by Proposition 2 we know that the game exhibits the same qualitative features for any $F_r = F_p$. Hence, when distribution of non-economic characteristics across income groups is identical and candidates are sufficiently differentiated, the income effect dominance result is really robust. To get a sense of the relative importance of the income effect we present below computational results from the case in which $s_A = -s_B$ and $F_r = F_p = N(0, 1)$.

s_A	$(t_A, t_B) = (1, 1)$ is a N.E.
-2	for any $q \in (0, 1)$
-1	for any $q \in (0, 1)$
-0.08	for $q \in (0.24, 1)$
-0.04	for $q \in (0.48, 1)$

Table 1. Equilibria for $F_r = F_p = N(0, 1)$.

As we see, the sufficiently large degree of candidate differentiation which have been found in Proposition 2 to be necessary for the existence of a pure strategy equilibrium need actually be very small. As we see in Table 1, if the majority of voters is poor ($q > \frac{1}{2}$) then any degree of candidate differentiation above 0.08 is enough to guarantee equilibrium existence.

3.3 Within-group Homogeneity Effect Dominance

We now move to what we consider to be the most important determinant of the equilibrium tax rate; the relationship between the densities of the swing voters of the two groups. By maintaining the parametrization of voters' preferences and income levels that we introduced above and by assuming that F_r and F_p is any admissible pair of distributions we can state the result that follows.

Proposition 5 *If the density of poor swing voters is larger than the density of rich swing voters ($f_p(\frac{s_A+s_B}{2}) \geq f_r(\frac{s_A+s_B}{2})$) then for any $q \in (0, 1)$ and any $s_B - s_A$ sufficiently large we have that $(t_A, t_B) = (1, 1)$ is the unique Nash equilibrium of the game. If the density of the rich swing voters is larger than the density of the poor swing voters ($f_r(\frac{s_A+s_B}{2}) > f_p(\frac{s_A+s_B}{2})$) then for any $q \in (0, 1)$ and any $s_B - s_A$*

sufficiently large we have that the unique Nash equilibrium of the game is $(t_A, t_B) = (t^*, t^*)$ *where* $t^* = \frac{f_p(\frac{s_A+s_B}{2})}{qf_p(\frac{s_A+s_B}{2})^2+(1-q)f_r(\frac{s_A+s_B}{2})^2}$.

Given Proposition 2, this result is quite straightforward. It suggests that not only the size of a group but, most importantly, the density of swing voters of a group can affect the equilibrium outcome in the direction preferred by that group. We moreover observe that this equilibrium tax rate does not depend on the degree of differentiation of the two candidates in the non-economic dimension. As in the case when F_r and F_p were identical (see Proposition 4), here as well by bringing candidates very close to each other we can only end up without any pure strategy equilibrium rather than smoothly affecting the taxation levels in a pure strategy equilibrium.[17]

Notice that the density of a distribution F which belongs to any general family, at its mean (denoted by $f(\frac{s_A+s_B}{2})$ if we assume that the mean of F is at $\frac{s_A+s_B}{2}$) is usually negatively related to its variance. That is, the relationship between $f_p(\frac{s_A+s_B}{2})$ and $f_r(\frac{s_A+s_B}{2})$ can be viewed as a rough, but fair in many cases, approximation of the relationship between the levels of within-group homogeneity of the two income groups.

We further observe that, for $f_r(\frac{s_A+s_B}{2}) > f_p(\frac{s_A+s_B}{2})$, it is true that:

$$\frac{\partial t^*}{\partial f_r(\frac{s_A+s_B}{2})} < 0, \ \frac{\partial t^*}{\partial f_p(\frac{s_A+s_B}{2})} > 0 \text{ and } \frac{\partial t^*}{\partial q} > 0.$$

That is, the more divided the group of poor voters in terms of non-economic characteristics, the smaller the level of the equilibrium tax rate.

Note that to obtain this result we need not assume anything about F_r and F_p - such as they are symmetric about $\frac{s_A+s_B}{2}$ or any other point for that matter - other than being twice differentiable. Hence, our model fully incorporates the case in which one income group can lean towards a specific candidate in the non-economic dimension. For instance, going back to the example presented in the introduction, it can be that poor voters are leaning towards the darker candidate while rich voters are relatively more pale or vice versa. That is, the two dimensions can be correlated.

Moreover, by specifically assuming that $s_A = -s_B = -1$, $F_p = N(0, z)$ and $F_r = N(0, 1)$ we can computationally show that this pure strategy Nash equilibrium exists for any standard deviation $z > 0$. Hence, even if the degree of within-group homogeneity of poor voters becomes very low compared to that of the rich voters (that is, z takes large values), candidate differentiation does not need to be immensely large for our equilibrium to exist.

[17] Note that this is also the case in the price subgames of the popular Hotelling (1929) first-location-then-price game when the locations of the two firms are very close (see d'Aspremont et al. 1979).

Proposition 6 *If $F_p = N(0, z)$ and $F_r = N(0, 1)$ for $z > 0$ and $s_A = -s_B = -1$ then for any $q \in (0, 1)$ we have that a) when the density of poor swing voters is larger than the density of rich swing voters ($z \leq 1$), $(t_A, t_B) = (1, 1)$ is the unique Nash equilibrium of the game and b) when the density of rich swing voters is larger than the density of poor swing voters ($z > 1$), $(t_A, t_B) = (t^*, t^*)$ where $t^* = \frac{1}{q+(1-q)z^2}$ is the unique Nash equilibrium of the game.*

Therefore, when candidates are sufficiently differentiated in the non-economic dimension, the ratio of the densities of the swing voters of the two income groups is more relevant in determining equilibrium redistribution than the ratio of the sizes of these groups. In such cases the within-group homogeneity effect dominates, or in other words becomes stronger than, both the group-size and the income effect: candidates will always pander to the *relatively more homogenous* group, irrespective of its size. In Figure 6 we present equilibrium tax rate t^* as a function of q and z. Observe that, for almost all values of q, $t^*(q, z)$ is strictly decreasing in the degree of relative within-poor heterogeneity captured by z. That is, the larger z is from 1 (poor are relatively less homogenous) the lower $t^*(q, z)$ will be and vice versa.

[Insert Figure 6 about here]

Finally, we would like to stress that the within-group homogeneity effect extends to the case in which there are more than two income groups. By following the proof of Proposition 2, one notices that the equilibrium existence and uniqueness results hold independently of how many income groups are assumed to exist. The complexity of equilibrium characterization, though, increases in several orders of magnitude. Despite this it is still clear that homogeneous income groups in terms of non-economic characteristics exhibit larger influence on the equilibrium tax rate than heterogeneous ones. For example, if we have three income groups (rich, median, poor) such that everybody except the rich were in favor of more redistribution[18] and if rich voters were more homogeneous than each of the other two groups, then again the equilibrium tax rate would reflect the preferences of the rich voters (the equilibrium tax rate would be low).

Within-group homogeneity: Swing voters' density, variance or what?

So far in this paper we use the term within-group homogeneity to describe the level of similarity of preferences of an income group on the non-economic dimension. Such a term naturally brings in ones mind the concepts of variance, entropy, mean deviation and other measures of statistical dispersion. Nevertheless our equilibrium seems not to directly depend on any such measures: the only features of our distributions that seem to influence the equilibrium outcome are the densities at the center, $f_p(\frac{s_A+s_B}{2})$

[18] This occurs when the median income is smaller than the average one (which is true in real world income distributions).

and $f_r(\frac{s_A+s_B}{2})$. It is of course true that for distributions with symmetric density about the center, $\frac{s_A+s_B}{2}$, the densities at the center are usually monotonically related to their variances. In particular when the distributions are of the same family (if, for example, F_r and F_p are both Normal distributions like in Proposition 6) statistical dispersion is one-to-one with the densities that our equilibrium depends on. But is this correspondence enough to justify the use of the term within-group homogeneity? Would it be more accurate if we simply used the term swing voter density instead?

We will try to sketch a negative answer to the latter question and, hence, defend the use of term within-group homogeneity, using a simple example. Consider the case that poor voters are uniformly distributed on $[-1,1]$, that $s_A = -s_B = -1$ and that

$$F_r(x) = \begin{cases} (1-a)(\frac{1}{2}+\frac{x}{200}) & \text{if } -100 \leq x < -a^2 \\ (1-a)(\frac{1}{2}+\frac{x}{200}) + a(\frac{1}{2}+\frac{x}{2a^2}) & \text{if } -a^2 \leq x < a^2 \\ (1-a)(\frac{1}{2}+\frac{x}{200}) + a & \text{if } a^2 \leq x \leq 100 \end{cases} \quad \text{for } a \in (0,10).$$

For very small values of a it is obvious that a) the density of rich swing voters, $f_r(0) = \frac{1-a}{200} + \frac{1}{2a}$, is much larger than the density of poor swing voters, $f_p(0) = \frac{1}{2}$ and that, conversely, b) the variance of the distribution of the rich voters is much larger than the variance of the distribution of poor voters; poor voters seem to be a more homogeneous group than rich ones. Our analysis suggests that, if a pure strategy equilibrium exists, equilibrium tax rate should be equal to $\frac{\frac{1}{4}}{q\frac{1}{4}+(1-q)(\frac{1-a}{200}+\frac{1}{2a})^2}$ which converges to zero when a converges to zero. Nevertheless, by studying $\pi_A(t_A, t_B)$ as a function of t_A for every $t_B \in [0,1]$ considering that a takes arbitrarily small values, we see a) that no pure strategy equilibrium exists, in particular no pair of low tax rates are close enough to being an equilibrium, and b) that the equilibrium mixed strategies should assign a probability mass arbitrarily close to one to tax rates arbitrarily close to one (see Fig. 7).

[Insert Figure 7 about here]

Hence, the relationship between swing voters densities is indeed an important determinant of equilibrium tax rates *if it goes sufficiently hand in hand with the relationship between the variances of the two distributions*. When there is a clash between these two measures, then no clear inferences may be drawn on which of the two measures mostly drives equilibrium tax rates. As we saw it could very well be the case that the relationship between the variances is more important than the relationship between the swing voters' densities. This is because, a) whether a pure strategy equilibrium exists and b) what a mixed equilibrium looks like when no pure one exists, depends on many features of the distributions including their statistical dispersion. Therefore, it becomes clear that the use of term within-group homogeneity -

even if it is admittedly less formal than swing voter density or variance - better captures the multiplicity of conditions which are relevant for the determination of equilibrium tax rate and this is why we use it in this paper.

3.4 Efficiency Costs of Taxation

It is true that redistribution is not an absolutely zero-sum procedure. It can involve efficiency costs; economic agents probably face less incentives to generate income when taxation is high compared to when taxation is low. In this part of the paper we briefly address this issue by incorporating in our model the following assumption: we now consider that the pre-redistribution income of all individuals depends on the applied tax rate. Formally, we assume that the pre-redistribution income of an individual is $y(1-ct)$ where, as before, $y \in \{m, M\}$ and $t \in [0,1]$ and moreover now $c \in [0,1]$ denotes the so-called efficiency costs. When c is large these costs are large and suggest that an increase in the tax rate is a strong counter incentive for income generation while when c is small these counter incentives are weak. The original version of our model obviously corresponds to the case of $c = 0$.

