Essays on the Single-mindedness Theory

Emanuele Canegrati
Catholic University, Milan

Abstract

The scope of this work is analysing how economic policies chosen by governments are influenced by the power of social groups. The core idea is taken from the Single-mindedness Theory, which states that preferences of groups and their ability to focus on the consumption of goods, or issues, enable them to achieve a great political power and eventually to obtain the most favourable policies.The general framework I designed departs from the tradional models which are based on the Median Voter Theorem (Black (1948), Dows (1957)) and which illustrate how in equilibrium political candidates choose the policy vector preferred by the median voter. Instead, my approach exploits the advantages of Probabilistic Voting Theory (Davis, Hinich, and Ordeshook (1970); Enelow and Hinich (1983), Lindbeck and Weibull (1987), (1993), Coughlin (1992), Persson and Tabellini (2000)) which are the ability to manage the multidimensionality of policies and the possibility to study more precisely how politicians tailor their policies to groups' features. Nevertheless, unlike classic probabilistic voting models, the theory I propose assumes that the density function which captures the distribution of political preferences of voters depends on consumption of goods and preferences of individuals. The higher the consumption of goods (or leisure), the higher the density, the higher the political power. This mechanism is better explained by considering the role played by swing voters, those individuals who do not have any particular preference for candidates. Since these voters are pivotal to changing the political equilibrium, candidates must favour them, because they realise that even a small change in policy could force them to vote for the other candidate who would win the elections. In other words, the lower the loyalty of voters for parties, the higher the benefit they obtain. There is no way for the candidates to avoid the threat represented by more powerful groups, as long as they are concerned with winning elections. As a consequence, these groups are better off and represent the winners of the political process.

The Single-minded Theory may be applied to several fields of Political Economy, both theoretical and econometrical. From a theoretical point of view I used the Theory in three papers.

The first deals with Social Security Systems and assumes that, in a society divided into two generations (the young and the old), one generation has greater preferences for leisure than the other. Furthermore, two vote-seeking candidates run for election and have to choose a vector of policy encompassing marginal tax rates on labour. The balanced-budget constraint they have to clear is no longer based on lump-sum transfers, as in the traditional literature, but on labour income distortionary taxation. In this constant-sum game, a generation obtains a benefit, whilst the other must bear the entire cost of social security systems. Furthermore, I demonstrate via numerical simulations that the gener-

ation which is more single-minded on leisure is better off, because it is more able to capture politicians. Finally, I demonstrate a set of useful results to be used in probabilistic voting models with distortionary taxation and single-minded generations: standoff in political competition, convergence of policies, characteristics of internal and corner equilibria when the value function is not strictly concave.

The second and the third papers analyse the problem of indirect and direct taxation moving from the hypothesis that Governments do not maximise a typical Social Welfare Function but the probability of winning elections, instead. For indirect taxation, results show how it is neither the goal of equity by the government nor the weight that society attaches to the utility of single individuals which drives the equilibrium policy, but the weight that candidates attach to the power of groups, instead. The essential basic principle stated by the Ramsey rule (1927) modified by Diamond (1975) is maintained, because it is still the distributive characteristic which drives the optimal tax rate in equilibrium; nevertheless, this time the distributive characteristic is a function of the size and density of groups, and it can be demonstrated that the optimal tax rate is a function of their political power. If in Diamond the poor were the better off groups and the rich the worse off groups, due to social weights attached by society, here the more powerful and single-minded groups are better off, whilst less powerful groups are worse off. The same thing happens to a model of direct taxation, where again I move from the hypothesis that candidates maximise the probability of winning elections and not a welfare function as in Mirlees (1971) and Atkinson and Stiglitz (1980). The optimal tax rate depends again on the density and size of groups and not on the importance attributed by society to individuals' wealth. In turn, these two models demonstrate how taxation loses its function of transferring resources from the rich to the poor, whilst they consider it a tool used by politicians in order to win elections. These models also offer a possible explanation for the existence of indirect taxation, when it was demonstrated that indirect taxation is not necessary under an optimal income tax structure (Atkinson and Stiglitz (1976)) and even if this structure were not optimally designed (Laroque (2005), Kaplow (2006)) . Considering that direct taxation is progressive, whilst indirect taxation is mildly regressive, we may understand how some social groups have more than an interest in preventing a substantial shift from indirect to direct taxation.

Finally I also wrote a fourth contribution which represents the empirical evidence of my work. From this point of view, there was a need to empirically demonstrate the validity of the assumptions on which the theory is based. Some claims, such as the existence of a difference in preference for goods and leisure amongst individuals, especially the young and the old, could appear too ad-hoc and deserved to be demonstrated. Using the British Election Study I was able to find the data needed to demonstrate how judgments and political preferences of individuals are related to age, along with other characteristics of individuals. To do that, I uses LOGIT/PROBIT regressions and non-parametric estimates in order to capture these differences amongst cohorts. In particular, results demonstrated how age is almost always a significant variable to explain political orientations, judgements given on governments' policies and the political activism of voters. Furthermore, Kernel Density estimation and Kolmogorv-Smirnov tests showed how cohorts have different distributions with respect to political parameter of interest (i.e. position of the right-left scale), corroborating the idea that the old and the young are differently minded about political affairs.

Contents

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All errors are mine.

The Single-Mindedness Theory: Micro-foundation and Applications to Social Security Systems

"We work in order to have leisure" (Aristotle)

Introduction

The participation in the labour force of older persons in the U.S. labour market has been steadily declining over the last century. If the labour force participation of men aged 65-69 was around 60 per cent in the 1950s, the same figure had fallen to 26 per cent in the 1990s (Diamond (1997)) (Figure 1). In many OECD countries, workers withdraw from the labour market well before the official retirement age. Eventually this long-term decline, associated with an increase in life expectancy, has led to a considerable increase in years spent in retirement. Also, Government expenditure on social security has been skyrocketing and so has the percentage of workers covered by the system (Figure 2). This situation risks becoming financially unsustainable over the next years, unless governments undertake structural reforms as suggested by many economists (see Feldstein and Liebman (2001) amongst the others).

Over the last few years, the economic literature has been trying to give plausible explanations for this strong change in old workers' lifestyles. According to an OECD survey (OECD (2005)) financial incentives embedded into public pensions and other assistance schemes pull old workers into retirement. Nevertheless, the OECD makes a distinction between *pull factors of retirement* and *push factors of retirement*. The former include all those financial benefits that incentivise workers to anticipate their retirement, whilst the latter refer to negative perceptions by old workers about their ability or productivity and to socio-demographic characteristics.

In this paper I will distance myself from the OECD's view, which considers financial benefits as a *pull factor* which reduces the amount of work. I suggest that preference of workers for leisure shapes the characteristics of modern social security systems. Thus, generosity of governments' transfers is not exogenously given but it is rather the effect of a precise political mechanism; this is driven by old workers who use their political power to obtain what they need to finance their retirement years.

To explain the early retirement phenomenon, I will use an overlapping generation model (OLG) which considers a society divided into two groups of workers: the old and the young. I will assume that there is political competition between two candidates who must choose effective marginal tax rates on labour in order to maximize the probability of winning elections.

The core assumption of the model is based on the idea of "single-mindedness", introduced by Mulligan and Sala-i-Martin (1999). They assumed that the old prefer leisure more than the young; this structure of preferences would explain why the old require (and eventually obtain) more generous transfers from the government and why social security expenditures have been increased so much in recent years. They adopted an OLG model where society is divided into old and young workers and showed that

> retired elderly can concentrate on issues that relate only to their age such as the pension or the health system

while the young have to choose amongst

> age-related and occupation issues

Eventually, they concluded,

> the elderly are politically powerful because they are more single-minded and (. . .) more single-minded groups tend to vote for larger social security programs that benefit them

According to this theory the group of old workers, because more single-minded, would have a greater leverage over politicians and they are more able to influence policy outcome (a sort of tyranny of the elder or "Gerontocracy", to quote authors).

Indeed, neither Demographics nor the need for assistance would explain the skyrocketing increase in the governments' expenditure for social security systems and the broad reduction in retirement age over the last decades, but preferences of the old for leisure would provide a more suitable explanation to this upward trend. In a recent work, Diamond (Diamond (2005)), attempting to describe the linkage between the social security system and the retirement in the U.S., wrote in his conclusions:

> there is clear evidence from both previous work (...) that the broad structure of the SS program influences retirement timing. Evidence on the effects of variation in the benefits provided by this program is less clear, however.

In particular, I will assume that the Government has to decide how to divide the revenues generated by the taxation of the two groups. In doing this, it exploits a balanced budget constraint which is based on (distortionary) labour income taxation. Eventually, I will demonstrate that the older generations obtain a higher tax credit (or a reduction in the effective marginal tax rate) than the younger generations and that they get a higher amount of leisure. This is a situation which is consistent with the old's needs, since their preferences are more oriented toward retirement than toward work. The work also explains the importance of the single-mindedness of social groups and the role of preferences of individuals in political competition. The more single-minded a group, the higher is its political power, captured by a density function which is assumed to be monotonically increasing in the level of leisure. Since more single-minded groups are, other things being equal, more politically powerful, they are more able to obtain favourable policies from political candidates in equilibrium.

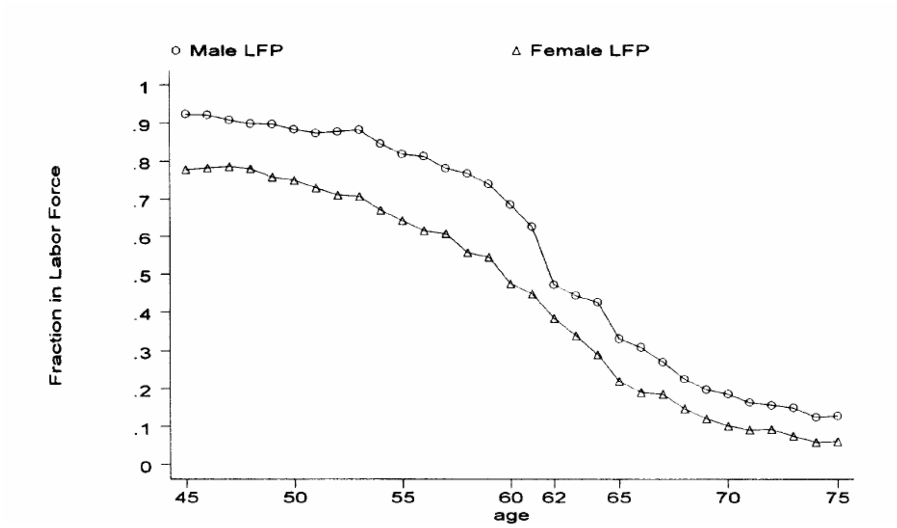

Figure 1 - Partecipation Rates by Age and Sex in the U.S.

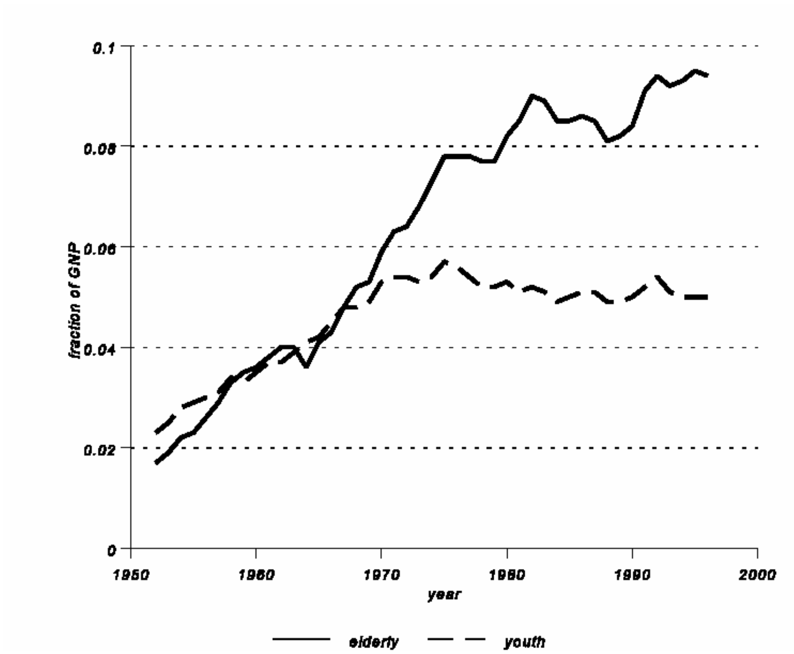

Figure 2 - Expenditures in social security programmes by cohort in the U.S.

The basic model

I consider an overlapping generation model, where each generation lives for two periods: *youth* and *old* age. At any period of time, the generation of youths coexists with the generation of the elderly. At the beginning of the next period, the elderly die, the young become old and a new generation of youths is born. As a consequence, there are two overlapping generations of people living at any one time. Generations are unlinked, meaning that for whatever reason, a generation does not leave any bequest to another generation. Individuals consume all the available income earned at a given period of time; thus, it is not possible either to save or to borrow money.

Then, at time $t = 0, ..., +\infty$, let a continuum of voters of size one be partitioned into two generations of workers $I = t-1, t$. The *old* represent the generation born at time $t-1$ and it is denoted by $t-1$ whilst the *young* represent the generation born at time t and it is denoted by t. The two generations have same size, which does not change over time[1]. A single worker is denoted by $i \in \left[0, \frac{1}{2}\right]$.

Each worker i has to decide how to divide his total endowment of time T between work, $L_t^i > 0$ and leisure, $l_t^i > 0$. If leisure is equal to the total endowment of time, I assume that the worker retires.

Every voter's welfare depends both on fiscal policies chosen by two political candidates $j = A, B$ which affect his consumption, known by both parties, and on personal attributes of candidates, which are only imperfectly observed by rivals. Both candidates have an ideological label (i.e. they are seen as Democrats or Republicans), exogenously given. In other words, I assume that individuals' preferences for consumption are perfectly observable, whilst other political features, such as ideology, are not (Linbeck and Weibull's *stochastic heterogeneity* (1987)). The deterministic component of workers' welfare is captured by a quasi-linear utility function in consumption and leisure, whilst the stochastic component is captured by the expression $\mathbf{D}^B \cdot (\xi_t^{i,I} + \zeta)$, where

$$\mathbf{D}^B = \begin{cases} 1 & if\ B\ wins \\ 0 & if\ A\ wins \end{cases}$$

The term $\zeta \lesseqgtr 0$ reflects B's general popularity amongst the electorate and it is only realized between the announcement of parties' policy vector and elections. It is not idiosyncratic, it is known by candidates, and it is uniformly distributed as

$$\zeta \sim U\left[-\frac{1}{2}, \frac{1}{2}\right]$$

with mean zero. Otherwise, the term $\xi_t^{i,I} \lesseqgtr 0$ represents an individual component of preferences for B. It is known by candidates and uniformly distributed as

$$\xi_t^{i,I} \sim U\left[-\frac{1}{2s^I}, \frac{1}{2s^I}\right]$$

with mean zero and density s^I.

A representative old worker at time t has the following utility function:

$$U_t^{i,t-1} = c_t^{t-1} + \psi^{t-1} \log l_t^{t-1} + \mathbf{D}^B \cdot (\xi_t^{i,t-1} + \zeta) \tag{1}$$

where c_t^{t-1} is consumption and $\psi^{t-1} \in [0,1]$ is a parameter representing the intrinsic preference of the old worker for leisure.

The old worker consumes all his income:

$$c_t^{t-1} = w^{t-1}(1 - \tau_t^{'t-1})(T - l_t^{t-1}) \tag{2}$$

where w^{t-1} is the unitary wage per hour worked, $\tau_t^{'t-1} := \tau\left(1 - a_t^{t-1}\right)$ the effective tax rate on labour income equal to the nominal tax rate $\tau \in \left[\tau^{\min}, \tau^{\max}\right]$ net of the tax credit $a_t^{t-1} \in \left[a_t^{t-1\min}, a_t^{t-1\max}\right]$, with $a_t^{t-1\min} < 1$ and $a_t^{t-1\max} > 1$.

I assume that τ is equal for every generation and steady over time. $\tau^{\min}$ and $\tau^{\max}$ denotes the minimum and maximum legal tax rates, whilst $a^{\min}$ and $a^{\max}$ the minimum and maximum tax credits, both written in a budget law.

Similarly, preferences of a representative young worker t are given by the following utility function:

$$U_t^{i,t} = c_t^t + \psi^t \log l_t^t + \beta(c_{t+1}^t + \psi^{t-1} \log l_{t+1}^t) + \mathbf{D}^B \cdot (\xi_t^{i,t} + \zeta) \tag{3}$$

subject to

$$c_t^t = w^t(1 - \tau_t^{'t})(T - l_t^t) \tag{4}$$

$$c_{t+1}^{t} = w^{t}(1-\tau_{t+1}^{\prime t})(T-l_{t+1}^{t}) \tag{5}$$

where β is a discount factor and $a_t^t \in \left[a_t^{t\,\min}, a_t^{t\,\max}\right]$ the tax credit, with $a_t^{t-1\,\min} < 1$ and $a_t^{t-1\,\max} > 1$.

Conditions $a_t^{I\,\min} < 1$, $a_t^{I\,\max} > 1$ make a redistribution programme feasible because, as we will see later in studying the budget constraint of the Government, it allows a generation to obtain positive transfers which are paid by the other generation.

Definition of Single-Mindedness

I introduce two essential definitions:

Definition 1 *generation A is said to be more single-minded than generation B with respect to leisure if its marginal utility of leisure is greater than B's. That is if $\psi^A > \psi^B$.*

This definition states that generations are not focused (single-minded) on leisure in the same way. They attribute different weights to leisure and thus are less or more prone to substitute it with consumption goods. I will provide later some empirical results which demonstrate that a difference between the young and old for leisure exists.

Definition 2 *generation A is said to be more politically powerful than generation B if its density is higher than B's. That is if $s^A > s^B$.*

The political power of a generation is represented by its ability to influence candidates' choices, when they have to take decisions about the optimal policy vector. In traditional probabilistic voting models this power is expressed by a density function which captures the distribution of the constituency.

Axiom 3 *the density function of a generation is monotonically increasing with the level of leisure. That is $s^I = s(l)$, with $\frac{\partial s}{\partial l} > 0$.*

Note, that this axiom brings something new with respect to previous probabilistic voting models, where the density function was only a constant and did not depend on anything.

In the resolution it will be demonstrated that $l^I = l(\psi)$ and $\frac{\partial l}{\partial \psi} > 0$; that is, leisure in monotonically increasing in preferences for leisure. This result enable us to show that, *ceteris paribus*, *an increase in the single-mindedness of a generation entails an increase in its political power*. To demonstrate this, it is sufficient applying the chain rule to obtain $\frac{ds^I}{d\psi^I} = \overbrace{\frac{\partial s^I}{\partial l^I}}^{>0} \cdot \overbrace{\frac{\partial l^I}{\partial \psi^I}}^{>0} > 0$.

This result says that the linkage between preferences of a generation and its political power passes through an increase in the level of leisure which the density depends upon. In other words, it must be the case where over leisure, different generations have different preferences for political parties. A greater level of single-mindedness entails higher values of the density function which tends to give to the distribution a ticker shape.

Different preferences for leisure

I introduce an axiom which refers to a fundamental difference between the young and the old.

Axiom 4 *the old are more single-minded for leisure than the young; that is,* $\psi^{t-1} > \psi^t$.

This axiom is certainly strong but it is supported by robust empirical evidence. As a matter of fact, Economics has produced many works providing possible explanations of the existence of a difference in preferences. Besides, recently other social sciences like Sociology and Psychology have added very useful contributions. In summarizing the most important achievements, I will make a distinction between economic reasons and non-economic reasons.

The **economic reasons** are contained mainly in works by Mulligan and Sala-i-Martin (1999).

1. `Differences in labour productivity`. Since labour productivity declines with age, the old are less productive than the young and, as a consequence, they earn a lower wage. This theory would explain the willingness of the old to retire early: less productive workers in the labour market find it profitable to devote relatively more of their time and effort to political activity, in order to gain monetary transfers that they would not obtain if they relied on the labour market. Nevertheless, for the theory to hold it is important to assume that leisure devoted to political activities is a *normal good*. That is, an increase in total leisure time provokes an

increase in leisure devoted to political activities, due to the income effect. Of course these assumptions are not unanimously accepted in literature. In particular, evidence about the effects of age on productivity and wages does not lead to clear-cut conclusions. For example, a work by Skierbekk (2003) found that individual job performance decreases from around 50 years of age and that productivity reductions at older ages are particularly strong for work tasks where problem solving, learning and speed are needed, while in jobs where experience and verbal abilities are important, older individuals' maintain a relatively high productivity level.

2. `Differences in Human Capital Accumulation`. The young are more engaged in self-financed human capital accumulation, while they work, than the old. As a consequence, the value of time for the young may be higher than their average hourly wage (see Stafford and Duncan (1985)).

3. `Long-term employment contracts`. The empirical evidence shows that due to Lazear-type contracts, labour productivity for workers aged 60+ is significantly lower than wages.

As for the **non-economic reasons**, I refer to a work by Hershey, Henkens and Van Dalen (2006). In comparing the Dutch with the U.S. social security system, the authors discovered that "the Americans had significantly longer future time perspectives, higher level of retirement goal clarity and they tended to be more engaged in retirement planning activities". Thus, these findings are able to explain the existence of sociocultural differences in the preferences for retirement. They go on affirming that "American workers think, prepare and save more for retirement... beginning in early adulthood", focusing on differences between societies, where there exists a major difference in financial responsibility, different level of uncertainty for future pension payouts and different psychological pressures. Finally, in concluding that the success of political initiatives depends in part on "changing the dimensions of the psyche that motivate individuals to adaptively prepare for old age", they implicitly recognize that preferences of individuals for leisure may endogenously change over time, again due to cultural and psychological issues.

A graphical illustration

In order to ease the comprehension of the relation between single-mindedness and political power I provide a graphical illustration. Figure 3 shows an example of different distributions amongst cohorts.

The figure shows how distributions of generations depend on leisure and that the old generation (red) has a thicker distribution than the young generation (orange). The distribution is assumed to be uniform. The broadness of the interval $\left[-\frac{1}{2s^I}, \frac{1}{2s^I}\right]$ is changeable, because s is a monotonically increasing function of leisure, and higher levels of leisure increase s, reducing the broadness of the interval. As a result, we obtain a higher concentration of "swing voters", those voters who are indifferent to the two candidates, around ζ.

Figure 4 shows the effects of an increase in ψ in a generation. A change in ψ (from ψ to ψ', with $\psi' > \psi$) entails an increase both in l and s. Since s stands at the denominator of the expression representing the endpoints of the interval, the broadness of the interval reduces and the distribution becomes thicker.

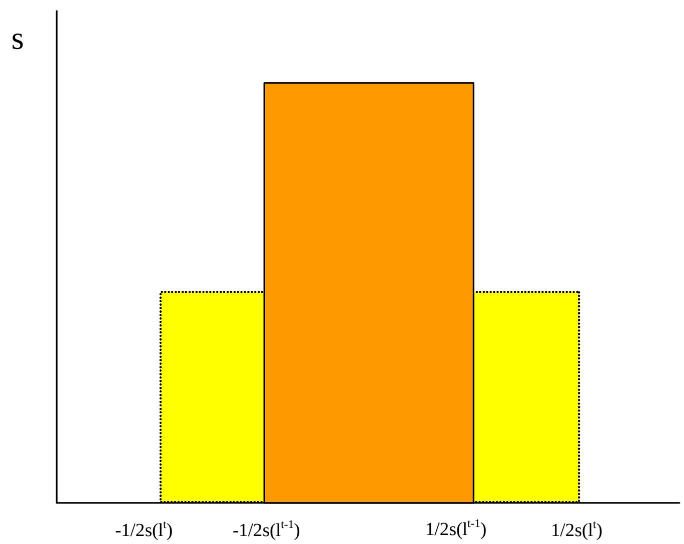

Figure 3 - Distribution functions of single-minded generations

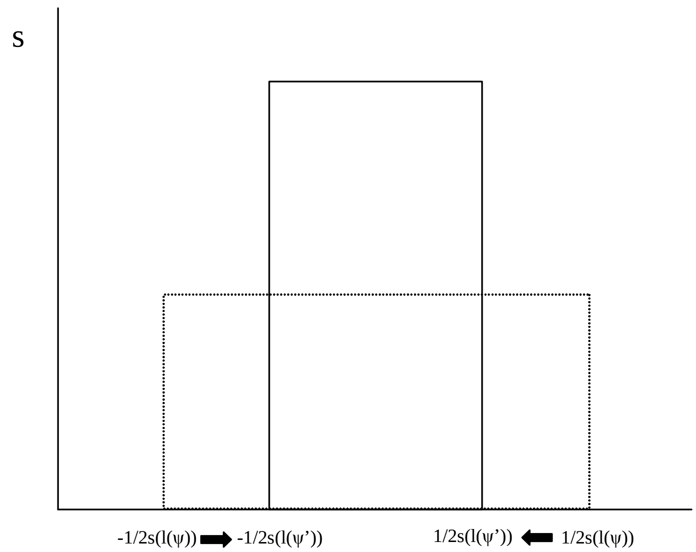

Figure 4 - Effects of a change in a generation' preferences on distribution

The Government

I consider two self-interested candidates $j = A, B$ who choose an element $\mathbf{q}_t^j = \left\{ \tau_t^{'t-1j}, \tau_t^{'tj} \right\}$, encompassing the two effective tax rates $\tau_t^{'t-1j}$ and $\tau_t^{'tj}$, from the (common) strategy set $\mathfrak{Q} \subset \mathbb{R}^2$.

Furthermore, I introduce the budget constraint of the Government at time t:

$$\Upsilon_t^j := \frac{1}{2}\tau_t^{'t-1j}(T - l_t^{t-1})w_t^{t-1} + \frac{1}{2}\tau_t^{'tj}(T - l_t^t)w_t^t = 0 \tag{6}$$

where $\frac{1}{2}\tau_t^{'t-1j}(T - l_t^{t-1})w_t^{t-1}$ represents the total revenues collected by the taxation of the old and $\frac{1}{2}\tau_t^{'tj}(T - l_t^t)w_t^t$ the total revenues collected by the taxation of the young.[2]

Since revenues are proportional to the amount of labour, taxation entails inefficiencies, as it distorts workers' decisions on the amount of labour supplied.

As suggested by Lindbeck and Weibull (1987), I assume the existence of a *balanced-budget redistribution* where the government cannot redistribute more resources than those available in the economy, and cannot use tax revenues for any other purpose than redistribution – so that the condition $\Upsilon_t^j = 0$ says that revenues collected via labour taxation are only used to redistribute wealth amongst cohorts. To avoid the case in which a difference in wage levels is the sole reason for early retirement I assume that wages are equal for every generation: $w_t^{t-1} = w_t^t = w$. Furthermore, without loss of generality, I normalize the wage rate to the unity.

The advantage of adopting a budget constraint with distortionary taxation like 6 is realism. Economists like Profeta (2002) and Mulligan and Sala-i-Martin (1999) formalized models attempting to explain the linkage between inter-generational redistribution and early retirement; nevertheless, they seem to be affected by a fundamental problem due to the use of lump-sum transfers. In Mulligan and Sala-i-Martin "an interest group may tax its members with a labour income tax and distribute the proceeds to them in a lump-sum fashion"; Profeta used lump-sum taxation to transfer wealth both within and amongst cohorts. Finally, Linbeck and Weibull studied a redistribution model with political competition where gross incomes are fixed and known and, "first-best (individual) lump-sum redistributions are in principle feasible". Unfortunately, a redistributive system with the presence of lump-sum taxation does not exist in the real world. All the most recent studies on features of social security systems around the world show that the taxation on income is the only source of financing social expenditures. For instance, Diamond (2005) found out that "The Social Security system in the U.S. today is financed by a payroll tax which is levied on workers and firms equally", whilst Mulligan and Sala-i-Martin, adopting a cross-section analysis of 89 countries, recognized that the 96 per cent of social security programs are financed via payroll taxes.

The political competition

The Lindbeck and Weibull framework

As said before voters' welfare depends both on a deterministic and a stochastic component. The presence of uncertainty, captured by variables related to preferences for political nominees, guarantees the existence of a NE in a multi-dimensional space (see Lindbeck and Weibull (1987) and Dixit and Londregan (1994)). In the absence of uncertainty candidates would be perfectly able to observe how voters cast their ballots and then each voter would abruptly switch backing toward the candidate who promises him the most favourable policy. In such a case the non-existence of an equilibrium is due to the fact that any chosen policy would be beaten by another policy. Therefore, traditional Downsian electoral competition models lead to a negative result where no Condorcet winner exists. Probabilistic voting models, instead, smooth out this discontinuity because a small change in the policy chosen entails only a small change in the probability of backing from voters and not a total loss of backing. Smoothing out the discontinuity in the probability of winning reopens the possibility that an equilibrium returns.

Each voter i in generation I votes for candidate B if and only if B's policy vector provides him with a greater utility than that provided by candidate A's policy vector. That is i votes for B if and only if:

$$V^I(\mathbf{q}_t^B) + \zeta + \xi_t^{i,I} \geq V^I(\mathbf{q}_t^A) \qquad \forall i \tag{7}$$

where $V^I(\mathbf{q}_t^j)$ represents the indirect utility function which generation I obtains under the policy vector chosen by candidate j, $\mathbf{q}_t^j$.

The role of swing voters

In each generation there is a fraction of *swing voters* ι, represented by all of those individuals who are indifferent between voting for A or B. For these voters the condition 7 holds with equality:

$$\xi_t^{\iota,I} = V^I(\mathbf{q}_t^A) - V^I(\mathbf{q}_t^B) - \zeta \tag{8}$$

Otherwise, all voters i with $\xi_t^{i,I} < \xi_t^{\iota,I}$ vote for A and all voters with $\xi_t^{i,I} > \xi_t^{\iota,I}$ vote for B. Swing voters are pivotal, since even a small change in the policy vector may force them to vote for a candidate. Suppose we start from a situation where A's policy, $\mathbf{q}_t^A$, is exactly equal to B's policy, $\mathbf{q}_t^B$. A candidate knows that, should it move away from that policy, some swing voters would be better off (and vote for him) and some others would be worse off (and vote for the other candidate). Thus, in choosing a policy, a candidate must calculate the number of swing voters which he gains and compare it with the number of swing voters he loses; a change in policy should be made if and only if a candidate evaluates that the number of swing voters gained outweighs the number of swing voters lost. For example, suppose that A increases its transfer to group $t-1$ by a small amount, due to an increase in the tax credit. Each old worker receives $\frac{\partial \Upsilon_t^A}{\partial a_t^{t-1A}}$. But since a change in the tax credit modifies the level of leisure, and the density of the group accordingly, as a result the cut-off point represented by equation 8 modifies as well. The magnitude of the shift is equal to the extra consumption that an individual obtains multiplied by the marginal utility of consumption $\frac{\partial \Upsilon_t^A}{\partial a_t^{t-1A}}\left(\frac{\partial IUF_t^{t-1}}{\partial a_t^{t-1A}}\right)$, where IUF_t denotes the Indirect Utility Function. Nevertheless, since candidates must stay within the budget, candidate A increases the taxation of the other group by $\frac{\partial \Upsilon_t^A}{\partial a_t^{tA}}\left(\frac{\partial IUF_t^{t}}{\partial a_t^{tA}}\right)$. Therefore, A finds the shift in a policy which favours the group of the old to its advantage if and only if

$$\frac{\partial \Upsilon_t^A}{\partial a_t^{t-1A}}\left(\frac{\partial IUF_t^{t-1}}{\partial a_t^{t-1A}}\right) s^{t-1} \geq \frac{\partial \Upsilon_t^A}{\partial a_t^{tA}}\left(\frac{\partial IUF_t^{t}}{\partial a_t^{tA}}\right) s^{t} \tag{9}$$

This condition states that the group which is more ready to switch its vote in response to a change in policy is treated more favourably by political candidates.

I denote the expected share of votes for candidate A in generation I at time t by $\pi_t^{A,I}$:

$$\pi_t^{A,I} = \frac{1}{2}s^I[\xi_t^I + \frac{1}{2s^I}] = \frac{1}{2}s^I\xi_t^I + \frac{1}{4} \tag{10}$$

and substituting (8) into (10) I obtain:

$$\pi_t^{A,I} = \frac{1}{2}s^I[V^I(\mathbf{q}_t^A) - V^I(\mathbf{q}_t^B) - \zeta] + \frac{1}{4} \tag{11}$$

The total number of expected votes which A obtains must sum the expected number of votes of the two groups:

$$\pi_t^A = \overbrace{\frac{1}{2}s^{t-1}[V^{t-1}(\mathbf{q}_t^A) - V^{t-1}(\mathbf{q}_t^B) - \zeta] + \frac{1}{4}}^{\pi_t^{At-1}} + \overbrace{\frac{1}{2}s^{t}[V^{t}(\mathbf{q}_t^A) - V^{t}(\mathbf{q}_t^B) - \zeta] + \frac{1}{4}}^{\pi_t^{At}} \tag{12}$$

Notice that π_t^A is a random variable since it depends on ζ which is also random and how, *ceteris paribus*, an increase in B's general popularity amongst the electorate reduces π_t^A. Candidate A's probability of winning is simply the probability to obtain the simple majority of votes:

$$p_t^A\left(\mathbf{q}_t^A,\mathbf{q}_t^B\right)=\Pr[\pi_t^A\geq\frac{1}{2}]=\Pr[\sum_{I=t-1}^{t}s^I[V^I(\mathbf{q}_t^A)-V^I(\mathbf{q}_t^B)-\zeta]\geq 0]$$

Rearranging terms we obtain:

$$p_t^A\left(\mathbf{q}_t^A,\mathbf{q}_t^B\right)=\Pr[\pi_t^A\geq\frac{1}{2}]=\Pr[\sum_{I=t-1}^{t}s^I[V^I(\mathbf{q}_t^A)-V^I(\mathbf{q}_t^B)]\geq\ \zeta\sum_{I=t-1}^{t}s^I]$$

Denoting $\sum_I s^I=s$ and $\frac{1}{s}\sum_I s^I[V^I(\mathbf{q}_t^A)-V^I(\mathbf{q}_t^B)]=\widehat{\zeta}$ we obtain:

$$p_t^A\left(\mathbf{q}_t^A,\mathbf{q}_t^B\right)=\Pr[\pi_t^A\geq\frac{1}{2}]=\Pr[\zeta\leq\widehat{\zeta}]:=\mathcal{F}\left(\widehat{\zeta}\right)$$

where $\mathcal{F}\left(\widehat{\zeta}\right)$ denotes the comulative density function. Finally, we also take into account the distribution of the random variable ς to write a final expression for the probability of winning:

$$p_t^A\left(\mathbf{q}_t^A,\mathbf{q}_t^B\right)=\Pr[\pi_t^A\geq\frac{1}{2}]=[\widehat{\zeta}+\frac{1}{2}]$$

Candidate B wins with probability $p_t^B=1-p_t^A$.

Notice that $p_t^j\left(\mathbf{q}_t^A,\mathbf{q}_t^B\right)$ may be written as the sum of probability of winning with respect to each generation, weighted by the size of the generation, equal to $\frac{1}{2}$; that is $p_t^j\left(\mathbf{q}_t^A,\mathbf{q}_t^B\right)=\frac{1}{s}\left(\frac{1}{2}p_t^{j,t}\left(\mathbf{q}_t^A,\mathbf{q}_t^B\right)+\frac{1}{2}p_t^{j,t-1}\left(\mathbf{q}_t^A,\mathbf{q}_t^B\right)\right)$, where $p_t^{j,I}\left(\mathbf{q}_t^A,\mathbf{q}_t^B\right)$ denotes the probability of winning for candidate j for generation I. I will use this decomposition in the following propositions.

Each candidate maximizes the probability of winning[3]; that is a candidate wants either to maximize the expected margin of victory or to minimize the expected margin of loss, given the other candidate's policy vector.

We now have all the elements to define a two-person, constant-sum and symmetric game Γ where the two candidates $j=A,B$ are players, the two policy vectors $\mathbf{q}_t^j\in\mathfrak{Q}\subset\mathbb{R}^2$ the strategies and the probabilities of winning $p_t^j\left(\mathbf{q}_t^A,\mathbf{q}_t^B\right):\mathfrak{Q}\times\mathfrak{Q}\longrightarrow\mathbb{R}$ the payoffs. Γ is written as $\left(\mathfrak{Q},\mathfrak{Q};p_t^A\left(\mathbf{q}_t^A,\mathbf{q}_t^B\right),p_t^B\left(\mathbf{q}_t^A,\mathbf{q}_t^B\right)\right)$. It is also useful to remind that in a two-person, constant-sum game a pair of policies $\left(\mathbf{q}_t^{A*},\mathbf{q}_t^{B*}\right)\in\mathfrak{Q}\times\mathfrak{Q}$ is an equilibrium if and only if it is a saddle point for the game

$$\Gamma = \left(\mathfrak{Q}, \mathfrak{Q}; p_t^A\left(\mathbf{q}_t^A, \mathbf{q}_t^B\right), 1 - p_t^A\left(\mathbf{q}_t^A, \mathbf{q}_t^B\right)\right)$$

Definition 5 *A Pair* $\left(\mathbf{q}_t^{A*}, \mathbf{q}_t^{B*}\right) \in \mathfrak{Q} \times \mathfrak{Q}$ *is called a (pure strategy) Nash equilibrium (NE) of* Γ *if and only if* $p_t^j\left(\mathbf{q}_t^A, \mathbf{q}_t^{B*}\right) \leqslant p_t^j\left(\mathbf{q}_t^{A*}, \mathbf{q}_t^{B*}\right) \leqslant p_t^j\left(\mathbf{q}_t^{A*}, \mathbf{q}_t^B\right)$*,* $\forall\ \mathbf{q}_t^A, \mathbf{q}_t^B \in \mathfrak{Q}$ *which satisfy the budget constraint.*

Timing of the game

The game has three stage. In the first the two candidates, simultaneously and independently, announce (and commit to) their policy vectors.