Without entering into unnecessary formalities and preserving the parametrization of the voters' utility function and income levels, we will now argue that introduction of this efficiency costs in our analysis *unambiguously* reinforces our main results: we find that the equilibrium tax rate is decreasing in c. That is, not only it can be the case, as before, that poor voters constitute a majority and the tax rate is very low (representation gap) but now, with the efficiency costs of taxation, the equilibrium tax rate is even lower. This is quite intuitive as introduction of these costs makes poor voters not be so much in favor of redistribution. Even in the case in which $m = 0$, and hence these costs do not affect the pre-redistribution income of poor voters, poor voters realize that if a very high tax rate is implemented rich voters will generate less income. Moreover, rich voters are now hurt from taxes in two ways and hence their reaction to an increasing tax rate is stronger than before. These forces are clear and *in the same direction* and push redistribution towards lower levels.

Using a same line of arguments as the one in the main model one can show that when candidates are sufficiently differentiated there exists a unique equilibrium tax rate, t^{**}, and it is such that

$$t^{**} = 1 \text{ if } c \leq \frac{qf_p(\frac{s_A+s_B}{2}) - qf_r(\frac{s_A+s_B}{2})}{f_r(\frac{s_A+s_B}{2}) + 2q[f_p(\frac{s_A+s_B}{2}) - f_r(\frac{s_A+s_B}{2})]} \text{ and } f_p(\tfrac{s_A+s_B}{2}) \geq f_r(\tfrac{s_A+s_B}{2})$$

and

$$t^{**} \in (0,1) \text{ such that } \frac{q(-1+2ct^{**})f_p(\frac{s_A+s_B}{2})}{\sqrt{(-1+q)t^{**}(-1+ct^{**})}} + \frac{(c+q-2cqt^{**})f_r(\frac{s_A+s_B}{2})}{\sqrt{(-1+ct^{**})(-1+qt^{**})}} = 0 \text{ otherwise.}$$

In Figure 8 we depict these equilibrium tax rates as a function of the efficiency costs of taxation, $c \in [0,1]$ for, $q = 0.8$, $f_p(\frac{s_A+s_B}{2}) = 1$ and $f_r(\frac{s_A+s_B}{2}) \in \{0.5, 0.75, 1, 1.25, 1.5\}$ and in Figure 9 we depict them as a function of the size of the group of poor voters $q \in [0,1]$ for $f_p(\frac{s_A+s_B}{2}) = 1$, $f_r(\frac{s_A+s_B}{2}) = 0.75$ and $c \in \{0.1, 0.2, 0.6\}$.

[Insert Figures 8 and 9 about here]

As we can see in these two figures, when taxation involves efficiency costs *ceteris paribus the rich are taxed even less.* In a sense efficiency costs of taxation are found to be a fourth distinct effect on the determination of equilibrium tax rate which does not upset the existence and direction of the other three ones.

4 Discussion and Policy Implications

The main point of this paper is to relate equilibrium levels of redistribution and taxation with candidate differentiation and voter heterogeneity on non-economic matters (e.g., culture, ethnic identity, religion etc.). Our results show that when candidates are sufficiently differentiated in non-economic dimensions, then a *democratic representation gap*[19] appears: it is possible for a relatively less divided and less diverse minority group to have it their way over taxation and redistribution choices. That is, candidate differentiation is a *sine qua non* condition for observing such a gap. The characterization of this interplay between voter heterogeneity on non-economic dimensions, candidate differentiation and redistribution is the first element that our analysis adds.

In addition, by returning to the parametrization of the model used for the statement of Proposition 6, we can study how the direction (Fig. 10) of this representation gap varies with the degree of relative within-group heterogeneity. While, starting from $z \leq 1$, candidate differentiation seems to initially favor the poor, the situation can be quickly reversed in favor of the rich voters, if polarization spills over from candidates to poor voters: equilibrium tax rate becomes very small. Hence, our findings can help understanding the current patterns of inequality and redistribution in the U.S. where a strong relationship between non-economic polarization and inequality has been documented (McCarty et al. 2006).

[Insert Figure 10 about here]

Overall, by exploring the interaction between inequality, redistribution and issues of identity (e.g., ethnic or religious), our work highlights how increased polarization on non-economic matters can raise

[19] Formally, we define a representation gap as the situation where either the equilibrium tax rate is above $\frac{1}{2}$ and $q < \frac{1}{2}$, or the equilibrium tax rate is below $\frac{1}{2}$ and $q > \frac{1}{2}$.

the relative salience of non-economic over economic issues, thus driving equilibrium redistribution in the direction favored by a homogenous, in terms of non-economic characteristics, minority. Hence, it becomes clear that policies which can exacerbate voter heterogeneity on non-economic matters or can unbundle the two issues will also determine redistributive outcomes to some extent. In that respect, our model allows us to draw some implications on a range of policy issues and assess their likely impact on overall inequality.

In what follows we briefly discuss two such policy applications (the design of fiscal institutions and the role of media) which have recently received renewed attention in the literature, in addition to applying our model to the politics of ethnicity where we draw some implications for future empirical research.

4.1 The Design of Fiscal Institutions

As our analysis has demonstrated, a two-way representation gap is likely to appear once we depart from the benchmark, yet unrealistic, case of minimal candidate differentiation and identical within-group homogeneity. That is, our results suggest that in the real world it is likely to end up with situations where either high inequality and no redistribution, or very high tax rates despite low inequality can both be sustained as political equilibria. Such situations not only are socially undesirable but at the same time are also inefficient as many studies have found that persistent deviations (in any direction) in the level of inequality or taxes are associated with reduced growth (Alesina and Rodrik 1994; Persson and Tabellini 1994; Banerjee and Duflo 2003; Barro and Redlick 2011). Our model offers some policy prescriptions that can mitigate those negative effects.

Since polarization over non-economic matters (such as culture, religion or identity) and candidate differentiation were found to have significant spillover effects on taxes and redistribution, one solution would be to unbundle economic from social issues either via fiscal policy decentralization (e.g., introducing referenda on spending and taxes) or by introducing constitutional constraints (e.g., upper and lower bounds) on tax rates. Both institutional changes could potentially limit the ability of candidates to exploit issues of identity and alter fiscal policy according to their electoral calculations. Finally, much like the case of monetary policy delegation, a similar approach can be pursued as far as fiscal policy is concerned. Since such representation gaps are the outcome of political competition, independent tax authorities and fiscal policy delegation might provide a way out from those suboptimal political equilibria. Thus, our work extends in another direction previous findings (Lockwood 2002) on the inefficiency of fiscal policy centralization.

4.2 Media and Polarization

In addition to the design of fiscal policy institutions, our work can also have implications on the regulation of media. As many studies have found, changes in the media landscape, such as making it more pluralistic or reducing the entry barriers, can have multiple effects on the level of polarization. On the one hand, as Campante and Hojman (2013) find "... if changes in media environment lead to a compression of the distribution of citizens' ideologies, parties have an electoral incentive to move towards the center" thus reducing the degree of candidate differentiation on non-economic matters. This, in turn, might help eliminating the observed representation gap, which currently tends to favor the rich,[20] implying an increase in redistribution. On the other hand, as Knight and Chiang (2011), DellaVigna and Kaplan (2007) and DellaVigna et al. (2014) demonstrate, the effect might go the opposite way: in certain cases exposure to a more diverse media landscape was found to increase social polarization, especially across less wealthy voters.

In both cases a lot seems to depend on the expected effect that changes in the media environment will have on social polarization and party platform differentiation. For example, media ownership by relatively wealthy individuals might allow them to use media as means of deliberately shifting the focus on issues related to identity (ethnic, religious or cultural) in order to avert more extreme redistribution.[21] Therefore, our work points to the fact that institutional changes on the media landscape, such as partisan control (e.g., Knight and Durante 2012) or entry and ownership regulations and policies, such as the promotion of public broadcasting, especially in highly socially polarized environments where inequality is rising will also have implications on redistribution and taxation. Thus, without further exploring those relationships, our work offers some directions for future empirical research by underlining an additional channel that can affect redistributive outcomes and inequality.

4.3 Empirical Implications: An Application to Ethnic Politics

Finally, our results can also be applied to examine the nature of redistribution in environments where ethnic tensions are present. One can easily interpret the non-economic dimension in our model in terms of racial or ethnic identity (as we have already done in the introduction). Then, our formal results imply that we should expect to see relatively less redistribution proposed by candidates when the group of high income voters is ethnically or racially more homogenous (see Fig. 4). In that sense, our model supplements existing empirical literature on the relationship between ethnic heterogeneity and preferences

[20] Evidence from the U.S., the U.K. and other advanced democracies clearly show that poor voters are relatively more heterogenous as far as a variety non-economic and cultural (e.g., ethnicity, identity, religion) issues are concerned.

[21] For instance, Knight and Chiang (2011) demonstrate how media endorsements over specific candidates are more influential amongst the more moderate voters.

for redistribution (e.g., Alesina et al. 2001; Alesina and Glaeser 2004; Dahlberg et al. 2012) in the following two ways.

Firstly, it can provide a theoretical explanation to recent empirical findings (e.g., Alesina et al. 2001; Alesina and Glaeser 2004) which show that societies with greater ethnic heterogeneity exhibit lower levels of redistribution and higher inequality than more homogenous ones. Given that the group of poor voters is usually ethnically more diverse and divided, (ethnically) differentiated candidates have stronger incentives to pander to the economic interests of the more homogenous rich elites. But, at the same time, it also points to a new direction that needs to be explored further: it is *relative within-group* ethnic heterogeneity that might be responsible for those patterns. Yet, we leave those questions open for future empirical research.

On a final note, in line with Esteban and Ray (2008) our work provides an additional insight on the incentives that relatively more homogenous rich elites have to support candidates or parties that campaign along the lines of ethnic or racial identity, in many ethnically divided and polarized societies (e.g., in Africa). This, in turn, raises the question on the ability of those elites to endogenously increase the salience of ethnic cleavages and to shift the axis of political competition from class to identity, thus fusing an ethnic instead of a class conflict which would otherwise result in more extreme redistribution. Hence, our work provides a framework to link economic inequality (and aversion to redistribution) with the salience of issues of race, ethnicity and other forms of identity (e.g., religion and culture).

A natural way to extend our work further would be to examine how issue salience arises endogenously. Assuming that parties or elites had preferences over redistribution and are able to choose the social issue over which they campaign what would their choice be? Should the social issue be correlated or completely orthogonal to the economic one? Our findings suggest that the answer to this question is not straightforward. What seems to matter the most is how divided are (in relative terms) the different income groups over any particular issue. Hence, candidates or elites favoring a specific group might better serve their interests by campaigning on an issue that their most-preferred group is the least "divided." In general, while answering those questions will help us shed some more light in the relationship between ethnic (or cultural) heterogeneity and inequality, their analysis goes beyond the scope of this present study. Thus, we defer them for future empirical and theoretical research.

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APPENDIX: Proofs and Figures

Proof of Proposition 1. Existence of an equilibrium in mixed strategies for any admissible parameters is guaranteed since the players' payoff functions satisfy Glicksberg's (1952) conditions (continuous and bounded payoff functions, compact strategy sets). ■

Proof of Proposition 2. Step 1 (Existence of a pure strategy equilibrium) Given the continuity of $\pi_A(t_A, t_B)$ and $\pi_B(t_A, t_B)$ in every $(t_A, t_B) \in [0,1]^2$ it follows that if we could find conditions which would guarantee that $\pi_A(t_A, t_B)$ is strictly quasiconcave in t_A for every $t_B \in [0,1]$ (equivalently, that $\pi_B(t_A, t_B)$ is strictly quasiconcave in t_B for every $t_A \in [0,1]$) we would establish existence of an equilibrium in pure strategies (see Debreu, 1952). To this end we will characterize conditions which guarantee that $\pi_A(t_A, t_B)$ is strictly concave in t_A for every $t_B \in [0,1]$ and hence that it is strictly quasiconcave in t_A for every $t_B \in [0,1]$. An analysis of the concavity of $\pi_B(t_A, t_B)$ is equivalent and hence omitted.

Notice that when $s_A < s_B$ we have

$\pi_A(t_A, t_B) = q \times F_p(i_p(t_A, t_B)) + (1-q) \times F_r(i_r(t_A, t_B))$

and hence that

$$\frac{\partial^2 \pi_A(t_A,t_B)}{\partial t_A^2} = q \times [\frac{\partial^2 F_p(i_p(t_A,t_B))}{\partial i_p(t_A,t_B)^2}(\frac{\partial i_p(t_A,t_B)}{\partial t_A})^2 + \frac{\partial F_p(i_p(t_A,t_B))}{\partial i_p(t_A,t_B)}\frac{\partial^2 i_p(t_A,t_B)}{\partial t_A^2}] + \\ +(1-q) \times [\frac{\partial^2 F_r(i_r(t_A,t_B))}{\partial i_r(t_A,t_B)^2}(\frac{\partial i_r(t_A,t_B)}{\partial t_A})^2 + \frac{\partial F_r(i_r(t_A,t_B))}{\partial i_r(t_A,t_B)}\frac{\partial^2 i_r(t_A,t_B)}{\partial t_A^2}].$$

We will argue that when $s_B - s_A$ is sufficiently large, the expression $\frac{\partial^2 F_p(i_p(t_A,t_B))}{\partial i_p(t_A,t_B)^2}(\frac{\partial i_p(t_A,t_B)}{\partial t_A})^2 + \frac{\partial F_p(i_p(t_A,t_B))}{\partial i_p(t_A,t_B)}\frac{\partial^2 i_p(t_A,t_B)}{\partial t_A^2}$ is strictly negative for any $(t_A, t_B) \in [0,1]^2$.

Implicit differentiation of

$$v(|i_p(t_A, t_B) - s_A|) + w(m(1-t_A) + T(t_A)) = v(|i_p(t_A, t_B) - s_B|) + w(m(1-t_B) + T(t_B))$$

with respect to t_A yields

$$\frac{\partial i_p(t_A,t_B)}{\partial t_A} = \frac{(m-M)(-1+q) \times w\prime(m+(m-M)(-1+q)t_A)}{-Sgn(i_p(t_A,t_B)-s_A) \times v\prime(|i_p(t_A,t_B)-s_A|) + Sgn(i_p(t_A,t_B)-s_B) \times v\prime(|i_p(t_A,t_B)-s_B|)}$$

which is always positive because the numerator is positive and a) if $t_A > t_B$ we have that $i_p(t_A, t_B) > \frac{s_A+s_B}{2} > s_A \rightarrow Sgn(i_p(t_A, t_B) - s_A) = 1$ and $|i_p(t_A, t_B) - s_A| > |i_p(t_A, t_B) - s_B|$ and hence by strict concavity of $v(\bullet)$ it follows that the denominator is positive independently of the value of $Sgn(i_p(t_A, t_B) - s_B)$, b) if $t_A = t_B$ we have that $i_p(t_A, t_B) = \frac{s_A+s_B}{2} \rightarrow Sgn(i_p(t_A, t_B) - s_A) = 1$, $Sgn(i_p(t_A, t_B) - s_B) = -1$ and $|i_p(t_A, t_B) - s_A| = |i_p(t_A, t_B) - s_B|$ and hence the denominator is positive and c) if $t_A < t_B$ we have that $i_p(t_A, t_B) < \frac{s_A+s_B}{2} < s_B \rightarrow Sgn(i_p(t_A, t_B) - s_B) = -1$ and $|i_p(t_A, t_B) - s_A| < |i_p(t_A, t_B) - s_B|$ and hence by strict concavity of $v(\bullet)$ it follows that the denominator is positive independently of the value of $Sgn(i_p(t_A,t_B)-s_A)$.

Hence, for every $(t_A,t_B)\in[0,1]^2$ it is true that $\frac{\partial i_p(t_A,t_B)}{\partial t_A}>0$. In a similar manner one can show that for every $(t_A,t_B)\in[0,1]^2$ it is true that $\frac{\partial i_p(t_A,t_B)}{\partial t_B}<0$. That is, it is true that $i_p(t_A,t_B)$ takes its maximal value at $(1,0)$ and its minimal value at $(0,1)$. We write these maximal and minimal values as a function of the pair (s_A,s_B); that is we consider that $i_p^{\max}(s_A,s_B)=i_p(1,0)$ and $i_p^{\min}(s_A,s_B)=i_p(0,1)$. Obviously, $i_p^{\max}(s_A,s_B)>\frac{s_A+s_B}{2}>i_p^{\min}(s_A,s_B)$.

Given that $w(\bullet)$ is continuous, strictly increasing and concave it follows that there exists $\theta>0$ such that if $s_B-s_A>\theta$ it is be the case that $i_p(t_A,t_B)\in(s_A,s_B)$ for every $(t_A,t_B)\in[0,1]^2$. One can actually show that $\theta=v^{-1}(-w(qm+(1-q)M)+w(m))$ by considering that candidate A chooses $t_A=0$, that candidate B chooses $t_B=1$ and that s_A and s_B are such that $i_p(t_A,t_B)=s_A$. Hence, assuming that a) s_B-s_A is sufficiently large and b) without loss of generality that $s_B=-s_A=s>0$, we implicitly differentiate

$$v(i_p^{\max}(-s,s)+s)+w(m(1-1)+T(1))=v(s-i_p^{\max}(-s,s))+w(m(1-0)+T(0))$$

with respect to s and we get

$$\frac{\partial i_p^{\max}(-s,s)}{\partial s}=\frac{v\prime(s-i_p^{\max}(-s,s))-v\prime(s+i_p^{\max}(-s,s))}{v\prime(s-i_p^{\max}(-s,s))+v\prime(s+i_p^{\max}(-s,s))}<0.$$

In a similar manner we can show that $\frac{\partial i_p^{\min}(-s,s)}{\partial s}>0$.

These two derivatives help us see that by moving simultaneously s_A and s_B away from a fixed point, the segment from which $i_p(t_A,t_B)$ takes its values shrinks around this fixed point.

Since when s_B-s_A is sufficiently large it is the case that $i_p(t_A,t_B)\in(s_A,s_B)$ we have

$$\frac{\partial i_p(t_A,t_B)}{\partial t_A}=\frac{(m-M)(-1+q)\times w\prime(m+(m-M)(-1+q)t_A)}{-v\prime(i_p(t_A,t_B)-s_A)-v\prime(s_B-i_p(t_A,t_B))}$$

and by further differentiating with respect to t_A we get

$$\frac{\partial^2 i_p(t_A,t_B)}{\partial t_A^2}=\frac{-(m-M)^2(-1+q)^2 w\prime\prime(m+(m-M)(-1+q)t_A)+(v\prime\prime(s_B-i_p(t_A,t_B))-v\prime\prime(-s_A+i_p(t_A,t_B)))(\frac{\partial i_p(t_A,t_B)}{\partial t_A})^2}{v\prime(s_B-i_p(t_A,t_B))+v\prime(-s_A+i_p(t_A,t_B))}.$$

Therefore,

$$\frac{\partial^2 F_p(i_p(t_A,t_B))}{\partial i_p(t_A,t_B)^2}(\frac{\partial i_p(t_A,t_B)}{\partial t_A})^2+\frac{\partial F_p(i_p(t_A,t_B))}{\partial i_p(t_A,t_B)}\frac{\partial^2 i_p(t_A,t_B)}{\partial t_A^2}=$$
$$=\frac{\partial^2 F_p(i_p(t_A,t_B))}{\partial i_p(t_A,t_B)^2}(\frac{(m-M)(-1+q)\times w\prime(m+(m-M)(-1+q)t_A)}{-v\prime(i_p(t_A,t_B)-s_A)-v\prime(s_B-i_p(t_A,t_B))})^2+$$
$$+\frac{\partial F_p(i_p(t_A,t_B))}{\partial i_p(t_A,t_B)}\frac{-(m-M)^2(-1+q)^2 w\prime\prime(m+(m-M)(-1+q)t_A)+(v\prime\prime(s_B-i_p(t_A,t_B))-v\prime\prime(-s_A+i_p(t_A,t_B)))(\frac{\partial i_p(t_A,t_B)}{\partial t_A})^2}{v\prime(s_B-i_p(t_A,t_B))+v\prime(-s_A+i_p(t_A,t_B))}=$$

$$= \frac{1}{v\prime(s_B - i_p(t_A,t_B)) + v\prime(-s_A + i_p(t_A,t_B))}\Big[\frac{\partial^2 F_p(i_p(t_A,t_B))}{\partial i_p(t_A,t_B)^2}\frac{[(m-M)(-1+q)\times w\prime(m+(m-M)(-1+q)t_A)]^2}{v\prime(i_p(t_A,t_B)-s_A)+v\prime(s_B-i_p(t_A,t_B))} +$$
$$+ \frac{\partial F_p(i_p(t_A,t_B))}{\partial i_p(t_A,t_B)}[-(m-M)^2(-1+q)^2 w\prime\prime(m+(m-M)(-1+q)t_A) +$$
$$+ (v\prime\prime(s_B - i_p(t_A,t_B)) - v\prime\prime(-s_A + i_p(t_A,t_B)))\,(\frac{\partial i_p(t_A,t_B)}{\partial t_A})^2]\Big].$$

We first notice that $\frac{1}{v\prime(s_B - i_p(t_A,t_B)) + v\prime(-s_A + i_p(t_A,t_B))} < 0$ for every $(t_A, t_B) \in [0,1]^2$ when $s_B - s_A$ sufficiently large. So the whole expression above is strictly negative if and only if the expression

$$\Big[\frac{\partial^2 F_p(i_p(t_A,t_B))}{\partial i_p(t_A,t_B)^2}\frac{[(m-M)(-1+q)\times w\prime(m+(m-M)(-1+q)t_A)]^2}{v\prime(i_p(t_A,t_B)-s_A)+v\prime(s_B-i_p(t_A,t_B))} +$$
$$+ \frac{\partial F_p(i_p(t_A,t_B))}{\partial i_p(t_A,t_B)}[-(m-M)^2(-1+q)^2 w\prime\prime(m+(m-M)(-1+q)t_A) +$$
$$+ (v\prime\prime(s_B - i_p(t_A,t_B)) - v\prime\prime(-s_A + i_p(t_A,t_B)))\,(\frac{\partial i_p(t_A,t_B)}{\partial t_A})^2]\Big]$$

is strictly positive.