In the second stage elections take place. A candidate wins if and only if she obtains the majority of votes; in the case of a tie a coin is tossed in order to decree the winner. Finally, in the third stage, workers choose their leisure, given the level of tax credits chosen by the Government.

Calculate the equilibrium

I solve the game by backward induction, starting from the final stage.

A representative old worker solves the following optimization problem:

$$\max_{\left\{l_t^{t-1}\right\}} \ c_t^{t-1} + \psi^{t-1} \log l_t^{t-1} + \mathbf{D}^B \cdot \left(\xi_t^{i,t-1} + \zeta\right)$$

$$s.t.\ c_t^{t-1} = \left(1 - \tau_t^{\prime t-1}\right)\left(T - l_t^{t-1}\right)$$

The optimal amount of leisure which solves the problem is:

$$l_t^{t-1*} = \frac{\psi^{t-1}}{1 - \tau_t^{\prime t-1}} \tag{13}$$

Substituting (13) into (1) we obtain an expression for the Indirect Utility Function:

$V_t^{t-1} = T\left(1 - \tau_t^{\prime t-1}\right) - \psi^{t-1} + \psi^{t-1} \log \psi^{t-1} - \psi^{t-1} \log\left(1 - \tau_t^{\prime t-1}\right) + \mathbf{D}^B \cdot \left(\xi_t^{i,t-1} + \zeta\right)$

with $1 - \tau\left(1 - a_t^{t-1}\right) > 0 \Longrightarrow a_t^{t-1} > 1 - \frac{1}{\tau}$ for the existence of the logarithm.

I do the same for the representative young worker:

$$\max_{\left\{l_t^t, l_{t+1}^t\right\}} c_t^t + \psi^t \log l_t^t + \beta\left(c_{t+1}^t + \psi^{t-1} \log l_{t+1}^t\right) + \mathbf{D}^B \cdot \left(\xi_t^{i,t} + \zeta\right)$$

$$s.t. \;\; c_t^t = \left(1 - \tau_t^{'t}\right)\left(T - l_t^t\right)$$

$$c_{t+1}^t = \left(1 - \tau_{t+1}^{'t}\right)\left(T - l_{t+1}^t\right)$$

The resolution of the problem yields the optimal level of leisure at time t and $t+1$ and the Indirect Utility Function:

$$l_t^{t*} = \frac{\psi^t}{1 - \tau_t^{'t}} \tag{14}$$

$$l_{t+1}^{t*} = \frac{\psi^{t-1}}{1 - \tau_{t+1}^{'t}} \tag{15}$$

$$V_t^t = T\left(1 - \tau_t^{'t}\right) - \psi^t + \psi^t \log \psi^t - \psi^t \log\left(1 - \tau_t^{'t}\right) \tag{16}$$

$$+\beta\left(T\left(1 - \tau_{t+1}^{'t}\right) - \psi^{t-1} + \psi^{t-1} \log \psi^{t-1} - \psi^{t-1} \log\left(1 - \tau_{t+1}^{'t}\right)\right) + \mathbf{D}^B \cdot \left(\xi_t^{i,t} + \zeta\right)$$

Comparative statics shows that the optimal level of leisure is increasing in preferences of groups for leisure and decreasing in the amount of tax credits. That is $\frac{dl_t^{I*}}{d\psi^I} = \frac{1}{1-\tau_t^{'I}} > 0$ and $\frac{dl_t^{I*}}{da_t^I} = -\frac{\tau\psi^I}{\left(1-\tau_t^{'I}\right)^2} < 0$.

Analysing the indirect utility functions with respect to $\tau_t^{'I}$ we may notice that two effects coexist: a `tax effect`, $T\left(1 - \tau_t^{'I}\right)$, and a `leisure effect`, $-\psi^I \log\left(1 - \tau_t^{'I}\right)$.

What is the effect of an increase in the optimal tax credit on the wealth of an individual? At a glance, one would be likely to answer that an increase in tax credits increases the individual's utility because the effective marginal tax rate is reduced and the net-of-taxes labour income is increased. But leisure effect says that an increase in tax credits reduces the amount of leisure, and eventually increases the utility. Therefore, the total effect on the welfare of an individual depends on which effect prevails.

In the second stage of the game

Proposition 6 *the political equilibrium is a tie.*

Proof. Candidates $j = A, B$ solve the following problem:

$$\max_{\left\{a_t^{t-1j}, a_t^{tj}\right\}} \; p_t^j \left(\mathbf{q}_t^A, \mathbf{q}_t^B\right)$$

$$s.t. \; \Upsilon_t^j = 0$$

$$a^{\min} \leq a_t^{Ij} \leq a^{\max}$$

The set of Kuhn-Tucker Conditions may be written as follows:

$$\begin{cases} \frac{\partial \Upsilon_t^A}{\partial a_t^{tA}} \lambda^A = \frac{\partial p_t^A}{\partial a_t^{tA}} \\ \frac{\partial \Upsilon_t^A}{\partial a_t^{t-1A}} \lambda^A = \frac{\partial p_t^A}{\partial a_t^{t-1A}} \end{cases} \tag{17}$$

$$\begin{cases} \frac{\partial \Upsilon_t^B}{\partial a_t^{tB}} \lambda^B = \frac{\partial p_t^B}{\partial a_t^{tB}} \\ \frac{\partial \Upsilon_t^B}{\partial a_t^{t-1B}} \lambda^B = \frac{\partial p_t^B}{\partial a_t^{t-1B}} \end{cases} \tag{18}$$

$$\Upsilon_t^j = 0 \tag{19}$$

$$-a_t^{Ij} \leq -a^{\min} \qquad \mu_1^j \geq 0 \qquad \mu_1^j \left(a_t^{Ij} - a^{\min}\right) = 0 \tag{20}$$

$$a_t^{Ij} - a^{\max} \leq 0 \qquad \mu_2^j \geq 0 \qquad \mu_2^j \left(a_t^{Ij} - a^{\max}\right) = 0 \tag{21}$$

where λ^A, λ^B are the two Lagrange multipliers which represent the *per capita marginal gain in expected votes* with respect to a marginal change in the policy made by candidates. In equilibrium λ^A must be equal to λ^B; namely, the per capita marginal gain in expected votes should be equalized between the two candidates. Suppose it is not; then, a candidate realizes that in changing her policy there is the possibility to obtain more votes than her rival and thus to win elections. As a consequence, there exists an incentive for her to increase transfers towards the generation which assures a greater increase in the expected number of votes; as long as this incentive persists an equilibrium cannot exist. ■

Conditions (17), (18) state that candidates choose tax credits up to the level where the marginal political cost (MPC), which represents the reduction in expected votes of raising an additional dollar, is equalized across cohorts. Hence, the political optimal structure is one which minimizes total political costs and clears the budget constraint. An example of political equilibrium is depicted in Figure 5.

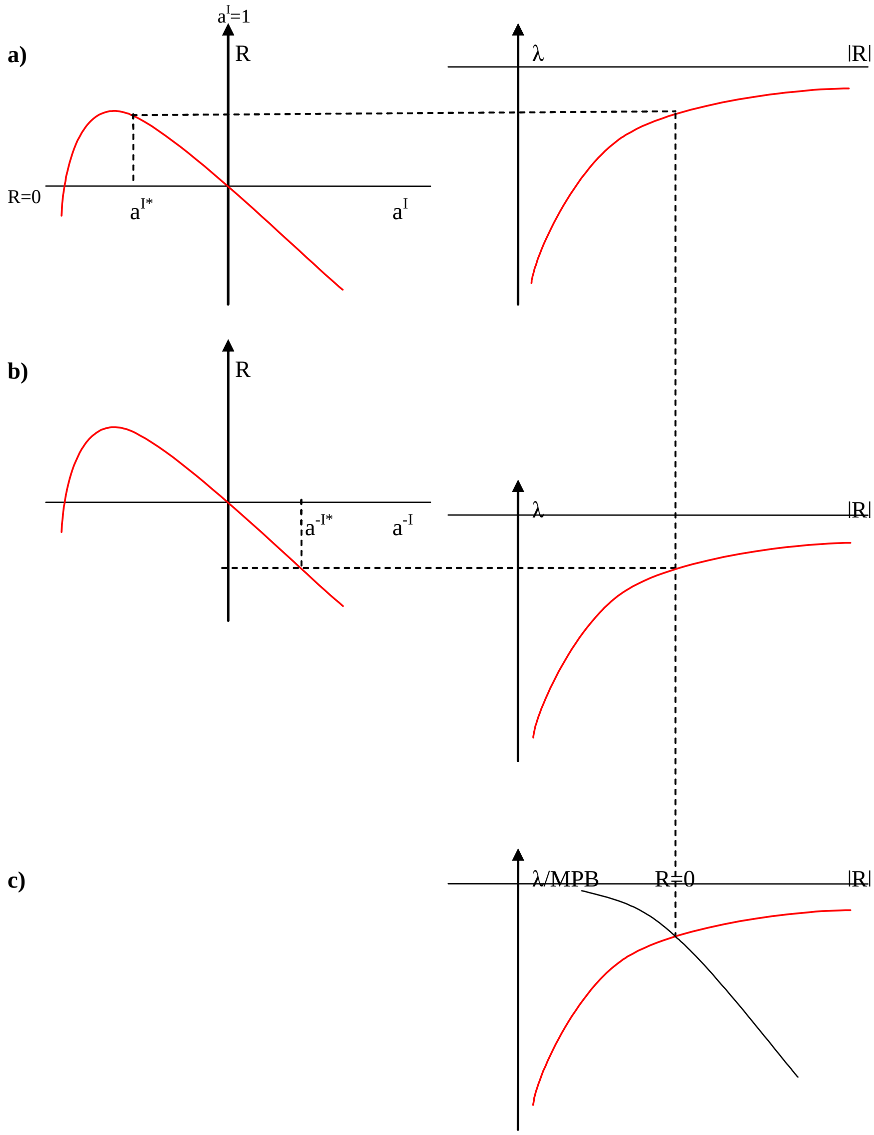

Figure 5 - Tax structure in a political equilibrium

Left-hand side graphs show revenues (vertical axis) as a function of tax credits (horizontal axis). The shape of the function reminds us of the famous "Laffer curve" or rate-revenue relationships. With respect to traditional Laffer curves, these ones have a negative segment; this is not surprising in a pure redistribution model, because if one generation obtains a positive transfer the other one must pay for it. Right-hand side graphs show the relation between Lagrange multipliers (vertical axis) and revenues (horizontal axis). Lambdas measure the intensity with which political tastes react to a change in full income by reducing expected backing. Different preferences for leisure and different economic and political reactions to taxation result in different tax rates. Finally, graph c shows the political equilibrium. The marginal political benefit (MPB) equates the sum of single MPBs expressed per dollar of expenditure. The equilibrium is represented by a point where the budget is cleared, $R_t^t + R_t^{t-1} = 0$, and the marginal political cost is equal to the marginal benefit, $MPC^* = MPB^*$. Nothing can be said about the concavity of p_t^j, due to the difficulties arising in evaluating the sign of the value function's second-order derivative[4].

Otherwise, Figure 6 shows a situation which cannot be an equilibrium.

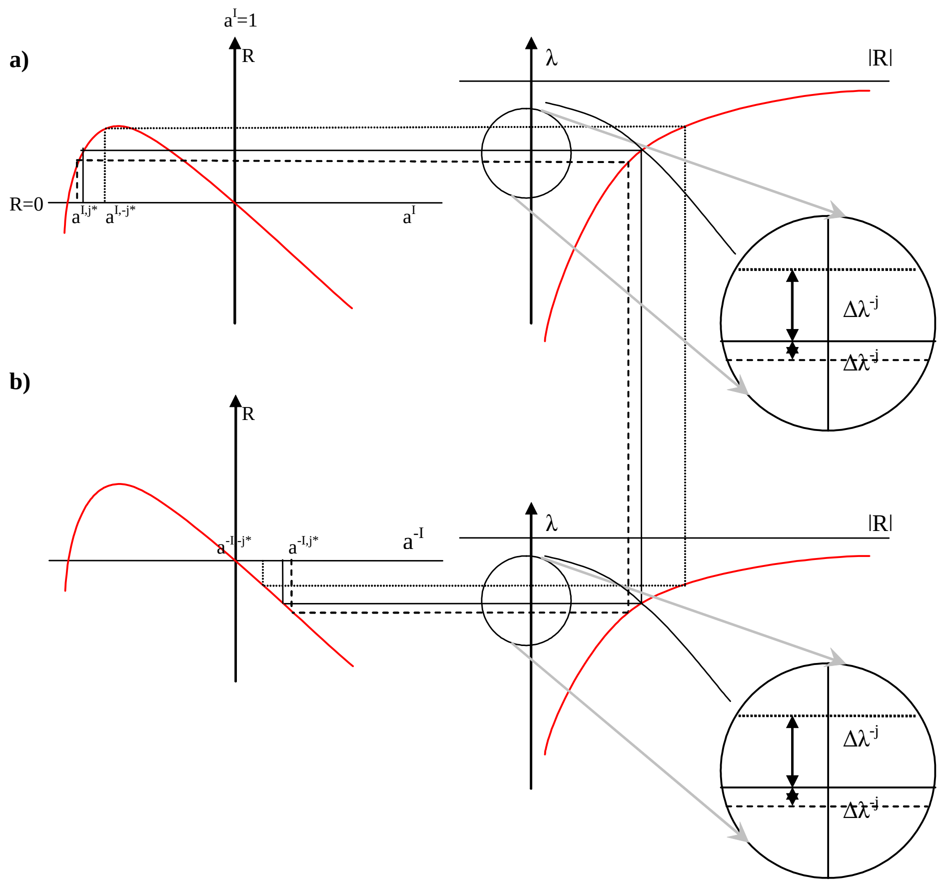

Figure 6 - Non-optimal policies

This time, the two candidates have chosen tax credits such that lambdas are not equalized. With respect to a situation where policies are convergent (solid line), candidate j (dashed line) has chosen a tax policy $\left(a_t^{Ij*}, a_t^{-Ij*}\right)$ and candidate $-j$ (dotted line) a tax policy $\left(a_t^{I-j*}, a_t^{-I-j*}\right)$. The circumscribed area shows that in this situation an increase in lambda by candidate j, $\Delta\lambda^j$, is greater than an increase in lambda by candidate $-j$, $\Delta\lambda^{-j}$; that is $\Delta\lambda^j > \Delta\lambda^{-j}$. But since we defined lambdas as the increase in probability of winning elections, it is clear how such a situation cannot be an equilibrium because j would obtain an increase in the probability of winning. As a consequence, $-j$ would have an incentive to mime j's policy. Therefore, the only possible equilibrium must be one where in moving away from a policy $\Delta\lambda^j = \Delta\lambda^{-j}$.

Corollary 7 *In equilibrium* $\widehat{\zeta} = 0$.

Proof. By proposition 6 the electoral equilibrium is a tie; then the probability of winning must be equal to $\frac{1}{2}$ for every candidate. Since $p_t^j = [\widehat{\zeta} + \frac{1}{2}]$, then $\widehat{\zeta}$ must be equal to zero. ■

In the first stage candidates choose optimal policy vectors which are obtained from the resolution of the maximization problem.

Proposition 8 *A tie in elections may be achieved (i) either if policies converge (ii) or if a policy chosen by one candidate favours one group and a policy chosen by the other candidate favours the other group.*

Proof. From Corollary 7 $\frac{1}{2s}\sum_I s^I[V^I(\mathbf{q}_t^{A*}) - V^I(\mathbf{q}_t^{B*})]$ is equal to zero. This may be achieved only in two ways. Either (i) when policies are convergent, $\mathbf{q}_t^{A*} = \mathbf{q}_t^{B*}$, which entails the equalization of the indirect utility functions $V^I(\mathbf{q}_t^{B*}) = V^I(\mathbf{q}_t^{A*})$; or (ii) when policies are divergent, $\mathbf{q}_t^{A*} \neq \mathbf{q}_t^{B*}$, and in this case the following condition must hold:

$$\frac{s^t}{s}[V^t(\mathbf{q}_t^{A*}) - V^t(\mathbf{q}_t^{B*})] + \frac{s^{t-1}}{s}[V^{t-1}(\mathbf{q}_t^{A*}) - V^{t-1}(\mathbf{q}_t^{B*})] = 0$$

which may be also written as:

$$\frac{s^t}{s}\left[V^t(\mathbf{q}_t^{A*}) - V^t(\mathbf{q}_t^{B*})\right] = \frac{s^{t-1}}{s}\left[V^{t-1}(\mathbf{q}_t^{B*}) - V^{t-1}(\mathbf{q}_t^{A*})\right]$$

■

Notice that:

1. if an equilibrium is achieved via a `policy convergence`, then it must be true that $p_t^{A,t} = p_t^{A,t-1} = p_t^{B,t} = p_t^{B,t-1} = \frac{1}{2}$.

2. if an equilibrium is achieved via a `policy divergence`, one of the following two statements must be true: (i) either $p_t^{A,t} = 1$, $p_t^{A,t-1} = 0, p_t^{B,t} = 0$, $p_t^{B,t-1} = 1$, (ii) or $p_t^{A,t} = 0$, $p_t^{A,t-1} = 1, p_t^{B,t} = 1, p_t^{B,t-1} = 0$.

Proposition 9 *if* $\mathbf{q}_t^A = \mathbf{q}_t^B = \mathbf{q}_t$ *then* $p_t^j(\mathbf{q}_t, \mathbf{q}_t) = \frac{1}{2}$.

Proof. Notice that if $\mathbf{q}_t^A = \mathbf{q}_t^B$, $V^{t-1}(\mathbf{q}_t^A) = V^{t-1}(\mathbf{q}_t^B)$ and $V^t(\mathbf{q}_t^A) = V^t(\mathbf{q}_t^B)$ and thus the probability of winning for the two candidates for generations I is equal to $\frac{1}{2}$. Since every generation has size equal to $\frac{1}{2}$, it must be $p_t^j(\mathbf{q}_t, \mathbf{q}_t) = \frac{1}{2}\left(\frac{1}{2}\right) + \frac{1}{2}\left(\frac{1}{2}\right) = \frac{1}{2}$. ■

The problem is now to evaluate whether the equilibrium of the model is achieved via a convergence or a divergence of policies. I will provide a sufficient (but not necessary) condition which assures that an equilibrium is achieved via policy convergence. Instead, note that the classic Lindbeck and Weibull's `monotonicity condition` for the policy convergence in probabilistic voting models is not applicable and thus cannot be used in this setting. Appendix 1 demonstrates the non-applicability of this condition.

Proposition 10 *In a constant-sum game* $\mathbf{q}_t^{A*} = \mathbf{q}_t^{B*} = \mathbf{q}_t^*$.

Proof. First of all, we have defined Γ as a constant-sum game, since $p_t^B\left(\mathbf{q}_t^A, \mathbf{q}_t^B\right) = 1 - p_t^A\left(\mathbf{q}_t^A, \mathbf{q}_t^B\right)$. Suppose now that the pair $(\mathbf{q}_t^{A\diamond}, \mathbf{q}_t^{B\diamond}) \in \mathfrak{Q} \times \mathfrak{Q}$ is the electoral equilibrium of the game. Suppose also that $\mathbf{q}_t^{A\diamond} \neq \mathbf{q}_t^{B\diamond}$. We know by (9) that $p_t^A\left(\mathbf{q}_t^{B\diamond}, \mathbf{q}_t^{B\diamond}\right) = \frac{1}{2}$. Therefore, by the definition of Nash Equilibrium it must be

$$p_t^A\left(\mathbf{q}_t^{A\diamond}, \mathbf{q}_t^{B\diamond}\right) > p_t^A\left(\mathbf{q}_t^{B\diamond}, \mathbf{q}_t^{B\diamond}\right) = \frac{1}{2} \tag{22}$$

By definition of constant-sum game we also know that $p_t^B\left(\mathbf{q}_t^{A\diamond}, \mathbf{q}_t^{A\diamond}\right) = 1 - p_t^A\left(\mathbf{q}_t^{A\diamond}, \mathbf{q}_t^{A\diamond}\right) = \frac{1}{2}$ and again by definition of Nash Equilibrium, it must be

$$p_t^B\left(\mathbf{q}_t^{B\diamond}, \mathbf{q}_t^{A\diamond}\right) > p_t^B\left(\mathbf{q}_t^{A\diamond}, \mathbf{q}_t^{A\diamond}\right) = \frac{1}{2} \tag{23}$$

Since $p_t^B\left(\mathbf{q}_t^{B\diamond}, \mathbf{q}_t^{A\diamond}\right) = 1 - p_t^A\left(\mathbf{q}_t^{B\diamond}, \mathbf{q}_t^{A\diamond}\right)$, this implies that $p_t^A\left(\mathbf{q}_t^{B\diamond}, \mathbf{q}_t^{A\diamond}\right) < \frac{1}{2}$. By 22, this implies that $p_t^A\left(\mathbf{q}_t^{A\diamond}, \mathbf{q}_t^{B\diamond}\right) > \frac{1}{2}$, a contradiction. Therefore, $\mathbf{q}_t^{B\diamond} = \mathbf{q}_t^{B\diamond}$. ■

Summarising, in this model the equilibrium is achievable via a convergence of policies even if the Lindbeck and Weibull monotonicity condition is not applicable. The Nash equilibrium of the game is

$$\left(\mathbf{q}_t^*, \mathbf{q}_t^*; \frac{1}{2}, \frac{1}{2}\right)$$

The optimal tax credit is a function of the density of both groups, of the nominal marginal tax rate, of the total endowment of time and of preferences of groups for leisure[5]. That is:

$$a_t^{Ij} = a\left(s\left(l\left(\psi^I, \tau\right)\right), s\left(l\left(\psi^{-I}, \tau\right)\right)\tau, T, \psi^I, \psi^{-I}\right)$$

In Mathematical Appendix 2 I will provide a complete resolution to the problem.

Analysing results we may see that this political economy framework suggests that tax rates should be differentiated. Indeed, if a traditional normative approach suggests that a benevolent government *should tax* the poorest groups less, this political economy outline suggests that in real world vote-seeker governments *tax* groups according to their ability to threaten politicians in an electoral competition.

An analytical solution to the maximization problem of the first stage is impossible to find because it is a hard task to understand which shape the value function has. Nevertheless, we know that since Q is a compact set and the value function is continuous in $\left[a_t^{I\min}, a_t^{I\max}\right]$ the `Weierstrass theorem` ensures that a maximum exists. Then, it only remains for us to understand whether the optimum is an interior solution or stands at one (or both) endpoint(s) of the interval.

If the maximum is an interior solution, it must come from the resolution of the first order conditions (see Appendix 2) which finds all the stationary points. Otherwise,

Proposition 11 *If the maximum is an endpoint solution, then the NE is*

$$\max\left\{\left(a_t^{t\min A}, a_t^{t-1\max A}; a_t^{t\min B}, a_t^{t-1\max B}\right), \left(a_t^{t-1\min A}, a_t^{t\max A}; a_t^{t-1\min B}, a_t^{t\max B}\right)\right\}$$

Proof. In order to balance the budget constraint, if the marginal tax rate of a generation is greater than one, the marginal tax rate of other generation must be lower than one; otherwise the sum of two positive tax revenues could never be equal to zero. Since $a_t^{I\min j} < 1$ and $a_t^{I\max j} > 1$, solutions such as $\left(a_t^{t\min A}, a_t^{t-1\min A}; a_t^{t\min B}, a_t^{t-1\min B}\right)$ or $\left(a_t^{t\max A}, a_t^{t-1\max A}; a_t^{t\max B}, a_t^{t-1\max B}\right)$ are not clearly achievable. Therefore, we must conclude that the only possible solution is

$$\max\left\{\left(a_t^{t\min A}, a_t^{t-1\max A}; a_t^{t\min B}, a_t^{t-1\max B}\right), \left(a_t^{t-1\min A}, a_t^{t\max A}; a_t^{t-1\min B}, a_t^{t\max B}\right)\right\}$$ [6]

■

This proposition has an important meaning. It says that, if an internal solution is not achievable, candidates must favour a generation and penalize the other generation as much as they can, by choosing the highest and the lowest tax rates in the set of common strategies.

As I stated before, due to the complexity of the system of equations we cannot rely on an analytical solution to the first stage of the game. Therefore, I introduce some conjectures about the equilibrium of the game and I verify them performing numerical simulations (see Appendix 3).

Conjecture 12 *Tax credits are higher for the older generations.*

Proof. result obtained via numerical simulations. ■

Conjecture 13 *The older generations offer either a very low level of labour or retire at all, depending on the values which parameters assume, whilst the younger generations offer a greater amount of labour.*

Proof. result obtained via numerical simulations. ■

Conjecture 14 *Tax revenues collected via labour taxation of the younger generations are positive, whilst those of the older generations are negative.*

Proof. result obtained via numerical simulations. ■

Analysing results of numerical simulation we may conclude that a fiscal system where self-interested governments maximize the probability of winning induces the old to retire early. In order to facilitate early retirement, revenues raised from the taxation of the old are negative and, on the contrary, revenues raised from the taxation of the young are positive and equal to the amount of transfers that the old receive. Thus, in this model there exists a net transfer of resources from the younger to the older generation, suggesting that the former carry the entire burden of social security systems, whilst the latter are net beneficiaries.

A variant with altruism

The simple model described above is able to explain the very negative phenomenon of early retirement. It depicts an economic environment where politicians are captured by most strongly focused single-minded groups. As long as candidates are self-interested and only aim to win elections, this political failure magnifies labour markets failures. Of course this cannot be optimal for society, especially considering the effects on inter-generational equity: older generations are net beneficiaries, whilst younger generations net payers. Is there any possibility of mitigating this uneven situation? As long as the old are selfish and only aim to maximise their welfare a solution which increases the young's welfare is hardly achievable. Otherwise, I suggest that altruism offers a rationale against early retirement. Altruism is seen as a change in preferences by the old which this time pays attention to the young's needs. This change in preferences should lead to a more equitable equilibrium.

In this chapter I consider a model where the old workers internalise their offspring's wealth. A classical altruistic model considers that households can be represented by a dynasty who perpetuates forever. As a consequence, the old internalize the utility function of the young. Hence, the new utility function of the old may be written as:

$$U^{t-1} = c_t^{t-1} + \psi^{t-1} \log l_t^{t-1} + \sigma U^t \tag{24}$$

where $\sigma \in [0, 1]$ is a parameter which captures the degree of altruism of the old for the young; the higher σ the more the old assign a greater importance to the young's wealth. Under this new framework, we should expect that policies chosen by the government become less burdensome on the young, since the old are now prone to share the onus of the system.

Conjecture 15 *with respect to the basic model, tax credits for the old (young) are lower (higher) and inter-generational transfers from the young to the old are reduced.*

Proof. result obtained via numerical simulations. ■

Conclusions

I introduced a very simple probabilistic voting model where the generation of the old is more-single minded than the generation of the young; that is, the former has greater preferences for leisure than the latter. This enables this group to be more politically powerful in a political competition between two candidates who have to choose effective marginal tax rates on labour in order to maximise the probability of winning elections. The equilibrium of the game is one where the two candidates even out and policies are convergent; this could be achieved via an internal or a corner solution, depending on the concavity/convexity of the value function. Simulations show that the old generation obtains higher tax credits, higher levels of leisure and positive inter-generational transfers. Therefore, the young are worse-off and they bear the burden of social security systems. Altruism may reduce this uneven redistribution scheme, lightening the excess pressure on younger generations. Inter-generational pacts could represent a possible solution to the early retirement problem, forcing the old to internalize the welfare of the young in order to make them share the entire burden of social security systems.

Mathematical Appendix 1

Proposition 16 *(Monotonicity condition) Assume (i) V_t^i is concave in q_t^j (ii) for each group and candidate $\frac{\frac{\partial p_t^j}{\partial a_t^{Ij}}}{\frac{\partial \Upsilon_t^j}{\partial a_t^{Ij}}}$ is strictly monotonic. If $\left(\mathbf{q}_t^{A*}, \mathbf{q}_t^{B*}\right)$ is a pure strategy electoral equilibrium, then $\mathbf{q}_t^{A*} = \mathbf{q}_t^{B*}$.*

Proof. From Proposition 6 we know that λ^j and λ^{-j} must be equal for every generation. This entails that the ratio between the two Lagrange multipliers of different candidates must be equal for every generation as well. I call this ratio $\rho^I := \frac{\lambda^{jI}}{\lambda^{-jI}}$. The problem is to assess whether this condition may be achieved under a divergence or a convergence of policies. To prove this, I start assuming that $\mathbf{q}_t^j \neq \mathbf{q}_t^{-j}$. Since candidates must clear the balanced-budget constraint, there must exist a generation which gets higher tax credits under candidate

j (suppose it is t) and another generation which gets higher tax credits under candidate $-j$ $(t-1)$. We have to assess whether the condition $\rho^t = \rho^{t-1}$ is achievable in such a situation. If it is, then an equilibrium is achieved under divergent policies; otherwise, policies are convergent. Notice that if both the numerator and the denominator are monotonic, the ratio is monotonic. If so, it means that (i) either $\rho^t > 1 > \rho^{t-1}$ or (ii) $\rho^{t-1} < 1 < \rho^t$; therefore, an equilibrium cannot be achieved via divergent policies. ■

In this model, and more in general in models where the direct utility function is quasi-linear in the consumption and leisure, the monotonicity condition cannot be applied to solve the candidate's problem. The failure of the monotonicity condition may have several implications. First of all, the possibility that the equilibrium is not achievable via a convergence of policies. Secondly, and more importantly, the convexity of V_t^i means that a maximum does not exist, since the value function is not concave.

(i) Convexity of V_t

Write the worker problem where the direct utility function is quasi-linear in consumption and leisure:

$$\max_{\{l_t\}} U_t = c_t + \psi \log l_t$$

subject to the budget constraint

$$c_t = \tau\left(1 - a_t^j\right)(T - l_t), l_t > 0$$

The optimal leisure is $l_t^* = \frac{\psi}{1-\tau\left(1-a_t^j\right)}$. Obtain the indirect utility function $V_t = T(1-\tau\left(1-a_t^j\right)) - \psi + \log\left(\frac{\psi}{1-\tau\left(1-a_t^j\right)}\right) = T(1-t) - \psi + \psi\log\psi - \psi\log w - \psi\log\left(1-\tau\left(1-a_t^j\right)\right)$. Define the constant term $A := T - 1 + \psi\log\psi$, substitute and obtain $V_t = A - \tau\left(1-a_t^j\right)T - \psi\log\left(1-\tau\left(1-a_t^j\right)\right)$. Write the first order condition

$$\frac{\partial V_t}{\partial a_t^j} = T\tau - \frac{\psi\tau}{1-\tau+\tau a_t^j} = 0$$

Note that there exist only a stationary point, $a_t^{jo} = 1 - \frac{\psi - T}{\tau\psi}$. Write the second order condition

$$\frac{\partial^2 V_t}{\partial\left(a_t^j\right)^2} = \frac{\psi\tau^2}{\left(1-\tau+\tau a_t^j\right)^2} > 0$$

That is, V_t is a convex function and $a_t^{jo} := \arg\min\left(V_t\right)$.

(ii) Non-monotonicity

Impose the ratio $\rho^I = \frac{\lambda^{jI}}{\lambda^{-jI}}$ to be equal to one, subtract the denominator from the numerator and verify whether the expression has a definite sign. Denoting $z_t = V^I(\mathbf{q}_t^j) - V^I(\mathbf{q}_t^{-j})$ we get the following:

$$\overbrace{\left(\frac{\frac{\partial}{\partial a_t^{tj}}\left(\frac{1}{s}\right)}{\frac{\partial \Upsilon^j}{\partial a_t^{tj}}} - \frac{\frac{\partial}{\partial a_t^{t-j}}\left(\frac{1}{s}\right)}{\frac{\partial \Upsilon^j}{\partial a_t^{t-j}}}\right)\sum_I \frac{1}{2}s^t z_t +}^{A} \tag{25}$$
$$\overbrace{+\frac{1}{s}\left(\left(\frac{\frac{\partial s^t}{\partial a_t^{tj}}}{\frac{\partial \Upsilon^j}{\partial a_t^{tj}}} - \frac{\frac{\partial s^t}{\partial a_t^{t-j}}}{\frac{\partial \Upsilon^j}{\partial a_t^{t-j}}}\right) z_t + \left(\frac{\frac{\partial V_t^t}{\partial a_t^{tj}}}{\frac{\partial \Upsilon^j}{\partial a_t^{tj}}} - \frac{\frac{\partial V_t^t}{\partial a_t^{t-j}}}{\frac{\partial \Upsilon^j}{\partial a_t^{t-j}}}\right) s^t\right)}^{B}$$

for generation t, and

$$\overbrace{-\left(\frac{\frac{\partial}{\partial a_t^{t-1j}}\left(\frac{1}{s}\right)}{\frac{\partial \Upsilon^j}{\partial a_t^{t-1j}}} - \frac{\frac{\partial}{\partial a_t^{t-1-j}}\left(\frac{1}{s}\right)}{\frac{\partial \Upsilon^j}{\partial a_t^{t-1-j}}}\right)\sum_I \frac{1}{2}s^{t-1} z_t +}^{C} \tag{26}$$
$$\overbrace{+\frac{1}{s}\left(\left(\frac{\frac{\partial s^{t-1}}{\partial a_t^{t-1j}}}{\frac{\partial \Upsilon^j}{\partial a_t^{t-1j}}} - \frac{\frac{\partial s^{t-1}}{\partial a_t^{t-1-j}}}{\frac{\partial \Upsilon^j}{\partial a_t^{t-1-j}}}\right)(-z_t) + \left(\frac{\frac{\partial V_t^{t-1}}{\partial a_t^{t-1j}}}{\frac{\partial \Upsilon^j}{\partial a_t^{t-1j}}} - \frac{\frac{\partial V_t^{t-1}}{\partial a_t^{t-1-j}}}{\frac{\partial \Upsilon^j}{\partial a_t^{t-1-j}}}\right) s^{t-1}\right)}^{D}$$

for generation $t-1$.

By the meaning of Proposition 6 A and C are equal to zero. Thus we have to verify that B and D are monotonic. Notice that as demonstrated before $\frac{\partial V_t^t}{\partial a_t^{tj}}$ is not monotonic and that $\frac{\partial \Upsilon^j}{\partial a_t^{tj}}$ is not monotonic either.

$sign(z_t)$ changes according to the interval where tax credits find. Denoting by $a_{|V_t=0^+}$ and $a_{|V_t=0^-}$ points where the V_t intersects the axis[7] (respectively at the right and at the left hand side) representing the tax credit we may easily see that 6 cases to study arise:

$$a_t^{-j+} < a_t^{j+} < a_{|V_t=0} \Longrightarrow z_t < 0$$

$$a_t^{-j+} < a_{|V_t=0} < a_t^{j+} < a_t^{jo} \Longrightarrow z_t < 0$$

$$a_{|V_t=0} < a_t^{-j+} < a_t^{j+} < a_t^{jo} \Longrightarrow z_t > 0$$

$$a_{|V_t=0} < a_t^{-j+} < a_t^{jo} < a_t^{j+} < a_{|V(a^{-j})<V(a^j)} \Longrightarrow z_t > 0$$

$$a_{|V_t=0^+} < a_t^{-j+} < a_t^{jo} < a_{|V(a_t^j)<V(a_t^{-j})} < a_t^{j+} < a_{|V_t=0^-} \Longrightarrow z_t > 0$$

$$a_{|V_t=0^+} < a_t^{-j+} < a_t^{jo} < a_{|V(a_t^j)<V(a_t^{-j})} < a|_{V_t=0^-} < a^{j+} \Longrightarrow z_t > 0$$

We study the sign of expression (25) and (26). Since the $sign\left(z_t\right)$ is discontinuous, $\frac{\partial V_t^j}{\partial a_t^{Ij}}$ and $\frac{\partial \Upsilon_t^j}{\partial a_t^{Ij}}$ are not monotonic, the sign of the expression is not clear and thus we cannot say *a-priori* whether the monotonicity condition holds. As a consequence the Lindbeck and Weibull's monotonicy condition may not be exploited in this model to demonstrate that an equilibrium is only achievable via a convergence of policies.