Considering that $s_A = \frac{s_A+s_B}{2} - c$ and $s_A = \frac{s_A+s_B}{2} + c$ we further observe that

$$\lim_{c\to+\infty} \frac{[(m-M)(-1+q)\times w\prime(m+(m-M)(-1+q)t_A)]^2}{v\prime(i_p(t_A,t_B)-s_A)+v\prime(s_B-i_p(t_A,t_B))} = 0,$$

because as we demonstrated when $s_B - s_A$ increases, $i_p(t_A, t_B)$ remains close to $\frac{s_A+s_B}{2}$ for every $(t_A, t_B) \in [0,1]^2$ and hence both $v\prime(i_p(t_A,t_B) - s_A)$ and $v\prime(s_B - i_p(t_A,t_B))$ converge to minus infinity,

$$\lim_{c\to+\infty} \frac{\partial i_p(t_A,t_B)}{\partial t_A} = \lim_{c\to+\infty} \frac{(m-M)(-1+q)\times w\prime(m+(m-M)(-1+q)t_A)}{-v\prime(i_p(t_A,t_B)-s_A)-v\prime(s_B-i_p(t_A,t_B))} = 0,$$

for the same reason, and therefore when $c \to +\infty$ the expression under study converges to

$$\frac{\partial F_p(i_p(t_A,t_B))}{\partial i_p(t_A,t_B)}[-(m-M)^2(-1+q)^2 w\prime\prime(m+(m-M)(-1+q)t_A)] > 0$$

which is true for every admissible parameter values.

That is, when $s_B - s_A$ is sufficiently large, $\frac{\partial^2 F_p(i_p(t_A,t_B))}{\partial i_p(t_A,t_B)^2}(\frac{\partial i_p(t_A,t_B)}{\partial t_A})^2 + \frac{\partial F_p(i_p(t_A,t_B))}{\partial i_p(t_A,t_B)}\frac{\partial^2 i_p(t_A,t_B)}{\partial t_A^2} < 0$ for every $(t_A, t_B) \in [0,1]^2$. Similar arguments guarantee that that when $s_B - s_A$ is sufficiently large, the expression $\frac{\partial^2 F_r(i_r(t_A,t_B))}{\partial i_r(t_A,t_B)^2}(\frac{\partial i_r(t_A,t_B)}{\partial t_A})^2 + \frac{\partial F_r(i_r(t_A,t_B))}{\partial i_r(t_A,t_B)}\frac{\partial^2 i_r(t_A,t_B)}{\partial t_A^2} < 0$ for every $(t_A, t_B) \in [0,1]^2$ too. Hence, when $s_B - s_A$ is sufficiently large $\pi_A(t_A, t_B)$ is strictly concave in t_A for every $t_B \in [0,1]$ (equivalently, $\pi_B(t_A, t_B)$ is strictly concave in t_B for every $t_A \in [0,1]$) and an equilibrium in pure strategies is guaranteed to exist.

Step 2 (Uniqueness of the equilibrium) Notice that the game is a constant-sum game and consider that (t_A, t_B) and $(\hat{t}_A, \hat{t}_B)$ are both equilibria of the game. These two strategy profiles to be distinct it should either be the case that $t_A \neq \hat{t}_A$ or that $t_B \neq \hat{t}_B$ - or both. Assume without loss of generality that $t_A \neq \hat{t}_A$. Since the game is constant-sum it follows that the equilibrium set is convex and hence that $(\hat{t}_A, t_B)$ is an equilibrium of the game too. But for $s_B - s_A$ sufficiently large we have seen that $\pi_A(t_A, t_B)$ is strictly concave in t_A for every $t_B \in [0,1]$ and it is thus impossible that both t_A and $\hat{t}_A$ are best responses of A to B playing t_B. That is, when $s_B - s_A$ sufficiently large an equilibrium in pure strategies exists and it is unique.

Step 3 (Characterization of the unique equilibrium) We take the derivative of the payoff function of player A with respect to t_A,

$$\frac{\partial \pi_A(t_A,t_B)}{\partial t_A} = q \times \frac{\partial F_p(i_p(t_A,t_B))}{\partial i_p(t_A,t_B)} \frac{\partial i_p(t_A,t_B)}{\partial t_A} + (1-q) \times \frac{\partial F_r(i_r(t_A,t_B))}{\partial i_r(t_A,t_B)} \frac{\partial i_r(t_A,t_B)}{\partial t_A},$$

and we observe that for $s_B - s_A$ sufficiently large it may be written as

$$\begin{gathered}\frac{\partial \pi_A(t_A,t_B)}{\partial t_A} = q \times \frac{\partial F_p(i_p(t_A,t_B))}{\partial i_p(t_A,t_B)} \frac{(m-M)(-1+q)\times w\prime(m+(m-M)(-1+q)t_A)}{-v\prime(i_p(t_A,t_B)-s_A)-v\prime(s_B-i_p(t_A,t_B))} + \\ +(1-q) \times \frac{\partial F_r(i_r(t_A,t_B))}{\partial i_r(t_A,t_B)} \frac{(m-M)q\times w\prime(M+(m-M)qt_A)}{-v\prime(i_r(t_A,t_B)-s_A)-v\prime(s_B-i_r(t_A,t_B))}.\end{gathered}$$

Then,

$$\begin{gathered}\frac{\partial \pi_A(t_A,t_B)}{\partial t_A}|_{t_A=t_B} = q \times f_p(\tfrac{s_A+s_B}{2}) \frac{(m-M)(-1+q)\times w\prime(m+(m-M)(-1+q)t_A)}{-2v\prime(\frac{s_B-s_A}{2})} + \\ +(1-q) \times f_r(\tfrac{s_A+s_B}{2}) \frac{(m-M)q\times w\prime(M+(m-M)qt_A)}{-2v\prime(\frac{s_B-s_A}{2})} = \\ = \frac{(m-M)q(1-q)}{-2v\prime(\frac{s_B-s_A}{2})}[f_r(\tfrac{s_A+s_B}{2})w\prime(M+(m-M)qt_A) - f_p(\tfrac{s_A+s_B}{2})w\prime(m+(m-M)(-1+q)t_A)].\end{gathered}$$

Notice that

$$\frac{\partial \pi_A(t_A,t_B)}{\partial t_A}|_{t_A=t_B=1} = \frac{(m-M)q(1-q)}{-2v\prime(\frac{s_B-s_A}{2})} w\prime(M+(m-M)q)[f_r(\tfrac{s_A+s_B}{2}) - f_p(\tfrac{s_A+s_B}{2})].$$

Hence, $f_r(\frac{s_A+s_B}{2}) \leq f_p(\frac{s_A+s_B}{2}) \rightarrow \frac{\partial \pi_A(t_A,t_B)}{\partial t_A}|_{t_A=t_B=1} \geq 0$ (one can also show that $f_r(\frac{s_A+s_B}{2}) \leq f_p(\frac{s_A+s_B}{2}) \rightarrow \frac{\partial \pi_B(t_A,t_B)}{\partial t_B}|_{t_A=t_B=1} \geq 0$). This, along with strict concavity of the players' payoff functions in own strategies, suggests that $(1,1)$ is the unique equilibrium.

Similarly, $f_r(\frac{s_A+s_B}{2})w\prime(M) \geq f_p(\frac{s_A+s_B}{2})w\prime(m) \rightarrow \frac{\partial \pi_A(t_A,t_B)}{\partial t_A}|_{t_A=t_B=0} \leq 0$ (one can also show that $f_r(\frac{s_A+s_B}{2})w\prime(M) \geq f_p(\frac{s_A+s_B}{2})w\prime(m) \rightarrow \frac{\partial \pi_B(t_A,t_B)}{\partial t_B}|_{t_A=t_B=0} \leq 0$). As above, this, along with strict concavity of the players' payoff functions in own strategies, suggests that $(0,0)$ is the unique equilibrium.

If none of these two inequalities hold, we observe that there exists a unique $t^* \in (0,1)$ such that $\frac{\partial \pi_A(t_A,t_B)}{\partial t_A}|_{t_A=t_B=t^*} = 0$ and $\frac{\partial \pi_B(t_A,t_B)}{\partial t_B}|_{t_A=t_B=t^*} = 0$. This is because, $w\prime(M+(m-M)qt)$ is positive and increasing in t while $w\prime(m+(m-M)(-1+q)t)$ is positive and decreasing in t. This $t^* \in (0,1)$ should be such that $f_r(\frac{s_A+s_B}{2})w\prime(M+(m-M)qt^*) = f_p(\frac{s_A+s_B}{2})w\prime(m+(m-M)(-1+q)t^*)$.

Observing that t^* is actually a function of the parameters of the model, implicit differentiation of the latter expression gives us $\frac{\partial t^*}{\partial q} > 0$, $\frac{\partial t^*}{\partial f_p(\frac{s_A+s_B}{2})} > 0$, $\frac{\partial t^*}{\partial f_r(\frac{s_A+s_B}{2})} < 0$. Finally, we observe that the equilibrium tax rate does not depend on the exact values of s_A and s_B. Hence it is true that as long as the degree of candidate differentiation $s_B - s_A$ remains large enough for our equilibrium to exists, variations in that degree do not affect equilibrium tax rate; $\frac{\Delta t^*}{\Delta(s_B - s_A)} = 0$ for $\Delta(s_B - s_A)$ sufficiently small. ■

Proof of Proposition 3. When $s_A = s_B$ a voter with income y votes for A when $w(y(1-t_A) + T(t_A)) > w(y(1-t_B) + T(t_B))$, for B when $w(y(1-t_B) + T(t_B)) > w(y(1-t_A) + T(t_A))$ and splits her vote between the two candidates if $w(y(1-t_A) + T(t_A)) = w(y(1-t_B) + T(t_B))$. By the fact that $w(\bullet)$ is strictly increasing it follows that if $y = m$ we have

$$\begin{aligned} w(m(1-t_A) + T(t_A)) > w(m(1-t_B) + T(t_B)) &\Longleftrightarrow t_A > t_B \\ w(m(1-t_B) + T(t_B)) > w(m(1-t_A) + T(t_A)) &\Longleftrightarrow t_B > t_A \\ w(m(1-t_A) + T(t_A)) = w(m(1-t_B) + T(t_B)) &\Longleftrightarrow t_A = t_B \end{aligned}$$

while if $y = M$ we have

$$\begin{aligned} w(M(1-t_A) + T(t_A)) > w(M(1-t_B) + T(t_B)) &\Longleftrightarrow t_A < t_B \\ w(M(1-t_B) + T(t_B)) > w(M(1-t_A) + T(t_A)) &\Longleftrightarrow t_B < t_A \\ w(M(1-t_A) + T(t_A)) = w(M(1-t_B) + T(t_B)) &\Longleftrightarrow t_A = t_B. \end{aligned}$$

That is all poor voters vote for the candidate who offers the highest tax rate and all rich voters vote for the candidate who offers the lowest tax rate. Hence if $q > \frac{1}{2}$ both candidates offer in equilibrium the highest possible tax rate, when $q < \frac{1}{2}$ both candidates offer in equilibrium the lowest possible tax rate and when $q = \frac{1}{2}$ any strategy profile is an equilibrium.

Proof of Proposition 4. To show why this proposition is true we start by studying how $i_p(t_A, t_B)$ and $i_r(t_A, t_B)$ behave when the proposed tax rates change. Here one can show that:

$$i_p(t_A, t_B) = \tfrac{1}{2} + \tfrac{-\sqrt{(1-q)t_A} + \sqrt{(1-q)t_B}}{2(-1+2s_A)}$$

and that

$$i_r(t_A, t_B) = \tfrac{1}{2} + \tfrac{-\sqrt{1-qt_A} + \sqrt{1-qt_B}}{2(-1+2s_A)}.$$

In the special case in which $t_B = 1$ we have that $i_p(t_A, 1) \in [0, 1]$ if and only if:

$$t_A \geq t_p = \max\left\{0,\ \tfrac{-2+q+4s_A-4s_A^2}{-1+q} - 2\sqrt{-\tfrac{1-4s_A+4s_A^2}{-1+q}}\right\}$$

and $i_r(t_A, 1) \in [0, 1]$ if and only if:

$$t_A \geq t_r = \max\left\{0,\ \tfrac{-1+q+4s_A-4s_A^2}{q} - 2\sqrt{-\tfrac{-1+q+4s_A-4qs_A-4s_A^2+4qs_A^2}{q^2}}\right\}.$$

We observe that for $q \leq \frac{1}{2}$ it is always the case that $t_r \leq t_p$.

This suggests that the payoff function of candidate A when candidate B is expected to announce a tax rate $t_B = 1$ is given by:

$$\pi_A(t_A, 1) = \begin{cases} (1-q) \text{ if } t_A < t_r \\ (1-q) \times (\frac{1}{2} + \frac{-\sqrt{1-qt_A}+\sqrt{1-q}}{2(-1+2s_A)}) \text{ if } t_r \leq t_A < t_p \\ (1-q) \times (\frac{1}{2} + \frac{-\sqrt{1-qt_A}+\sqrt{1-q}}{2(-1+2s_A)}) + q \times (\frac{1}{2} + \frac{-\sqrt{(1-q)t_A}+\sqrt{1-q}}{2(-1+2s_A)}) \text{ if } t_A \geq t_p \end{cases}$$

We observe that $\pi_A(t_A, 1)$ is continuous and that $\frac{\partial \pi_A(t_A,1)}{\partial t_A} < 0$ for $t_r < t_A < t_p$ and that $\frac{\partial \pi_A(t_A,1)}{\partial t_A} > 0$ for $t_A > t_p$; candidates for maxima are $t_A \in [0, t_r]$ and $t_A = 1$. We compute $\pi_A(0,1)$ and $\pi_A(1,1)$ and by routine algebra we establish that $\pi_A(0,1) < \pi_A(1,1)$ if and only if $s_A < \frac{-1+2q}{2q} + \frac{1}{2}\sqrt{\frac{1-3q+3q^2-q^3}{q^2}}$. We can do the same process for player B and show that $\pi_B(1, t_B) < \pi_B(1,1)$ for any $t_B \in [0,1)$ if and only if $s_A < \frac{-1+2q}{2q} + \frac{1}{2}\sqrt{\frac{1-3q+3q^2-q^3}{q^2}}$. This proves why the strategy profile $(t_A, t_B) = (1,1)$ is a Nash equilibrium when $s_A < \frac{-1+2q}{2q} + \frac{1}{2}\sqrt{\frac{1-3q+3q^2-q^3}{q^2}}$ and $q \leq \frac{1}{2}$.

When $q > \frac{1}{2}$ it is not always true that $t_r \leq t_p$. If s_A and q are such that $t_r \leq t_p$ then the payoff function of A when B is expected to play $t_B = 1$ is the same as before. We compute again $\pi_A(0,1)$ and $\pi_A(1,1)$ and by routine algebra we establish that $\pi_A(0,1) < \pi_A(1,1)$ for any $s_A \in [0, \frac{1}{2})$. As before this is enough to establish that $(t_A, t_B) = (1,1)$ is a Nash equilibrium. When s_A and q are such that $t_r > t_p$ then the payoff function of A when B is expected to play $t_B = 1$ becomes:

$$\pi_A(t_A, 1) = \begin{cases} (1-q) \text{ if } t_A < t_p \\ (1-q) + q \times (\frac{1}{2} + \frac{-\sqrt{(1-q)t_A}+\sqrt{1-q}}{2(-1+2s_A)}) \text{ if } t_p \leq t_A < t_r \\ (1-q) \times (\frac{1}{2} + \frac{-\sqrt{1-qt_A}+\sqrt{1-q}}{2(-1+2s_A)}) + q \times (\frac{1}{2} + \frac{-\sqrt{(1-q)t_A}+\sqrt{(1-q)}}{2(-1+2s_A)}) \text{ if } t_A \geq t_r \end{cases}$$

We observe that $\pi_A(t_A, 1)$ is continuous and that $\frac{\partial \pi_A(t_A,1)}{\partial t_A} > 0$ for $t_p \leq t_A < t_r$ and that $\frac{\partial \pi_A(t_A,1)}{\partial t_A} > 0$ for $t_A > t_r$; the unique candidate for maximum is $t_A = 1$. Hence, even if $t_r > t_p$, $(t_A, t_B) = (1,1)$ is a Nash equilibrium of the game. Notice that when $q > \frac{1}{2}$ we have that $\pi_A(0,1) < \pi_A(1,1)$ for any $s_A < \frac{1}{2}$.

To show that this is the unique equilibrium of the game, notice that our game is a zero-sum game. That is, every equilibrium strategy is also a minimaximizer strategy. But we have proved that for the cases (i) $q \leq \frac{1}{2}$ and $s_A < \frac{-1+2q}{2q} + \frac{1}{2}\sqrt{\frac{1-3q+3q^2-q^3}{q^2}}$ and (ii) $q > \frac{1}{2}$ and $s_A < \frac{1}{2}$ the payoff function $\pi_A(t_A, 1)$ (and $\pi_B(1, t_B)$) has a unique maximum at $t_A = 1$ ($t_B = 1$). That is, no other minimaximizer strategy exists for any of our players and hence no other, pure or mixed, equilibrium exists. The same holds true for the corner case $q \leq \frac{1}{2}$ and $s_A = \frac{-1+2q}{2q} + \frac{1}{2}\sqrt{\frac{1-3q+3q^2-q^3}{q^2}}$. But, an extra argument is needed here in order for the uniqueness argument to be complete.

What is left to be proven is that for the rest of the parameter values, that is for $q \leq \frac{1}{2}$ and $s_A \in (g(q), \frac{1}{2})$ there is no equilibrium in pure strategies. Notice that when $f_r(x) = f_r(s_A + s_B - x)$ and $f_p(x) = f_p(s_A + s_B - x)$ (when the density of each of the two distributions is symmetric about $\frac{s_A+s_B}{2}$) we have that the game is symmetric in game-theoretic terms. That is, $\pi_A(\dot{t}, \ddot{t}) = \pi_B(\ddot{t}, \dot{t})$ for any $(\dot{t}, \ddot{t}) \in [0,1]^2$. This is obviously the case here where both F_r and F_p are assumed to be uniform in $[0,1]$. In a symmetric zero-sum game it is true that if an equilibrium in pure strategies exists then a symmetric equilibrium in pure strategies exists too. For $q \leq \frac{1}{2}$ and $s_A \in (g(q), \frac{1}{2})$ we already know that $\pi_A(0,1) > \pi_A(1,1)$ and thus it follows that $(t_A, t_B) = (1,1)$ is not a Nash equilibrium of the game. But can it be that $(t_A, t_B) = (\hat{t}, \hat{t})$ is an equilibrium for $\hat{t} < 1$? Since $s_A = 1 - s_B$ it should be true that in any profile $(t_A, t_B) = (\hat{t}, \hat{t})$ it must hold that $i_p(\hat{t}, \hat{t}) = \frac{1}{2}$ and that $i_r(\hat{t}, \hat{t}) = \frac{1}{2}$ and that for $(t_A, t_B) \in (\hat{t} - \varepsilon, \hat{t} + \varepsilon)$ for $\varepsilon > 0$ sufficiently small it should be the case that:

$$\pi_A(t_A, t_B) = (1-q) \times \left(\frac{1}{2} + \frac{-\sqrt{1-qt_A}+\sqrt{1-qt_B}}{2(-1+2s_A)}\right) + q \times \left(\frac{1}{2} + \frac{-\sqrt{(1-q)t_A}+\sqrt{(1-q)t_B}}{2(-1+2s_A)}\right).$$

We notice that for any $\hat{t} < 1$ it is true that $\frac{\partial \pi_A(t_A,t_B)}{\partial t_A}|_{t_A=t_B=\hat{t}} > 0$ for any $q \in (0,1)$. Hence, no pure strategy equilibrium can exist for any $s_A \in [0, \frac{1}{2})$ and any $q \in (0,1)$ apart from the strategy profile $(t_A, t_B) = (1,1)$. But as we argued for $q \leq \frac{1}{2}$ and $s_A \in (g(q), \frac{1}{2})$ it is never the case that $(t_A, t_B) = (1,1)$ is an equilibrium. That is, for these parameter values the game does not admit a Nash equilibrium in pure strategies. This completes the proof. ■

Proof of Proposition 5. The first part of this proposition is a direct corollary of Proposition 2. When $f_r(\frac{s_A+s_B}{2}) > f_p(\frac{s_A+s_B}{2})$ we know from Proposition 2 and its proof that a Nash equilibrium may exist only where $\frac{\partial \pi_A(t_A,t_B)}{\partial t_A}|_{t_A=t_B} = 0$. By routine algebra we find that (t_A, t_B) such that $t_A = t_B$ can satisfy this condition if and only if $t_A = t_B = t^* = \frac{f_p(\frac{s_A+s_B}{2})^2}{qf_p(\frac{s_A+s_B}{2})^2+(1-q)f_r(\frac{s_A+s_B}{2})^2}$ which is strictly larger than zero and strictly smaller than one for any $f_r(\frac{s_A+s_B}{2}) > f_p(\frac{s_A+s_B}{2})$ and any $q \in (0,1)$. And because we know that when $s_B - s_A$ is large enough a unique equilibrium exists, the identified symmetric strategy profile must be the unique equilibrium of the game. ■