Mathematical Appendix 2

In this Appendix I provide a complete resolution to the candidates' problem when the equilibrium is internal. The two candidates face exactly the same optimization problem, maximizing the probability of winning.

$$\max_{\left\{a_t^{tj}, a_t^{t-1j}\right\}} p_t^j = \frac{1}{2} + \frac{1}{2s} \sum_{I=t-1}^{t} s^I \left[V^i\left(\mathbf{q}_t^j\right) - V^i\left(\mathbf{q}_t^{-j}\right)\right]$$

$$\Upsilon_t^j := \frac{\tau}{2} \sum_{I=t-1}^{t} \left(T - l_t^I\right)\left(1 - a_t^{Ij}\right) = 0$$

$$a^{\min} \leq a_t^{Ij} \leq a^{\max}$$

I write the Lagrangian function for candidate j:

$$\mathcal{L}^j = \frac{1}{2} + \frac{1}{2s} \sum_{I=t-1}^{t} s^I \left[V^i\left(\mathbf{q}_t^j\right) - V^i\left(\mathbf{q}_t^{-j}\right)\right] - \lambda^j\left(\Upsilon_t^j\right) - \mu_1^j\left(a^{\min} - a_t^{Ij}\right) - \mu_2^j\left(a_t^{Ij} - a^{\max}\right)$$

Deriving the Lagrangian I obtain Kuhn-Tucker conditions:

$$\begin{cases} (1)\ \frac{\partial \mathcal{L}^j}{\partial a_t^{t-1j}} := \frac{\partial}{2\partial a_t^{t-1j}}\left(\frac{1}{s}\right)\sum_I s^I\left[V^i\left(\mathbf{q}_t^j\right)-V^i\left(\mathbf{q}_t^{-j}\right)\right]+ \\ +\frac{1}{2s}\cdot\frac{\partial s^{t-1}}{\partial l_t^{t-1}}\cdot\frac{\partial l_t^{t-1}}{\partial a_t^{t-1j}}\left(V_t^{t-1j}-V_t^{t-1-j}\right)+\frac{s^{t-1}}{2s}\left(\frac{\partial V_t^{t-1}}{\partial a_t^{t-1j}}\right)+\mu_1^j-\mu_2^j=\lambda^j\left(\frac{\partial \Upsilon_t^j}{\partial a_t^{\tau-1j}}\right) \\ (2)\ \frac{\partial \mathcal{L}^j}{\partial a_t^{tj}} := \frac{\partial}{2\partial a_t^{tj}}\left(\frac{1}{s}\right)\sum_I s^I\left[V^i\left(\mathbf{q}_t^j\right)-V^i\left(\mathbf{q}_t^{-j}\right)\right]+ \\ +\frac{1}{2s}\cdot\frac{\partial s^t}{\partial l_t^t}\cdot\frac{\partial l_t^t}{\partial a_t^{tj}}\left(V_t^{tj}-V_t^{t-j}\right)+\frac{s^t}{2s}\left(\frac{\partial V_t^t}{\partial a_t^{tj}}\right)+\mu_1^j-\mu_2^j=\lambda^j\left(\frac{\partial \Upsilon_t^j}{\partial a_t^{tj}}\right) \\ (3)\ \Upsilon_t^j=0 \\ (4)\ a^{\min}-a_t^{Ij}\leq \quad \mu_1^j\geq 0 \quad \mu_1^j\left(a_t^{Ij}-a^{\min}\right)=0 \\ (5)\ a_t^{Ij}-a^{\max}\leq 0 \quad \mu_2^j\geq 0 \quad \mu_2^j\left(a_t^{Ij}-a^{\max}\right)=0 \end{cases}$$

By Proposition 10 we know that at an equilibrium $\mathbf{q}_t^A = \mathbf{q}_t^B$, such that first order conditions if the solution is internal may be simplified in the following way:[8]

$$\begin{cases} (1)\ \frac{\partial \mathcal{L}^A}{\partial a_t^{t-1A}} := \frac{s^{t-1}}{2s}\left(\frac{\partial V_t^{t-1}}{\partial a_t^{t-1A}}|_{\mathbf{q}_t^A=\mathbf{q}_t^{A*}}\right)=\lambda^A\left(\frac{\partial \Upsilon_t^A}{\partial a_t^{t-1A}}|_{\mathbf{q}_t^A=\mathbf{q}_t^{A*}}\right) \\ (2)\ \frac{\partial \mathcal{L}^A}{\partial a_t^{tA}} := \frac{s^t}{2s}\left(\frac{\partial V_t^t}{\partial a_t^{tA}}|_{\mathbf{q}_t^A=\mathbf{q}_t^{A*}}\right)=\lambda^A\left(\frac{\partial \Upsilon_t^A}{\partial a_t^{tA}}|_{\mathbf{q}_t^A=\mathbf{q}_t^{A*}}\right) \\ (3)\ \Upsilon_t^A=0 \\ (4)\ \mu_1^A=0 \quad \mu_1^A\left(a_t^{IA}-a^{\min}\right)=0 \\ (5)\ \mu_2^A=0 \quad \mu_2^A\left(a_t^{IA}-a^{\max}\right)=0 \\ (6)\ \frac{\partial \mathcal{L}^B}{\partial a_t^{t-1B}} := \frac{s^{t-1}}{2s}\left(\frac{\partial V_t^{t-1}}{\partial a_t^{t-1B}}|_{\mathbf{q}_t^B=\mathbf{q}_t^{B*}}\right)=\lambda^B\left(\frac{\partial \Upsilon_t^B}{\partial a_t^{t-1B}}|_{\mathbf{q}_t^B=\mathbf{q}_t^{B*}}\right) \\ (7)\ \frac{\partial \mathcal{L}^B}{\partial a_t^{tB}} := \frac{s^t}{2s}\left(\frac{\partial V_t^t}{\partial a_t^{tB}}|_{\mathbf{q}_t^B=\mathbf{q}_t^{B*}}\right)=\lambda^B\left(\frac{\partial \Upsilon_t^B}{\partial a_t^{tB}}|_{\mathbf{q}_t^B=\mathbf{q}_t^{B*}}\right) \\ (8)\ \Upsilon_t^B=0 \\ (9)\ \mu_1^B=0 \quad \mu_1^B\left(a_t^{IB}-a^{\min}\right)=0 \\ (10)\ \mu_2^B=0 \quad \mu_2^B\left(a_t^{IB}-a^{\max}\right)=0 \\ (11)\ \lambda^A=\lambda^B=\lambda \end{cases}$$

We then obtain the reaction functions:

$$r_t^A = \begin{cases} a_t^{tA} = r\left(a_t^{tB}, a_t^{t-1B}, s\left(l\left(\psi^{t-1},\tau\right)\right), s\left(l\left(\psi^t,\tau\right)\right), \tau, T, \psi^{t-1}, \psi^t\right) \\ a_t^{t-1A} = r\left(a_t^{tB}, a_t^{t-1B}, s\left(l\left(\psi^{t-1},\tau\right)\right), s\left(l\left(\psi^t,\tau\right)\right), \tau, T, \psi^{t-1}, \psi^t\right) \end{cases}$$

$$r_t^B = \begin{cases} a_t^{tB} = r\left(a_t^{tA}, a_t^{t-1A}, s\left(l\left(\psi^{t-1},\tau\right)\right), s\left(l\left(\psi^t,\tau\right)\right), \tau, T, \psi^{t-1}, \psi^t\right) \\ a_t^{t-1B} = r\left(a_t^{tA}, a_t^{t-1A}, s\left(l\left(\psi^{t-1},\tau\right)\right), s\left(l\left(\psi^t,\tau\right)\right), \tau, T, \psi^{t-1}, \psi^t\right) \end{cases}$$

Solving the system we obtain the optimal vector of policies from the set of intersection points Λ_1 :

$a_t^{t-1A} = a(s\left(l\left(\psi^{t-1},\tau\right)\right), s\left(l\left(\psi^t,\tau\right)\right), \tau, T, \psi^{t-1}, \psi^t)$

$a_t^{tA} = a(s\left(l\left(\psi^{t-1},\tau\right)\right), s\left(l\left(\psi^t,\tau\right)\right), \tau, T, \psi^{t-1}, \psi^t)$

$a_t^{t-1B} = a(s\left(l\left(\psi^{t-1},\tau\right)\right), s\left(l\left(\psi^{t},\tau\right)\right), \tau, T, \psi^{t-1}, \psi^{t})$
$a_t^{tB} = a(s\left(l\left(\psi^{t-1},\tau\right)\right), s\left(l\left(\psi^{t},\tau\right)\right), \tau, T, \psi^{t-1}, \psi^{t})$
with $a_t^{t-1A} = a_t^{t-1B}$ and $a_t^{tA} = a_t^{tB}$

With altruism the first order conditions are modified as follows:

$$\begin{cases}
(1)\ \frac{\partial \mathcal{L}^A}{\partial a_t^{t-1A}} := \frac{s^{t-1}}{2s}\left(\frac{\partial V_t^{t-1}}{\partial a_t^{t-1A}}\right) = \lambda^A\left(\frac{\partial \Upsilon_t^A}{\partial a_t^{t-1A}}\right) \\
(2)\ \frac{\partial \mathcal{L}^A}{\partial a_t^{tA}} := \frac{s^{t}}{2s}\left(\frac{\partial V_t^{t}}{\partial a_t^{tA}}\right) + \frac{\sigma s^{t-1}}{2s}\left(\frac{\partial V_t^{t}}{\partial a_t^{t-1A}}\right) = \lambda^A\left(\frac{\partial \Upsilon_t^A}{\partial a_t^{tA}}\right) \\
(3)\ \Upsilon_t^A = 0 \\
(4)\ \mu_1^A = 0 \quad \mu_1^A\left(a_t^{IA} - a^{\min}\right) = 0 \\
(5)\ \mu_2^A = 0 \quad \mu_2^A\left(a_t^{IA} - a^{\max}\right) = 0 \\
(6)\ \frac{\partial \mathcal{L}^B}{\partial a_t^{t-1B}} := \frac{s^{t-1}}{2s}\left(\frac{\partial V_t^{t-1}}{\partial a_t^{t-1B}}\right) = \lambda^B\left(\frac{\partial \Upsilon_t^B}{\partial a_t^{t-1B}}\right) \\
(7)\ \frac{\partial \mathcal{L}^B}{\partial a_t^{tB}} := \frac{s^{t}}{2s}\left(\frac{\partial V_t^{t}}{\partial a_t^{tB}}\right) + \frac{\sigma s^{t-1}}{2s}\left(\frac{\partial V_t^{t}}{\partial a_t^{t-1B}}\right) = \lambda^B \frac{\partial \Upsilon_t^B}{\partial a_t^{tB}} \\
(8)\ \Upsilon_t^B = 0 \\
(9)\ \mu_1^B = 0 \quad \mu_1^B\left(a_t^{IB} - a^{\min}\right) = 0 \\
(10)\ \mu_2^B = 0 \quad \mu_2^B\left(a_t^{IB} - a^{\max}\right) = 0 \\
(11)\ \lambda^A = \lambda^B = \lambda
\end{cases}$$

which gives a new set of intersection points Λ:
$a_t^{t-1A} = a(s\left(l\left(\psi^{t-1},\tau\right)\right), s\left(l\left(\psi^{t},\tau\right)\right), \tau, T, \psi^{t-1}, \psi^{t}, \sigma)$
$a_t^{tA} = a(s\left(l\left(\psi^{t-1},\tau\right)\right), s\left(l\left(\psi^{t},\tau\right)\right), \tau, T, \psi^{t-1}, \psi^{t}, \sigma)$
$a_t^{t-1B} = a(s\left(l\left(\psi^{t-1},\tau\right)\right), s\left(l\left(\psi^{t},\tau\right)\right), \tau, T, \psi^{t-1}, \psi^{t}, \sigma)$
$a_t^{tB} = a(s\left(l\left(\psi^{t-1},\tau\right)\right), s\left(l\left(\psi^{t},\tau\right)\right), \tau, T, \psi^{t-1}, \psi^{t}, \sigma)$
with $a_t^{t-1A} = a_t^{t-1B}$ and $a_t^{tA} = a_t^{tB}$

Appendix 3 - Numerical simulations

Numerical simulations were performed in order to assess the validity of conjectures 12-14, under the assumption that the maximum is an interior solution to the maximization problem. They jointly suppose that the old generation, because more single-minded, obtains more favourable policies from governments. That is, the old obtain higher tax credits (conjecture 12) and positive intergenerational transfers (conjecture 14). Furthermore, the combination of higher preferences for leisure and higher tax credits enables the old to reach higher levels of leisure (conjecture 13). As a consequence the young are worse off, because they obtain lower tax credits and have to endure the entire cost of social security systems[9]. I assume that optimal values are always acceptable, that is

$a_t^{\max}$ is sufficiently high to be always greater than a_t^{Ij*}. Solutions show that only one stationary point exists.

To perform simulations a suitable density function is required. As suggested by Profeta (2002) I will use one with a constant positive elasticity ε

$$s^I = (l^I)^\varepsilon$$

with $\varepsilon = 1$ for computational purposes. Table 1 shows results. The nominal marginal tax rate, τ, was set equal to 1 and the total endowment of time, T, equal to 0.9. Simulations were performed using different values of preferences of workers for leisure, under the condition that the parameter of the old is higher the that of the young. Tax credits are always higher for the old but the difference between tax credits of the two generations reduces with respect to a reduction in the difference between preferences. Leisure is always higher for the old and the amount of leisure increases both for the young and for the old from situation 1 to situation 9. Tax revenues are always positive for the generation of the young and negative for the generation of the old, meaning that the young bear the entire burden of social security systems; otherwise, the old get a transfer (i.e. a pension). Notice that the inter-generational redistribution effect is higher the higher is the difference between preference for leisure amongst cohorts. Finally, notice that, even though the sum of preferences for leisure of the old and the young is equal to one, the total level of leisure is not constant. The worst situation for the aggregate level of employment is achieved in situation 9, whilst the reverse is true for situation 1.

	ψ^{t-1}	ψ^t	τ	T	a^{t-1}	a^t	l^{t-1}	l^t	l	T^{t-1}	T^t
1	0.95	0.05	1	0.9	2.144	0.261	0.442	0.19	0.632	−0.261	0.261
2	0.9	0.1	1	0.9	1.915	0.385	0.469	0.259	0.728	−0.196	0.196
3	0.85	0.15	1	0.9	1.739	0.484	0.488	0.309	0.797	−0.152	0.152
4	0.8	0.2	1	0.9	1.592	0.571	0.502	0.35	0.852	−0.117	0.117
5	0.75	0.25	1	0.9	1.465	0.649	0.511	0.384	0.895	−0.09	0.09
6	0.7	0.3	1	0.9	1.352	0.722	0.517	0.415	0.932	−0.067	0.067
7	0.65	0.35	1	0.9	1.25	0.791	0.519	0.442	0.961	−0.047	0.047
8	0.6	0.4	1	0.9	1.159	0.859	0.517	0.465	0.982	−0.03	0.03
9	0.55	0.45	1	0.9	1.076	0.928	0.51	0.484	0.994	−0.014	0.014

Table 1 - Numerical simulation (basic model)

Notice that the result which states that the old enjoy lower effective marginal tax rates than the young contradicts previous results obtained by probabilistic voting models applied to social security systems. In Profeta, the old are taxed more heavily than the young (Proposition 3.1, p. 345); the same result is achieved by Mulligan and Sala-i-Martin (Proposition 8, p.31).

Table 2 shows results of simulations performed with the altruistic model in order to check the validity of conjecture 15. The altruistic parameter was set equal to 0.3. With respect to results obtained with the basic model notice that the old (young) obtain lower (higher) tax credits and that there are less redistributive effects since transfers from the young to the old are reduced. Furthermore, notice that in situation 9 the young obtain a positive transfer, although this is rather small. Leisure increases for the old, meaning that the higher effective marginal tax rate increases the incentive to quit the labour force, whilst leisure of the young reduces. Aggregate leisure reduces as well, except for situations 8, 9 where this is slightly higher than the previous situation.

	ψ^{t-1}	ψ^t	τ	T	σ	a^{t-1}	a^t	l^{t-1}	l^t	l	T^{t-1}	T^t
1	0.95	0.05	1	0.9	0.3	2.104	0.342	0.451	0.145	0.596	−0.247	0.247
2	0.9	0.1	1	0.9	0.3	1.845	0.503	0.487	0.198	0.685	−0.174	0.174
3	0.85	0.15	1	0.9	0.3	1.645	0.625	0.516	0.239	0.755	−0.123	0.123
4	0.8	0.2	1	0.9	0.3	1.479	0.723	0.540	0.276	0.816	−0.086	0.086
5	0.75	0.25	1	0.9	0.3	1.338	0.804	0.56	0.31	0.87	−0.057	0.057
6	0.7	0.3	1	0.9	0.3	1.217	0.873	0.575	0.343	0.918	−0.035	0.035
7	0.65	0.35	1	0.9	0.3	1.111	0.932	0.584	0.375	0.959	−0.017	0.017
8	0.6	0.4	1	0.9	0.3	1.019	0.987	0.588	0.405	0.993	−0.003	0.003
9	0.55	0.45	1	0.9	0.3	0.939	1.040	0.585	0.432	1.017	0.009	−0.009

Table 2 - Numerical simulation (altruistic model)

A Contribution to the Positive Theory of Indirect Taxation

Introduction

Taxation has been a much-discussed topic in the economic literature. From previous contributions we know that maximum efficiency is achieved via lump-sum taxes, because they nullify the excess burden of taxation. Nevertheless, such taxation is not desirable because it is considered unjust. Thus, in order to achieve equity goals, benevolent governments must accept that taxpayers distort their economic choices in order to escape the burden of taxation. As a consequence market failures arise, such as a reduction in the labour supply.

In democratic societies, allocation choices for the public sector are made through voting, and through the actions of elected representatives. Economic outcomes must be evaluated in a broader context, one that allows for the possibility of setting tax rates at a candidate's discretion, together with the collective nature of existing political institutions that must be relied on to take decisions on fiscal issues.

Depending on whether the political decision-making mechanism is considered by the analysis or not, the literature on taxation is divided in two main streams of research: the normative and the positive approach.

The *normative approach* seeks efficiency-oriented solutions considering the existence of a benevolent social-planner who avoids any concern regarding collective action. A tenet achieved by this analysis states that a tax system is efficient if it minimizes the total excess burden of raising a given amount of revenue. A typical application of this approach is the inverse elasticity rule associated with Ramsey (1927) who analysed an economy with sales taxes imposed on different commodities. This work concludes by affirming that, in order to minimise the excess burden, higher tax rates should be levied on commodities which have a relatively inelastic demand in the range of the demand function with respect to commodities whose demands are more elastic, so as to raise a given total revenue while avoiding, as far as possible, the excess burdens associated with the substitution away from commodities whose after-tax price has risen. Furthermore, a version of Ramsey's rule modified by Diamond (1975) envisions a planner who takes distributional goals into account, derived from a welfare function where weights are attached to the welfare of different individuals. In order to maximise social welfare the planner equalizes distributionally weighted marginal excess burdens per dollar raised across available tax bases.

Otherwise, the *positive approach* studies collective choice processes and their influence on political and economic outcomes. Works belonging to this second strand not only focus on market failures but also on political failures. Two recent works (Polo, 1998; Svensson, 1997) focus on the role of political competition, where candidates propose policy platforms in order to maximise the probability of winning elections (or the number of votes), under conditions of uncertainty about voters' political preferences. Since individuals aim to maximise their utility influenced by public policies, they react positively to an increase in the amount of public goods and negatively to the payment of taxes and to welfare losses caused by taxation. The maximisation of the probability of winning is achievable if politicians design an equilibrium tax structure which equalises the change in opposition per marginal tax dollar raised across groups.

It is essential to understand equilibrium outcomes produced by well-functioning political processes, and to examine how such outcomes change when imperfections become part of the collective action. This implies that we need a model of *collective choice* as our starting point that allows us to study and demonstrate the existence and stability of political equilibria and to examine the nature of specific equilibrium policies or outcomes. *Probabilistic voting Theory* is able to accomplish this goal, since the resulting Nash equilibria amongst parties are Pareto-optimal. (Hettich and Winer 1999, Chapter 4.) However, the need to take this basic analytical step is not tied to the use of a particular framework; rather, it arises from the fundamental nature of normative analysis itself. Imperfections in private markets have their counterparts in failures of the political process. As a consequence, we must focus on the operation of the collective decision mechanism in order to identify those features that cause it to operate imperfectly. Not only must we begin by modelling a political process that leads to an optimal allocation of resources, but it is also necessary to determine tailored tax policies that will be part of the political equilibrium. Once this has been accomplished, we can then extend the examination to specific imperfections of collective decision-making and trace out their implications for structure of the tax policies. Few authors writing on taxation have concerned themselves with this research programme but unless it is carried out, economists cannot accomplish an analysis of tax policy failures that has the same force as does the well-known work on private market imperfections.

Finally, when we also introduce equity goals into the analysis we must deal with welfare state programmes which transfer resources amongst groups. A question naturally arises: to what extent do voters' preferences influence these programmes? A standard model of redistributive taxation may be found in Romer (1975), Roberts (1977) and Meltzer and Richard (1981); if we suppose that both individual productivity and the availability of leisure differ, it can be demonstrated that political candidates commit to the policy preferred by the median voter. In equilibrium, taxes are higher the greater the distance between median and mean income, a specific measure of income inequality. Nevertheless, in these models the single-peakedness condition, which is necessary for an equilibrium to exist, is very likely to fail, as the authors demonstrated.

In this paper I will analyse how self-interested governments set their taxation policies in a probabilistic voting model. Candidates are pure voter-seekers and aim to maximise the probability of winning elections. Society is divided into groups who assign different weights to consumption of goods, based on their preferences; that is, they have different levels of single-mindedness. Results show how in equilibrium candidates must satisfy the most powerful groups, which do not necessarily represent the median voter, or the middle class, but may be located at extreme positions on the income scale. The introduction of a probabilistic voting model characterized by single-minded groups changes the classic result of median voter models because it is no longer the position on the income scale which drives the choice of candidates but rather the ability of groups to focus on issues they prefer. This ability enables them to achieve a strong political power which candidates cannot help going along with, because they would lose the elections otherwise. Escaping the more single-minded groups is impossible for politicians, as long as they are prisoners of their own self-interest. In this vicious circle, the function of taxation is reduced to one of merely protecting private interests. Results of this model represent the antithesis of classic normative models. Taxation loses its pro-active role as a mechanism to redistribute resources from the rich to the poor or to supply public goods and becomes only a way to win elections, no matter if this means protecting even the richest components of society.

Results of this model would also provide a possible explanation for the existence of indirect taxation. This is an old issue addressed by Atkinson and Stiglitz (1976) who demonstrated that the optimal direct-cum-indirect tax problem puts all commodity taxes to zero and raises everything through income tax. More recent works by Laroque (2005) and Kaplow (2006) demonstrated that Atkinson and Stiglitz's result is even stronger because there appears to be no role for taxes on commodities even in the presence of a non-optimally designed tax structure. Then, why are Governments so reluctant to abolish indirect taxation? If we consider that direct taxation is progressive in practice whilst indirect taxation is mildly regressive[10] it might be perfectly possible to see the interest of powerful interest groups in preventing a substantial shift from indirect to direct taxation. If more single-minded groups are found amongst the richest component of society and are not favourable to increase the weight of direct taxation with respect to indirect taxation, Governments could not undertake this reform. As a consequence income distribution is less egalitarian.

A model of indirect taxation

I consider a society divided into H groups, indexed by $h = 1, ..., H$. Groups have size f^h and their members are exactly alike. Two political candidates, $j = D, R$, run for an election. Both candidates have an ideological label (for example, Democrats and Republicans) which is exogenously given. Voters' welfare depends on two components; the first is deterministic and it is represented by the consumption of goods, whilst the second is stochastic and derives from the personal attributes of candidates.

Each individual in group h derives his consumption from n goods x_i^h, indexed by $i = 1, ..., n$. Consumption is a function of the tax policy chosen by candidates and it is perfectly observable. The deterministic component of welfare may be written in a logarithmic fashion, $\sum_{i=1}^{n} \psi_i^h \log x_i^h$, where ψ_i^h represents the weight (importance) that group h attaches to good i.

The stochastic component is denoted by $D^R \cdot \left(\xi^h + \varsigma\right)$, where the indicator function

$$D^R = \begin{cases} 1 & if\ R\ wins \\ 0 & if\ D\ wins \end{cases}$$

The random variable $\varsigma \lesseqgtr 0$ reflects candidate R's popularity amongst voters and it is realized between the announcement of policies and elections. It is not idiosyncratic and it is uniformly distributed as

$$\varsigma \sim U\left[-\frac{1}{2},\frac{1}{2}\right]$$

with mean zero. Otherwise, $\xi^h \lesseqgtr 0$ represents an idiosyncratic random variable which measures voters' preferences for D. It is not perfectly observable by candidates and it is uniformly distributed as

$$\xi^h \sim U\left[-\frac{1}{2s^h},\frac{1}{2s^h}\right]$$

again with mean zero and density s^h.

Therefore, a representative individual in group h maximizes the following utility function:

$$U^h = \sum_{i=1}^{n}\psi_i^h \log x_i^h + D^R \cdot \left(\xi^h + \varsigma\right) \tag{27}$$

under the following budget constraint

$$\sum_{i=1}^{n} q_i^j x_i^h = M^h \tag{28}$$

where M^h is the income of any individual in group h. I denote by $q_i^j = p_i + t_i^j$ the consumption price of good i, by p_i the fixed production price[11] and by t_i^j the unit excise tax levied by candidate j on good i. Hence, $\overrightarrow{x} = [x_1,...,x_n] \in X \subset \mathbb{R}^n$ denotes the vector of consumption, $\overrightarrow{q^j} = \left[q_1^j,...,q_n^j\right] \in Q^j \subset \mathbb{R}^n$ the vector of consumption prices, $\overrightarrow{p} = [p_1,...,p_n] \in P \subset \mathbb{R}^n$ the vector of production prices and $\overrightarrow{t^j} = \left[t_1^j,...,t_n^j\right] \in T^j \subset \mathbb{R}^n$ the vector of tax rates.

I introduce two important definitions:

Definition 17 *group A is said to be more single-minded than group B with respect to good i if the weight assigned by A to i is greater than the weight assigned by B. That is, if* $\psi_i^A > \psi_i^B$.

This definition states that groups, in attaching weights to goods, are less or more willing to substitute a good with another[12], depending on the preferences they have for every good. As a consequence, there exist some goods whose consumption is more claimed by groups, because its reduction would affect their welfare in a more tangible way.

Definition 18 *group A is said to be more politically powerful than group B if its density is higher than B's. That is if* $s^A > s^B$.

In this case the political power of a group must be intended as the ability of influencing candidates' choices, when they have to take decisions over a policy. In traditional probabilistic voting models this power is expressed by a density function which captures the distribution of the constituency.

The demand for goods

Individuals maximize 27 subject to 28. The Lagrangian function for a representative individual in group h is

$$\mathcal{L}^h = \sum_{i=1}^{n} \psi_i^h \log x_i^h + D^R \cdot \left(\xi^h + \varsigma\right) + \lambda^h \left(M^h - \sum_{i=1}^{n} q_i^j x_i^h\right)$$

The set of first order conditions is

$$\begin{pmatrix} \frac{\partial \mathcal{L}^1}{\partial x_1^1} & \cdots & \frac{\partial \mathcal{L}^H}{\partial x_1^H} \\ \vdots & \ddots & \\ \frac{\partial \mathcal{L}^1}{\partial x_n^1} & & \frac{\partial \mathcal{L}^H}{\partial x_n^H} \\ \frac{\partial \mathcal{L}^1}{\partial \lambda^1} & & \frac{\partial \mathcal{L}^H}{\partial \lambda^H} \end{pmatrix} = \begin{pmatrix} \frac{\psi_1^1}{x_1^1} = \lambda^1 q_1^j & \cdots & \frac{\psi_1^H}{x_1^H} = \lambda^H q_1^j \\ \vdots & \ddots & \vdots \\ \frac{\psi_n^1}{x_n^1} = \lambda^1 q_n^j & & \frac{\psi_n^H}{x_n^H} = \lambda^H q_n^j \\ \sum_{i=1}^{n} q_i^j x_i^1 = M^1 & & \sum_{i=1}^{n} q_i^j x_i^H = M^H \end{pmatrix}$$

The resolution of first order conditions yields the Marshallian demand functions $x_i^{h*} = \frac{\psi_i^h M^h}{q_i^j}$and the indirect utility functions

$$V\left(x\left(q_i^j, M^h\right)\right) = \sum_{i=1}^{n} \psi_i^h \log \frac{\psi_i^h M^h}{q_i^j} + D^R \cdot \left(\xi^h + \varsigma\right)$$

Political Competition

I consider now the problem of candidates. What distinguishes this contribution from previous taxation models in Political Economy is `the existence of a new setting where probabilistic voting and single-mindedness theory fuse together`. In the classic literature governments had always been considered as benevolent planners, who aimed to maximise a Social Welfare Function whose characteristics depended on the preferences of society for equity, perfectly mirrored by policy-maker's preferences. Weights attached to the utility of different agents were higher for the poor and lower for the rich.

Instead, in this model politicians are considered as voter-seekers who aim to maximise the probability of winning elections by choosing an optimal policy vector $\overrightarrow{t^j}$. Each voter in group h votes for R if and only if R's policy provides him with a greater utility than that provided by D. That is a generic voter ι votes for D if and only if:

$$V^h\left(\overrightarrow{t^R}\right) + \xi^{\iota,h} + \varsigma \geq V^h\left(\overrightarrow{t^D}\right) \qquad \forall \iota \tag{29}$$

where $V^h\left(\overrightarrow{t^j}\right)$ represents the indirect utility function which group h derives under the vector of policies chosen by candidate j. Within each group there is a fraction of *swing voters*, denoted by $\widehat{\iota}$, represented by those individuals who are indifferent between D or R. For these voters equation 29 holds with equality:

$$\xi^{\widehat{\iota},h} = V^h\left(\overrightarrow{t^D}\right) - V^h\left(\overrightarrow{t^R}\right) - \varsigma \tag{30}$$

Otherwise, voter ι votes for D if $\xi^{\iota,h} < \xi^{\widehat{\iota},h}$ and for R if $\xi^{\iota,h} > \xi^{\widehat{\iota},h}$. Swing voters are pivotal, since even a small change in the policy vector makes them no longer indifferent to candidates and it forces them to vote for one of two.

The probability of winning elections for candidate j is given by

$$p^j\left(\overrightarrow{t^j}, \overrightarrow{t^{-j}}\right) = \frac{1}{2} + \frac{d}{s}\sum_{h=1}^{H} f^h s^h \left[V\left(\overrightarrow{t^j}\right) - V\left(\overrightarrow{t^{-j}}\right)\right] \tag{31}$$

where $V\left(\overrightarrow{t^j}\right) := V\left(p_i + t_i^j, M^h\right)$ and $s := \sum_h s^h f^h$.

Axiom 19 *the density function of a group is twice differentiable and monotonically increasing in the level of consumption of goods. That is* $s^h = s(x_1^h, ..., x_n^h)$, *with* $\frac{\partial s^h}{\partial x_i^h} > 0$.

This axiom brings something new with respect to the traditional probabilistic voting models, where the density function was always treated as a constant. The idea to make the density function depend on the consumption of goods is new and deserve to be explained. The classic literature on probabilistic voting models (Persson and Tabellini (2000), Lindbeck and Weibull (1987), and Coughlin (1992)) has always assumed that preferences of voters for political candidates have a distribution where the density function is a constant. Instead, in this model, the density function is increasing in the level of consumption which is in turn affected by the vector of policies. Candidates realize that, should they change a policy, the welfare of groups would change and their political power, captured by the density function, accordingly. Hence, a nexus is created amongst governments' policies, voters' consumption and political power of groups which eventually affects elections' outcome.

Furthermore, as suggested by Lindbeck and Weibull (1987), I assume that

Remark 20 *there exists a balanced-budget constraint*

$$\sum_h f^h \sum_i t_i^j x\left(q_i^j, M^h\right) = 0 \tag{32}$$

which coerces the government to redistribute via transfers all the tax revenues collected.

This assumption allows us to treat the model as `purely redistributive`, which has the advantage of clearly showing the redistributive effects, neglecting any concern about the existence of public expenditure. In turn, equation 32 says that all the revenues collected via taxation are used to redistribute wealth amongst groups. As a consequence, if some groups are better off by the achievement of a net transfer, some others must necessarily be worse off because they have to bear the entire payment of these transfers.

Finally, notice how this political game is a two-person, constant-sum and symmetric game where a pair of policies is an `equilibrium pair` if and only if it is a saddle point for

$$\Gamma = \left(T^D, T^R; p^D, 1 - p^D\right)$$

The equilibrium

To solve the problem I write the Lagrangian function for candidate D (the same holds for candidate R):

$$\mathcal{L}^D = \frac{1}{2} + \frac{d}{s} \sum_h f^h s^h \left[V\left(\overrightarrow{t^D}\right) - V\left(\overrightarrow{t^R}\right)\right] + \mu^D \left(\sum_h f^h \sum_i t_i^D x\left(q_i^D, M^h\right)\right) \tag{33}$$

The set of first order conditions is:

$$\begin{cases} \frac{\partial \mathcal{L}^D}{\partial q_1^D} = \frac{\partial}{\partial q_1^D}\left(\frac{1}{s}\right) d\sum_h f^h s^h \left[V\left(\overrightarrow{t^D}\right) - V\left(\overrightarrow{t^R}\right)\right] + \frac{d}{s}\sum_h f^h \frac{\partial s^h}{\partial q_1^D}\left[V\left(\overrightarrow{t^D}\right) - V\left(\overrightarrow{t^R}\right)\right] + \\ + \frac{d}{s}\sum_h \frac{\partial V^h}{\partial q_1^D} f^h s^h + \mu^D \left(\sum_o t_o^D \sum_h f^h \frac{\partial x_o^h}{\partial q_o^D} + x_o^h\right) = 0 \qquad o \neq i \\ \vdots \\ \frac{\partial \mathcal{L}^D}{\partial q_n^D} = \frac{\partial}{\partial q_n^D}\left(\frac{1}{s}\right) d\sum_h f^h s^h \left[V\left(\overrightarrow{t^D}\right) - V\left(\overrightarrow{t^R}\right)\right] + \frac{d}{s}\sum_h f^h \frac{\partial s^h}{\partial q_n^D}\left[V\left(\overrightarrow{t^D}\right) - V\left(\overrightarrow{t^R}\right)\right] + \\ + \frac{d}{s}\sum_h \frac{\partial V^h}{\partial q_n^D} f^h s^h + \mu^D \left(\sum_o t_o^D \sum_h f^h \frac{\partial x_o^h}{\partial q_o^D} + x_o^h\right) = 0 \\ \frac{\partial \mathcal{L}^D}{\partial \mu^D} = \sum_h f^h \sum_i t_i^D x\left(q_i^D, M^h\right) = 0 \end{cases}$$

In this game, the existence of an equilibrium is guaranteed by the concavity of the utility functions. This proof was used for voting models by Hinich et al. (1973). An easy proof is also provided for a special case of redistributive models by Coughlin (1985).

Proposition 21 *In a constant-sum game an equilibrium is achieved via a convergence of policy; that is:* $\overrightarrow{t^{D*}} = \overrightarrow{t^{R*}}$.

Proof. First of all, we have defined Γ as a constant-sum game, since $p^R\left(\overrightarrow{t^D}, \overrightarrow{t^R}\right) = 1 - p^D\left(\overrightarrow{t^D}, \overrightarrow{t^R}\right)$. Suppose now that the pair $\left(\overrightarrow{t^{D\diamond}}, \overrightarrow{t^{R\diamond}}\right) \in T \times T$ is an equilibrium of the game. Suppose also that $\overrightarrow{t^{D\diamond}} \neq \overrightarrow{t^{R\diamond}}$. We know from Proposition 6 that $p^D\left(\overrightarrow{t^R}, \overrightarrow{t^R}\right) = \frac{1}{2}$. Therefore, by the definition of a Nash Equilibrium it must be

$$p^D\left(\overrightarrow{t^{D\diamond}}, \overrightarrow{t^{R\diamond}}\right) > p^D\left(\overrightarrow{t^R}, \overrightarrow{t^R}\right) = \frac{1}{2} \tag{34}$$

By the definition of a constant-sum game we also know that $p^R\left(\overrightarrow{t^D}, \overrightarrow{t^D}\right) = 1 - p^D\left(\overrightarrow{t^D}, \overrightarrow{t^D}\right) = \frac{1}{2}$ and again by the definition of a Nash Equilibrium, it must be

$$p^R\left(\overrightarrow{t^{R\diamond}}, \overrightarrow{t^{D\diamond}}\right) > p^R\left(\overrightarrow{t^D}, \overrightarrow{t^D}\right) = \frac{1}{2} \tag{35}$$

Since $p^R\left(\overrightarrow{t^{R\diamond}}, \overrightarrow{t^{D\diamond}}\right) = 1 - p^D\left(\overrightarrow{t^{R\diamond}}, \overrightarrow{t^{D\diamond}}\right)$, this implies that $p^D\left(\overrightarrow{t^{R\diamond}}, \overrightarrow{t^{D\diamond}}\right) < \frac{1}{2}$. By 34, this implies that $p^D\left(\overrightarrow{t^{R\diamond}}, \overrightarrow{t^{D\diamond}}\right) > \frac{1}{2}$, a contradiction. Therefore, $\overrightarrow{t^{D\diamond}} = \overrightarrow{t^{R\diamond}}$. ■

Corollary 22 *In equilibrium,* $V\left(\overrightarrow{t^{D\diamond}}\right) = V\left(\overrightarrow{t^{R\diamond}}\right)$.