Proof of Proposition 6. To prove this proposition we complement formal arguments with computational results. First notice that when $F_p = N(0,z)$ and $F_r = N(0,1)$, $f_p(0) \geq f_r(0)$ is equivalent to $z \leq 1$. Now, for any value of z we have that $\pi_A(1,1) = \frac{1}{2}$ (due to symmetry of the game) and that $\pi_A(t_A, 1)$ is continuous. In particular for any pair $(q,z) \in (0,1) \times (0,1]$ we have that $\frac{\partial^2 \pi_A(t_A,t_B)}{\partial t_A^2}|_{t_A=t_B=1} = \frac{q(-1+q-qz)}{16\sqrt{2}\sqrt{\pi-\pi qz}} < 0$ and for any $t_A < 1$ that $\pi_A(t_A, 1) < \frac{1}{2}$ (see Fig. 11). Hence, when $(q,z) \in (0,1) \times (0,1]$ it is the case that $\pi_A(t_A, 1)$ admits a unique global maximum at $t_A = 1$. Therefore, the symmetric and zero-sum nature of the game ensures that for $z \leq 1$ the strategy profile $(t_A, t_B) = (1, 1)$ is the unique Nash equilibrium of the game.

[Insert Figure 11 about here]

When $z > 1$, that is when $f_r(0) > f_p(0)$, it is the case that $\frac{\partial \pi_A(t_A,t_B)}{\partial t_A}|_{t_A=t_B=1} < 0$ and that $\frac{\partial \pi_A(t_A,t_B)}{\partial t_A}|_{t_A=t_B=0} > 0$. It is moreover true that there exists a unique $\mathring{t}_A(q, z) \in [0, 1]$ which is such that $\frac{\partial \pi_A(t_A,\frac{1}{q+(1-q)z^2})}{\partial t_A}|_{t_A=\mathring{t}_A(q,z)} = 0$ (see Fig. 12). Finally, by routine algebra we have that $\frac{\partial \pi_A(t_A,\frac{1}{q+(1-q)z^2})}{\partial t_A}|_{t_A=\frac{1}{q+(1-q)z^2}} = 0$. Hence, when $z > 1$ it is the case that $\pi_A(t_A, \frac{1}{q+(1-q)z^2})$ admits a unique global maximum at $t_A = \frac{1}{q+(1-q)z^2}$. As before, the symmetric and zero-sum nature of the game ensures that for $z > 1$ the strategy profile $(t_A, t_B) = (\frac{1}{q+(1-q)z^2}, \frac{1}{q+(1-q)z^2})$ is the unique Nash equilibrium of the game.

[Insert Figure 12 about here]

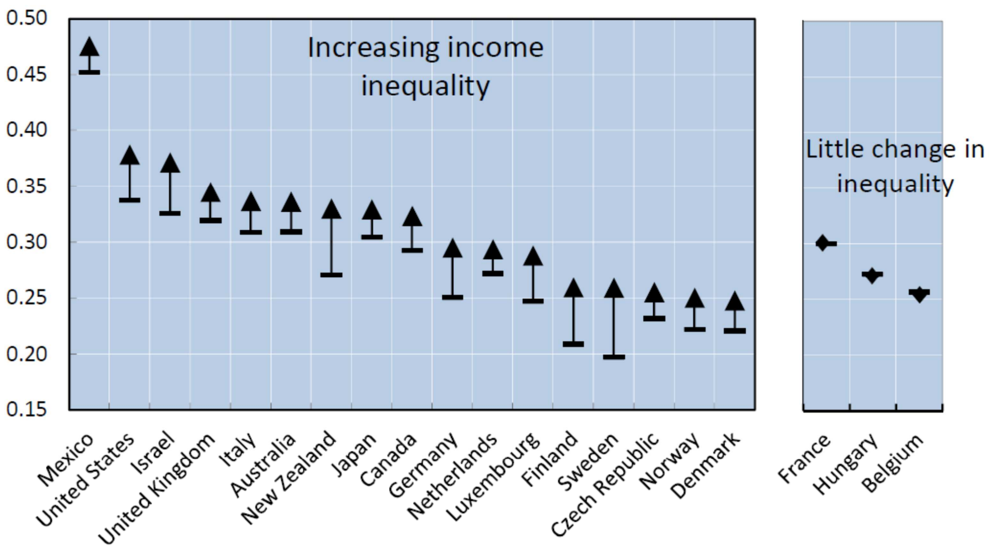

Fig. 1. Change in the Gini coefficients of income inequality in OECD (from 1985 to 2008)
Source: OECD Database on Household Income Distribution and Poverty.

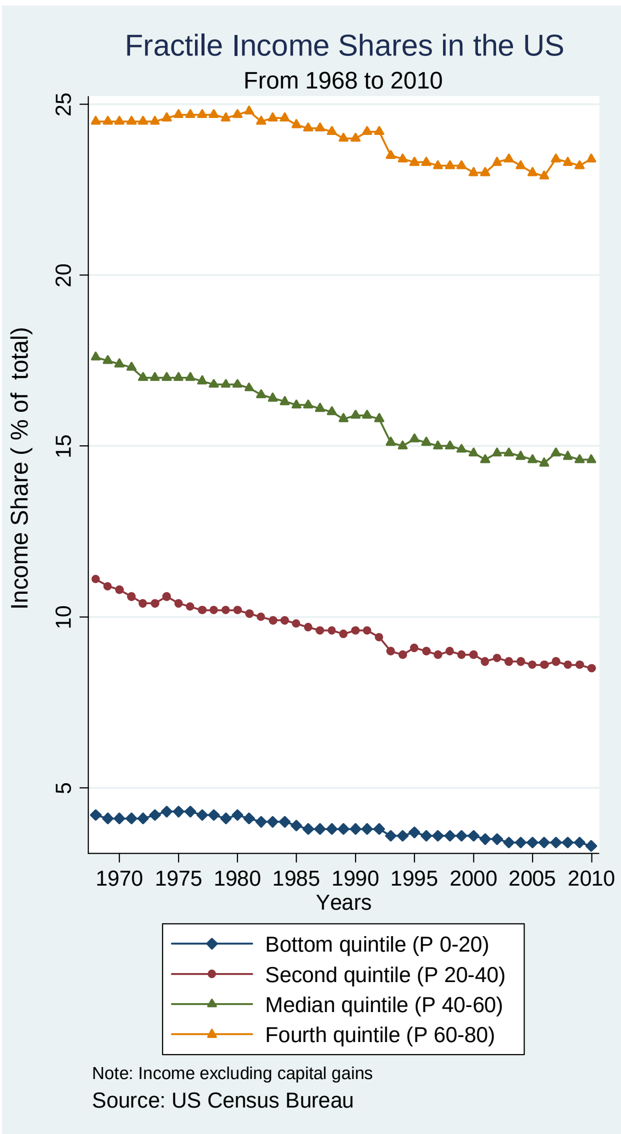

Fig. 2.a. Fractile income shares in the US: 1968 – 2010.

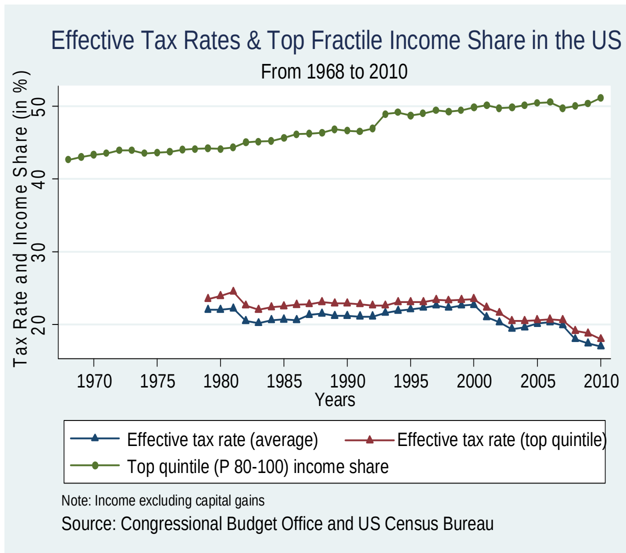

Fig. 2.b. Effective tax rates and top quintile income share in the US: 1968 – 2010.

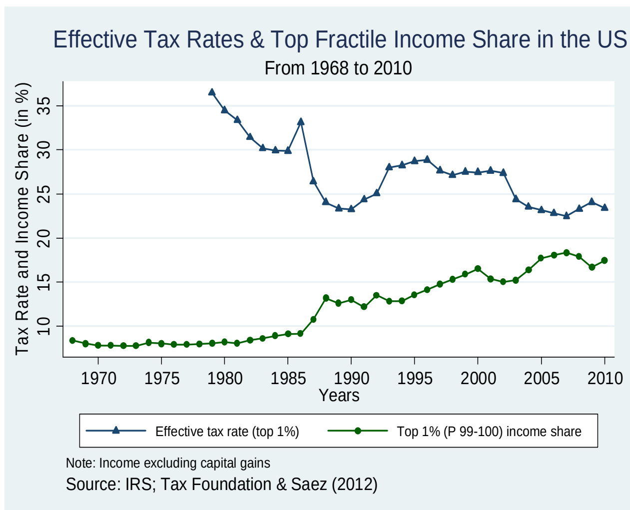

Fig. 2.c. Effective tax rates and top 1% income share in the US: 1968 – 2010.