Proof. By the meaning of Proposition 6, $\overrightarrow{t^{D\diamond}} = \overrightarrow{t^{R\diamond}}$. Therefore, $V\left(\overrightarrow{t^{D}}\right) = V\left(\overrightarrow{t^{R}}\right)$. ■

Exploiting Corollary 7, we may re-write the first order conditions in the following manner:

$$\begin{cases} \frac{\partial \mathcal{L}^D}{\partial q_1^D} = \frac{d}{s}\sum_h \frac{\partial V^h}{\partial q_1^D} f^h s^h + \mu^D \left(\sum_o t_o^D \sum_h f^h \frac{\partial x_o^h}{\partial q_o^D} + x_o^h\right) = 0 & o \neq i \\ \vdots \\ \frac{\partial \mathcal{L}^D}{\partial q_n^D} = \frac{d}{s}\sum_h \frac{\partial V^h}{\partial q_n^D} f^h s^h + \mu^D \left(\sum_o t_o^D \sum_h f^h \frac{\partial x_o^h}{\partial q_o^D} + x_o^h\right) = 0 \\ \frac{\partial \mathcal{L}^D}{\partial \mu^D} = \sum_h f^h \sum_i t_i^D x\left(q_i^D, M^h\right) = 0 \end{cases}$$

From `Roy's Identity` we know that $\frac{\partial V^h}{\partial q_i^D} = -\lambda^h x_i^h$ where λ^h is the marginal utility of income. Applying `Slutzky decomposition` we obtain the `Slutzky matrix`

$$D_{q^j} x\left(q^j, M^h\right) = D_{q^j} h\left(q^j, U^h\right) - D_{M^h} x\left(q^j, M^h\right) x\left(q^j, M^h\right)^{\top}$$

An element of the matrix is $\frac{\partial x_i^h}{\partial q_i^D} = \frac{\partial \left(x_i^h\right)^c}{\partial q_i^D} - \frac{\partial x_i^h}{\partial M^h} x_i^h$, where $\frac{\partial \left(x_i^h\right)^c}{\partial q_i^D}$ is the change in the Hicksian demand with a change in price, representing the *substitution effect*, and $\frac{\partial x_i^h}{\partial M^h} x_i^h$ is the *income effect*. Under the hypothesis of normal goods, $\frac{\partial x_i^h}{\partial q_i^D} < 0$, for every i. Substituting these two expressions in the set of first order conditions we obtain:

$$\frac{\partial \mathcal{L}^D}{\partial q_i^D} = -\sum_h \left(\lambda^h f^h s^h \frac{d}{s} + \mu^D f^h \sum_o t_o^D \frac{\partial x_o^h}{\partial M^h}\right) x_i^h + \\ + \mu^D \left(\sum_o t_o^D \sum_h f^h \xi_{oi}^h + x_o^h\right) = 0 \tag{36}$$

Expression

$$\alpha^{h,D} := \lambda^h f^h s^h \frac{d}{s} + \mu^D f^h \sum_o t_o^D \frac{\partial x_o^h}{\partial M^h}$$

denotes the *marginal probability of winning of* D for group h. It measures the weight that D attaches to a group as a function of its political power, represented by two parameters: density and size. A suitable interpretation for this expression is the following: Government's transfers are a function of the weight that candidates attach to groups, which depends on the effect that a change in the utility of the group, due to a change in the policy vector, has on the probability of winning elections at the margin. Hence, groups are assigned with a weight which is higher the more powerful the group. Furthermore, $\phi_{oi}^h := \frac{\partial \left(x_i^h\right)^c}{\partial q_o^D}$ represents the effect of a variation in price of good o on the compensated demand of good i for group h. Equation 36 may be re-written as follows:

$$\frac{\partial \mathcal{L}^D}{\partial q_i^D} = -\sum_h \alpha^h x_i^h + \mu^D \left(\sum_o t_o^D \sum_h f^h \phi_{oi}^h + x_o^h \right) = 0 \tag{37}$$

Dividing both sides by μ^D and x_i^h and re-arrange terms we finally obtain:

$$-\frac{\sum_o t_o^D \sum_h f^h \phi_{oi}^h}{x_i^h} = -\frac{\Delta x_i^{ch}}{x_i^h} = \frac{\mu^D - \chi_i^h}{\mu^D} \tag{38}$$

$\forall i$

$\chi_i^{h,D} := \frac{\sum_h \alpha^h x_i^h}{x_i^h}$ represents what in literature is known as the *ditributive characteristic* of good i for group h and for candidate D. $-\frac{\Delta x_i^{ch}}{x_i^h}$ measures the approximate proportional variation in the compensated aggregate demand of good i.

Proposition 23 *The distributive characteristic is higher the higher is the amount of good consumed by groups which receive a higher weight by candidates, that is the more single-minded.*

Proof. the distributive characteristic of good i for group h and for candidate D is obtained by multiplying the *marginal probability of winning of candidate j* for group h by the consumption of a good by group h with respect to the total consumption of good i. Notice that $\chi_i^{h,D}$ is increasing in $\alpha^{h,D}$, being $\frac{\partial \chi_i^{h,D}}{\partial \alpha^{h,D}} = 1$. We also know that $\alpha^{h,D}$ increases with respect to an increase in the group's density

$$\frac{\partial \alpha^h}{\partial s^h} = \lambda^h f^h \frac{d}{s} \left(1 - \frac{\overbrace{f^h s^h}^{<1}}{s} \right) > 0$$

By Axiom 19 we know that the density function is monotonically increasing in the consumption of goods. Finally, the first order derivative of the Marshallian functions is increasing in the level of single-mindedness, since $\frac{\partial x_i^{h*}}{\partial \psi_i^h} = \frac{M^h}{q_i^j} > 0$. ■

More single-minded groups provide the candidates with a higher *marginal probability of winning,* which translates the consumption of goods in higher level of the distributive characteristic. Therefore, we have found a precise linkage between single-mindedness and distributive characteristic represented by the following transmission mechanism:

$$single - mindedness\ (\uparrow) \Longrightarrow consumption\ of\ good\ (\uparrow) \Longrightarrow$$

$$density\ function\ (\uparrow) \Longrightarrow distributive\ characteristic\ (\uparrow)$$

Proposition 24 *The optimal tax structure induces a lower reduction in the consumption of those goods which are the most preferred by more single-minded groups.*

Proof. a reduction in the consumption is captured by the left-hand side of 38, which is negative. This expression is lower the lower is the right-hand side, which is lower the smaller the difference between μ^j and $\alpha^{h,j}$. By proposition 23 we know that the distributive characteristic is higher the higher the single-mindedness of a group and hence the right-hand side reduces as well. ■

To what extent do the taxation of goods obtained in this Political Economy framework differ from the classic taxation *à la* Ramsey? To answer, we must compare the many-person Ramsey's rule (Diamond, 1975) with equation 38. In the former optimal tax rates induce a lower reduction in the consumption of those goods which are more consumed by the poor, because they gain a higher weight by society. Instead, in 38, the weight attached by the Government does not only depend on individuals' income but also on groups' political power. That is, the more powerful groups obtain a higher political consideration by candidates. As a consequence, candidates do not take equity goals into account as in the classic Ramsey rule, and this attitude represents the real political failure of the model. The difference between the traditional Ramsey rule $-\frac{\sum_o t_o \sum_h \phi_{oi}^h}{x_i^h} = \frac{\mu - \chi_i^h}{\mu}$ and 38 can be calculated taking the difference of the two expressions. This difference, equal to $\lambda^h \left(\frac{\partial W}{\partial V^h} - f^h s^h \frac{d}{s}\right) + \mu^j \left(1 - f^h\right) \sum_o t_o^j \frac{\partial x_o^h}{\partial M^h}$, is higher the lower f^h and s^h; this means that the less single-minded groups receive a lower weight by candidates, whilst under Ramsey the social weight assigned by the Government depended on the effect which an increase in the utility of group h has on the social welfare at the margin, $\frac{\partial W}{\partial V^h}$. This weight is generally higher for the poorest as long as the Social Welfare Function is strictly concave. Notice that 38 does not say that candidates totally neglect the welfare of the poor because $\alpha^{h,j}$ is higher the higher is the marginal utility of income, λ^h, which is higher for the poorest[13]. Notice also that the classic Ramsey rule and 38 coincide if $\frac{\partial W}{\partial V^h} = f^h s^h \frac{d}{s}$; that is, *if the importance attributed by society to the increase in the welfare of group h is exactly equal to the political importance attributed by candidates to the same group.* In this case, and only in this case, the normative and the positive approaches achieve the same results. Nevertheless, a tenet taken from the theory of optimal taxation still holds: in equilibrium, tax rates chosen by candidates are differentiated, even though the redistribution does not take place between the rich and the poor but between the strongest and the weakest groups of society. The following table compares results obtained under the classic Ramsey rule and 38.

	Classic Ramsey rule	Single-mindedness rule
General formula	$-\frac{\sum_o t_o \sum_h \phi_{oi}^h}{x_i^h} = \frac{\mu - \chi_i^h}{\mu}$	$-\frac{\sum_o t_o^D \sum_h f^h \phi_{oi}^h}{x_i^h} = \frac{\mu^D - \chi_i^h}{\mu^D}$
Distributive characteristic	$\frac{\sum_h \left(\lambda^h + \mu \sum_o t_o \frac{\partial x_o^h}{\partial M^h} \right) x_i^h}{x_i^h}$	$\frac{\sum_h \left(\lambda^h f^h s^h \frac{d}{s} + \mu^D f^h \sum_o t_o^D \frac{\partial x_o^h}{\partial M^h} \right) x_i^h}{x_i^h}$
Distortion on consumption	yes	yes
Political failure	no	yes
Achievement of equity goals	yes	depending on the location of single-minded groups on the income scale
Better off groups	poor	more single-minded
Worse off groups	rich	less single-minded
Highest weight assigned	poor	more single-minded

Legend of symbols	
$h = 1, ..., H$	social groups
f^h	group's size
$j = D, R$	political candidates
$i = 1, ..., n$	goods
x_i^h	consumption of goods
ψ_i^h	preference for goods/level of single-mindedness
ξ^h	idiosyncratic stochastic variable
ς	non-idiosyncratic stochastic variable
$q_i^j = p_i + t_i^j$	consumption price = production price + tax rate
s^h	density function of idiosyncratic variable/political power of a group
d	density function of non-idiosyncratic variable
λ^h	marginal utility of income
α^j	marginal probability of winning of D for group h
ϕ_{oi}^h	effect of a variation in price of good o on the compensated demand of good i for group h
$\chi_i^{h,j}$	distributive characteristic
φ^h	preferences for public good
G^j	public good

Endogenous public expenditure

I analyse now an extension of the previous model considering a Government which must choose both the tax rates and the provision of a public good. The introduction of public goods in probabilistic voting models with single-minded groups raises two fundamental questions:

1. to what extent is the optimal provision of public goods influenced by distortionary taxation?

2. to what extent is the traditional Samuelson rule modified when the Government is not benevolent but aims to maximise the probability of winning elections?

The problem of the individual may be re-written in the following log-linear fashion:

$$\max_{\{x_i^h\}} \sum_{i=1}^{n} \psi_i^h \log(x_i^h) + \varphi^h \log G^j + D^R \cdot \left(\xi^h + \varsigma\right)$$

$$s.t. \sum_{i=1}^{n} q_i^j x_i^h = M^h$$

where G^j denotes the per-capita level of provision of a public good chosen by candidates and φ^h the idiosyncratic preference of group h for the provision of the public good, or in other words, the mindedness of the group for the amount of the public good. The production of this good is entirely financed by taxes levied on the tax-payers. Thus, individuals' choices are influenced by the amount of the public good. On the one hand, G reduces the individuals' disposable income, since the higher G the higher the taxes which individuals must pay to balance the budget. In turn, public expenditure crowds out private consumption. On the other hand, the arising substitution effect depends on the degree of complementarity or substitutability between private and public goods; the effect of a change in the amount of public good on private goods is higher the higher is the degree of complementarity between private and public goods.

Solving the individual maximization problem we obtain the Marshallian functions $x_i^{h*} = \frac{\psi_i^h M^h}{q_i^j}$ and the Indirect Utility Function

$$U\left(x_i^{h*}, G^j\right) = V\left(x\left(q_i^j, M^h\right), G^j\right)$$

The Government's budget constraint is:

$$C\left(G^{j}\right)\sum_{h} f^{h}=\sum_{h} f^{h}\sum_{i} t_{i}^{j} x\left(q_{i}^{j}, M^{h}\right)$$

where $C\left(G^{j}\right)$ denotes the per-capita cost function of the public good. I assume that $C\left(G^{j}\right)$ is a twice differentiable function, with $C_{G^{j}} := \frac{\partial C\left(G^{j}\right)}{\partial G^{j}} > 0$ and $C_{G^{j}G^{j}} := \frac{\partial^{2} C\left(G^{j}\right)}{\partial^{2} G^{j}} > 0$; that is, the production of the public good has marginal decreasing costs. Furthermore, $C_{G^{j}}$ measures the Marginal Rate of Transformation (MRT) and in order to emphasise this fact I will define $C_{G^{j}} := MRT^{j}$.

Secondly, I solve the candidate's problem, which is the same as before, modified only by the presence of the public good. I will denote the new candidate policy vector by $\eta^{j}=\left[t_{1}^{j}, \ldots, t_{n}^{j}, G^{j}\right] \in \Phi^{j} \subset \mathbb{R}^{n+1}$ and I write the Lagrangian function:

$$\mathcal{L}^{j}=\frac{1}{2}+\frac{d}{s}\sum_{h} f^{h} s^{h}\left[V\left(\eta^{j}\right)-V\left(\eta^{-j}\right)\right]+$$

$$+\mu^{j}\left(\sum_{h} f^{h}\sum_{i} t_{i}^{j} x\left(q_{i}^{j}, M^{h}\right)-C\left(G^{j}\right)\sum_{h} f^{h}\right) \tag{39}$$

First, notice that 38 does not change even in the presence of public expenditure which finances public goods.

Proposition 25 *the marginal rate of transformation is equal to the sum of idiosyncratic preferences for the public good of groups weighted by their size and density.*

Proof. The first order conditions for 39 are:

$$\frac{\partial \mathcal{L}^{j}}{\partial q_{1}^{j}}=\frac{d}{s}\sum_{h}\frac{\partial V^{h}}{\partial q_{1}^{j}} f^{h} s^{h}+\mu^{j}\left(\sum_{o} t_{o}^{j}\sum_{h} f^{h}\frac{\partial x_{o}^{h}}{\partial q_{1}^{j}}+x_{o}^{h}\right)=0$$

$$\vdots$$

$$\frac{\partial \mathcal{L}^{j}}{\partial q_{n}^{j}}=\frac{d}{s}\sum_{h}\frac{\partial V^{h}}{\partial q_{n}^{j}} f^{h} s^{h}+\mu^{j}\left(\sum_{o} t_{o}^{j}\sum_{h} f^{h}\frac{\partial x_{o}^{h}}{\partial q_{n}^{j}}+x_{o}^{h}\right)=0 \tag{40}$$

$$\frac{\partial \mathcal{L}^{j}}{\partial G^{j}}=\frac{d}{s}\sum_{h}\frac{\partial V^{h}}{\partial G^{j}} f^{h} s^{h}-\mu^{j}\left(MRT^{j}\sum_{h} f^{h}\right)=0 \tag{41}$$

Since in equation 41 $\frac{\partial V^h}{\partial G^j} = \frac{\varphi^h}{G^j}$ we obtain a final version of the equation which refers to the choice of public good:

$$\frac{d\sum_h \varphi^h f^h s^h}{sG^j \sum_h f^h} = \mu^j \left(MRT^j\right) \tag{42}$$

■

Suppose now, without loss of generality, that $C\left(G^j\right) = \left(G^j\right)^2$, with $MRT^j = 2G^j$. Equation 42 becomes

$$\frac{d\sum_h \varphi^h f^h s^h}{sG^j \sum_h f^h} = 2\mu^j G^j \tag{43}$$

which, solved with respect to G^j yields:

$$G^{j*} = \left(\frac{d\sum_h \varphi^h f^h s^h}{2s\mu^j \sum_h f^h}\right)^{\frac{1}{2}} \tag{44}$$

This expression clearly shows how the provision of public good depends on the mindedness of groups, that is on the idiosyncratic parameter φ^h.

In this expression μ^j represents the `marginal cost of public funds`, defined as the social cost of spending one extra dollar on any given public good and it measures the distortionary effect of taxation.

Proposition 26 *The provision of public good is strictly increasing in the single-mindedness of the group, weighted by its density and size and decreasing in the marginal cost of public fund.*

Proof. Performing some comparative statics we can see that

$$\frac{\partial G^{j*}}{\partial \varphi^h} = \frac{1}{2}\left(\frac{d\sum_h \varphi^h f^h s^h}{2s\mu^j \sum_h f^h}\right)^{-\frac{1}{2}} \frac{df^h s^h}{2s\mu^j \sum_h f^h} > 0$$

$$\frac{\partial G^{j*}}{\partial s^h} = \frac{1}{2}\left(\frac{d\sum_h \varphi^h f^h s^h}{2s\mu^j \sum_h f^h}\right)^{-\frac{1}{2}} \frac{df^h \varphi^h}{2s\mu^j \sum_h f^h} > 0$$

$$\frac{\partial G^{j*}}{\partial f^h} = \frac{1}{2}\left(\frac{d\sum_h \varphi^h f^h s^h}{2s\mu^j \sum_h f^h}\right)^{-\frac{1}{2}} \frac{d}{2s\mu^j} \frac{\varphi^h s^h \sum_h f^h - \sum_h \varphi^h f^h s^h}{\left(\sum_h f^h\right)^2} > 0$$

$$\frac{\partial G^{j*}}{\partial \mu^j} = -\frac{1}{2}\left(\frac{d\sum_h \varphi^h f^h s^h}{2s\mu^j \sum_h f^h}\right)^{-\frac{1}{2}} \frac{df^h s^h}{2s\left(\mu^j\right)^2 \sum_h f^h} < 0$$

■

Otherwise, the Ramsey rule does not change with respect to the previous case and the reason is simple. If the Ramsey rule detects the most efficient way to finance a certain level of expenditure, *for every level of expenditure*, all the more so it must detect the most efficient way to finance the level of expenditure when this is chosen in an optimal way to finance G. Of course tax rates differ, depending on the level of G, since higher level of G entails higher level of tax revenues, but the optimal tax rate *structure* does not change with respect to the previous case.

Concluding, the Single-mindedness Theory states again that, in order to win elections, candidates must content more single-minded groups who are the real winners of the political game. In this case the provision of public good is higher the higher the presence of more single-minded groups which ask for it. With respect to the classic theory and Samuelson rule, a model with single-minded groups tells us that the provision of public goods is not only inefficient because of the presence of distortionary taxation, but also because of the political failure which society falls into, due to the presence of powerful interest groups.

Conclusions

In this paper I analysed how voter-seeking candidates decide indirect taxation policies in a Probabilistic Voting model. Results show that candidates are captured by the most powerful (single-minded) groups, which not necessarily coincide with the median voter, but may represent even the richest components of society. These results are at odds with the classic results achieved by using the median voter theorem, because it is no longer the median position on the income scale which drives the equilibrium policy, but the ability of groups to focus on their preferred issues instead.

Secondly, this model provides a possible explanation to the existence of indirect taxation, since we perfectly know that the optimal direct-*cum*-indirect tax problem puts all commodity taxes to zero and raises everything through income tax (Atkinson and Stiglitz, 1976). Instead, in the model I suggested there is more than one interest by powerful single-minded groups to prevent a substantial shift from indirect to direct taxation. Since indirect taxation is mostly regressive whilst direct taxation mostly progressive, richest single-minded groups would stand up for this shift. The direct-*cum*-indirect tax problem can be perfectly studied using Probabilistic Voting and Single-mindedness theory and I hope this could be done in future contributions.

A Contribution to the Positive Theory of Direct Taxation

Introduction

All modern democracies impose direct taxes on income in order to achieve redistribution goals. A common belief taken from the optimal theory of taxation affirms that a better income distribution may be achieved via a system where income tax paid as a fraction of before-tax income increases somewhat with income. Nevertheless, even though statutory schedules are revised from time to time, the stylised facts show that in Britain and America "from the 1970s to the 1990s inequality rose in both countries" and "redistribution toward the poor tends to happen least in those times and polities where it would seem most justified by the usual goal of welfare policy" (Lindert (2000)). Other evidence which shows an increasing level of inequality within industrialized countries was found by Gottschalk and Smeeding (2000). Finally, a comprehensive study made by the United Nations (WIDER 2000) demonstrated that a recent increase in inequality has taken place in several countries such as Australia, United Kingdom, United States, Chile, Peru, Bangladesh, China, Philippines and Poland. As a result, it seems that redistribution and equity goals are far from being reached even in more industrialised countries.

It is interesting to investigate the possible causes of this failure and this paper suggests that an explanation can be found in the analysis of the political process. In particular, I suggest that the level of inequality in income distribution is due to the existence of voter-seeking candidates who maximise the probability of winning elections instead of the social welfare function as in the theory of optimal taxation. This is of course not a completely new attempt. Some economists who tried to find a political economy explanation to redistribution issues were concerned with the schedule that emerges in a political equilibrium, with the prior question as to whether an equilibrium exists (Boadway and Keen, 2000). First works using the Median Voter Theorem failed to achieve this goal, because of the impossibility of finding a Condorcet winner. Since single-peakedness of preferences on tax rates is a sufficient condition to find a median voter equilibrium, the conditions for the existence of single-peaked preferences must be examined. Itsumi (1974) demonstrated that the non-single-peakedness of utility curves is more likely to arise when the dispersion of ability is larger and the preference for leisure is greater and it happens to individuals just below the average ability class. Romer (1975) demonstrated that single-peakedness condition is achievable only in a situation where unemployment does not exist. If this is not the case the size of the work force changes as the tax rate changes; and so the behaviour of all of the interesting variables becomes crucially dependent on the entire skill distribution. As a result, the hypothesis of single-peakedness for all individuals is no longer guaranteed. Nevertheless, Roberts (1977) demonstrated that a Condorcet winner exists even if the single-peakedness condition is not satisfied; it is sufficient that preferences satisfy the *hierarchical adherence* condition, that is that there exists an ordering of individuals such that the pre-tax income is monotonically increasing irrespective of the tax schedule. More recently, Gans and Smart (1996) demonstrated that the existence of a Condorcet winner is guaranteed by the Mirrlees-Spence single-crossing condition. Nevertheless, all approaches using the Median Voter Theorem fail once we assume that voters vote over multi-dimensional issues. Furthermore, the *hierarchical adherence* condition seems to be particularly restrictive, since it does not allow for the possibility that an individual may dislike a small increase in the marginal tax rate if this increase causes a large reduction in his labour supply but may prefer further increases if his labour supply function entails a small decrease of labour under that rate.

Instead, probabilistic voting models support the existence of multi-dimensional policies and thus they are more suitable in explaining political equilibria. Coughlin (1986), Lindbeck and Weibull (1987,1993) studied a problem of redistribution using probabilistic voting with lump-sum transfers. An interesting result achieved by these models states that the lower the loyalty of a voter for a party, the more generous the transfer he gets. In political economy literature these less loyal individuals are called *swing voters* in order to denote their proclivity to swing from one party to another as a consequence of a small change in policy. Unfortunately, as explained by Canegrati (2006), lump-sum taxation is never used in practise, while the distribution of income takes always place via income taxation.

In this paper I use the Probabilistic Voting Theory in order to explain why, in the real world, the use of direct taxation may not necessarily lead to an increase in equity. Exploiting the framework suggested by Atkinson and Stiglitz (1980), but moving from the hypothesis that political candidates are not benevolent but simple voter-seekers, I will demonstrate that, in order to win elections, a candidate must favour the most powerful or "single-minded" groups. That is, those groups which, due to their idiosyncratic preference for leisure, are more able to focalise on leisure have a stronger political power and are more influencing in determine the outcome of policies. Should these single-minded components be located amongst the richest individuals of society, we would achieve an equilibrium where direct taxation is no longer an instrument to reduce inequality, but a tool which increases it, favouring the most powerful group.

A model of direct taxation

I consider a society divided in H groups, indexed by $h = 1, ..., H$. Groups have size f^h, and their members are perfectly identical. Two political candidates, $j = D, R$, run for an election. Both candidates have an ideological label (for example, Democrats and Republicans), exogenously given. Voters' welfare depends on two components; the first is deterministic and it is represented by consumption, whilst the second is stochastic and derives from personal attributes of candidates.

I assume that each individual in group h derives his consumption from only one good. The stochastic component is captured by expression $D^R \cdot \left(\xi^h + \varsigma\right)$, where the indicator function

$$D^R = \begin{cases} 1 & if\ R\ wins \\ 0 & if\ D\ wins \end{cases}$$

Term $\varsigma \lesseqgtr 0$ reflects candidate R's popularity amongst the electorate and it is realized between the announcement of policies and elections. It is not idiosyncratic and it is uniformly distributed

$$\varsigma \sim U\left[-\frac{1}{2}, \frac{1}{2}\right]$$

with mean zero. Otherwise, term $\xi^h \lesseqgtr 0$ represents an idiosyncratic component which measures voters' preferences for candidate R. It cannot be perfectly observed by candidates and it is uniformly distributed

$$\xi^h \sim U\left[-\frac{1}{2s^h}, \frac{1}{2s^h}\right]$$

again with mean zero and density s^h.

Hence, each individual in group h has the following utility function

$$U^h = U\left(c^h, l^h; \psi^h\right) + D^R \cdot \left(\xi^h + \varsigma\right) \tag{45}$$

where c^h denotes consumption, l^h labour and ψ^h is a parameter which captures the preference of groups for leisure. The utility function is increasing in consumption and decreasing in labour. The labour income is given by $I^h = wl^h$ where w denotes the real wage, equal for every group. Income is taxed according to a linear taxation $T(I^h) = -X^{jh} + t^j I^h$, $X^{jh} > 0$ represents a fixed subsidy and t^j is the marginal tax rate on labour. In the absence of savings, consumption of individuals may be written as

$$c^h = X^{jh} + \left(1 - t^j\right) wl^h \tag{46}$$

I introduce now three useful definition[14]

Definition 27 ***(Single-mindedness)*** *group A is said to be more single-minded than group B with respect to leisure if the weight assigned by A is greater than the weight assigned by B. That is, if* $\psi^A > \psi^B$.

Definition 28 ***(Political power)*** *group A is said to be more politically powerful than group B if its density is higher than B's. That is if* $s^A > s^B$.

Definition 29 *the density function of a group is monotonically increasing in the amount of leisure. That is* $s^h = s(l^h)$, *with* $\frac{\partial s^h}{\partial l^h} > 0$.

Substituting 46 in 45, we may write the following maximisation problem:

$$\max_{\{l^h\}} \; U\left(X^{jh} + \left(1 - t^j\right) wl^h, l^h; \psi^h\right) + D^R \cdot \left(\xi^h + \varsigma\right)$$

whose resolution yields the optimal choice for leisure $l^{h*} = l\left(X^{jh}, \left(1 - t^j\right) w\right)$ and the Indirect Utility Function

$$V\left(X^{jh}, \left(1 - t^j\right) w; \psi^h\right) = \tag{47}$$

$$= U\left(X^{jh} + \left(1 - t^j\right) wl^h\left(X^{jh}, \left(1 - t^j\right) w\right), l^h\left(X^{jh}, \left(1 - t^j\right) w\right); \psi^h\right)$$

Candidates maximize the probability of winning elections under the balanced-budget constraint

$$\sum_h f^h \left(t^j wl^h - X^{jh}\right) = 0$$

They realize that the choice on tax rates modifies individuals' choice on the amount of labour to supply. Differentiating 47 with respect to X^{jh} and t^j we obtain $\frac{\partial V^h}{\partial X^{jh}} = \lambda^h$ and $\frac{\partial V^h}{\partial t^j} = -\lambda^h wl^h$, where λ^h represents the marginal utility of income for group h. Candidates must choose an optimal policy vector $\eta^j = \left[t^j, X^{j1}, ..., X^{jH}\right] \in \Phi^j \subset \mathbb{R}^{H+1}$.

The Lagrangian function for candidate j is

$$\mathcal{L}^j = \frac{1}{2} + \frac{d}{s}\sum_h f^h s^h \left[V\left(\eta^j\right) - V\left(\eta^{-j}\right)\right] + \mu^j \left(\sum_h f^h \left(t^j wl^h - X^{jh}\right)\right) \quad (48)$$

Referring to Proposition 6 and Corollary 7 we may write first order conditions in the following fashion

$$\begin{cases} \frac{\partial \mathcal{L}^j}{\partial X^{jh}} = \frac{d}{s}\sum_h s^h f^h \lambda^h + \mu^j \sum_h \left(t^j w \frac{\partial l^h}{\partial X^{jh}} - n\right) = 0 \\ \frac{\partial \mathcal{L}^j}{\partial t^j} = -\frac{d}{s}\sum_h s^h f^h \lambda^h wl^h + \mu^j \sum_h \left(t^j w \frac{\partial l^h}{\partial t^j} - \sum_h wl^h\right) = 0 \\ \frac{\partial \mathcal{L}^j}{\partial \mu^j} = \sum_h f^h \left(t^j wl^h - X^{jh}\right) = 0 \end{cases}$$

Dividing $\frac{\partial \mathcal{L}^j}{\partial X^{jh}}$ by μ^j we obtain

$$\frac{\partial \mathcal{L}^j}{\partial X^{jh}} = \frac{d}{\mu^j s}\sum_h s^h f^h \lambda^h + \sum_h \left(\tau^j w \frac{\partial l^h}{\partial X^{jh}} - n\right) = 0$$

Differentiating l^h with respect to t^j we obtain $\frac{\partial l^h}{\partial t^j} = -\frac{\partial l^h}{\partial w}$. Applying the `Slutzky decomposition` we obtain $\frac{\partial l^h}{\partial w} = \frac{\partial l^{hc}}{\partial w} + \frac{\partial l^h}{\partial X^{jh}} l^h$, where $\frac{\partial l^{hc}}{\partial w} > 0$ represents the compensative variation of labour supply. Substituting in $\frac{\partial \mathcal{L}^j}{\partial t^j}$, we obtain

$$\frac{\partial \mathcal{L}^j}{\partial t^j} = -\frac{d}{s}\sum_h s^h f^h \lambda^h wl^h + \mu^j \left\{\sum_h \left(t^j w \left[-\left(\frac{\partial l^{hc}}{\partial w} + \frac{\partial l^h}{\partial X^{jh}} l^h\right)\right] + \sum_h wl^h\right)\right\} = 0 \quad (49)$$

and rearranging terms

$$\frac{\partial \mathcal{L}^j}{\partial t^j} = -\sum_h \left(\frac{d}{s} s^h f^h \lambda^h + \mu^j t^j w \frac{\partial l^h}{\partial X^{jh}}\right) wl^h + \quad (50)$$

$$+\mu^j \frac{t^j}{1-t^j} \sum_h l^h w \left[-\left(1-t^j\right) \left(\frac{\partial l^{hc}}{\partial w} \frac{1}{l^h} \right) \right] + \mu^j \sum_h w l^h = 0$$

Let us define $\epsilon^{jh} := w\left(1-t^j\right)\left(\frac{\partial l^{hc}}{\partial w}\frac{1}{l^h}\right)$ as the compensated elasticity of labour price for group h and re-write 50 as

$$\frac{\partial \mathcal{L}^j}{\partial t^j} = -\sum_h \left(\frac{d}{s} s^h f^h \lambda^h + \mu^j t^j w \frac{\partial l^h}{\partial X^{jh}} \right) w l^h - \mu^j \frac{t^j}{1-t^j} \sum_h l^h w \epsilon^{jh} + \mu^j \sum_h w l^h = 0 \tag{51}$$

Furthermore, let us impose $\varphi^h := \frac{d}{s} s^h f^h \lambda^h + \mu^j t^j w \frac{\partial l^h}{\partial X^{jh}}$, $I^h = wl^h$ and substitute again in 51 we obtain

$$\frac{\partial \mathcal{L}^j}{\partial t^j} = -\sum_h \varphi^h I^h - \mu^j \frac{t^j}{1-t^j} \sum_h I^h \epsilon^{jh} + \mu^j \sum_h I^h = 0 \tag{52}$$

Re-arranging terms we obtain the following expression:

$$\frac{t^j}{1-t^j} = \frac{\sum_h I^h - \sum_h \varphi^h I^h}{\sum_h I^h \epsilon^{jh}} \tag{53}$$

where $\overline{\varphi} := \frac{\sum_h \varphi^h}{n}$. Finally we obtain

$$\frac{t^j}{1-t^j} = \frac{n\overline{I}\overline{\varphi} - \sum_h \varphi^h I^h}{\sum_h I^h \epsilon^{jh}} = -\frac{cov\left(\varphi^h, I^h\right)}{\sum_h I^h \epsilon^{jh}} \tag{54}$$

where $\overline{I}$ represents the average income. The covariance on the right hand side of 54 is made by terms φ^h and I^h. φ^h represents the candidate marginal probability of income in group h and it is composed by two terms

1. $\frac{d}{s} s^h f^h \lambda^h$ which measures by how much an increase in the utility of a group affects the probability of winning elections at the margin and represents the weight attached to a change in individual's income by candidates. This weight is greater for more single-minded groups if the function expressing the probability of winning elections is strictly concave. Notice that λ^h is greater for the poorest individuals, because marginal utility of income is decreasing with respect to income. Nevertheless, the poor do not get more favourable taxation than the rich if their political power is not sufficient to capture politicians;

2. the effect of an extra-dollar on revenues, weighted by μ which translates a change in revenues in the probability of winning.

Let us now analyse 54 starting from the left-hand side. Notice that

$$\frac{\partial}{\partial t^j}\left(\frac{t^j}{1-t^j}\right)=\frac{1}{\left(1-t^j\right)^2}>0$$

As a consequence, the tax rate is higher the higher is the right-hand side.

Proposition 30 *the tax rate is lower the higher is the political power of the social group.*

Proof. notice that expression $\frac{t^j}{1-t^j}$ is lower the higher is φ^h. The political power of a group is captured by $\frac{d}{s}s^h f^h$, since the higher the size and the density of a group, the higher the power of its influence as a consequence of a variation in the redistribution policy chosen by the Government. ■

A model with income heterogeneity

Suppose now that the segmentation of society in groups is made according to two dimensions: preferences for leisure and wages. That is, individuals differ also for their levels of income, not only preference for leisure. Then, I cluster the constituency into $H \times K$ groups, where H represents the number of groups obtained by clustering the population with respect to preference for leisure and K the number of groups obtained by clustering with respect to labour income. Thus, each individual belongs to a cluster $\{h, k\}$, where $h = 1, ..., H$ indexes groups according to the preference of individuals for leisure and $k = 1, ..., K$ indexes groups according individuals' income. The deterministic component of utility of an individual h, k is written as:

$$U^{h,k}=U\left(c^{h,k},l^{h,k};\psi^h\right) \tag{55}$$

and the consumption

$$c^{h,k}=X^{jh,k}+\left(1-t^j\right)w^k l^{h,k} \tag{56}$$

The stochastic component is captured by expression $D^R\cdot\left(\xi^h+\pi^k+\varsigma\right)$, which this time encompasses another idiosyncratic variable, π^k. The two idiosyncratic variables are uniformly distributed on intervals $\left[-\frac{1}{2s^h}, \frac{1}{2s^h}\right]$ and $\left[-\frac{1}{2s^k}, \frac{1}{2s^k}\right]$, respectively. Variable ξ^h captures political preferences of voters according to their preferences for leisure, whilst variable π^k captures the political preferences of voters according to their labour income. For example, a voter in the cluster $\{h, k\}$ may prefer candidate D to candidate R for the first dimension, because the former chooses a policy which better reflects his needs for leisure, but in the same breath may prefer candidate R to candidate D for the second dimension because it chooses a policy which strongly protects his income.

The new maximisation problem may be written as

$$\max_{\{l^{h,k}\}} U^{h,k}\left(X^{jh,k} + \left(1 - t^j\right) w^k l^{h,k}, l^{h,k}; \psi^h\right) + D^R \cdot \left(\xi^h + \pi^k + \varsigma\right)$$

Candidates maximise the following Lagrangian function

$$\mathcal{L}^j = \frac{1}{2} + \frac{d}{s^1 s^2}\sum_h\sum_k f^{h,k} s^h s^k \left[V\left(\eta^j\right) - V\left(\eta^{-j}\right)\right] + \tag{57}$$

$$+\mu^j\left(\sum_h\sum_k f^{h,k}\left(t^j w^k\left(1 - l^{h,k}\right) - X^{jh,k}\right)\right)$$

where $s^1 := \sum_h s^h f^h$ and $s^2 := \sum_k s^k f^k$.

First order conditions are

$$\begin{cases} \frac{\partial \mathcal{L}^j}{\partial X^{jh,k}} = \frac{d}{s^1 s^2}\sum_h\sum_k s^h f^{h,k}\lambda^{h,k} + \mu^j\sum_h\sum_k\left(t^j w^k \frac{\partial l^{h,k}}{\partial X^{jh,k}} - n\right) = 0 \\ \frac{\partial \mathcal{L}^j}{\partial t^j} = -\frac{d}{s^1 s^2}\sum_h\sum_k s^h f^{h,k}\lambda^{h,k} w^k l^{h,k} + \mu^j\sum_h\sum_k\left(t^j w^k \frac{\partial l^{h,k}}{\partial t^j} - \sum_h\sum_k w^k l^{h,k}\right) = 0 \\ \frac{\partial \mathcal{L}^j}{\partial \mu^j} = \sum_h\sum_k f^{h,k}\left(t^j w^k l^{h,k} - X^{jh,k}\right) = 0 \end{cases}$$

Again exploiting the Roy identity and the Slutzky decomposition we can re-write the derivative of the Lagrangian with respect to the tax rate as follows

$$\frac{\partial \mathcal{L}^j}{\partial t^j} = -\frac{d}{s^1 s^2}\sum_h\sum_k s^h s^k f^{h,k}\lambda^h w^k l^{h,k} + \tag{58}$$

$$+\mu^j\left\{\sum_h\sum_k\left(t^j w^k\left[-\left(\frac{\partial l^{h,kc}}{\partial w^k} + \frac{\partial l^{h,k}}{\partial X^{jh,k}} l^{h,k}\right)\right] + \sum_h\sum_k w^k l^{h,k}\right)\right\} = 0$$

and re-arranging terms we obtain

$$\frac{\partial \mathcal{L}^j}{\partial t^j} = -\sum_h\sum_k \left(\frac{d}{s^1 s^2} s^h s^k f^{h,k} \lambda^h w^k l^{h,k} + \mu^j t^j w^k \frac{\partial l^{h,k}}{\partial X^{jh,k}} \right) w^k l^{h,k} + \\ + \mu^j \frac{t^j}{1-t^j} \sum_h\sum_k w^k l^{h,k} \left[-\left(1-t^j\right) \left(\frac{\partial l^{h,kc}}{\partial w^k} \cdot \frac{1}{l^{h,k}} \right) \right] + \mu^j \sum_h\sum_k w^k l^{h,k} = 0$$

Let us define $\varphi^{h,k} := \frac{d}{s^1 s^2} s^h s^k f^{h,k} \lambda^h + \mu^j t^j w^k \frac{\partial l^{h,k}}{\partial X^{jh,k}}$ and substitute we obtain:

$$\frac{t^j}{1-t^j} = \frac{\sum_h\sum_k I^{h,k} - \sum_h\sum_k \varphi^{h,k} I^{h,k}}{\sum_h\sum_k I^{h,k} \epsilon^{jh,k}} \tag{59}$$

And defining $\overline{\varphi} := \frac{\sum_h\sum_k \varphi^{h,k}}{n}$ we finally obtain

$$\frac{t^j}{1-t^j} = \frac{n\overline{I}\overline{\varphi} - \sum_h\sum_k \varphi^{h,k} I^{h,k}}{\sum_h\sum_k I^{h,k} \epsilon^{jh,k}} = -\frac{cov\left(\varphi^{h,k}, I^{h,k}\right)}{\sum_h\sum_k I^{h,k} \epsilon^{jh,k}} \tag{60}$$

This time, the mindedness of individuals is two-dimensional and thus, the political power of groups depends on the combination of the two mindedness. Notice that density functions enter $\varphi^{h,k}$ in a multiplicative way, meaning that a weak-minded group on a dimension may reinforce its total mindedness thanks to being strong-minded on the other dimension. Nevertheless, the main achievement of the Single-mindedness Theory still holds; the tax rate will be lower the higher is the political power of the group, since $\frac{t^j}{1-t^j}$ is lower the higher $\varphi^{h,k}$. This allows us to affirm that results of the theory, which affirms that more single-minded groups are the most favoured groups by a taxation policy, are robust even in a multi-dimensional space.

Measuring income inequality at a microeconomic level

We now have all the elements to measure how groups' welfare is affected by the decisions taken by self-interested candidates who choose their taxation policy in order to maximise the probability of winning elections. The goal of this section is twofold: measuring the difference in the level of inequality amongst age groups and analysing the relation between this inequality and the structure of taxations systems. To the best of my knowledge this is the first attempt to measure the cohort-specific inequality and the first time that the Gini index is disaggregated at a microeconomic level in order to capture in a more precise way the differences in inequality amongst social groups. In other words, I suggest that the Gini index measured at a `macroeconomic level` to capture the general inequality levels of countries, is the result of many Gini indexes calculated at a `microeconomic level`. Calculating Gini indexes at a microeconomic levels allows us to evaluate more precisely the impact of the Government's policies on groups' welfare, something which cannot be made by using the Gini index calculated at a country level.

The question addressed is: which are the age groups which are afflicted by the highest degree of inequalitity? In order to answer this question we must remember that inequality measurement is always an attempt to give meaning to comparisons of income distributions in terms of criteria which may be derived from ethical principles, appealing mathematical constructs or simple intuition (Cowell, 2000). As a consequence, before measuring the level of inequality in practise it is necessary to define the concepts, the ranking criteria and the indices necessary to achieve our goal.

Distributional and Ranking concepts

I will denote by $\mathcal{F}$ the space of all univariate probability distributions with support $\Lambda \subseteq \Re; x \in \Lambda$ represents a particular value of income and $F \in \mathcal{F}$ one of the possible income distribution. So $F(x \leq \widetilde{x})$ represents the proportion of population with income less than $\widetilde{x}$. Furthermore define $\underline{x} := inf(\Lambda)$ and denote by $\mathcal{F}(\varrho) \subseteq \mathcal{F}$ a subset with given mean $\varrho : \mathcal{F} \mapsto \Re$ given by

$$\varrho(F) := \int x dF(x) \tag{61}$$

and $f : \Lambda' \mapsto \Re$ as a density function, supposed that F is continuous over some intervals $\Lambda' \subseteq \Lambda$. Furthermore, in order to compare distributions, I assume the existence of a complete and transitive binary relation $\succcurlyeq_I$on $\mathcal{F}$, called *inequality ordering* and represented by $I : F \mapsto \Re$, if the ordering is continuous.[15]

In order to compare distributions we also need some ranking criteria over $\mathcal{F}$. I use the notation $\succcurlyeq_T$to indicate the *ranking* induced by a comparison principle T. Three possible situations arise:

Definition 31 *For all* $F, G \in \mathcal{F}$:

(a) *(strict dominance)* $G \succ_T F \Leftrightarrow G \succcurlyeq_T F \quad \wedge \quad F / \succcurlyeq_T G$.
(b) *(equivalence)* $G \sim_T F \Leftrightarrow G \succcurlyeq_T F \quad \wedge \quad F \succcurlyeq_T G$.
(c) *(non-comparability)* $G \perp_T \quad F \Leftrightarrow G / \succcurlyeq_T F \quad \wedge \quad F / \succcurlyeq_T G$.

Suppose now to focus on the concept of social-welfare function, expressed in the following additively separable form:

$$W(F) = \int u(x)\, dF(x) \tag{62}$$

where $u : \mathcal{F} \mapsto \Re$ is an evaluation function. Denote by $\hat{W}_1$ the subclass of SWFs where u is increasing and by $\hat{W}_2$ the subclass of $\hat{W}_1$ where u is also concave. Furthermore, define the set of age years A where a is a given age in A. Finally, introduce the following

Definition 32 *For all* $F \in \mathcal{F}$, $a \in A$ *and for all* $0 \leq q \leq 1$, *the quantile functional for a given age year is defined by*

$$Q(F;(q,a)) = \inf\{x | F(x) \geq q, a\} = x_{qa} \tag{63}$$

This definition enables us to state the theorem of *first-order distributional dominance*

Theorem 33 $G \succcurlyeq_Q F \Leftrightarrow W(G) \geq W(F)\ \forall \left(W \in \hat{W}_1\right)$

Otherwise, if we consider this other

Definition 34 *For all* $F \in \mathcal{F}$, $a \in A$ *and for all* $0 \leq q \leq 1$, *the cumulative income functional for a given age year is defined by*

$$C(F;(q,a)) := \int_x^{Q(F;(q,a))} x dF(x) \tag{64}$$

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which leads us to the theorem of *second-order distributional dominance*

Theorem 35 $\forall F, G \in \mathcal{F}\ (\varrho) : G \succcurlyeq_C F \Leftrightarrow W(G) \geq W(F)\ \forall \left(W \in \hat{W}_2\right)$

Suppose now that a distribution depends on the effects of a policy $p \in P$, where P is the space of all the possible policies. Without loss of generality, I suppose that $P = \left\{p^1, p^2\right\}$. Suppose also that distribution F is obtained under policy p^1 and distribution G is obtained under policy p^2. We may denote by $F = F\left(p^1, a\right)$ and $G = G\left(p^2, a\right)$ the distribution obtained under the two policies for a given age group a.

We want to define a comparison criterion for judging policies and their effects on the distribution of age groups.

Theorem 36 *(First-order distributional dominance) For all* $p^1, p^2 \in P$*,* $a \in A$: $p^1 \succcurlyeq_Q p^2 \Leftrightarrow W\left(F\left(p^1, a\right)\right) \geq W\left(G\left(p^2, a\right)\right) \; \forall \left(W \in \hat{W}_1\right)$

Theorem 37 *(Second-order distributional dominance) For all* $p^1, p^2 \in P$*,* $a \in A$*,* $F, G \in \digamma\ (\varrho) : p^1 \succcurlyeq_C p^2 \Leftrightarrow W\left(F\left(p^1, a\right)\right) \geq W\left(G\left(p^2, a\right)\right) \; \forall \left(W \in \hat{W}_2\right)$

These two theorems simply state that a policy q^1 is preferred to policy q^2 if and only if `the welfare obtained under the distribution it generates is higher than the welfare obtained under the distribution generated by the other policy for every age group`. Notice that this condition must hold *for every age group*; that means that we should see an improvement in welfare of all cohorts.

Decomposition indices

The Generalised Entropy measure is the more suitable index to analyse inequality within and between groups because of its decomposability. It may be written as

$$GE(\alpha) = \overbrace{\int_h f^h \left(\frac{x_h}{x}\right)^\alpha I_h(\alpha)}^{within-group\ inequality} + \overbrace{I_{bet}(\alpha)}^{between-group\ inequality} \tag{65}$$

where

$$I_{bet}(\alpha) = \frac{1}{\alpha(\alpha-1)} \left[\int_h f^h \left(\frac{x_h}{x}\right)^\alpha - 1\right] \tag{66}$$

The α in 66 is a parameter that characterises different members of the GE class: a high positive value of α yields an index that is very sensitive to income transfers at the top of the distribution. In particular, $GE(0)$ represents the mean logarithmic deviation, $GE(1)$ the Theil index, and $GE(2)$ the half of square of the coefficient of variation.

Another useful indicator to measure the inequality between groups is represented by Gini:

$$G = 1 + \frac{1}{N} - \left[\frac{2}{N^2 x}\right]\left[\int_h (N - h + 1)\, x_h\right] \tag{67}$$

where $N = \int w_h$, $w_h = f^h N$. When data are unweighted, $w_h = 1$ and $N = H$. Individuals are ranked in ascending order of h.

Empirical evidence from the Luxemburg Income Study

Dataset

The Luxembourg Income Study (LIS) is a panel database including 30 countries and made by 5 *waves* of data from 1979 – 2002. The source of data is represented by country specific household income surveys. For example, individual data from the United States is taken from the Current Population Survey. Datasets are identified by a code made by two letters denoting a country and two numbers which identify the wave of data. For instance, US00 identifies the wave 2000 for the United States. I used data of 17 countries (here with the relative LIS codes): `Austria` (`AT`), `Belgium` (`BE`), `Canada` (`CA`), `Czech Republic` (`CZ`), `Switzerland` (`CH`), `Germany` (`DE`), `Denmark` (`DK`), `Estonia` (`EE`), `Spain` (`ES`), `Finland` (`FI`), `France` (`FR`), `Greece` (`GR`), `Hungary` (`HU`), `Ireland` (`IE`), `Israel` (`IL`), `Italy` (`IT`), `Luxemburg` (`LU`), `Mexico` (`MX`), `Netherlands` (`NL`), `Norway` (`NO`), `Poland` (`PL`), `Romania` (`RO`), `Russia` (`RU`), `Slovak Republic` (`SK`), `Slovenia` (`SI`), `Sweden` (`SE`), `Taiwan` (`TW`), `United Kingdom` (`UK`) and `United States` (`US`).

The dataset includes data at an individual or household level, on demographics, expenditure, income, labor market outcomes and tax variables.

Inequality indexes were calculated using the definition of disposable income, calculated as follows:

`disposable income = compensation of employees + gross self-employment income + realised property income + occupational pensions`[17] `+ other` `cash income`[18] `+ social insurance cash transfers`[19] `+ universal cash transfers`[20] `+ social assistance`[21] `- direct taxes - social security contributions`

This choice is natural because the disposable income allows us to assess the impact of taxation on individuals' welfare and thus to evaluate the degree of inequality as a result of the candidates' choice.

Cohort-specific inequality

In order to assess the level of inequality amongst cohorts I used the Jenkins' Stata routine `ineqdec0` which estimates a range of inequality and related indices (Generalized Entropy of class a, Atkinson class A(e), the Gini coefficient and the percentile ratios), plus decompositions of a subset of these indices by population subgroups. Calculations do not exclude values less than or equal to zero. Appendix 1 reports an example of results for the Generalized Entropy index of class 2 and the Gini index calculated for Austria[22]. Here I will briefly provide a description of data analysing the evolution of the indexes over time for every country.

1. *Austria*. It is characterised by a low level of inequality, with the average Gini index equal to 0.29 in 2000, lower then the levels reached in previous years. The maximum value of the Gini index was reached in 1995 (0.33) and since than it is decreased. The country has always been characterised for higher levels of inequality amongst the older cohorts, especially for individuals aged over 50.

2. *Belgium*. The country is characterised by a low level of inequality, with the Gini indexes constantly lower than 0.3. Nevertheless, the index worsen from 0.26 reached in 1985 to 0.286 in 2000. Nevertheless, in 2000 the situation had a more equitable distribution amongst cohorts, whilst before the inequality was more concentrated amongst elder cohorts.

3. *Canada*. Canada has characterised by a medium level of inequality, with the Gini index which remained all in all steady over time. The higher levels of the Gini index is concentrated amongst the younger cohorts and the individuals aged over 45, even though these differences with respect to the average are not particularly high.

4. *Switzerland*. The inequality in Switzerland has been soundly reduced since 1982, when the Gini index was equal to 0.35, much higher than the same

value calculated in 2000 (0.264). Wealth is well distributed amongst cohorts and we almost never observe values above 0.4. A slight increase in inequality levels is observable amongst people between 60 and 70, but still these values are not particularly high.

5. *Czech Republic*. The country is characterised by a low level of inequality and a very fair distribution of wealth amongst cohorts. The very low level of the variance (0.001) states that the difference from a cohort to another is minimal and we never observe values of the Gini index above 0.4.

6. *Germany*. The level of inequality is low, even though we observe a slight increase in the Gini index from 1984 to 2000. The distribution of wealth is very fair, and even amongst the younger and older components of society we do not observe radical changes with respect to the average.

7. *Denmark*. Denmark is characterised by a very low level of inequality, with an exception represented by 1995 when the Gini index was equal to 0.361. Nevertheless, we observe that amongst younger cohorts the inequality increases.

8. *Spain*. The country is characterised by a medium level of inequality and the situation remained all in all steady over years. The inequality increases when we consider people aged 60 and this situation has worsen in 2000.

9. *Finland*. The level of inequality is low, even though the situation has worsen since 1995. The wealth is well distributed amongst cohorts, with a slight increase in the values of the Gini index for individuals in their fifties.

10. *Hungary*. Like others former communist countries, the situation in Hungary in characterised by a general low level of inequality which has remained steady over the 1990s and by a well distribution of wealth amongst different cohorts, with values of the Gini index which are almost never higher than 0.4. In particular this feature has improved since the beginning of the 1990s.

11. *Greece*. We do not have data in order to make a comparison, but still the situation of Greece is characterised by a medium level of inequality, with a general increase in the level of inequality amongst the younger and the elder cohorts.

12. *Ireland*. Ireland is characterised by a medium level of inequality. The situation has slightly improved since the end of the 1980s. The wealth is well distributed amongst cohorts, with higher levels of inequality observable amongst the elder components of society.

13. *Israel*. Inequality in Israel is particularly worsen since the end of the 1970s, with the Gini index which increased from 0.29 to 0.36. Nevertheless, if we analyse the redistribution of wealth amongst cohorts we may record an improvement during the recent years, where we do not observe great differences amongst cohorts, even though the level of the Gini index are slightly higher for elder cohorts.

14. *Italy*. Italy is characterised by a medium level of inequality. The situation is worsen over years and the Gini index has increased from 0.315 in 1986 to 0.356 in 2000. The country is characterised by the harmful phenomenon of the increase in the inequality amongst younger cohorts which, on average, has doubled or tripled (depending on the cohort analysed) in 2000. Differences are observable also amongst elder cohorts, even tough not in the same manner as for the younger.

15. *Luxemburg*. The country is characterised by a very low level of inequality, which has remained steady over time. The wealth is very well distributed amongst cohorts and the variance is amongst the lowest we observed.

16. *Mexico*. Mexico has one of the worse values of the Gini index. Over years the indicator has always been higher than 0.4, with values even higher than 0.5 in 1990s. The situation does not seem to be improved and we record very high level of the Gini index, sometimes higher than 0.6, especially amongst elder cohorts.

17. *The Netherlands*. The country is characterised by a very low level of inequality and the Gini index has improved from the 1980s, with a significant improvement in 2000. The distributions of wealth amongst cohorts is very good, especially recently, and we do not observe any worsening in the Gini index amongst elder components of society.

18. *Norway*. Norway has a medium level of inequality, which is significantly improved since the end of the 1970s when the Gini index was equal to 0.46, even though the situation is worsening in recent years. As other Scand-

inavian countries, also Norway has a very fair redistribution of wealth amongst cohorts and this situation has been preserved over years.

19. *Poland*. Poland is characterised by a low level of inequality and the Gini index has improved recently with respect to the previous years. Like other former communist countries, wealth is well distributed amongst cohorts, since the variance is very low (0.001).

20. *Romania*. The country is characterised by a medium level of inequality and by a well distribution of wealth amongst cohorts.

21. *Russia*. The situation in Russia is particularly negative, especially if we consider that the country has one of the worst value for the Gini index (0.42 in 2000). It has also a bad distribution of wealth amongst cohorts, with a variance which is ten times the variance that we observe in Scandinavian countries. Unlike the other countries, Russia is characterised by having high Gini index concentrated amongst middle generations, whilst the values of the index are lower amongst the elder components of society.

22. *Sweden*. Like the other Scandinavian countries, also Sweden has relatively low levels of inequality which has remained steady over time and a very good distribution of wealth amongst cohorts, with values of the Gini index which are slightly higher for younger cohorts.

23. *Slovak Republic*. The country is characterised by a low level of inequality and a very good distribution of wealth amongst generations. In particular, observe that the level of variance (0.0009) is the lowest observed in our dataset.

24. *Slovenia*. Although we do not have many observations we may say that the country is characterised by low levels of inequality and a good distribution of wealth amongst cohorts.

25. *Taiwan*. The country is characterised by a medium level of inequality, even though the situation is worsened over the recent years. The country has always been characterised by higher levels of inequality amongst elder cohorts, especially for individuals aged 60.

26. *United Kingdom*. The country is characterised by a medium level of inequality, even though the situation has steadily worsened since the end of the 1960s. The distribution of wealth amongst cohorts is all in all good,

but especially over the last year we observe a worsening in the Gini index amongst individuals aged 50.

27. *United States.* The country is characterised by a medium level of inequality and by a worsening in the level of distribution, even though the phenomenon has not reached the magnitude achieved by the United Kingdom. The system is fair and we do not observe particular spike in the distribution of wealth amongst cohorts.

Empirical Framework

In order to evaluate if and how the cohort-specific inequality depends on the structure of taxation system I run a regression using the Gini index calculated by using the Jenkins' routine for every age group as dependent variable. The regressors are both variables which capture the characteristics of the taxation system and some control variables, such as the GDP growth rate, unemployment rate and consumer price index (CPI). Regressions were made only for 17 countries (Austria, Belgium, Canada, Switzerland, Germany, Denmark, Spain, Finland, France, Greece, Ireland, Italy, Luxemburg, Mexico, Norway, Sweden, United States) because of the absence of data for the other countries, for year 2000. The specification of the model is the following

$$gini = \beta_0 + \beta_1 ttw + \beta_2 tmpit + \beta_3 nptdi + \beta_4 gdp99 + \quad (68)$$
$$+\beta_5 ur99 + \beta_6 cpi99 + \beta_{6+g} \sum_{g=1}^{61} d_g + \varepsilon_t$$

where
gini=Gini index (2000)

ttw is a variable indicating the total tax wedge which may be one of the following:

ttw67 = Total tax wedge as a 67% of Average Wage; marginal personal income tax and social security contribution rates on gross labour income

ttw100 = Total tax wedge as a 100% of Average Wage; marginal personal income tax and social security contribution rates on gross labour income

ttw133 = Total tax wedge as a 133% of Average Wage; marginal personal income tax and social security contribution rates on gross labour income

ttw167 = Total tax wedge as a 167% of Average Wage; marginal personal income tax and social security contribution rates on gross labour income

attw67 = Total tax wedge as a 67% of Average Wage; average personal income tax and social security contribution rates on gross labour income

attw100 = Total tax wedge as a 100% of Average Wage; average personal income tax and social security contribution rates on gross labour income

attw133 = Total tax wedge as a 133% of Average Wage; average personal income tax and social security contribution rates on gross labour income

attw167 = Total tax wedge as a 167% of Average Wage; average personal income tax and social security contribution rates on gross labour income

tmpit = Top marginal personal income tax rates for employee (combined)

nptdi = Net personal Tax; overall statutory tax rates on dividend income

gdp99 = GDP Growth Rate 1999

ur99 = Unemployment rate 1999

cpi99 = Consumer price index 1999

$\mathbf{d}_g$ = dummy for age group g

The marginal and average tax rates "all-in" for employees includes personal income tax and employee social security contributions and less cash benefits, for a single individual without children at different income levels. Marginal tax rates measure how much of the extra wage income an individual worker keeps after taxes, whilst average tax rates measure how much total net income after tax changes if one decides to join (or exit from) the labour market (OECD, 2004).

The taxation of personal capital income varies substantially amongst OECD countries because some of them tax all personal capital income at a flat rate and wage and pensions at progressive rates (Dual-income tax); in other countries the taxation is progressive and the capital is taxed at more or less the same rates as labour (comprehensive income tax systems); finally in some countries we observe a semi-dual income taxation of capital income, since some capital is taxed at lower rates than wage income. Due to these differences, the OECD has chosen to use the taxation of dividends as a proxy for the taxation of capital, in order to allow for comparability. Appendix 2 reports the results of regressions and relative graphics of coefficients betas.

The total tax wedge and overall statutory tax rates on dividend income are always statistically significant at 1 per cent of the significant interval, meaning that these two variables have a great explanatory power for the cohort-specific inequality. More controversial is the evidence about the top marginal personal income tax rates for employee; this variable is significant at 5 per cent of the confidence interval only when we use the total tax wedge as a 133 and 167 per cent of the average wage with marginal personal income tax and as a 167 per cent of the average wage with average personal income tax.

As for the age groups dummies, we can observe that, most of the times, they are statistically significant at 1 per cent of the confidence interval for young cohorts; otherwise, they are never significant for old cohorts (especially for individuals aged 50 or more).

Therefore, overall results shows the existence of a strong relation between the taxation system and the inequality amongst age-groups, especially for younger individuals.

Concluding remarks

In this paper I analysed a probabilistic voting model of direct taxation where self-interested governments set their policies in order to maximise the probability of winning elections. Society is divided into groups who have different preferences for the consumption of leisure. The use of a probabilistic voting model characterized by the presence of single-minded groups changes the classic results of median voter models because it is no longer the level of income which drives the equilibrium policies but the ability of groups to focus on leisure, instead. This ability enables them to achieve a strong political power which candidates cannot help going along with, because they would lose the elections otherwise. I also show the robustness of the single-mindedness theory in a two-dimensional setting, where individuals differ also for their levels of income, not only preference for leisure. Results from the Luxemburg Income Study corroborate the theoretical results and show how goals in terms of cohort-specific inequality are still very far from being reached in the real world.

Appendix 1

AUSTRIA

age	gen2_AT81	gen2_AT87	gen2_AT94	gen2_AT95	gen2_AT97	gen2_AT00
19	0.27523	0.04553	0.22233	0.40876	0.20567	0
20	0.21493	0.08294	0.38405	0.47644	0.10894	0.02608
21	0.20278	0.13421	0.22409	0.39933	0.18989	0.12403
22	0.16485	0.14668	0.12977	0.26077	0.14164	0.26366
23	0.20968	0.13639	0.16412	0.35486	0.18645	0.16583
24	0.183	0.12371	0.16439	0.21554	0.12458	0.06911
25	0.12369	0.0986	0.12998	0.27466	0.14559	0.08143
26	0.13922	0.10477	0.1369	0.16417	0.10172	0.13755
27	0.13348	0.08437	0.27687	0.2169	0.07776	0.09473
28	0.12026	0.09914	0.12282	0.15547	0.11324	0.08929
29	0.11832	0.12484	0.12105	0.17941	0.16818	0.09229
30	0.10514	0.07123	0.12206	0.14645	0.07855	0.0828
31	0.12493	0.07577	0.13736	0.12271	0.13538	0.12616
32	0.12843	0.09248	0.11921	0.12224	0.14661	0.12119
33	0.12578	0.06034	0.09069	0.12836	0.06415	0.25269
34	0.11477	0.07832	0.13371	0.12119	0.05808	0.09634
35	0.11387	0.06752	0.07042	0.12258	0.18114	0.19637
36	0.10709	0.06045	0.36603	0.18879	0.07509	0.09409
37	0.10542	0.0819	0.11164	0.14147	0.08084	0.07739
38	0.12518	0.08893	0.16063	0.10928	0.06272	0.23582
39	0.1198	0.12965	0.28495	0.12378	0.22948	0.09471
40	0.11621	0.0734	0.19278	0.1259	0.09638	0.06439
41	0.11476	0.10087	0.09561	0.13351	0.12711	0.06265
42	0.14295	0.1029	0.11324	0.13888	0.3054	0.1261
43	0.11068	0.10255	0.10202	0.1121	0.13436	0.13967
44	0.1123	0.11499	0.29329	0.15698	0.09731	0.09694
45	0.14254	0.12846	0.13047	0.13542	0.25254	0.08503
46	0.14773	0.1432	0.09814	0.1402	0.10193	0.09825
47	0.15354	0.1382	0.3126	0.15642	0.17973	0.14639
48	0.14812	0.14279	0.14581	0.16197	0.12727	0.13686
49	0.1721	0.13782	0.11283	0.15114	0.12356	0.11355
50	0.16461	0.15592	0.19426	0.16682	0.20683	0.3045
51	0.17518	0.17292	0.18427	0.16892	0.14611	0.08092
52	0.17536	0.19792	0.13339	0.19878	0.15831	0.12516
53	0.14163	0.18818	0.2575	0.17703	0.14604	0.16831
54	0.17207	0.15597	0.317	0.17525	0.1299	0.26289
55	0.1933	0.19222	0.26579	0.20559	0.17101	0.07751
56	0.17301	0.15026	0.16685	0.20935	0.18652	0.15374
57	0.21078	0.23471	0.29849	0.18397	0.16035	0.19093
58	0.17809	0.14317	0.20851	0.19244	0.29088	0.1275
59	0.24858	0.19516	0.16402	0.19507	0.18774	0.16268
60	0.23237	0.1913	0.14822	0.22121	0.18515	0.2102
61	0.35633	0.27229	0.17028	0.18902	0.12613	0.36048
62	0.29752	0.20967	0.17248	0.23411	0.13744	0.225
63	0.25695	0.25638	0.39155	0.2236	0.16006	0.17547
64	0.2984	0.25927	0.14831	0.22759	0.18302	0.12149
65	0.30494	0.25167	0.24476	0.22662	0.20914	0.24762
66	0.2042	0.19542	0.1497	0.18072	0.15705	0.30201
67	0.34052	0.20299	0.1706	0.22394	0.182	0.28207
68	0.22707	0.16918	0.19639	0.20563	0.33885	0.17858
69	0.29017	0.18181	0.14626	0.21686	0.14935	0.14879

70	0.16389	0.20754	0.2764	0.24003	0.13561	0.25692
71	0.21415	0.21932	0.18063	0.23711	0.20396	0.26261
72	0.23721	0.27098	0.18201	0.24913	0.2422	0.22027
73	0.24773	0.21071	0.24251	0.24612	0.25004	0.11828
74	0.33316	0.25256	0.30121	0.25233	0.13601	0.21595
75	0.08446	0.22245	0.16496	0.23895	0.23343	0.14067
76	0.31632	0.16431	0.25675	0.20827	0.34988	0.23612
77	0.25462	0.21869	0.30179	0.25463	0.27684	0.15107
78	0.2384	0.2024	0.0738	0.17864	0.26674	0.28586
79	0.32036	0.27349	0.30181	0.18722	0.18339	0.53275
80	0.29263	0.41491	0.23909	0.25137	0.18485	0.33009
81	0.18971	0.25238	0.3126	0.20594	0.20055	0.20875
82	0.34148	0.15121	0.64463	0.29873	0.34728	0.23852
83	0.30446	0.14992	0.14279	0.1739	0.22801	0.1129
84	0.18058	0.20339	0.26669	0.26928	0.13868	0.18779
85	0.26799	0.14716	0.81539	0.25191	0.26707	0.22778
mean	**0.194701642**	**0.15986239**	**0.2104709**	**0.2031606**	**0.1713091**	**0.18750269**
var	**0.005348056**	**0.00467133**	**0.01461624**	**0.00489227**	**0.00465142**	**0.03411195**

Generalised Entropy index of class 2 – Austria

AUSTRIA						
age	***gini_AT81***	***gini_AT87***	***gini_AT94***	***gini_AT95***	***gini_AT97***	***gini_AT00***
19	*0.39331*	*0.165*	*0.32396*	*0.49366*	*0.34815*	*0*
20	*0.33342*	*0.21484*	*0.48782*	*0.53148*	*0.24158*	*0.12464*
21	*0.34635*	*0.2482*	*0.32848*	*0.49308*	*0.33878*	*0.26498*
22	*0.3138*	*0.30051*	*0.2892*	*0.39798*	*0.28853*	*0.38474*
23	*0.34377*	*0.2801*	*0.28641*	*0.4439*	*0.34479*	*0.31939*
24	*0.33223*	*0.2734*	*0.31163*	*0.36834*	*0.2854*	*0.20894*
25	*0.27054*	*0.25413*	*0.29086*	*0.36606*	*0.29696*	*0.22803*
26	*0.28121*	*0.2506*	*0.29161*	*0.3172*	*0.25754*	*0.29544*
27	*0.28693*	*0.23084*	*0.39289*	*0.33255*	*0.21966*	*0.24874*
28	*0.27475*	*0.24968*	*0.27362*	*0.29819*	*0.25888*	*0.2313*
29	*0.27253*	*0.22118*	*0.27959*	*0.32533*	*0.30598*	*0.23743*
30	*0.25192*	*0.21639*	*0.26879*	*0.28727*	*0.22515*	*0.23132*
31	*0.27494*	*0.22042*	*0.28066*	*0.27357*	*0.26008*	*0.26603*
32	*0.26382*	*0.23589*	*0.27455*	*0.27653*	*0.24352*	*0.25903*
33	*0.26459*	*0.19244*	*0.24022*	*0.27098*	*0.20338*	*0.32614*
34	*0.26383*	*0.21469*	*0.26214*	*0.26944*	*0.18455*	*0.2442*
35	*0.26658*	*0.20652*	*0.21277*	*0.27218*	*0.31182*	*0.29127*
36	*0.25672*	*0.19381*	*0.32719*	*0.30489*	*0.21418*	*0.22432*
37	*0.25394*	*0.22468*	*0.26349*	*0.27316*	*0.22032*	*0.21517*
38	*0.27302*	*0.22602*	*0.3012*	*0.25282*	*0.20128*	*0.32656*
39	*0.26937*	*0.2648*	*0.31238*	*0.26487*	*0.30128*	*0.24025*
40	*0.26547*	*0.21428*	*0.25922*	*0.27347*	*0.24307*	*0.19358*
41	*0.26022*	*0.24372*	*0.2396*	*0.27913*	*0.27366*	*0.19388*
42	*0.28717*	*0.25204*	*0.25477*	*0.28579*	*0.28737*	*0.26779*
43	*0.25601*	*0.23317*	*0.22375*	*0.26781*	*0.27716*	*0.29304*
44	*0.26522*	*0.26394*	*0.37591*	*0.31539*	*0.23653*	*0.24844*
45	*0.29626*	*0.28116*	*0.28151*	*0.29439*	*0.30746*	*0.23509*
46	*0.29664*	*0.28307*	*0.24653*	*0.29133*	*0.24389*	*0.23056*
47	*0.29704*	*0.28863*	*0.37568*	*0.30984*	*0.30803*	*0.26479*
48	*0.30311*	*0.29325*	*0.27717*	*0.30879*	*0.2858*	*0.27147*
49	*0.31757*	*0.29232*	*0.27142*	*0.30706*	*0.28039*	*0.26043*
50	*0.31804*	*0.31016*	*0.33211*	*0.31875*	*0.32616*	*0.3463*
51	*0.32003*	*0.31846*	*0.32179*	*0.32209*	*0.29315*	*0.21885*
52	*0.31062*	*0.33522*	*0.28635*	*0.34522*	*0.30501*	*0.28289*
53	*0.28966*	*0.33477*	*0.36788*	*0.32576*	*0.29033*	*0.29552*
54	*0.32434*	*0.30437*	*0.37261*	*0.32349*	*0.27981*	*0.34564*
55	*0.34286*	*0.32361*	*0.37072*	*0.34425*	*0.32273*	*0.22011*
56	*0.33244*	*0.30134*	*0.32016*	*0.34463*	*0.31008*	*0.31161*
57	*0.34206*	*0.3577*	*0.34199*	*0.33644*	*0.30323*	*0.32773*
58	*0.32809*	*0.30237*	*0.33627*	*0.33439*	*0.38825*	*0.28035*
59	*0.35688*	*0.33072*	*0.31582*	*0.34097*	*0.32636*	*0.31101*
60	*0.35154*	*0.32342*	*0.30133*	*0.34344*	*0.33323*	*0.33324*
61	*0.40119*	*0.34792*	*0.31025*	*0.327*	*0.28138*	*0.38135*
62	*0.40636*	*0.33541*	*0.32669*	*0.35504*	*0.2833*	*0.34629*
63	*0.37624*	*0.35783*	*0.38393*	*0.34128*	*0.27253*	*0.31462*
64	*0.38643*	*0.32938*	*0.29589*	*0.35342*	*0.31883*	*0.2694*
65	*0.34965*	*0.34863*	*0.3467*	*0.34904*	*0.34311*	*0.37096*
66	*0.32376*	*0.33048*	*0.2918*	*0.31964*	*0.29739*	*0.35958*
67	*0.39054*	*0.33276*	*0.30745*	*0.34469*	*0.31361*	*0.33097*
68	*0.34391*	*0.31334*	*0.33929*	*0.33509*	*0.40072*	*0.31957*
69	*0.37072*	*0.32545*	*0.27846*	*0.34646*	*0.30326*	*0.4507*