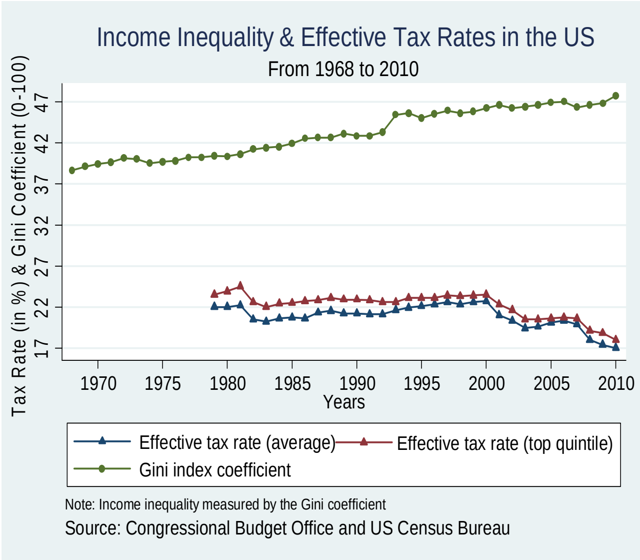

Fig. 3. Rising income inequality and average taxation

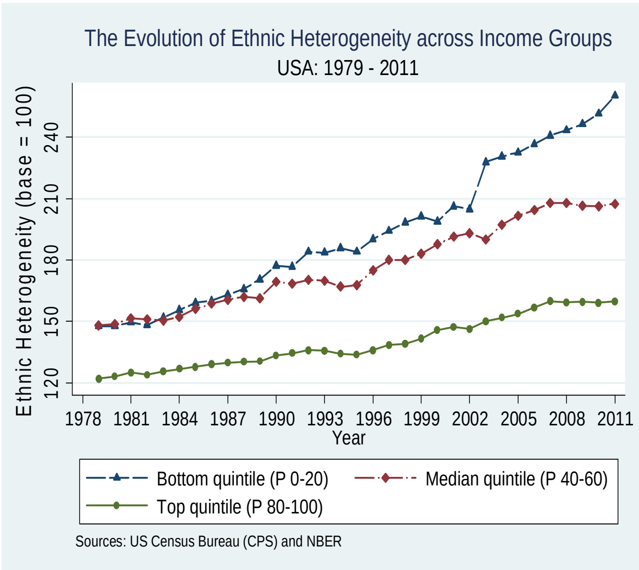

Fig. 4.a. The evolution of ethnic heterogeneity across different income groups: USA from 1979 to 2011.

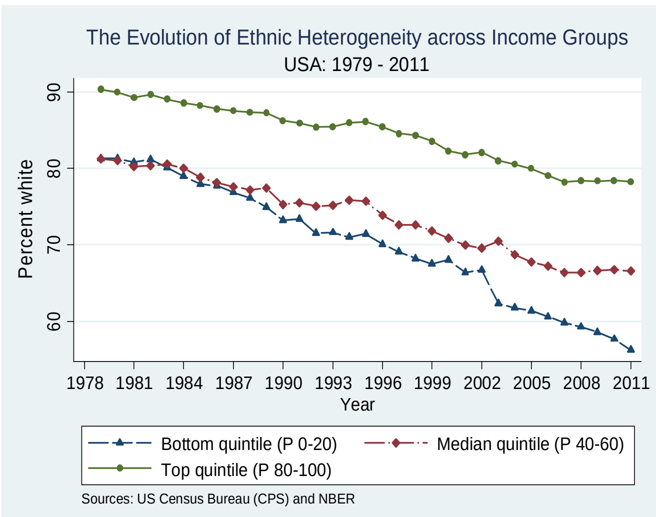

Fig. 4.b. The change in the percent of white (non-hispanic) population across different income groups: USA from 1979 to 2011

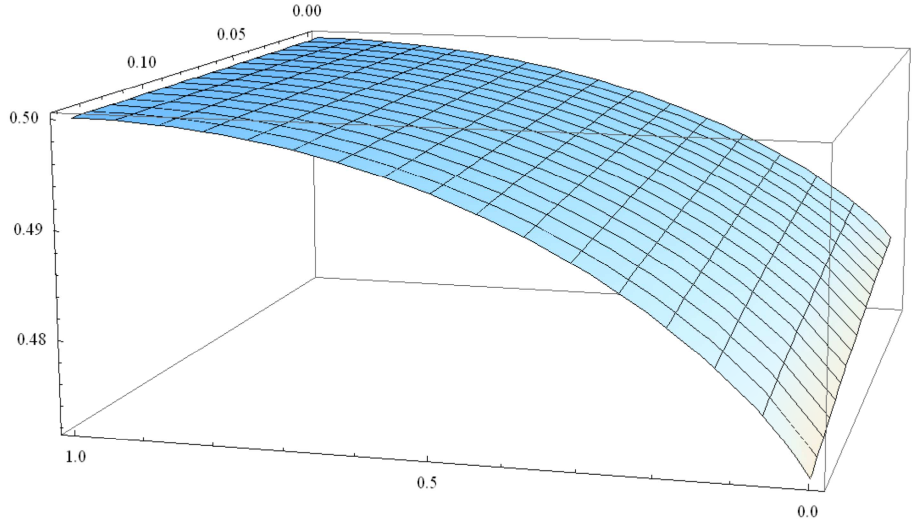

Fig. 5. The payoffs of candidate A, $\pi_A(t_A, 1)$ - height - as a function of $t_A \in [0,1]$ - length - and $s_A = 1 - s_B \in [0,0.14]$ - width - when: (i) the income distribution is given by a uniform distribution on [0, 1] and (ii) B is expected to play $t_B = 1$.

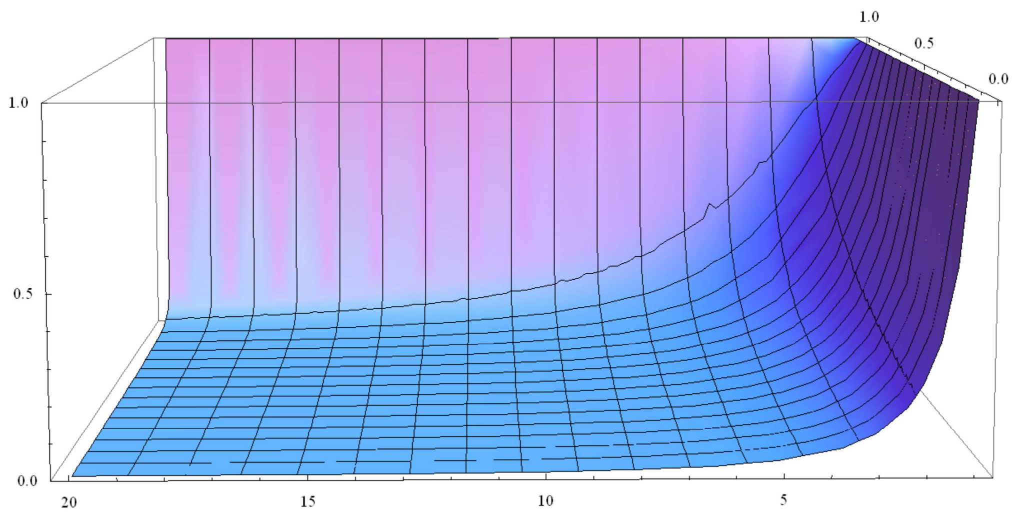

Fig. 6. Equilibrium tax rate $t^*(q,z)$ - height - as a function of the size of poor voters $q \in (0,1)$ - width - and the relative within-poor heterogeneity $z \in (1,20]$ - length - proxied by the variance of the distribution of poor voters $F_p = N(0,z)$ keeping constant the variance of the distribution of rich voters $F_r = N(0,1)$.

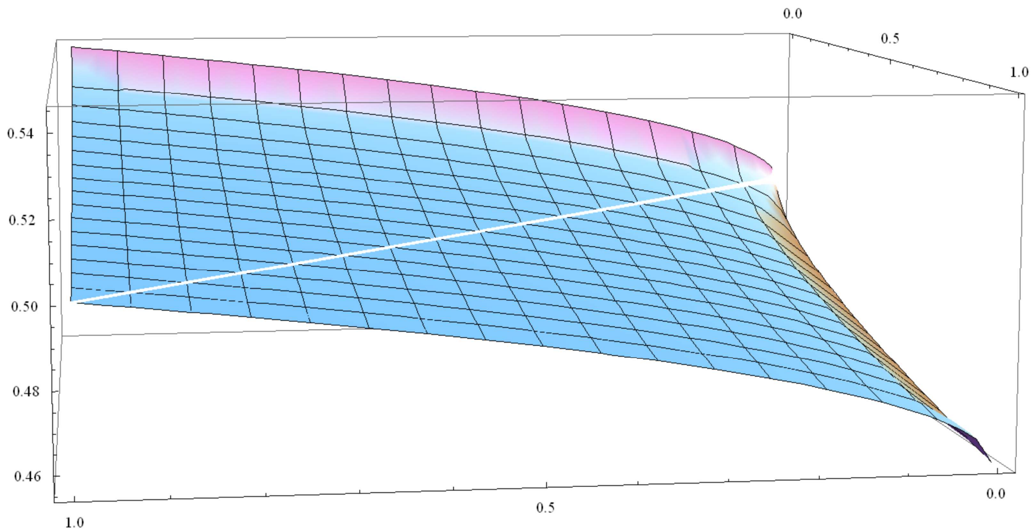

Fig. 7. The payoff of candidate A - height - as a function of the tax rate she promises - length - and the tax rate that candidate B promises - width - when $a = 0.005$ and $q = 0.8$.

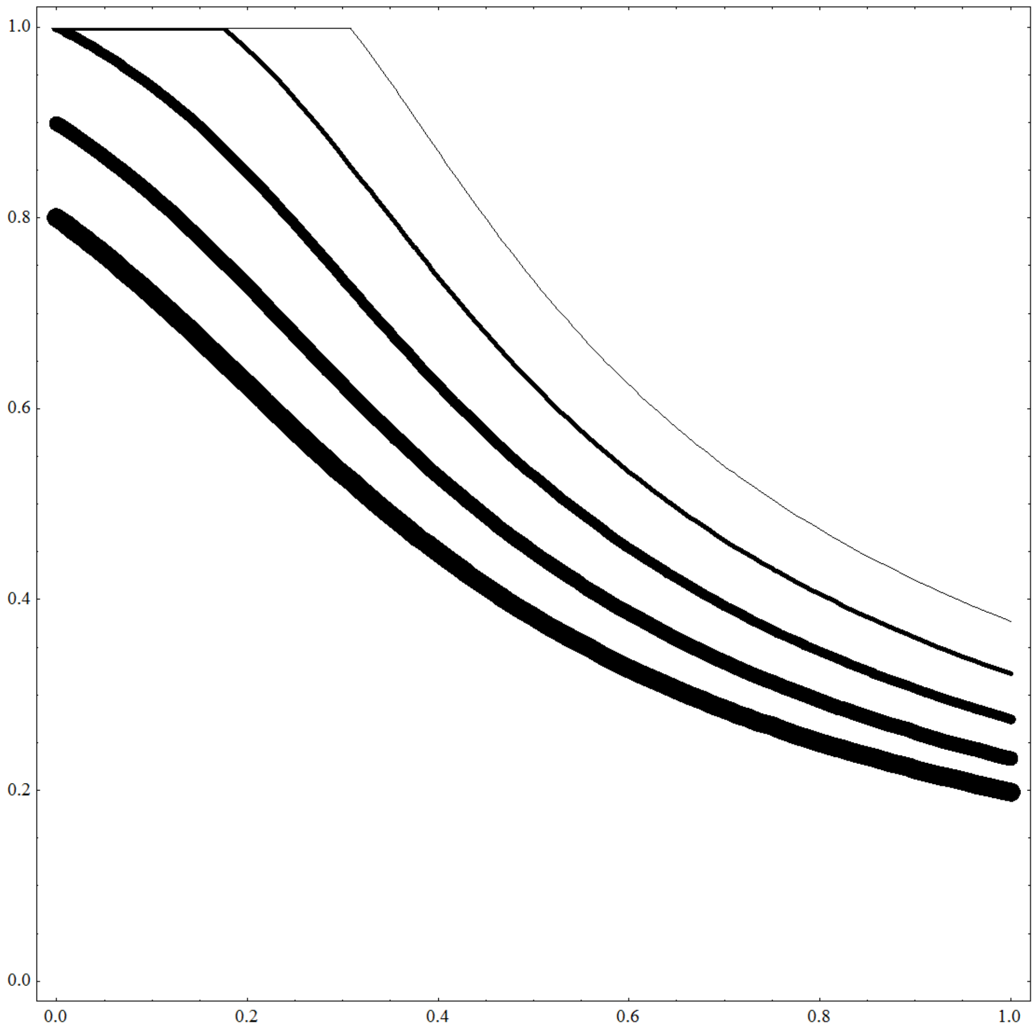

Fig. 8. Equilibrium tax rates as a function of $c \in [0,1]$ when $q = 0.8$ and the density of the poor swing voters is equal to one, for various values of the rich swing voters' density (the larger the rich swing voters' density, the thicker the curve).