70	*0.29057*	*0.33147*	*0.35869*	*0.3553*	*0.28895*	*0.36374*
71	*0.31555*	*0.34256*	*0.31918*	*0.33555*	*0.34597*	*0.37462*
72	*0.34093*	*0.33963*	*0.33223*	*0.33968*	*0.35403*	*0.34496*
73	*0.34316*	*0.33162*	*0.35085*	*0.3432*	*0.34818*	*0.26466*
74	*0.3715*	*0.33968*	*0.38*	*0.3564*	*0.29269*	*0.33997*
75	*0.22339*	*0.33832*	*0.28789*	*0.33898*	*0.33405*	*0.30024*
76	*0.36109*	*0.29289*	*0.38212*	*0.33695*	*0.39371*	*0.34608*
77	*0.32062*	*0.32974*	*0.36341*	*0.3438*	*0.34286*	*0.29808*
78	*0.33052*	*0.30874*	*0.21323*	*0.33045*	*0.35599*	*0.35192*
79	*0.36176*	*0.33943*	*0.38749*	*0.31905*	*0.33698*	*0.46303*
80	*0.3174*	*0.34514*	*0.30635*	*0.34904*	*0.31509*	*0.37855*
81	*0.28384*	*0.33127*	*0.37685*	*0.34072*	*0.30976*	*0.31737*
82	*0.39251*	*0.26995*	*0.42346*	*0.35192*	*0.43507*	*0.37498*
83	*0.34346*	*0.26694*	*0.29686*	*0.30181*	*0.31937*	*0.23866*
84	*0.30677*	*0.30612*	*0.34138*	*0.32218*	*0.28217*	*0.306*
85	*0.33595*	*0.27948*	*0.45054*	*0.30442*	*0.3346*	*0.35994*
mean	**0.315472537**	**0.2863588**	**0.316761791**	**0.330851045**	**0.298165821**	***0.290544478***
var	**0.001848617**	**0.0023986**	**0.002868845**	**0.002566864**	**0.002360967**	***0.005210053***

Gini index – Austria

Appendix 2

Gini index	Coef.	Robust Std. Err.	t	P>|t|	95% Conf. Interval	
ttw67	-0.26158	0.017453	-14.99	0(***)	-0.29583	-0.22733
tmpit	-0.03427	0.027968	-1.23	0.221	-0.08915	0.020615
nptdi	-0.0014	0.000153	-9.14	0(***)	-0.0017	-0.0011
gdpgr99	-0.00127	0.001235	-1.03	0.302	-0.0037	0.001148
ur99	0.004558	0.000538	8.47	0(***)	0.003501	0.005614
cpi99	0.003593	0.000571	6.29	0(***)	0.002472	0.004713
g1	-0.04796	0.044034	-1.09	0.276	-0.13437	0.038448
g2	-0.01879	0.032442	-0.58	0.563	-0.08246	0.044869
g3	0.002495	0.026636	0.09	0.925	-0.04977	0.054765
g4	-0.01684	0.02337	-0.72	0.471	-0.0627	0.02902
g5	-0.01278	0.023486	-0.54	0.587	-0.05887	0.03331
g6	-0.03823	0.022421	-1.71	0.088(*)	-0.08223	0.005766
g7	-0.03082	0.022227	-1.39	0.166	-0.07444	0.012794
g8	-0.05092	0.020377	-2.5	0.013(**)	-0.09091	-0.01094
g9	-0.04708	0.019986	-2.36	0.019(**)	-0.0863	-0.00786
g10	-0.06087	0.019446	-3.13	0.002(***)	-0.09903	-0.02271
g11	-0.0572	0.021709	-2.63	0.009(***)	-0.0998	-0.0146
g12	-0.04536	0.020593	-2.2	0.028(**)	-0.08577	-0.00495
g13	-0.05675	0.019982	-2.84	0.005(***)	-0.09597	-0.01754
g14	-0.04373	0.022909	-1.91	0.057(*)	-0.08868	0.001227
g15	-0.05049	0.020255	-2.49	0.013(**)	-0.09024	-0.01074
g16	-0.03276	0.022496	-1.46	0.146	-0.0769	0.011389
g17	-0.03842	0.020263	-1.9	0.058(*)	-0.07818	0.001342
g18	-0.04039	0.020145	-2.01	0.045(**)	-0.07992	-0.00086
g19	-0.05085	0.021489	-2.37	0.018(**)	-0.09302	-0.00868
g20	-0.04138	0.021431	-1.93	0.054(*)	-0.08344	0.000677
g21	-0.04254	0.019101	-2.23	0.026(**)	-0.08002	-0.00506
g22	-0.0427	0.020468	-2.09	0.037(**)	-0.08287	-0.00254
g23	-0.04093	0.020344	-2.01	0.044(**)	-0.08086	-0.00101
g24	-0.04215	0.021371	-1.97	0.049(**)	-0.08409	-0.00021
g25	-0.0363	0.020695	-1.75	0.08(*)	-0.07691	0.004308
g26	-0.04259	0.020543	-2.07	0.038(**)	-0.08291	-0.00228
g27	-0.03686	0.021344	-1.73	0.084(**)	-0.07874	0.005026
g28	-0.02599	0.021631	-1.2	0.23	-0.06843	0.016462
g29	-0.02117	0.021254	-1	0.319	-0.06288	0.020536
g30	-0.01459	0.0213	-0.69	0.493	-0.05639	0.027208
g31	-0.01491	0.020186	-0.74	0.46	-0.05452	0.024705
g32	-0.01456	0.020957	-0.69	0.487	-0.05569	0.026565
g33	-0.0216	0.021233	-1.02	0.309	-0.06327	0.020066
g34	-0.00826	0.019735	-0.42	0.676	-0.04699	0.030469
g35	-0.01953	0.020283	-0.96	0.336	-0.05933	0.020276
g36	0.015429	0.031929	0.48	0.629	-0.04723	0.078086
g37	-0.00274	0.021461	-0.13	0.898	-0.04485	0.039376
g38	0.01969	0.021875	0.9	0.368	-0.02324	0.062617
g39	0.041252	0.023599	1.75	0.081(*)	-0.00506	0.087563
g40	0.013112	0.02005	0.65	0.513	-0.02623	0.052457
g41	0.023191	0.020628	1.12	0.261	-0.01729	0.06367
g42	0.020414	0.02242	0.91	0.363	-0.02358	0.06441
g43	0.015101	0.021085	0.72	0.474	-0.02628	0.056478
g44	0.028168	0.019497	1.44	0.149	-0.01009	0.066427
g45	0.01119	0.02246	0.5	0.618	-0.03288	0.055265
g46	0.024157	0.0225	1.07	0.283	-0.02	0.06831

g47	0.00951	0.020796	0.46	0.648	-0.0313	0.05032
g48	0.007551	0.021572	0.35	0.726	-0.03478	0.049883
g49	-0.00595	0.023663	-0.25	0.801	-0.05239	0.040482
g50	0.000394	0.023093	0.02	0.986	-0.04492	0.04571
g51	-0.01166	0.024581	-0.47	0.635	-0.0599	0.036578
g52	0.007726	0.022344	0.35	0.73	-0.03612	0.051572
g53	-0.00681	0.022707	-0.3	0.764	-0.05137	0.037745
g54	0.001128	0.022218	0.05	0.96	-0.04247	0.044729
g55	-0.00276	0.023866	-0.12	0.908	-0.04959	0.044079
g56	-0.0037	0.021853	-0.17	0.866	-0.04658	0.039183
g57	-0.01108	0.024447	-0.45	0.65	-0.05906	0.036892
g58	-0.01288	0.020855	-0.62	0.537	-0.05381	0.028046
g59	0.002195	0.024229	0.09	0.928	-0.04535	0.04974
g60	-0.00992	0.021595	-0.46	0.646	-0.05229	0.032461
g61	0.007792	0.029873	0.26	0.794	-0.05083	0.066414
cons	0.468766	0.024516	19.12	0(***)	0.420657	0.516875
Number of obs	*1054*					
R-squared	*0.4484*					

OLS Regression ttw67; (***) significant at 1% C.I.; (**) significant at 5% C.I.; (*) significant at 10% C.I.

Gini index	Coef.	Robust Std. Err.	t	P>|t|	95% Conf. Interval	
ttw100	-0.24639	0.016318	-15.1	0(***)	-0.27841	-0.21436
tmpit	-0.02015	0.028762	-0.7	0.484	-0.07659	0.036295
nptdi	-0.00136	0.000151	-9.02	0(***)	-0.00166	-0.00106
gdpgr99	0.003968	0.001269	3.13	0.002(***)	0.001478	0.006457
ur99	0.003176	0.00054	5.88	0(***)	0.002117	0.004235
cpi99	0.003563	0.000567	6.28	0(***)	0.00245	0.004676
g1	-0.04796	0.044788	-1.07	0.284	-0.13585	0.039929
g2	-0.01879	0.033175	-0.57	0.571	-0.0839	0.046307
g3	0.002495	0.027212	0.09	0.927	-0.0509	0.055895
g4	-0.01684	0.023517	-0.72	0.474	-0.06299	0.02931
g5	-0.01278	0.024025	-0.53	0.595	-0.05992	0.034369
g6	-0.03823	0.022532	-1.7	0.09(*)	-0.08245	0.005984
g7	-0.03082	0.02291	-1.35	0.179	-0.07578	0.014135
g8	-0.05092	0.02085	-2.44	0.015(**)	-0.09184	-0.01001
g9	-0.04708	0.020652	-2.28	0.023(**)	-0.0876	-0.00655
g10	-0.06087	0.020019	-3.04	0.002(***)	-0.10015	-0.02158
g11	-0.0572	0.021831	-2.62	0.009(***)	-0.10004	-0.01436
g12	-0.04536	0.021517	-2.11	0.035(**)	-0.08758	-0.00313
g13	-0.05675	0.020206	-2.81	0.005(***)	-0.0964	-0.0171
g14	-0.04373	0.02368	-1.85	0.065(*)	-0.0902	0.00274
g15	-0.05049	0.020643	-2.45	0.015(**)	-0.091	-0.00998
g16	-0.03276	0.02299	-1.42	0.155	-0.07787	0.012358
g17	-0.03842	0.020944	-1.83	0.067(*)	-0.07952	0.00268
g18	-0.04039	0.02139	-1.89	0.059(*)	-0.08237	0.001585
g19	-0.05085	0.022314	-2.28	0.023(**)	-0.09464	-0.00706
g20	-0.04138	0.021515	-1.92	0.055(*)	-0.0836	0.000842
g21	-0.04254	0.019674	-2.16	0.031(**)	-0.08115	-0.00393
g22	-0.0427	0.020978	-2.04	0.042(**)	-0.08387	-0.00154
g23	-0.04093	0.020789	-1.97	0.049(**)	-0.08173	-0.00014
g24	-0.04215	0.021902	-1.92	0.055(*)	-0.08513	0.000829
g25	-0.0363	0.021874	-1.66	0.097(*)	-0.07923	0.006621
g26	-0.04259	0.021254	-2	0.045(**)	-0.0843	-0.00089
g27	-0.03686	0.022275	-1.65	0.098(*)	-0.08057	0.006852
g28	-0.02599	0.02293	-1.13	0.257	-0.07098	0.01901
g29	-0.02117	0.022379	-0.95	0.344	-0.06509	0.022744
g30	-0.01459	0.02246	-0.65	0.516	-0.05867	0.029484
g31	-0.01491	0.020868	-0.71	0.475	-0.05586	0.026042
g32	-0.01456	0.021726	-0.67	0.503	-0.0572	0.028075
g33	-0.0216	0.022239	-0.97	0.332	-0.06524	0.022039
g34	-0.00826	0.020788	-0.4	0.691	-0.04905	0.032536
g35	-0.01953	0.020734	-0.94	0.347	-0.06022	0.02116
g36	0.015429	0.032236	0.48	0.632	-0.04783	0.078689
g37	-0.00274	0.022781	-0.12	0.904	-0.04744	0.041967
g38	0.01969	0.022392	0.88	0.379	-0.02425	0.063631
g39	0.041252	0.024176	1.71	0.088(*)	-0.00619	0.088694
g40	0.013112	0.020815	0.63	0.529	-0.02773	0.053959
g41	0.023191	0.020788	1.12	0.265	-0.0176	0.063985
g42	0.020414	0.02307	0.88	0.376	-0.02486	0.065686
g43	0.015101	0.021472	0.7	0.482	-0.02704	0.057236
g44	0.028168	0.020094	1.4	0.161	-0.01126	0.0676
g45	0.01119	0.022519	0.5	0.619	-0.033	0.05538
g46	0.024157	0.023924	1.01	0.313	-0.02279	0.071104

g47	0.00951	0.021409	0.44	0.657	-0.0325	0.051521
g48	0.007551	0.021926	0.34	0.731	-0.03548	0.050579
g49	-0.00595	0.024293	-0.25	0.806	-0.05363	0.041718
g50	0.000394	0.024138	0.02	0.987	-0.04697	0.047762
g51	-0.01166	0.025142	-0.46	0.643	-0.061	0.037678
g52	0.007726	0.022616	0.34	0.733	-0.03665	0.052107
g53	-0.00681	0.023343	-0.29	0.77	-0.05262	0.038993
g54	0.001128	0.022979	0.05	0.961	-0.04397	0.046222
g55	-0.00276	0.024664	-0.11	0.911	-0.05116	0.045646
g56	-0.0037	0.022248	-0.17	0.868	-0.04736	0.039959
g57	-0.01108	0.025256	-0.44	0.661	-0.06064	0.03848
g58	-0.01288	0.021683	-0.59	0.553	-0.05543	0.029669
g59	0.002195	0.025012	0.09	0.93	-0.04689	0.051277
g60	-0.00992	0.022064	-0.45	0.653	-0.05322	0.033382
g61	0.007792	0.02988	0.26	0.794	-0.05084	0.066427
cons	0.459757	0.024464	18.79	0(***)	0.41175	0.507764
Number of obs	*1054*					
R-squared	*0.4263*					

OLS Regression ttw100; (***) significant at 1% C.I.; (**) significant at 5% C.I.; (*) significant at 10% C.I.

Gini index	Coef.	Robust Std. Err.	t	P>|t|	95% Conf. Interval	
ttw133	-0.24076	0.016967	-14.19	0(***)	-0.27406	-0.20747
tmpit	-0.0557	0.028137	-1.98	0.048(**)	-0.11091	-0.00049
nptdi	-0.00123	0.000152	-8.08	0(***)	-0.00153	-0.00093
gdpgr99	0.003717	0.001212	3.07	0.002(***)	0.001338	0.006096
ur99	0.003761	0.000538	6.99	0(***)	0.002705	0.004817
cpi99	0.003329	0.000564	5.91	0(***)	0.002223	0.004436
g1	-0.04796	0.044732	-1.07	0.284	-0.13574	0.039818
g2	-0.01879	0.033071	-0.57	0.57	-0.08369	0.046102
g3	0.002495	0.02708	0.09	0.927	-0.05065	0.055637
g4	-0.01684	0.023416	-0.72	0.472	-0.06279	0.02911
g5	-0.01278	0.02354	-0.54	0.587	-0.05897	0.033416
g6	-0.03823	0.022497	-1.7	0.09(*)	-0.08238	0.005916
g7	-0.03082	0.022752	-1.35	0.176	-0.07547	0.013825
g8	-0.05092	0.020532	-2.48	0.013(**)	-0.09122	-0.01063
g9	-0.04708	0.020332	-2.32	0.021(**)	-0.08697	-0.00718
g10	-0.06087	0.019983	-3.05	0.002(***)	-0.10008	-0.02165
g11	-0.0572	0.02156	-2.65	0.008(***)	-0.09951	-0.01489
g12	-0.04536	0.021093	-2.15	0.032(**)	-0.08675	-0.00397
g13	-0.05675	0.020013	-2.84	0.005(***)	-0.09603	-0.01748
g14	-0.04373	0.023231	-1.88	0.06(*)	-0.08932	0.00186
g15	-0.05049	0.020468	-2.47	0.014(**)	-0.09066	-0.01032
g16	-0.03276	0.022986	-1.43	0.154	-0.07786	0.012351
g17	-0.03842	0.020777	-1.85	0.065(*)	-0.07919	0.002352
g18	-0.04039	0.021073	-1.92	0.056(*)	-0.08175	0.000963
g19	-0.05085	0.02198	-2.31	0.021(**)	-0.09398	-0.00772
g20	-0.04138	0.021363	-1.94	0.053(*)	-0.0833	0.000543
g21	-0.04254	0.019571	-2.17	0.03(**)	-0.08094	-0.00413
g22	-0.0427	0.021053	-2.03	0.043(**)	-0.08402	-0.00139
g23	-0.04093	0.020659	-1.98	0.048(**)	-0.08147	-0.0004
g24	-0.04215	0.021493	-1.96	0.05(**)	-0.08433	2.73E-05
g25	-0.0363	0.02135	-1.7	0.089(*)	-0.0782	0.005593
g26	-0.04259	0.020918	-2.04	0.042(**)	-0.08364	-0.00154
g27	-0.03686	0.021777	-1.69	0.091(*)	-0.07959	0.005875
g28	-0.02599	0.022451	-1.16	0.247	-0.07004	0.01807
g29	-0.02117	0.021984	-0.96	0.336	-0.06431	0.021968
g30	-0.01459	0.022015	-0.66	0.508	-0.05779	0.028611
g31	-0.01491	0.020526	-0.73	0.468	-0.05519	0.025371
g32	-0.01456	0.021314	-0.68	0.495	-0.05639	0.027266
g33	-0.0216	0.021758	-0.99	0.321	-0.0643	0.021097
g34	-0.00826	0.020108	-0.41	0.681	-0.04772	0.031202
g35	-0.01953	0.020378	-0.96	0.338	-0.05952	0.020462
g36	0.015429	0.032251	0.48	0.632	-0.04786	0.078718
g37	-0.00274	0.022061	-0.12	0.901	-0.04603	0.040553
g38	0.01969	0.022041	0.89	0.372	-0.02356	0.062943
g39	0.041252	0.023821	1.73	0.084(*)	-0.00549	0.087997
g40	0.013112	0.020521	0.64	0.523	-0.02716	0.053383
g41	0.023191	0.020629	1.12	0.261	-0.01729	0.063673
g42	0.020414	0.022522	0.91	0.365	-0.02378	0.06461
g43	0.015101	0.021306	0.71	0.479	-0.02671	0.056912
g44	0.028168	0.019706	1.43	0.153	-0.0105	0.066838
g45	0.01119	0.022041	0.51	0.612	-0.03206	0.054442
g46	0.024157	0.023343	1.03	0.301	-0.02165	0.069964

g47	0.00951	0.021193	0.45	0.654	-0.03208	0.051098
g48	0.007551	0.021858	0.35	0.73	-0.03534	0.050444
g49	-0.00595	0.023976	-0.25	0.804	-0.053	0.041096
g50	0.000394	0.023819	0.02	0.987	-0.04635	0.047135
g51	-0.01166	0.024868	-0.47	0.639	-0.06046	0.03714
g52	0.007726	0.022862	0.34	0.735	-0.03714	0.052589
g53	-0.00681	0.023273	-0.29	0.77	-0.05248	0.038855
g54	0.001128	0.022698	0.05	0.96	-0.04341	0.045671
g55	-0.00276	0.024504	-0.11	0.91	-0.05084	0.045332
g56	-0.0037	0.02214	-0.17	0.867	-0.04715	0.039747
g57	-0.01108	0.025077	-0.44	0.659	-0.06029	0.038128
g58	-0.01288	0.021454	-0.6	0.548	-0.05498	0.029222
g59	0.002195	0.024748	0.09	0.929	-0.04637	0.05076
g60	-0.00992	0.022106	-0.45	0.654	-0.0533	0.033464
g61	0.007792	0.029765	0.26	0.794	-0.05062	0.066202
cons	0.474443	0.024745	19.17	0(***)	0.425884	0.523003
Number of obs	*1054*					
R-squared	*0.4296*					

OLS Regression ttw133; (***) significant at 1% C.I.; (**) significant at 5% C.I.; (*) significant at 10% C.I.

Gini index	Coef.	Robust Std. Err.	t	P>|t|	95% Conf. Interval	
ttw133	-0.24076	0.016967	-14.19	0(***)	-0.27406	-0.20747
tmpit	-0.0557	0.028137	-1.98	0.048(**)	-0.11091	-0.00049
nptdi	-0.00123	0.000152	-8.08	0(***)	-0.00153	-0.00093
gdpgr99	0.003717	0.001212	3.07	0.002(***)	0.001338	0.006096
ur99	0.003761	0.000538	6.99	0(***)	0.002705	0.004817
cpi99	0.003329	0.000564	5.91	0(***)	0.002223	0.004436
g1	-0.04796	0.044732	-1.07	0.284	-0.13574	0.039818
g2	-0.01879	0.033071	-0.57	0.57	-0.08369	0.046102
g3	0.002495	0.02708	0.09	0.927	-0.05065	0.055637
g4	-0.01684	0.023416	-0.72	0.472	-0.06279	0.02911
g5	-0.01278	0.02354	-0.54	0.587	-0.05897	0.033416
g6	-0.03823	0.022497	-1.7	0.09(*)	-0.08238	0.005916
g7	-0.03082	0.022752	-1.35	0.176	-0.07547	0.013825
g8	-0.05092	0.020532	-2.48	0.013(**)	-0.09122	-0.01063
g9	-0.04708	0.020332	-2.32	0.021(**)	-0.08697	-0.00718
g10	-0.06087	0.019983	-3.05	0.002(***)	-0.10008	-0.02165
g11	-0.0572	0.02156	-2.65	0.008(***)	-0.09951	-0.01489
g12	-0.04536	0.021093	-2.15	0.032(**)	-0.08675	-0.00397
g13	-0.05675	0.020013	-2.84	0.005(***)	-0.09603	-0.01748
g14	-0.04373	0.023231	-1.88	0.06(*)	-0.08932	0.00186
g15	-0.05049	0.020468	-2.47	0.014(**)	-0.09066	-0.01032
g16	-0.03276	0.022986	-1.43	0.154	-0.07786	0.012351
g17	-0.03842	0.020777	-1.85	0.065(*)	-0.07919	0.002352
g18	-0.04039	0.021073	-1.92	0.056(*)	-0.08175	0.000963
g19	-0.05085	0.02198	-2.31	0.021(**)	-0.09398	-0.00772
g20	-0.04138	0.021363	-1.94	0.053(*)	-0.0833	0.000543
g21	-0.04254	0.019571	-2.17	0.03(*)	-0.08094	-0.00413
g22	-0.0427	0.021053	-2.03	0.043(**)	-0.08402	-0.00139
g23	-0.04093	0.020659	-1.98	0.048(**)	-0.08147	-0.0004
g24	-0.04215	0.021493	-1.96	0.05(**)	-0.08433	2.73E-05
g25	-0.0363	0.02135	-1.7	0.089(*)	-0.0782	0.005593
g26	-0.04259	0.020918	-2.04	0.042(**)	-0.08364	-0.00154
g27	-0.03686	0.021777	-1.69	0.091(**)	-0.07959	0.005875
g28	-0.02599	0.022451	-1.16	0.247	-0.07004	0.01807
g29	-0.02117	0.021984	-0.96	0.336	-0.06431	0.021968
g30	-0.01459	0.022015	-0.66	0.508	-0.05779	0.028611
g31	-0.01491	0.020526	-0.73	0.468	-0.05519	0.025371
g32	-0.01456	0.021314	-0.68	0.495	-0.05639	0.027266
g33	-0.0216	0.021758	-0.99	0.321	-0.0643	0.021097
g34	-0.00826	0.020108	-0.41	0.681	-0.04772	0.031202
g35	-0.01953	0.020378	-0.96	0.338	-0.05952	0.020462
g36	0.015429	0.032251	0.48	0.632	-0.04786	0.078718
g37	-0.00274	0.022061	-0.12	0.901	-0.04603	0.040553
g38	0.01969	0.022041	0.89	0.372	-0.02356	0.062943
g39	0.041252	0.023821	1.73	0.084(*)	-0.00549	0.087997
g40	0.013112	0.020521	0.64	0.523	-0.02716	0.053383
g41	0.023191	0.020629	1.12	0.261	-0.01729	0.063673
g42	0.020414	0.022522	0.91	0.365	-0.02378	0.06461
g43	0.015101	0.021306	0.71	0.479	-0.02671	0.056912
g44	0.028168	0.019706	1.43	0.153	-0.0105	0.066838
g45	0.01119	0.022041	0.51	0.612	-0.03206	0.054442
g46	0.024157	0.023343	1.03	0.301	-0.02165	0.069964

g47	0.00951	0.021193	0.45	0.654	-0.03208	0.051098
g48	0.007551	0.021858	0.35	0.73	-0.03534	0.050444
g49	-0.00595	0.023976	-0.25	0.804	-0.053	0.041096
g50	0.000394	0.023819	0.02	0.987	-0.04635	0.047135
g51	-0.01166	0.024868	-0.47	0.639	-0.06046	0.03714
g52	0.007726	0.022862	0.34	0.735	-0.03714	0.052589
g53	-0.00681	0.023273	-0.29	0.77	-0.05248	0.038855
g54	0.001128	0.022698	0.05	0.96	-0.04341	0.045671
g55	-0.00276	0.024504	-0.11	0.91	-0.05084	0.045332
g56	-0.0037	0.02214	-0.17	0.867	-0.04715	0.039747
g57	-0.01108	0.025077	-0.44	0.659	-0.06029	0.038128
g58	-0.01288	0.021454	-0.6	0.548	-0.05498	0.029222
g59	0.002195	0.024748	0.09	0.929	-0.04637	0.05076
g60	-0.00992	0.022106	-0.45	0.654	-0.0533	0.033464
g61	0.007792	0.029765	0.26	0.794	-0.05062	0.066202
cons	0.474443	0.024745	19.17	0(***)	0.425884	0.523003
Number of obs	*1054*					
R-squared	*0.4720*					

OLS Regression ttw167; (***) significant at 1% C.I.; (**) significant at 5% C.I.; (*) significant at 10% C.I.

Gini index	Coef.	Robust Std. Err.	t	P>|t|	95% Conf. Interval	
attw67	-0.33975	0.021997	-15.45	0(***)	-0.38292	-0.29659
tmpit	-0.00283	0.02861	-0.1	0.921	-0.05897	0.053314
nptdi	-0.00131	0.000155	-8.46	0(***)	-0.00161	-0.00101
gdpgr99	-0.0046	0.001317	-3.49	0.001(***)	-0.00718	-0.00201
ur99	0.003453	0.000542	6.37	0(***)	0.00239	0.004516
cpi99	0.003837	0.00057	6.73	0(***)	0.002718	0.004956
g1	-0.04796	0.044461	-1.08	0.281	-0.13521	0.039287
g2	-0.01879	0.032597	-0.58	0.564	-0.08276	0.045173
g3	0.002495	0.026656	0.09	0.925	-0.04981	0.054804
g4	-0.01684	0.02327	-0.72	0.469	-0.0625	0.028825
g5	-0.01278	0.023091	-0.55	0.58	-0.05809	0.032536
g6	-0.03823	0.022245	-1.72	0.086(*)	-0.08188	0.00542
g7	-0.03082	0.022014	-1.4	0.162	-0.07402	0.012377
g8	-0.05092	0.020069	-2.54	0.011(**)	-0.09031	-0.01154
g9	-0.04708	0.019582	-2.4	0.016(**)	-0.0855	-0.00865
g10	-0.06087	0.019174	-3.17	0.002(***)	-0.09849	-0.02324
g11	-0.0572	0.02099	-2.73	0.007(***)	-0.09839	-0.01601
g12	-0.04536	0.020073	-2.26	0.024(**)	-0.08475	-0.00597
g13	-0.05675	0.019501	-2.91	0.004(***)	-0.09502	-0.01848
g14	-0.04373	0.022428	-1.95	0.051(*)	-0.08774	0.000284
g15	-0.05049	0.019737	-2.56	0.011(**)	-0.08922	-0.01176
g16	-0.03276	0.021802	-1.5	0.133	-0.07554	0.010027
g17	-0.03842	0.019801	-1.94	0.053(**)	-0.07728	0.000436
g18	-0.04039	0.019686	-2.05	0.04(**)	-0.07902	-0.00176
g19	-0.05085	0.021155	-2.4	0.016(**)	-0.09236	-0.00933
g20	-0.04138	0.020873	-1.98	0.048(**)	-0.08234	-0.00042
g21	-0.04254	0.018703	-2.27	0.023(**)	-0.07924	-0.00584
g22	-0.0427	0.020158	-2.12	0.034(**)	-0.08226	-0.00315
g23	-0.04093	0.019876	-2.06	0.04(**)	-0.07994	-0.00193
g24	-0.04215	0.020871	-2.02	0.044(**)	-0.08311	-0.00119
g25	-0.0363	0.020188	-1.8	0.072(*)	-0.07592	0.003313
g26	-0.04259	0.020099	-2.12	0.034(**)	-0.08203	-0.00315
g27	-0.03686	0.020786	-1.77	0.076(*)	-0.07765	0.00393
g28	-0.02599	0.021225	-1.22	0.221	-0.06764	0.015664
g29	-0.02117	0.020576	-1.03	0.304	-0.06155	0.019205
g30	-0.01459	0.020696	-0.71	0.481	-0.0552	0.026022
g31	-0.01491	0.019596	-0.76	0.447	-0.05336	0.023548
g32	-0.01456	0.020567	-0.71	0.479	-0.05492	0.025799
g33	-0.0216	0.020914	-1.03	0.302	-0.06264	0.019439
g34	-0.00826	0.019174	-0.43	0.667	-0.04588	0.029368
g35	-0.01953	0.019721	-0.99	0.322	-0.05823	0.019172
g36	0.015429	0.031347	0.49	0.623	-0.04608	0.076944
g37	-0.00274	0.020927	-0.13	0.896	-0.0438	0.038328
g38	0.01969	0.02119	0.93	0.353	-0.02189	0.061273
g39	0.041252	0.023859	1.73	0.084(*)	-0.00557	0.088071
g40	0.013112	0.019524	0.67	0.502	-0.0252	0.051425
g41	0.023191	0.020156	1.15	0.25	-0.01636	0.062746
g42	0.020414	0.021693	0.94	0.347	-0.02216	0.062983
g43	0.015101	0.02053	0.74	0.462	-0.02519	0.055388
g44	0.028168	0.018913	1.49	0.137	-0.00895	0.065283
g45	0.01119	0.021769	0.51	0.607	-0.03153	0.053908
g46	0.024157	0.021954	1.1	0.271	-0.01893	0.067239

g47	0.00951	0.020503	0.46	0.643	-0.03073	0.049745
g48	0.007551	0.021203	0.36	0.722	-0.03406	0.049159
g49	-0.00595	0.022976	-0.26	0.796	-0.05104	0.039133
g50	0.000394	0.022603	0.02	0.986	-0.04396	0.04475
g51	-0.01166	0.024223	-0.48	0.63	-0.05919	0.035874
g52	0.007726	0.021904	0.35	0.724	-0.03526	0.050709
g53	-0.00681	0.021965	-0.31	0.756	-0.04992	0.036289
g54	0.001128	0.02162	0.05	0.958	-0.0413	0.043555
g55	-0.00276	0.023419	-0.12	0.906	-0.04871	0.043202
g56	-0.0037	0.021246	-0.17	0.862	-0.04539	0.037992
g57	-0.01108	0.023983	-0.46	0.644	-0.05815	0.035982
g58	-0.01288	0.020314	-0.63	0.526	-0.05274	0.026984
g59	0.002195	0.02367	0.09	0.926	-0.04425	0.048644
g60	-0.00992	0.021266	-0.47	0.641	-0.05165	0.031814
g61	0.007792	0.029251	0.27	0.79	-0.04961	0.065193
cons	0.475867	0.024318	19.57	0(***)	0.428146	0.523587
Number of obs	*1054*					
R-squared	*0.4533*					

OLS Regression attw67; (***) significant at 1% C.I.; (**) significant at 5% C.I.; (*) significant at 10% C.I.

Gini index	**Coef.**	**Robust Std. Err.**	**t**	**P>|t|**	**95% Conf. Interval**	
attw100	-0.34485	0.022688	-15.2	0(***)	-0.38937	-0.30033
tmpit	0.014947	0.028642	0.52	0.602	-0.04126	0.071154
nptdi	-0.00131	0.000155	-8.42	0(***)	-0.00161	-0.001
gdpgr99	-0.00193	0.001267	-1.52	0.128	-0.00442	0.000555
ur99	0.00372	0.000535	6.96	0(***)	0.002671	0.004769
cpi99	0.004089	0.000573	7.13	0(***)	0.002963	0.005214
g1	-0.04796	0.044191	-1.09	0.278	-0.13468	0.038756
g2	-0.01879	0.032621	-0.58	0.565	-0.08281	0.045219
g3	0.002495	0.0271	0.09	0.927	-0.05069	0.055676
g4	-0.01684	0.023707	-0.71	0.478	-0.06336	0.029682
g5	-0.01278	0.023705	-0.54	0.59	-0.0593	0.033741
g6	-0.03823	0.022499	-1.7	0.09(*)	-0.08238	0.00592
g7	-0.03082	0.022495	-1.37	0.171	-0.07497	0.013321
g8	-0.05092	0.020605	-2.47	0.014(**)	-0.09136	-0.01049
g9	-0.04708	0.020164	-2.33	0.02(**)	-0.08664	-0.00751
g10	-0.06087	0.019644	-3.1	0.002(***)	-0.09942	-0.02232
g11	-0.0572	0.021682	-2.64	0.008(***)	-0.09975	-0.01465
g12	-0.04536	0.020721	-2.19	0.029(**)	-0.08602	-0.0047
g13	-0.05675	0.020009	-2.84	0.005(***)	-0.09602	-0.01749
g14	-0.04373	0.022888	-1.91	0.056(*)	-0.08864	0.001187
g15	-0.05049	0.020492	-2.46	0.014(**)	-0.0907	-0.01028
g16	-0.03276	0.022484	-1.46	0.145	-0.07688	0.011365
g17	-0.03842	0.020474	-1.88	0.061(*)	-0.0786	0.001757
g18	-0.04039	0.020275	-1.99	0.047(**)	-0.08018	-0.0006
g19	-0.05085	0.021623	-2.35	0.019(**)	-0.09328	-0.00842
g20	-0.04138	0.02161	-1.91	0.056(*)	-0.08379	0.001027
g21	-0.04254	0.019241	-2.21	0.027(**)	-0.0803	-0.00478
g22	-0.0427	0.020584	-2.07	0.038(**)	-0.0831	-0.00231
g23	-0.04093	0.020357	-2.01	0.045(**)	-0.08088	-0.00099
g24	-0.04215	0.02152	-1.96	0.05(**)	-0.08438	0.00008
g25	-0.0363	0.020967	-1.73	0.084(*)	-0.07745	0.004842
g26	-0.04259	0.020742	-2.05	0.04(**)	-0.0833	-0.00189
g27	-0.03686	0.02139	-1.72	0.085(*)	-0.07883	0.005117
g28	-0.02599	0.021809	-1.19	0.234	-0.06878	0.016811
g29	-0.02117	0.021439	-0.99	0.324	-0.06324	0.020899
g30	-0.01459	0.021451	-0.68	0.497	-0.05669	0.027505
g31	-0.01491	0.02026	-0.74	0.462	-0.05467	0.024851
g32	-0.01456	0.021159	-0.69	0.492	-0.05608	0.026962
g33	-0.0216	0.021422	-1.01	0.314	-0.06364	0.020437
g34	-0.00826	0.019858	-0.42	0.678	-0.04723	0.030711
g35	-0.01953	0.020532	-0.95	0.342	-0.05982	0.020764
g36	0.015429	0.032262	0.48	0.633	-0.04788	0.078739
g37	-0.00274	0.021543	-0.13	0.899	-0.04501	0.039536
g38	0.01969	0.022019	0.89	0.371	-0.02352	0.062899
g39	0.041252	0.024146	1.71	0.088(*)	-0.00613	0.088636
g40	0.013112	0.020173	0.65	0.516	-0.02647	0.052698
g41	0.023191	0.020678	1.12	0.262	-0.01739	0.06377
g42	0.020414	0.02241	0.91	0.363	-0.02356	0.06439
g43	0.015101	0.021149	0.71	0.475	-0.0264	0.056603
g44	0.028168	0.019627	1.44	0.152	-0.01035	0.066684
g45	0.01119	0.022371	0.5	0.617	-0.03271	0.055091
g46	0.024157	0.022637	1.07	0.286	-0.02027	0.06858

g47	0.00951	0.021106	0.45	0.652	-0.03191	0.050929
g48	0.007551	0.021734	0.35	0.728	-0.0351	0.050201
g49	-0.00595	0.023751	-0.25	0.802	-0.05256	0.040653
g50	0.000394	0.023316	0.02	0.987	-0.04536	0.046148
g51	-0.01166	0.024911	-0.47	0.64	-0.06055	0.037225
g52	0.007726	0.022604	0.34	0.733	-0.03663	0.052083
g53	-0.00681	0.022866	-0.3	0.766	-0.05169	0.038058
g54	0.001128	0.022415	0.05	0.96	-0.04286	0.045115
g55	-0.00276	0.024023	-0.11	0.909	-0.0499	0.044386
g56	-0.0037	0.022017	-0.17	0.867	-0.04691	0.039504
g57	-0.01108	0.024406	-0.45	0.65	-0.05898	0.03681
g58	-0.01288	0.021254	-0.61	0.545	-0.05459	0.028829
g59	0.002195	0.024319	0.09	0.928	-0.04553	0.049917
g60	-0.00992	0.021813	-0.45	0.649	-0.05272	0.03289
g61	0.007792	0.030088	0.26	0.796	-0.05125	0.066835
cons	0.47152	0.024669	19.11	0(***)	0.423109	0.51993
Number of obs	*1054*					
R-squared	*0.4543*					

OLS Regression attw100; (***) significant at 1% C.I.; (**) significant at 5% C.I.; (*) significant at 10% C.I.

Gini index	Coef.	Robust Std. Err.	t	P>|t|	95% Conf. Interval	
attw133	-0.35432	0.022434	-15.79	0(***)	-0.39835	-0.3103
tmpit	0.034216	0.028787	1.19	0.235	-0.02227	0.090706
nptdi	-0.00129	0.000153	-8.46	0(***)	-0.00159	-0.00099
gdpgr99	-0.00059	0.001235	-0.48	0.634	-0.00301	0.001835
ur99	0.00376	0.000524	7.18	0(***)	0.002732	0.004787
cpi99	0.004163	0.000572	7.28	0(***)	0.00304	0.005285
g1	-0.04796	0.043972	-1.09	0.276	-0.13425	0.038326
g2	-0.01879	0.032457	-0.58	0.563	-0.08249	0.044898
g3	0.002495	0.027163	0.09	0.927	-0.05081	0.055798
g4	-0.01684	0.023726	-0.71	0.478	-0.0634	0.029718
g5	-0.01278	0.023749	-0.54	0.591	-0.05938	0.033826
g6	-0.03823	0.022429	-1.7	0.089(*)	-0.08224	0.005781
g7	-0.03082	0.022673	-1.36	0.174	-0.07532	0.01367
g8	-0.05092	0.020563	-2.48	0.013(**)	-0.09128	-0.01057
g9	-0.04708	0.020189	-2.33	0.02(**)	-0.08669	-0.00746
g10	-0.06087	0.019611	-3.1	0.002(***)	-0.09935	-0.02238
g11	-0.0572	0.02162	-2.65	0.008(***)	-0.09963	-0.01477
g12	-0.04536	0.020721	-2.19	0.029(**)	-0.08602	-0.00469
g13	-0.05675	0.020011	-2.84	0.005(***)	-0.09602	-0.01748
g14	-0.04373	0.022815	-1.92	0.056(*)	-0.0885	0.001044
g15	-0.05049	0.020528	-2.46	0.014(**)	-0.09077	-0.01021
g16	-0.03276	0.022514	-1.45	0.146	-0.07694	0.011423
g17	-0.03842	0.020482	-1.88	0.061(*)	-0.07861	0.001774
g18	-0.04039	0.020355	-1.98	0.047(**)	-0.08034	-0.00045
g19	-0.05085	0.021573	-2.36	0.019(**)	-0.09318	-0.00851
g20	-0.04138	0.021688	-1.91	0.057(*)	-0.08394	0.001181
g21	-0.04254	0.019253	-2.21	0.027(**)	-0.08032	-0.00476
g22	-0.0427	0.020581	-2.07	0.038(**)	-0.08309	-0.00232
g23	-0.04093	0.020208	-2.03	0.043(**)	-0.08059	-0.00128
g24	-0.04215	0.021399	-1.97	0.049(**)	-0.08414	-0.00016
g25	-0.0363	0.021146	-1.72	0.086(*)	-0.0778	0.005193
g26	-0.04259	0.020682	-2.06	0.04(**)	-0.08318	-0.00201
g27	-0.03686	0.021292	-1.73	0.084(*)	-0.07864	0.004925
g28	-0.02599	0.021794	-1.19	0.233	-0.06875	0.016781
g29	-0.02117	0.021534	-0.98	0.326	-0.06343	0.021085
g30	-0.01459	0.021461	-0.68	0.497	-0.05671	0.027524
g31	-0.01491	0.020225	-0.74	0.461	-0.0546	0.024781
g32	-0.01456	0.021109	-0.69	0.49	-0.05598	0.026863
g33	-0.0216	0.021282	-1.01	0.31	-0.06337	0.020163
g34	-0.00826	0.019828	-0.42	0.677	-0.04717	0.030652
g35	-0.01953	0.020487	-0.95	0.341	-0.05973	0.020676
g36	0.015429	0.032493	0.47	0.635	-0.04833	0.079192
g37	-0.00274	0.021391	-0.13	0.898	-0.04471	0.039238
g38	0.01969	0.022095	0.89	0.373	-0.02367	0.063048
g39	0.041252	0.02414	1.71	0.088	-0.00612	0.088624
g40	0.013112	0.020114	0.65	0.515	-0.02636	0.052584
g41	0.023191	0.020501	1.13	0.258	-0.01704	0.063422
g42	0.020414	0.022393	0.91	0.362	-0.02353	0.064357
g43	0.015101	0.021084	0.72	0.474	-0.02627	0.056475
g44	0.028168	0.019686	1.43	0.153	-0.01046	0.0668
g45	0.01119	0.022171	0.5	0.614	-0.03232	0.054698
g46	0.024157	0.022634	1.07	0.286	-0.02026	0.068573

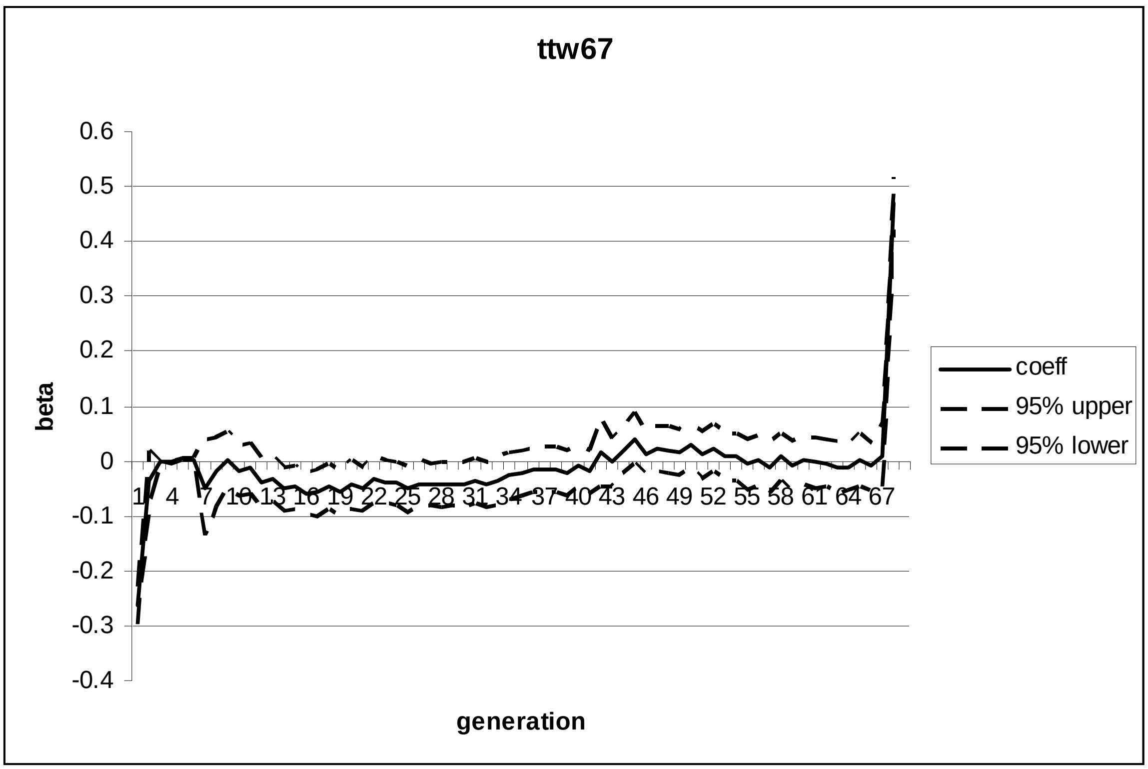
g47	0.00951	0.021172	0.45	0.653	-0.03204	0.051057
g48	0.007551	0.021795	0.35	0.729	-0.03522	0.050321
g49	-0.00595	0.023764	-0.25	0.802	-0.05259	0.04068
g50	0.000394	0.0234	0.02	0.987	-0.04553	0.046312
g51	-0.01166	0.025006	-0.47	0.641	-0.06073	0.037412
g52	0.007726	0.022763	0.34	0.734	-0.03694	0.052396
g53	-0.00681	0.022985	-0.3	0.767	-0.05192	0.038291
g54	0.001128	0.022423	0.05	0.96	-0.04287	0.04513
g55	-0.00276	0.023984	-0.11	0.909	-0.04982	0.04431
g56	-0.0037	0.022083	-0.17	0.867	-0.04704	0.039634
g57	-0.01108	0.024273	-0.46	0.648	-0.05872	0.036551
g58	-0.01288	0.021411	-0.6	0.548	-0.0549	0.029137
g59	0.002195	0.024411	0.09	0.928	-0.04571	0.050098
g60	-0.00992	0.021768	-0.46	0.649	-0.05263	0.032801
g61	0.007792	0.030132	0.26	0.796	-0.05134	0.066922
cons	0.471559	0.024513	19.24	0(***)	0.423456	0.519663
Number of obs	*1054*					
R-squared	*0.4651*					

OLS Regression attw133; (***) significant at 1% C.I.; (**) significant at 5% C.I.; (*) significant at 10% C.I.

Gini index	Coef.	Robust Std. Err.	t	P>|t|	95% Conf. Interval	
attw167	-0.36892	0.022812	-16.17	0(***)	-0.41369	-0.32416
tmpit	0.052806	0.02888	1.83	0.068(**)	-0.00387	0.10948
nptdi	-0.00134	0.00015	-8.91	0(***)	-0.00163	-0.00104
gdpgr99	-0.00033	0.001202	-0.27	0.784	-0.00269	0.002028
ur99	0.003747	0.000519	7.21	0(***)	0.002728	0.004766
cpi99	0.004263	0.000571	7.47	0(***)	0.003144	0.005383
g1	-0.04796	0.043982	-1.09	0.276	-0.13427	0.038347
g2	-0.01879	0.032367	-0.58	0.562	-0.08231	0.044721
g3	0.002495	0.02702	0.09	0.926	-0.05053	0.055519
g4	-0.01684	0.023625	-0.71	0.476	-0.0632	0.029521
g5	-0.01278	0.023555	-0.54	0.588	-0.059	0.033447
g6	-0.03823	0.022232	-1.72	0.086(*)	-0.08186	0.005395
g7	-0.03082	0.022547	-1.37	0.172	-0.07507	0.013421
g8	-0.05092	0.020344	-2.5	0.012(**)	-0.09085	-0.011
g9	-0.04708	0.019977	-2.36	0.019(**)	-0.08628	-0.00787
g10	-0.06087	0.019483	-3.12	0.002(***)	-0.0991	-0.02264
g11	-0.0572	0.021386	-2.67	0.008(***)	-0.09917	-0.01523
g12	-0.04536	0.020473	-2.22	0.027(**)	-0.08553	-0.00518
g13	-0.05675	0.01981	-2.86	0.004(***)	-0.09563	-0.01788
g14	-0.04373	0.022584	-1.94	0.053(*)	-0.08805	0.000589
g15	-0.05049	0.020323	-2.48	0.013(**)	-0.09037	-0.01061
g16	-0.03276	0.022393	-1.46	0.144	-0.0767	0.011186
g17	-0.03842	0.020317	-1.89	0.059(*)	-0.07829	0.00145
g18	-0.04039	0.020251	-1.99	0.046(**)	-0.08013	-0.00065
g19	-0.05085	0.021374	-2.38	0.018(**)	-0.09279	-0.0089
g20	-0.04138	0.021522	-1.92	0.055(*)	-0.08361	0.000855
g21	-0.04254	0.019131	-2.22	0.026(**)	-0.08008	-0.005
g22	-0.0427	0.02047	-2.09	0.037(**)	-0.08287	-0.00254
g23	-0.04093	0.02001	-2.05	0.041(**)	-0.0802	-0.00167
g24	-0.04215	0.021158	-1.99	0.047(**)	-0.08367	-0.00063
g25	-0.0363	0.020942	-1.73	0.083(*)	-0.0774	0.004793
g26	-0.04259	0.020418	-2.09	0.037(**)	-0.08266	-0.00253
g27	-0.03686	0.02104	-1.75	0.08(*)	-0.07815	0.004429
g28	-0.02599	0.021534	-1.21	0.228	-0.06824	0.01627
g29	-0.02117	0.021284	-0.99	0.32	-0.06294	0.020595
g30	-0.01459	0.021243	-0.69	0.492	-0.05628	0.027095
g31	-0.01491	0.019971	-0.75	0.456	-0.0541	0.024283
g32	-0.01456	0.02085	-0.7	0.485	-0.05548	0.026355
g33	-0.0216	0.021113	-1.02	0.307	-0.06303	0.019831
g34	-0.00826	0.01954	-0.42	0.673	-0.0466	0.030087
g35	-0.01953	0.020254	-0.96	0.335	-0.05927	0.020219
g36	0.015429	0.032518	0.47	0.635	-0.04838	0.079242
g37	-0.00274	0.021085	-0.13	0.897	-0.04411	0.038638
g38	0.01969	0.021919	0.9	0.369	-0.02332	0.062704
g39	0.041252	0.024076	1.71	0.087(*)	-0.00599	0.088497
g40	0.013112	0.019938	0.66	0.511	-0.02601	0.052238
g41	0.023191	0.020221	1.15	0.252	-0.01649	0.062872
g42	0.020414	0.022073	0.92	0.355	-0.0229	0.063729
g43	0.015101	0.020816	0.73	0.468	-0.02575	0.055949
g44	0.028168	0.019459	1.45	0.148	-0.01002	0.066353
g45	0.01119	0.02174	0.51	0.607	-0.03147	0.053853
g46	0.024157	0.022284	1.08	0.279	-0.01957	0.067885

g47	0.00951	0.020968	0.45	0.65	-0.03164	0.050657
g48	0.007551	0.02156	0.35	0.726	-0.03476	0.049861
g49	-0.00595	0.023372	-0.25	0.799	-0.05182	0.039909
g50	0.000394	0.023146	0.02	0.986	-0.04503	0.045815
g51	-0.01166	0.02473	-0.47	0.637	-0.06019	0.03687
g52	0.007726	0.022615	0.34	0.733	-0.03665	0.052105
g53	-0.00681	0.02277	-0.3	0.765	-0.0515	0.037868
g54	0.001128	0.02218	0.05	0.959	-0.0424	0.044653
g55	-0.00276	0.023738	-0.12	0.908	-0.04934	0.043827
g56	-0.0037	0.021789	-0.17	0.865	-0.04646	0.039057
g57	-0.01108	0.023965	-0.46	0.644	-0.05811	0.035945
g58	-0.01288	0.021161	-0.61	0.543	-0.0544	0.028645
g59	0.002195	0.024108	0.09	0.927	-0.04511	0.049504
g60	-0.00992	0.021563	-0.46	0.646	-0.05223	0.032399
g61	0.007792	0.029858	0.26	0.794	-0.0508	0.066385
cons	0.476033	0.024325	19.57	0(***)	0.428298	0.523768
Number of obs	*1054*					
R-squared	*0.4720*					

OLS Regression attw167; (***) significant at 1% C.I.; (**) significant at 5% C.I.; (*) significant at 10% C.I.



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generation
coeff
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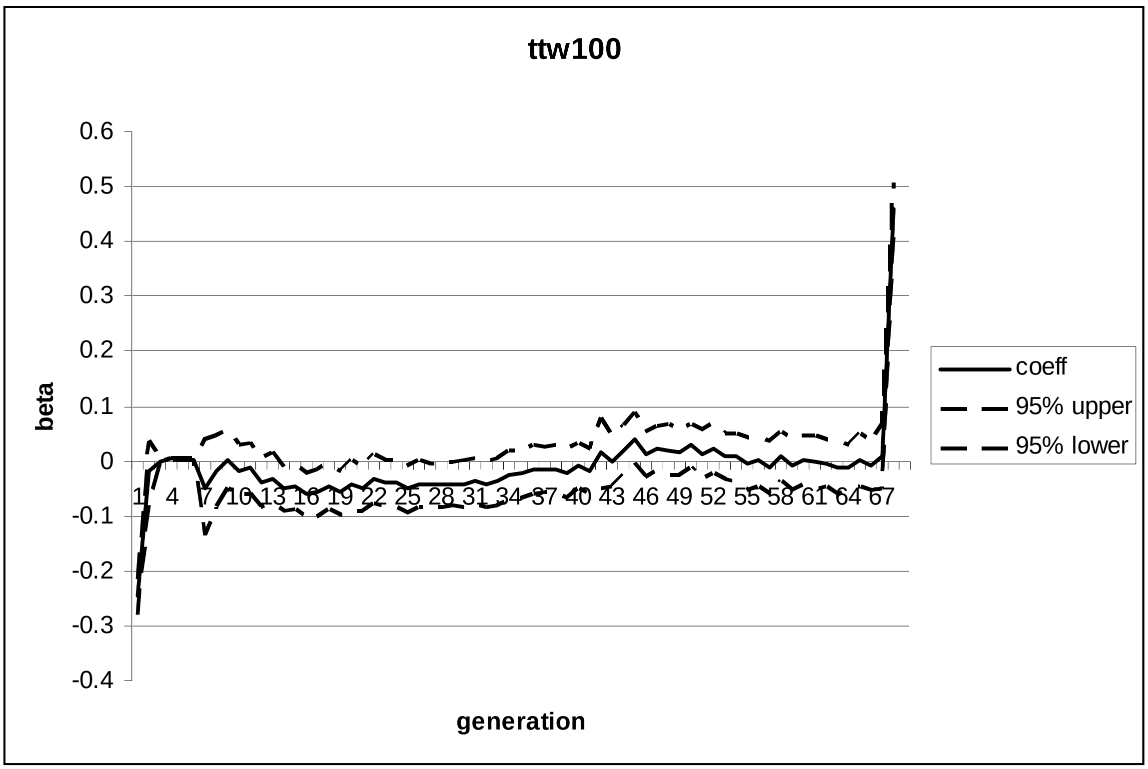
95% lower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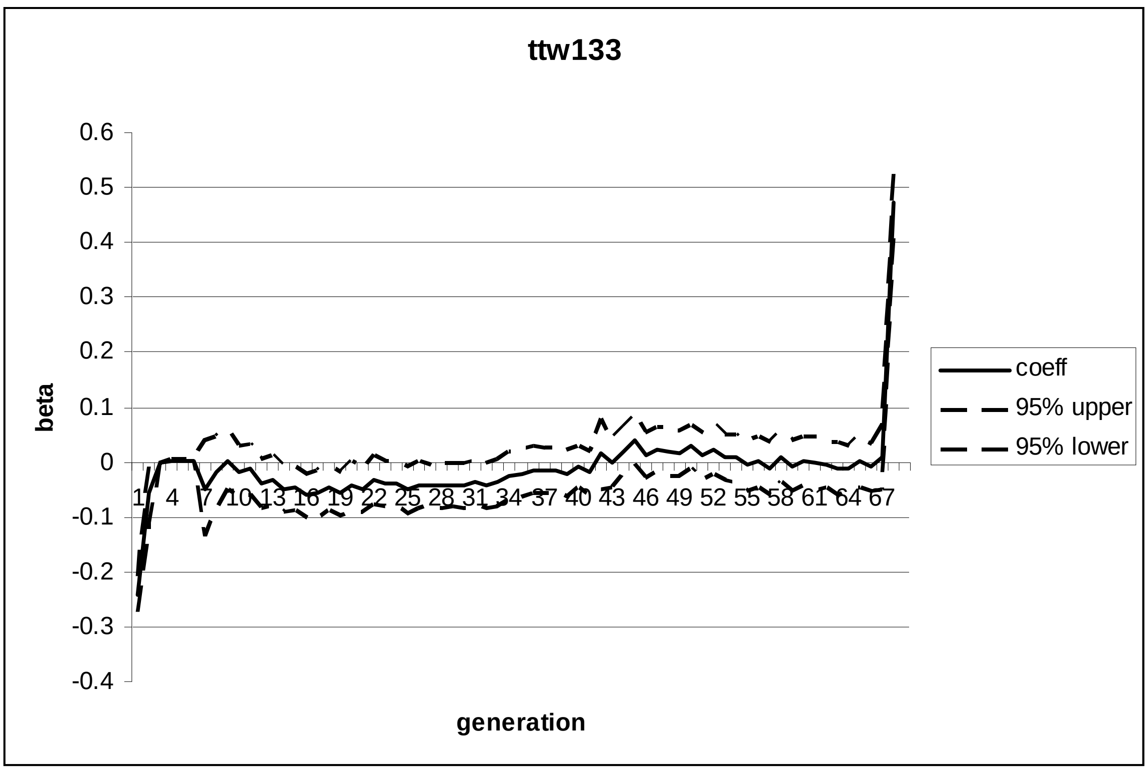
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generation
coeff
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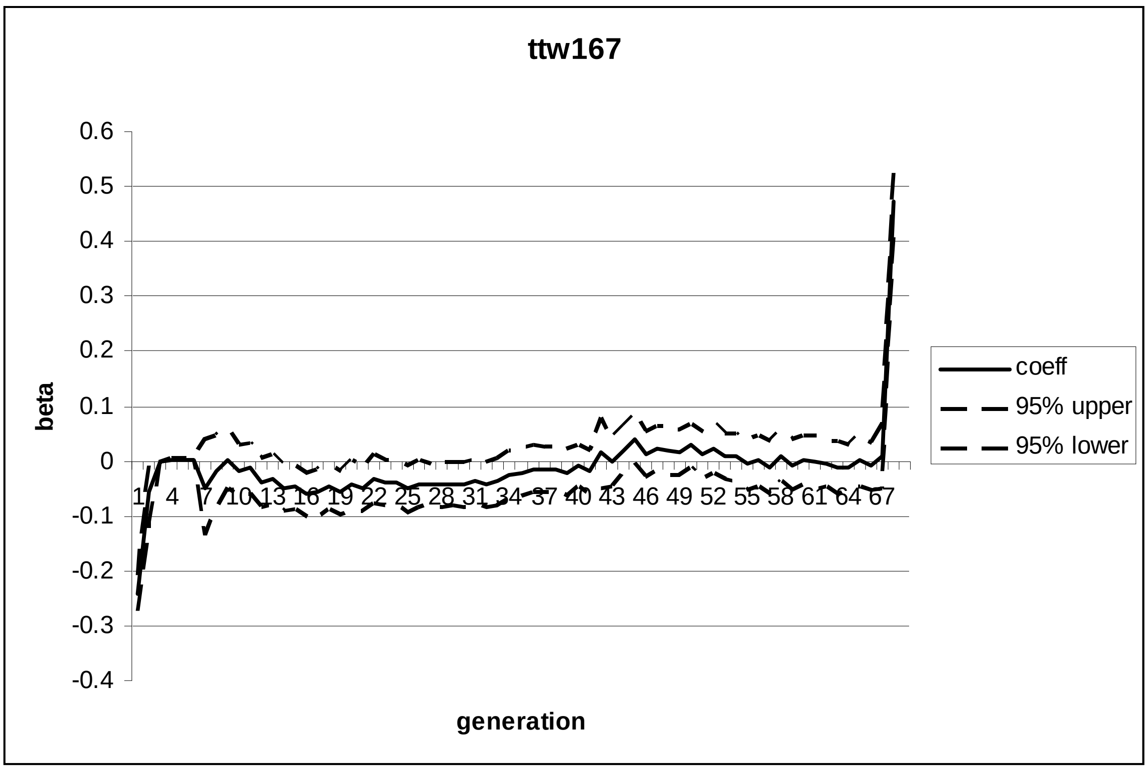
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generation
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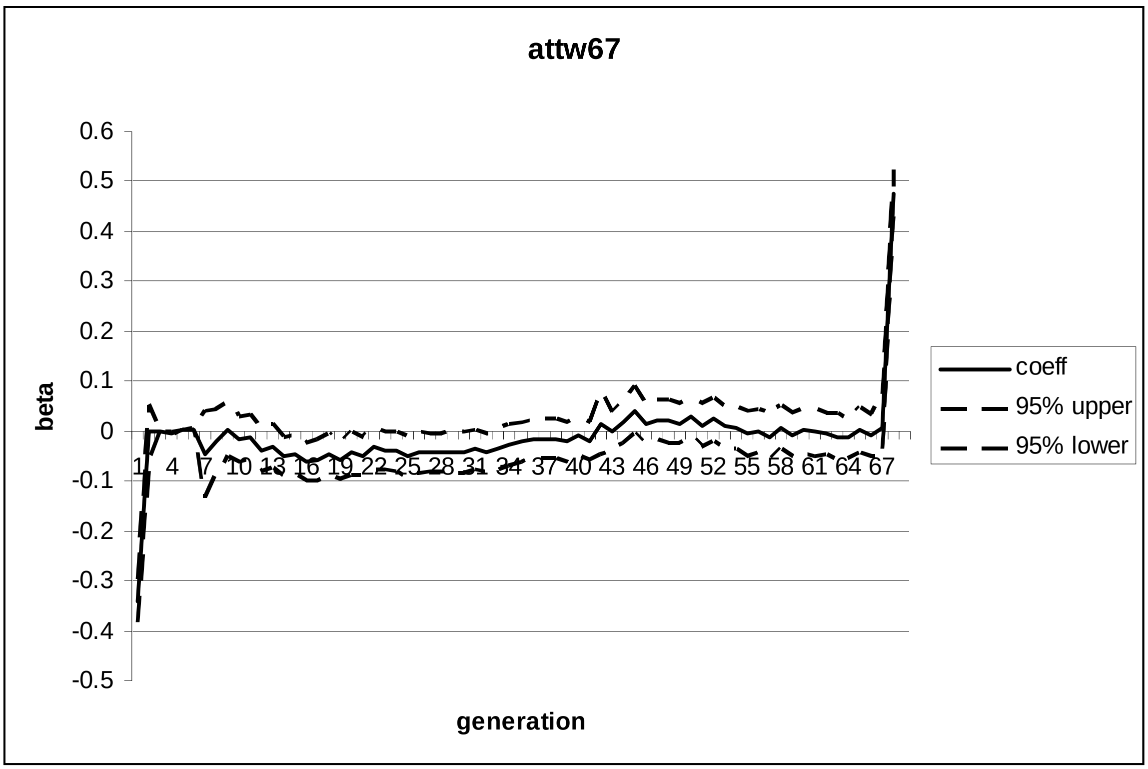
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generation
coeff
95% upper
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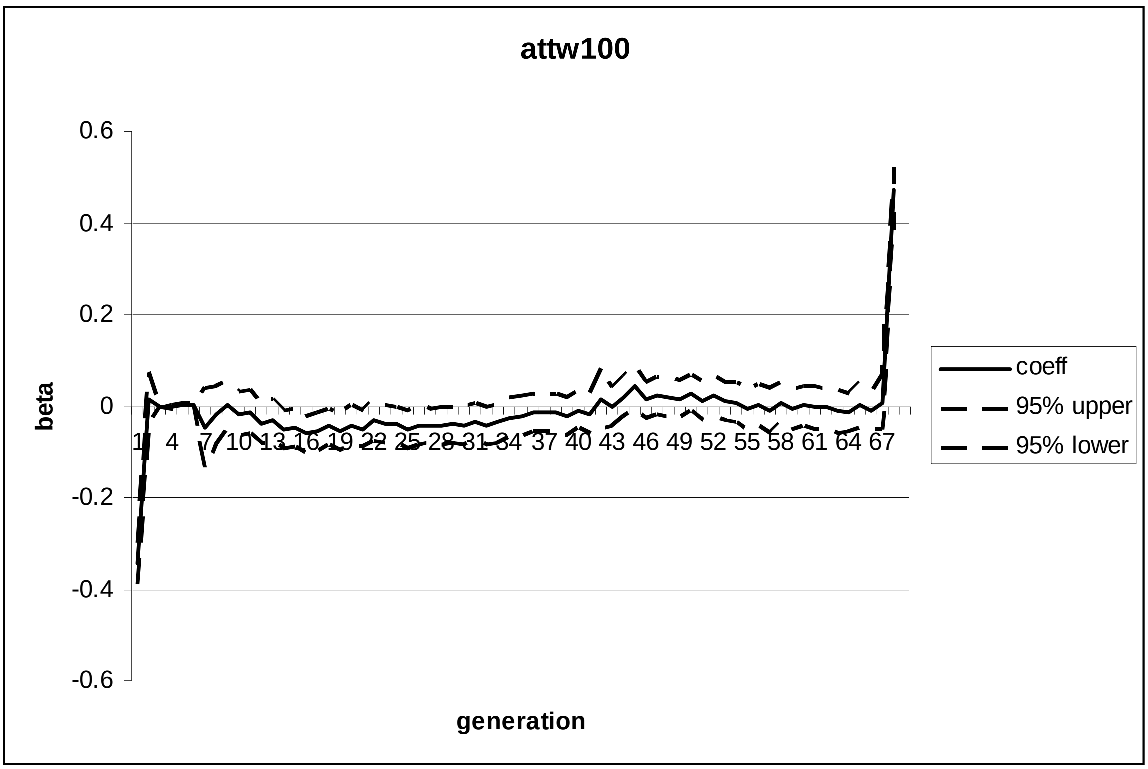
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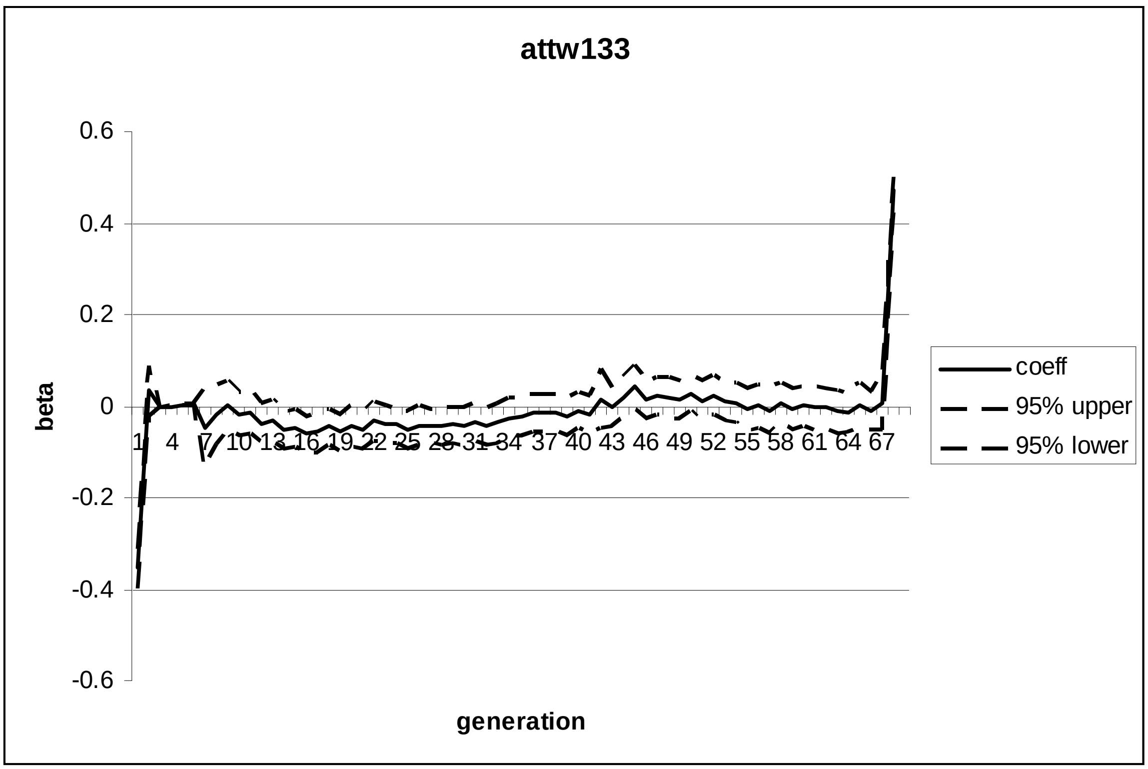
95% lower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generation
coeff
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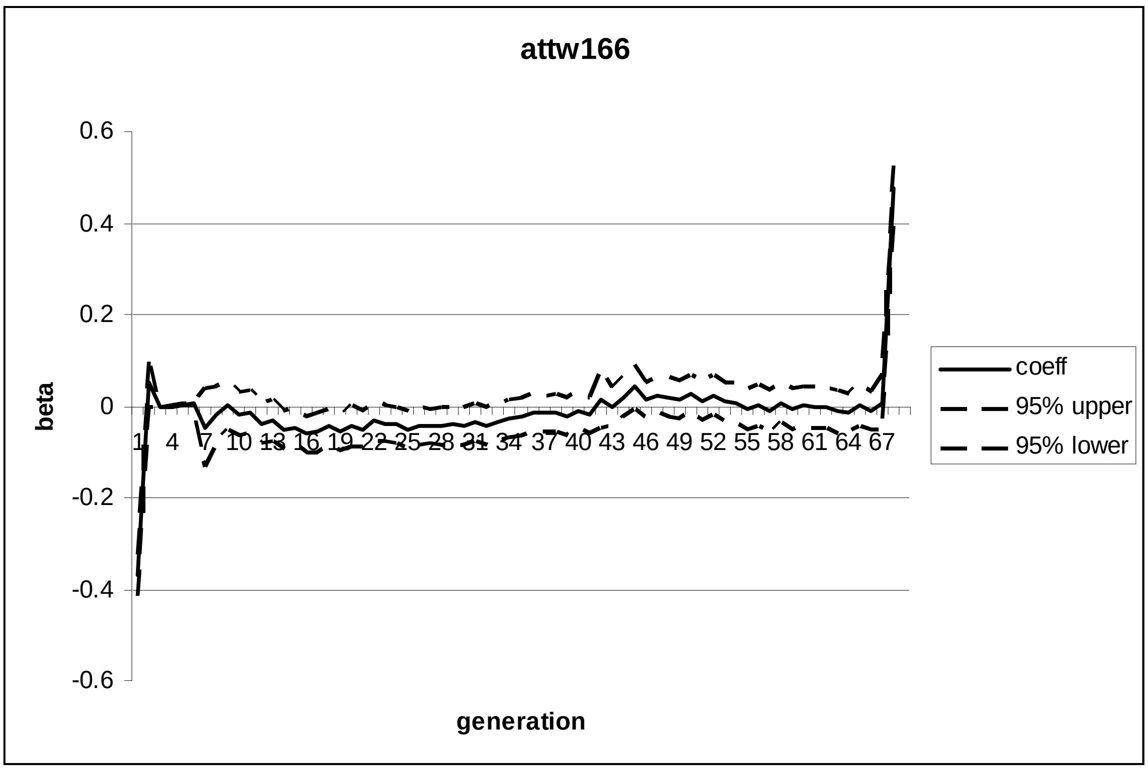
95% lower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beta
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generation
coeff
95% upper
95% lower

Do political preferences depend on age? Evidence from British general elections 2005

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   Any man who is under 30, and is not a liberal, has no heart;
and any man who is over 30, and is not a conservative, has
no brains.

   (Whiston Churchill, attributed)
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Introduction

Uncertainty has always been one of the most difficult variables to model and measure in the Voting Theory. In studying the political process we realise that uncertainty is bi-directional: on the one hand there exists uncertainty of voters towards political candidates, meaning that they are not perfectly able to evaluate whether policies implemented by politicians are good or bad; on the other hand there is uncertainty amongst politicians towards voters' preferred issues, meaning that they are not able perfectly to observe electorate's preference for a given policy.

Nowadays we have very advanced theoretical tools to study uncertainty in elections. Perhaps, the most useful is the Probabilistic Voting Theory [see Enelow and Hinich (1984), Coughlin (1992)]. A branch of this science suggests that voters' preferences may be represented in a multidimensional space and synthesized by Ideal Points. It assumes also that a candidate's goal is minimising the distance between these Ideal Points and a chosen policy, whose results is equivalent to maximising the probability of winning elections. Nevertheless, from a methodological perspective, the most difficult problem to solve is related to measurement aspects. This topic is effectively studied in Alvarez (1997). He identifies two distinct levels for measuring uncertainty: the first is represented by *aggregate* measurements, which analyse aggregated variations in voter's perceptions towards candidate policy positions and the second by *individual* measeurements, which in turn may be divided into *inferential* and *direct* measurement. The following scheme reports a complete taxonomy of measurement systems to detect political uncertainty.

1. Aggregate
2. Individual
   (a) Inferential
   (b) Direct
      i. Direct Survey Question
      ii. Direct Operationalization

The Direct Survey Question is an appoach based on asking respondents directly about the certainty of their political perceptions, whilst the Direct Operationalization is based on measuring the variation in voter's perception of candidate issue positions, relative to the positions of the candidates towards these issues.

Unfortunately, the numerous results achieved by the Voting Theory are not equally supported by robust empirical evidence. For instance we lack deep evidence on whether a significant difference of judgement amongst the electorate with respect to some characteristics of individuduals exists.

Literature on voting behaviour has divided between two strands: one which considers vote choices as the product of a `personal` calculus and depends on individuals' personal characteristics, attitudes and interests and another which considers vote choices as a `social` calculus focusing on the role played by interpersonal communication and intermediaries such as media and organizations (see Beck et al. (2002)).