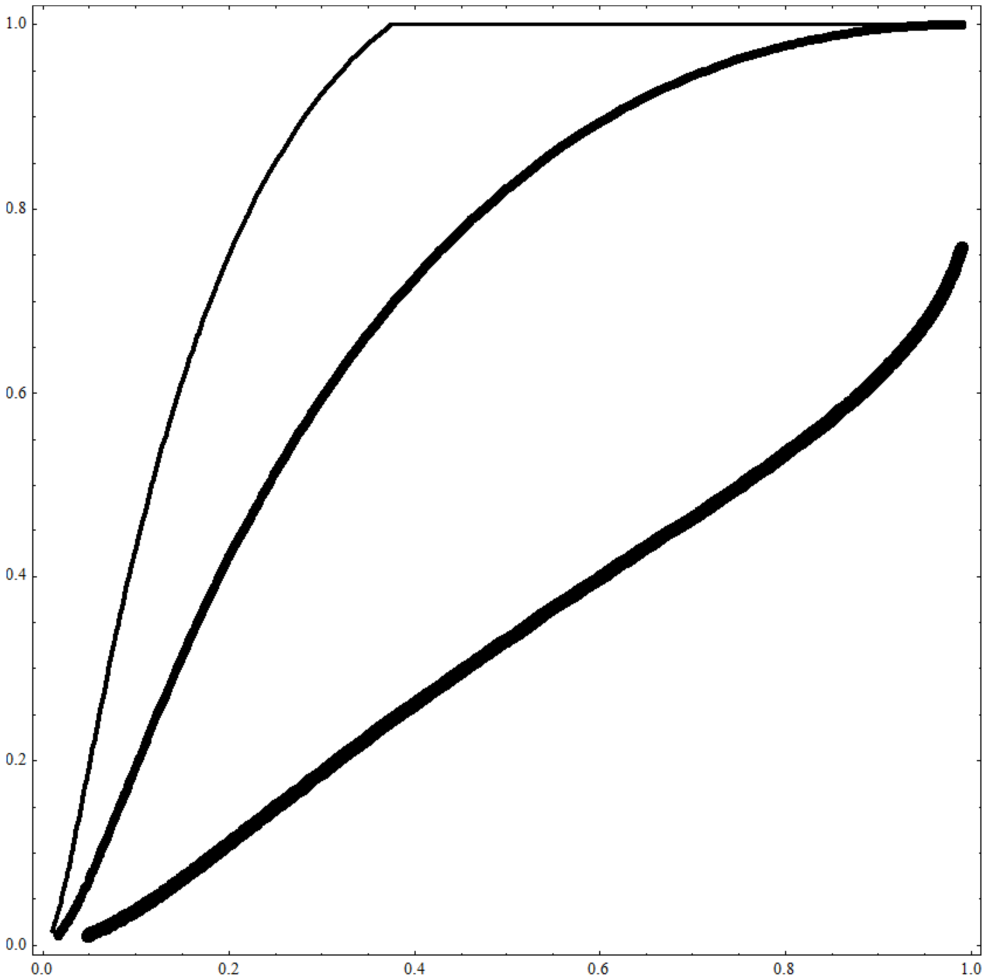

Fig. 9. Equilibrium tax rates as a function of $q \in [0,1]$ when the density of poor swing voters is equal to one and the density of rich swing voters is equal to 0.75, for various values of the efficiency costs of taxation (the larger the efficiency costs, the thicker the curve).

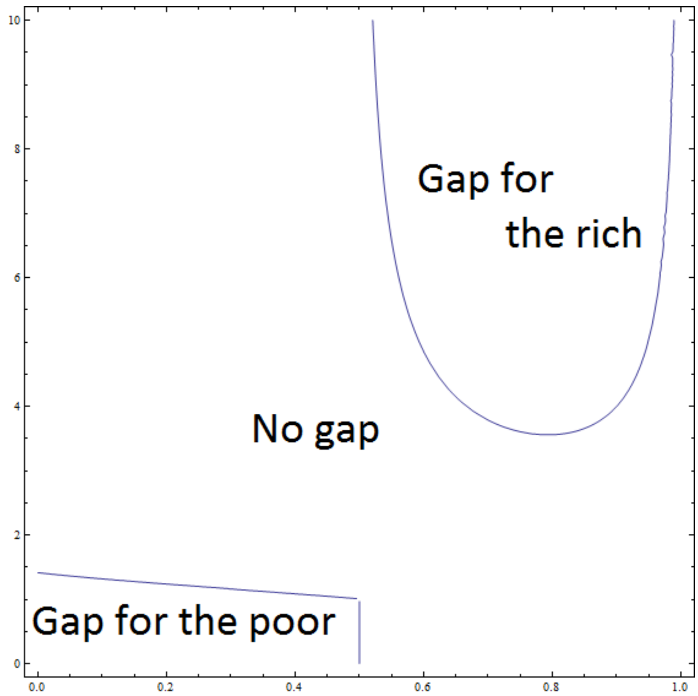

Fig. 10. The presence and the direction of the representation gap when candidates are differentiated ($s_A = -s_B = -1$), as a function of the size of poor voters $q \in (0,1)$ – width - and relative within-poor heterogeneity $z \in (0,10]$ - height.

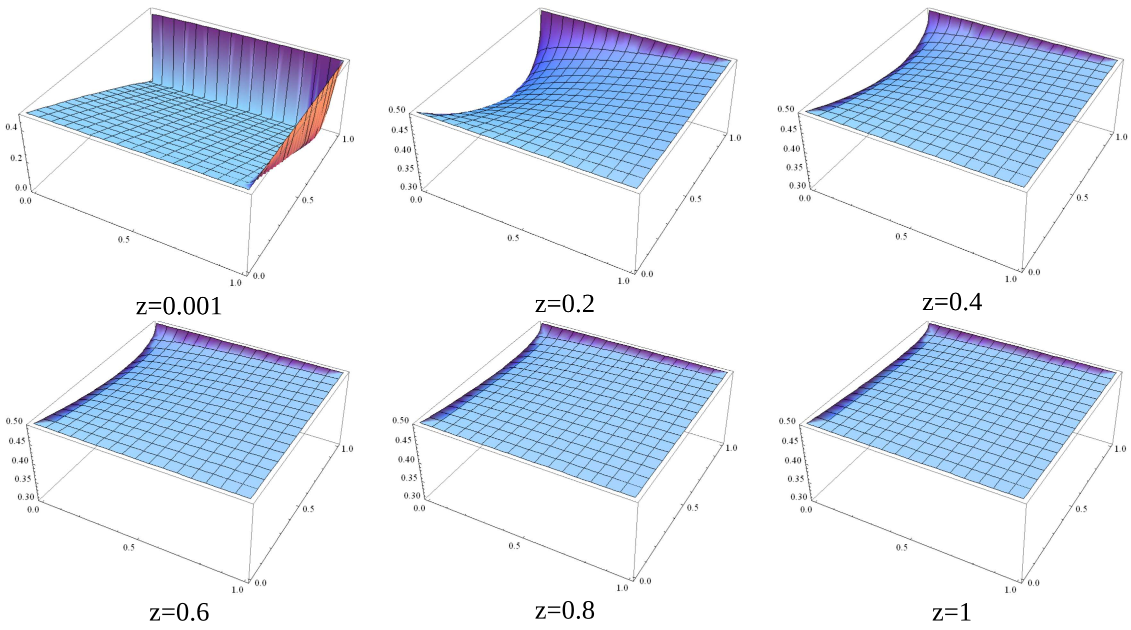

Fig. 11. The value of $\pi_A(t_A, 1)$ - height - as a function of $t_A \in [0,1]$ - length - and $q \in (0,1)$ - width - for $z = 0.001; 0.2; 0.4; 0.6; 0.8; 1$.

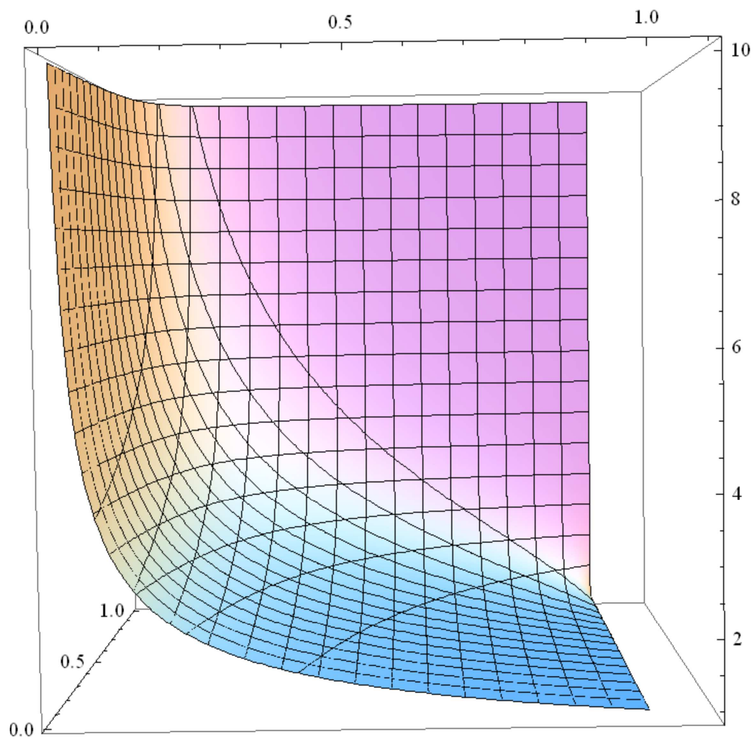

Fig. 12. Values of $t_A \in [0,1]$ - length - of $q \in (0,1)$ - width - and of $z \in (1,10]$ - height - which give to the derivative of the payoff function of player A a value equal to zero when B is expected to play $t_B = \frac{1}{q+(1-q)z^2}$