In this paper I will not consider social factors, even though it would be interesting to analyse the role played by the bias of political communications due to perception and exposure to messages sent by politicians and intermediaries[23]. Otherwise, I will present fresh empirical evidence upon political preferences of British voters and upon the judgements they give to the Government's job on specific policies (i.e. taxation) to assess whether different generations (the old and the young) have different political tendencies. The linkage between age and political tastes has already been studied in empirical studies on voting. There are many works which witness that this relationship is strongly significant. Miller et al. (1998) discovered that the older Russians participated in the Russian 1996 presidential elections at a higher rate than the average citizen and that voters aged 60+ preferred the Communist Gennadii Zyuganov, whilst people under that age preferred the pro-reform democratic party led by Boris Yeltsin. Rose and Mishler (1998) used survey data from 1995 in Hungary, Poland, Romania and Slovenia to demonstrate that older people are more likely to have positive support, a function of lifetime learning, and more educated people, who are disproportionately young, are also more likely to be positive supporters. Pammet and DeBardeleben (1996) used a multivariate analysis to demonstrate that age is important in predicting political/election interest in Russia and Ukraine, in that older voters prove to be more interested in politics. Ruding et al. (1996), in an attempt to build a precise profile of the British Green Party voter, discovered that the main socio-demographic correlates of voting are youth and education. Other studies which found statistically significant relations between age on political tastes may be found in Nadeau et al. (2002), Tranter (2003), Dorussen and Taylor (2001), Jackson and Carsey (2007).

To measure the attitude of the British electorate towards specific issues I will rely on Direct Survey Questions, since they do not suffer from problems which frequently affect inferential measures related to econometric analysis, in particular reliance on the vagaries of different estimation methods. In fact, Direct Survey Questions ask respondents to locate either themselves or political candidates on scales related to one or more issue. The British Election Study 2005 (BES) is particularly suitable to achieve this goal, due to its broad coverage of issues, to the large sample dimension and to the reliability of answers provided by respondents.

Political Parties in the United Kingdom

Over the last two centuries the United Kingdom has had a prevailingly two-party system. Before the mid-19th century British politics was dominated by the Whigs and the Tories, where the former, more keen on reform, were associated with the newly emerging industrial classes, and the latter were associated with the conservative and landed gentry and the Church. After 1834 the Tories changed their name and evolved into the Conservative Party, and the Whigs evolved into the Liberal Party. These two parties dominated the political scene until the 1920s, when the Liberal Party was replaced as the main left-wing party by the emerging Labour Party, who represented an alliance between the Trade Unions and various socialist societies. The Liberals later merged with the Social

Democratic Party, which was founded in 1981, because they had very similar views and became the Liberal Democrats which are now a sizeable third party whose electoral results have improved in recent years.

Nowadays, the UK's "first-past-the-post" electoral system leaves small parties disadvantaged on a national scale. It can, however, allow parties with concentrations of supporters to flourish. These parties include two national parties, Plaid Cymru, the Party of Wales (founded in 1925), and the Scottish National Party (founded in 1934). Northern Ireland parties include the Ulster Unionists, formed in the early part of the 20th century, the Democratic Unionists, founded in 1971 by a group that broke away from the Ulster Unionists, the Social Democratic and Labour Party, founded in 1970, and Sinn Féin. In Scotland, Wales and Northern Ireland these parties have indeed won seats on the "first-past-the-post" system.

In recent years, proportional representation-based voting systems have been adopted for elections to the Scottish Parliament, the National Assembly for Wales, the Northern Ireland Assembly, the London Assembly and the UK's seats in the European Parliament. In these bodies, minor parties have also had some success.

Traditionally political parties have been private organisations with no official recognition by the state. The Registration of Political Parties Act 1998 changed that by creating a register of parties. The Electoral Commission's register of political parties lists the details of parties registered to fight elections with their name in the United Kingdom. Under current electoral law only registered party names can be used on ballot papers by those wishing to fight elections. As of 12 January 2007 it shows the number of registered political parties as below.

185 parties have their name registered for use only in England

1 party has its name registered for use in England and Scotland.

6 parties have their name registered for use in England and Wales.

144 parties have their name registered for use in England, Scotland and Wales.

17 parties have their name registered for use only in Scotland.

10 parties have their name registered for use in Wales only

In Northern Ireland, 58 parties are on the register, including the Conservative Party which fights elections in the province.

Three parties dominate politics in the House of Commons. They all operate throughout Great Britain (only the Conservative Party runs candidates in Northern Ireland). Most of the British Members of the European Parliament, the Scottish Parliament, and the National Assembly for Wales represent one of these parties:

Labour Party, centre-right to left-wing (traditionally left-wing but now more centre-right), *Co-operative Party* (all Co-operative Party MPs are also Labour MPs as part of a long-standing electoral agreement), *Conservative Party*, centrist to right (traditionally centre-right), and Liberal Democrats, centrist to centre-left.

Tables 3-4 show the composition of the House of Commons and the House of Lords.

Affiliation	**Members**
Labour Party	352
Conservative Party	196
Liberal Democrats	63
Democratic Unionist Party	9
Scottish National Party	6
Sinn Féin	5
Plaid Cymru	3
Social Democratic and Labour Party	3
Independents	1
Independent Labour	1
Ulster Unionist Party	1
RESPECT The Unity Coalition	1
Health Concern	1
Speaker and Deputies	4
Total	**646**

Table 3: Composition of the House of Commons

Affiliation	Life peers	Hereditary peers	Lords spiritual	Total
Labour	208	4	0	212
Conservative	159	47	0	206
Liberal Democrats	73	5	0	78
UKIP	1	1	0	2
Green	1	0	0	1
Cross-benchers	168	33	0	201
Non-affiliated	9	2	0	11
Lords Spiritual	0	0	26	26
Total	620	92	26	737

Table 4: Composition of the House of Lords

British Election Study (2005): characteristics and dimension of the sample

According to Sanders et al. (2007) the 2005 BES is based on two parallel panel surveys. The main study is a two-wave face-to-face national probability panel survey, with the first wave conducted between February and March 2005 and the second wave conducted between May and July 2005, starting right after the May 5th general election. The face-to-face study is complemented by a three-wave internet panel survey. The pre-election wave questionnaires in both the face and internet surveys are identical, insofar as this was possible given that different modes were involved.

In-Person Surveys: the 2005 BES in-person pre-election baseline survey was conducted before the election campaign officially began. The survey was designed to yield a representative sample of 'non-institutionalized' adults aged 18 and older living in Great Britain (people living in Northern Ireland and Scots living north of the Caledonian canal were excluded). A clustered multi-stage design was employed. First, 128 constituencies were sampled (77 in England, 29 in Scotland and 22 in Wales). Constituencies were sampled using three stratification criteria: (i) electoral marginality in the 2001 general election, (ii) region in England/Scotland and percent Welsh speakers in Wales, and (iii) population density. Within each constituency selected, two wards were randomly chosen, and within each ward household addresses were selected with equal probability from the national postcode address file. For households with multiple occupants, one person (the potential respondent) was selected at random using a modified Kish grid.

The N for the pre-election campaign survey was, 3589, with a response rate of 60.5%. Beginning immediately after the election, all of the pre-election respondents were asked to do a second in-person interview. The resulting pre-post panel N was 2959 (panel retention rate = 82.4%). To provide a representative national post-election sample, the panel was supplemented by a 'top-up' sample (N = 1202) chosen using the methods described above. All of the post-election top-up respondents were interviewed in-person. The unweighted post-election sample N thus was 4161 and, altogether, 4791 respondents participated in one or both of the in-person interviews.

The in-person survey data were weighted using a combination of factors designed to correct for unequal selection probabilities arising from deliberate oversampling in Scotland and Wales, deliberate oversampling of marginal constituencies, variation in the number of households at selected addresses, and variation in the number of people living in selected households. In addition, a set of post-stratification or 'calibration' weights for age and gender were employed.

Internet Surveys: Similar to the in-person pre-election survey, the first wave of the internet survey was conducted just before the election campaign formally began. Potential internet respondents were selected from YouGov's master panel which included 89,000 people at the time the study was conducted.8 People join the YouGov master panel in one of three ways: (i) by visiting the YouGov website (www.YouGov.com) and registering; (ii) by being recruited by one of several professional third-party recruiters (e.g., Win4Now) employed by YouGov; (iii) through ad-hoc alliances between YouGov and partners such as media outlets interested in conducting specific survey research projects. Respondents in such surveys can be invited to join the YouGov master panel.

Potential respondents for the BES pre-election baseline internet survey were randomly selected from subsections of the master panel defined in terms of demographics (age, gender), media consumption (newspaper readership) and a political criterion (reported vote in the preceding (2001) general election). The total (unweighted) N for the YouGov pre-campaign survey was 7793. During the election campaign 6068 of these respondents participated in a rolling campaign panel survey designed to track the dynamics of public opinion as the campaign unfolded. Immediately after the election, 5910 of the pre-campaign respondents participated in a post-election survey. The response rate for the initial pre-campaign survey was 52.0%, and panel retention rates were 77.9% (campaign survey), and 75.8% (post-election survey).

After the three waves of the internet survey were completed, post-stratification weights for the data were developed using demographic criteria (gender, age within gender, region and social class), as well as newspaper readership and vote in the 2001 general election. Similar to the in-person surveys, information from the 2001 UK census was used to develop the demographic weighting factors for the internet surveys. Data from the National Readership Survey (an annual random probability in-person survey with 34,000 respondents) were used to construct the newspaper readership weighting factor, and the past vote weighting factor was developed based on the results of a large in-house analysis of false-memory effects.

Econometric framework

This paper aims to assess whether differences in political preferences amongst constituencies depend on age[24]. In particular, I want to evaluate whether there exists a significant relationship between the positioning of voters on a political scale and their age. Furthermore, I want to examine the existence of a connection between age and political judgement given by voters on the Government's work and the manner in which it handles political issues, such as economy and taxation. The idea that social groups may have different political preferences about some issues is taken by the Single-mindedness Theory (see Canegrati (2006)) which states that a difference in individuals' preferences generates different distributions and, since some groups are more compact than others around some issues, they are more able to influence the political competition outcome. For instance, let us assume that workers choose their labour supply taking into account both their preferences and marginal tax rates on labour chosen by the government, and that candidates choose tax rates to maximise the probability of winning elections. Then, equilibrium policies are driven by social groups' power which is statistically captured by the distribution function of the electorate. Should this assumption be correct we expect to find variable *age*, used as a regressor, statistically significant in an econometric model where preferences or judgements of voters are used as dependent variables.

The goal of the econometric analysis is then verifying the existence of a difference in distributions of voters with respect to their age.

First, I will verify the existence of this difference by performing a Kernel Density Estimation (see Parzen (1962)) which enables to extrapolate the data to the entire population given some data about a sample. Furthermore, I will exploit the Kolmogorov-Smirnov test to inquire whether the distribution of the old differs from that of the young, under the null hypothesis of equality in distributions.

Secondly, in order to assess whether age shapes political preferences of individuals, I will perform some regressions under different specificiations of the model.

The first specification is:

$$y_i^1 = \alpha + \Sigma_{i=1}^3 x_i + \varepsilon_i \qquad (69)$$

where y_i^1 represents the positioning of a voter on the left-right political scale and x_i are regressors which summarize some basic characteristics of the individual, such as region, age and gender. Nevertheless, since we might not exclude that other variables may influence the positioning on the political scale, a second specification is introduced:

$$y_i^2 = \alpha + \Sigma_{i=1}^3 x_i + \Sigma_{i=1}^7 s_i + \varepsilon_i \tag{70}$$

where some new regressors, s_i, are added, which denote social and economical characteristics of the voter, such as level of education, marital and employment status, type of job, size of community where the individual lives, ethnicity and membership in a religious group.

The third specification is:

$$y_i^3 = \alpha + \Sigma_{i=1}^2 x_i + \Sigma_{i=1}^3 s_i + \Sigma_{i=1}^4 a_i + \varepsilon_i \tag{71}$$

I introduced four new regressors, a_i, which represent the level of involvement of the voter in political actions, such as the attempt to persuade other voters to vote for a candidate, the degree of participation in political meetings or protests and other variables such as the level of satisfaction about democracy in Great Britain.

Finally, in a fourth specification:

$$y_i^4 = \alpha + \Sigma_{i=1}^2 x_i + \Sigma_{i=1}^3 s_i + \Sigma_{i=1}^2 a_i + \Sigma_{i=1}^7 j_i + \varepsilon_i \tag{72}$$

I add seven regressors which represent the judgement of a voter on the political situation in the United Kingdom. There is both a general judgement over the job made by Blair's government and more specific judgements on how the cabinet handled some issues such as crime, asylum seekers, National Health Service, terrorism, economy and taxation.

Regressions were performed using Ordered LOGIT and PROBIT. The choice on these models naturally arose by considering that independent variables are treated as ordinal, since a political scale has a natural ordering (left to right), even though distances between adjacent levels are not quantifiable. In these models an uderlying score has been estimated as a linear function of the regressors and a set of cut points. The probability of observing an outcome equal to o corresponds to the probability that the estimated linear function and an error term lies within an interval delimited by the estimated cut points. For instance, the probability that a responder i finds himself/herself at the fourth level of the left-right scale is equal to:

$\Pr(level_i = o) = \Pr(h_{o-1} < \gamma_1 x_{1i} + ... + \gamma_h x_{hi} + v_i \leq h_i)$

where v_i is assumed to be distributed according to a LOGIT (PROBIT) distribution

$$\begin{cases} = \frac{1}{1=\exp(-h_o+\sum \gamma_h x_h)} - \frac{1}{1=\exp(-h_{o-1}+\sum \gamma_h x_h)}, & \textit{in the case of LOGIT} \\ = \Phi(h_o - \sum \gamma_h x_h) - \Phi(h_{o-1} - \sum \gamma_h x_h), & \textit{in the case of PROBIT} \end{cases}$$

where $\Phi(\cdot)$ is the standard normal cdf.

Estimation's outcomes consists both in a set of h coefficients and in a set of $O - 1$ cut points, with O equal to the number of possible outcomes.

Descriptive Statistics

Table 5 summarizes descriptive statistics. Appendix 1 reports the questions of the survey used for the analysis with the relative answers, expressed in percentage. Questions 1-10 refer to the basic characteristics of the respondent, such as region, age, gender, marital status, socio-economical status, employment status, size of the community, ethnicity and affiliation to a religion. Questions 11-21 refer to political preferences. In particular questions 11-12 refer to the level of political activism of the individual. Question 11 shows that the great majority of respondents have never tried to talk to people in order to persuade them to vote for a particular candidate (55.16 per cent) and that only 5.83 per cent have, whilst other responders answered that rarely (19.58 per cent) or occasionally (18.59 per cent) have. Furthermore question 12 shows that 74.8 per cent of individuals have never tried to directly show their support for a political candidate by attending a meeting, and only 5.38 per cent answered that they did it frequently. According to the joint reading of these two questions, it seems that the percentage of political activists may be quantified at around 5 per cent, whilst the percentage of totally inactive may be quantified between 55 and 75 per cent. Question 13 shows the percentage of respondents who took part in a protest. The percentage of individuals who answered "yes" (11.4) is distinctly lower than those who answered "no" (87,12), again confirming the existence of a political inertia amongst the electorate. Question 14 shows the level of satisfaction for the degree of democracy in the United Kingdom. It emerges that the percentage of those who answered "very" (5.71) or "fairly" (44.68) satisfied is almost equal to that of those who answered "not very" (29.68) or "not at all" satisfied (17.02). Questions 15-21 refer to the judgement made by respondents on the Government's job. In particular, question 15 asks to express an overall judgement on the most important issues: answers show that the great majority of individuals have a negative opinion about how the Government has operated, 32,68 per cent believe that the Government has made a bad job and 27.42 per cent believe that the Government has made a very bad job. Only 21.44 per cent believe that the job has been good and 6.16 per cent that the job has been very good. Questions 16-21 refer to more specific topics such as crime, asylum seekers, the NHS, terrorism, the economy and taxation. Here, judgements seem to be worse for security issues and slightly better for economic issues. In particular the judgement on how government has handled crime and asylum seekers is particularly negative, whilst it gets better for the management of the NHS and terrorism. As for economic issues, the general judgement on how the Government has managed the economy is firmly positive: only 6.58 per cent expressed a very bad judgement and 14.22 per cent a fairly bad one, whilst 36.35 per cent expressed a fairly good judgment and 14.37 per cent a very good one, even though this judgement gets worse once individuals were asked to express an opinion about the taxation issue; there, 19.27 per cent expressed a very bad opinion and 22.7 per cent a fairly bad one, against 25.53 per cent who expressed a fairly good opinion and 3.78 per cent who expressed a very good opinion. Finally, question 22 asked individuals to place themselves on a eleven-level left-right political scale. The lowest level (0) corresponds to the extreme left position, whilst the highest level (11) corresponds to the extreme right position. It can be easily seen that the majority of respondents are located at the centre-left position, which reflects the political tendency which the British electorate assumed during 2005 general elections.

Variable	Observation	Mean	Std. Dev.	Min	Max
Persuasion attempt	3325	3.265865	.9664927	1	5
Meeting attendance	3325	3.571429	.8697147	1	5
Vote in 2005	3326	1.191221	.3933216	1	2
When decided to vote	2690	2.375465	1.341721	1	5
Contact	3326	1.6819	.4958324	1	3
Take part in protests	3326	1.900782	.3447819	1	3
Work with others	3326	1.806073	.4601135	1	3
Government affects personal finances	3326	2.084787	.9216021	1	5
Age	3326	44.69092	14.88701	19	76
Gender	3326	1.517739	.4997604	1	2
Education	3234	10.99474	5.482896	1	20
Belong trade union	3326	.1767889	.3815473	0	1
Belong business association	3326	.0222489	.1475143	0	1
Belong farmer association	3326	.002706	.0519562	0	1
Belong professional association	3326	.1304871	.3368892	0	1

Table 5: Descriptive statistics

Non-parametric Analysis

Kernel Density Estimation

Kernel Density Estimation intends to give a shape to the distribution of the electorate for chosen variables (left-right political scale, judgement on how the Government handled the economy and taxation). Kernel estimators smooth out the contribution of each observed data point over a local neighbourhood of that data point. Data point x_i contributes to the estimate at point x depending on how apart x_i and x are. The extent of this contribution depends on two factors: the shape of the kernel function chosen and its bandwidth. The estimated density may be written as:

$$\widehat{\beta} = \frac{1}{n}\sum_{i=1}^{n} Ke\left(\frac{x - x_i}{j}\right)$$

where Ke is a kernel function, j the bandwidth and x the point where the density is evaluated. The Epanechnikov

$$Ke\left[z\right] = \begin{cases} \frac{3}{4}\left(1 - \frac{1}{5}z^2\right)/5 & \text{if } |z| < \sqrt{5} \\ 0 & \text{otherwise} \end{cases}$$

is the kernel function I used, since it is the most efficient in minimizing the mean integrated squared error. Notice that the choice of j will decide how many values are included in estimating the density at each point and in this model is determined as

$$m = \min\left(\sqrt{variance_x}, \frac{\text{interquartile range}_x}{1.349}\right)$$

$$j = \frac{0.9m}{n^{\frac{1}{5}}}$$

where x is the variable for which the kernel is estimated and n the number of observations.

In order to perform a Kernel density estimation the presence of a continuous random variable is required. Our data are taken from a survey based on scales, which are discrete by definition; as a consequence Kernel density estimation cannot be made, unless we transform the data from discrete to continuous. To solve this problem, I then perform the analysis on predicted (*ex-post*) values obtained by regressing age upon political variables. Since predicted values are the probability which a single voter has to be located on a point of the scale we have obtained a continuous random variable which may be tested.

Kolmogorov-Smirnov test

The Kolmogorov-Smirnov tests the equality of the comulative density function of two distinct samples. In our case we have two sub-samples; I denote by X_o the sub-sample of the old voters and by X_y the sub-sample of the young voters. The size of the first sub-sample is equal to o and that of the second sub-sample is equal to y. Furthermore, I call $F(X_o)$ the comulative density function of the old and $F(X_y)$ the comulative density function of the young. The goal of the test is verify that:

$$H_0 : F(X_o) = F(X_y) \quad vs \quad H_1 : F(X_o) \neq F(X_y)$$

That is, the null hypothesis H_0 assume the equality in distributions. In order to pass the test, the statistic

$$\Phi_{oy} = \left(\frac{oy}{o+y}\right)^{\frac{1}{2}} \sup_x |F_o(x) - F_y(x)|$$

must not depend on F (*distribution free* property) and the comulative density function of the true underlying distribution of the data must converge to the comulative density function of the Kolmogorov-Smirnov distribution

$$H(t) = 1 - 2\sum_{i=1}^{\infty} (-1)^{i-1} \exp\left(-2i^2 t\right)$$

where t denotes the upper limit of the interval.

Performing the Kolmogorov-Smirnov test in our case may cause problems with the standard errors, due to the transformation of the data from discrete to continuous. As a consequence, the test is made on predicted values at the second stage of the analysis. In principle, a correction in the standard errors should be made, unless the test provides very low p-values which make this correction useless.

Main findings

Positioning on the Left-Right political scale

Table 6 reports the results of regressions. First of all, notice that results do not differ with respect to the two methods: this is not surprising if we consider that the LOGIT distribution differs from the PROBIT only because of its fatter tails. Due to this similarity, I will only comment the results obtained with LOGIT estimations, but the same hold for PROBIT.

- The first specification of the model says that variable **region** is not statistically significant, whilst variables **age** and **gender** are significant at one per cent and ten per cent of the confidence interval respectively. The insignificance of the variable region is not surprising, since we do not expect that a region is statistically oriented to the left rather than to the right. Otherwise, age is strongly significant, meaning that for an increase of one year in age, the level on the left-right scale increases by 0.012 while the other variables are held constant. Since higher values in the political scale means one is more right-oriented, the sign of the log-odds indicates that the old are more conservative than the young. Also the variable gender is statistically significant, this time with a negative coefficient equal to -0.12. This means that being a female decreases the expected change in the level of the political scale which in an ultimate analysis indicates that women are more labourist than conservative.

- The second specification introduces other socio-economic variables, but we can see that only **education, size of community** and **religion membership** are statistically significant. Interpreting the education coefficient is not an easy task since elements of the variable do not follow a particular ordering; thus we cannot say whether an increase in the level of education increases the probability to be located on a higher level of the political scale. Otherwise, size of community indicates that living in a bigger community decreases the expectation to be conservative by 0.055. Finally not being a member of a religious group entails a decrease in the dependent variable of 0.281, meaning that religious responders are more conservative.

- The third specification adds some proxies which measure the political activism. With respect to the previous specification we may see that the level of education is no longer significant, whilst two new variables, **level of satisfaction about democracy in Britain** and **taking part in protests** are. In particular most satisfied people tend to be more conservative (the expected increase on the political scale is 0.366) and so are people who take part in protests.

- Finally, the fourth specification adds opinions about the Government's job. It is interesting to notice that the overall judgement is not significant at all, whilst more specific assessments (apart from the management of asylum seekers) are very significant. As we expected a worse opinion about the government's job on a single issue increases the expectation to find in higher levels on the left-right scale, or in other words to be more conservative. Notice that this does not hold if we refers to the opinion about terrorism where the higher the level of dissatisfaction, the higher the expectations to be labourist (-0.249).

Dependent variable *left-right scale (Left-Right)*	LOGIT (1)	PROBIT (1)	LOGIT (2)	PROBIT (2)	LOGIT (3)	PROBIT (3)	LOGIT (4)	PROBIT (4)
Region	.001	.001	-.002	.000				
	(0.868)	*(0.798)*	*(0.857)*	*(0.963)*				
Age	.012***	.006***	.005*	.003*	.005*	.003**	.005**	.0034**
	(0.000)	*(0.000)*	*(0.065)*	*(0.061)*	*(0.067)*	*(0.048)*	*(0.050)*	*(0.023)*
Gender	-.12*	-.062	-.135*	-.070*	-.143**	-.069*	-.173**	-.1042**
	(0.085)	*(0.124)*	*(0.063)*	*(0.093)*	*(0.045)*	*(0.093)*	*(0.020)*	*(0.015)*
Education			-.018**	-.009**	-.009	-.004	.003	.001
			(0.015)	*(0.032)*	*(0.165)*	*(0.208)*	*(0.641)*	*(0.803)*
Marital status			-.024	-.015				
			(0.202)	*(0.163)*				
Employment status			.002	.000				
			(0.875)	*(0.948)*				
Social-economic conditions			-.022	-.010				
			(0.174)	*(0.260)*				
Size of community			-.055***	-.031***	-.055***	-.03***	-.033**	-.02**
			(0.000)	*(0.001)*	*(0.000)*	*(0.001)*	*(0.029)*	*(0.026)*
Ethnicity			-.019	-.009				
			(0.269)	*(0.320)*				
Member of religion			-.281***	-.170***	-.305***	-.181***	-.239***	-.147***
			(0.000)	*(0.000)*	*(0.000)*	*(0.000)*	*(0.000)*	*(0.000)*
Persuasion attempt					.039	.012		
					(0.393)	*(0.639)*		
Meeting attendance					-.059	-.032		
					(0.247)	*(0.246)*		
Satisfaction about Democracy					.366***	.192***	-.118**	-.057*
					(0.000)	*(0.000)*	*(0.030)*	*(0.070)*
Take part to protest					.869***	.465***	.626***	.353***
					(0.000)	*(0.000)*	*(0.000)*	*(0.000)*
Judgement on Government job							-.005	-.0024
							(0.873)	*(0.901)*
Judgement how Labour Government handled crime							.207***	.099***
							(0.000)	*(0.001)*
Judgement how Labour Government handled asylum							.329***	.19***
							(0.000)	*(0.000)*
Judgement how Labour Government handled NHS							.083*	.053**
							(0.063)	*(0.036)*
Judgement how Labour Government handled terrorism							-.249***	-.135***
							(0.000)	*(0.000)*
Judgement how Labour Government handled economy							.33***	.171***
							(.000)	*(0.000)*
Judgement how Labour Government handled taxation							.191***	.094***
							(.000)	*(0.000)*
Cut point 1	-3.47	-1.80	-5.02	-2.68	-2.39	-1.30	-.98	-.46
Cut point 2	-2.84	-1.54	-4.44	-2.43	-1.78	-1.04	-.36	-.20
Cut point 3	-1.79	-1.03	-3.32	-1.90	-.66	-.50	.78	.35
Cut point 4	-.85	-.52	-2.37	-1.38	.30	.02	1.83	.92
Cut point 5	-.18	-.12	-1.68	-.96	1.01	.44	2.64	1.39
Cut point 6	1.05	.64	-.43	-.19	2.32	1.24	4.16	2.28
Cut point 7	1.59	.97	.11	.13	2.88	1.58	4.79	2.65
Cut point 8	2.37	1.40	.89	.56	3.67	2.02	5.65	3.13
Cut point 9	3.41	1.91	1.91	1.07	4.72	2.54	6.75	3.69
Cut point 10	4.19	2.26	2.73	1.43	5.53	2.90	7.58	4.06
Number of observations	2557	2557	2432	2432	2479	2479	2480	2480
Pseudo R2	0.0027	0.0026	0.0074	0.0195	0.0180	0.0180	0.0644	0.0586

TABLE 6: Positioning on the left-right scale. *Regressions with robust standard errors (p-values in parenthesis); (***) significant at 1% of the C.I.; (**) significant at 5% of the C.I.; (*) significant at 10% of the C.I.*

Judgement on Government's policies

Tables 7-8 show results about judgements made by respondents on the way the Government managed the economy and taxation.

- *economy*: the judgement on how Blair's Government handled the economy statistically depends on **gender**, **being a member of a trade union and being a member of a farmer association** (all statistically significant at the 1 per cent of the confidence interval) and on the **level of education** (5 per cent of the confidence interval).
- *taxation*: the judgement on how Blair's Government handled taxation statistically depends on **age**, **gender, being a member of a trade union** and **being member of a business association** (all statistically significant at the 1 per cent of the confidence interval) and on the **size of community** (10 per cent of the confidence interval).

Of course these are quite remarkable results. First, notice how the judgement which voters give to how government handled taxation depends upon a more complex set of variables, suggesting that taxation is a more specific and targeted policy than the economy in general. Secondly, age is strongly statistically significant in the judgement on the taxation policy; the coefficient has a positive sign, meaning that an increase in age generates more negative judgement on policies.

Dependent variable government handles economy	
Age	*-.000*
	(0.742)
Gender	*.328****
	(0.000)
Education	*-.013***
	(0.036)
Marital status	*-.008*
	(0.622)
Employment status	*.005*
	(0.697)
Religion	*.029*
	(0.591)
Belong trade union	*-.330****
	(0.000)
Belong business association	*.165*
	(0.500)
Belong farmer association	*2.535****
	(0.000)
Belong professional union	*-.044*
	(0.684)
Size of community	*-.014*
	(0.310)
Number of observations	*3067*
Pseudo R2	*0.0072*

TABLE 7: Judgement on how the Government handled the economy. *Ordered Logit regressions with robust standard errors (p-values in parenthesis); (***) significant at 1% of the C.I.; (**) significant at 5% of the C.I.; (*) significant at 10% of the C.I.*

Dependent variable government handles taxation	
Age	*.008****
	(0.002)
Gender	*-.306****
	(0.000)
Education	*-.001*
	(0.823)
Marital status	*.016*
	(0.326)
Employment status	*-.005*
	(0.714)
Religion	*-.045*
	(0.385)
Belong trade union	*-.448****
	(0.000)
Belong business association	*.401****
	(0.09)
Belong farmer association	*.46*
	(0.577)
Belong professional union	*.067*
	(0.527)
Size of community	*-.023**
	(0.078)
Number of observations	*3064*
Pseudo R2	*0.0079*

Table 8: Judgement on how the Government handled taxation. *Ordered Logit regressions with robust standard errors (p-values in parenthesis); (***) significant at 1% of the C.I.; (**) significant at 5% of the C.I.; (*) significant at 10% of the C.I.*

Results of non parametric analysis

Appendix 2 shows results of the non parametric analysis. Graphs show Kernel Density estimations performed for the old and the young for every predicted level of the left-right scale and for every question, whilst tables 9-11 show results of the Kolmogorov-Smirnov test. As for the Kernel Density estimation it is easy to see by the meaning of the graphs (Figure 7) how the two distribution functions are separated, meaning that there is a clear difference in distributions between the two cohorts. Only in a single case this does not happen, Figure 7.a, which refers to the probability to be located on the fifth level of the left-right scale; here the two distribution functions almost overlap, meaning that the difference in distributions is minimal. However, since this is an isolated case, we do not have elements to provide a plausible explanation about why this happens at this level of the scale.

Analysing results obtained performing the Kolmogorov-Smirnov test, it is easy to see that the hypothesis of equality of distribution functions is strongly rejected at 1 per cent of the significance level, again allowing us to conclude that the old and the young have different distributions. Notice that in the Kolmogorov-Smirnov test, p-values are always perfectly equal to zero, which is absolutely a strong result and allow us to skip the correction of the standard errors.

Corrected K-S	D	P-value	Corrected
p1	1.0000	0.000	0.000
p2	1.0000	0.000	0.000
p3	1.0000	0.000	0.000
p4	0.4531	0.000	0.000
p5	1.0000	0.000	0.000
p6	1.0000	0.000	0.000
p7	1.0000	0.000	0.000
p8	1.0000	0.000	0.000
p9	1.0000	0.000	0.000
p10	1.0000	0.000	0.000
p11	1.0000	0.000	0.000

Table 9: Two-sample Kolmogorov-Smirnov test for equality of distribution functions: *Positioning on the left-right scale*

Corrected K-S	D	P-value	Corrected
p1	1.0000	0.000	0.000
p2	1.0000	0.000	0.000
p3	1.0000	0.000	0.000
p4	0.4531	0.000	0.000
p5	1.0000	0.000	0.000
p6	1.0000	0.000	0.000

Table 10: Two-sample Kolmogorov-Smirnov test for equality of distribution functions: *How government handled the economy*

Corrected K-S	D	P-value	Corrected
p1	1.0000	0.000	0.000
p2	1.0000	0.000	0.000
p3	1.0000	0.000	0.000
p4	0.4531	0.000	0.000
p5	1.0000	0.000	0.000
p6	1.0000	0.000	0.000

Table 11: Two-sample Kolmogorov-Smirnov test for equality of distribution functions: *How government handled taxation*

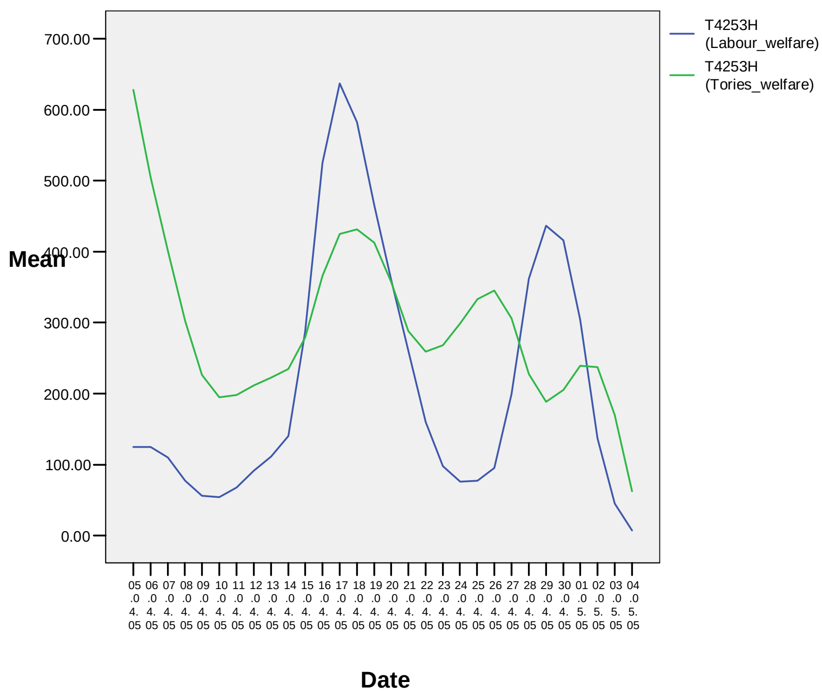
Political competition and campaigning

As I said in the introductory chapter, political choices can be analysed either as the product of a personal calculus or as a sum of sociological factors. The model I presented spouses the former approach. Nevertheless, one may argue that also the latter must be explored in order to have more robust results. From this perspective it would be useful to analyse the manifestos of political parties, press releases and the strategies used during the electoral campaign because it is easy to image how these factors might have been influencing voters' opinion. Since our empirical evidence demonstrated how the old are more conservative than the young, one may wonder if the Conservative party was more focused on issues related to the old's needs (i.e. social welfare, pensions, etc.). If so, this evidence could represent a possible cause to explain this age bias. An interesting work by Brandemburg (2005) collected all press releases published during the campaign period from the websites of the three main parties (Labours, Tories and Liberal Democrats)[25] and discovered that "the Labour government was most single-minded, devoting over a third of their output to economic questions, while the Conservatives divided their attention almost equally between economy, welfare and crime". Table 12 shows how the Labour party devoted 27.1 per cent of its output to social welfare whilst the Tories only the 22.4 per cent and the Liberal Democrats the 29.9 per cent.

Labour		Conservatives		Liberal Democrats	
Economy	33.6%	Economy	25.6%	Social Welfare	29.9%
Social Welfare	27.1%	Social Welfare	22.4%	Economy	22.1%
Education	15.8%	Crime/Justice	18.6%	Education	11.3%
Crime/Justice	8.2%	Education	12.9%	Iraq	10.7%
Immigration	4.4%	Immigration	8.0%	Crime/Justice	7.5%
Arts/Culture	2.9%	Political System	3.6%	Environment	5.8%

Table 12: Main Policy dimensions during the campaign

Furthermore, time series data found out (Graph 1) the existence of a significant correlation between Labour and Tories on social welfare (0.37)



Graph 1: Time-series data, Labour-Tories: social welfare

This evidence clarifies that the idea according to which the old voted the Conservative party because it devoted more emphasis to social welfare during the electoral campaign is wrong. Actually these data show the opposite situation. One may also argue that the Conservative party was more covered by the media, but the study showed how "the 2005 campaign was notably in the overrepresentation that the Labour party received". In fact the Labour party obtained the 53.1 per cent of the total party coverage in the national press, whilst the Conservative party only the 27.6 per cent[26]. Thus, also this argument cannot be brough as evidence against the age bias.

Conclusions

In this paper I analysed the British Election Study 2005 in order to assess whether political preferences for candidates and judgments made by voters on Government's job depend on age. To achieve this goal, I run Ordered LOGIT and PROBIT regressions using different specifications of the model. Furthermore, I performed non-parametric analysis, using the Kernel Density estimation and the Kolmogorov-Smirnov test. Results are robust in showing that variable age is strongly significant, demonstrating that in the British electorate the old are more conservative than the young. In particular, the old seem to be more conservative than the young and particularly strict in their judgments on the Government's policies. Even though statistical results are particularly robust in showing this correlation it would be interesting to evaluate whether this phenomenon takes place also in other countries. Furthermore, an interesting research agenda can be set, in order to discover which individual characteristics are statistically significant in shaping electoral preferences. I hope these hints may find a room in future works.

Appendix 1

List of questions with relative answers

1. **REGION**
   In which of the following do you live?

East Anglia	7.398%
East Midlands	7.489%
Greater London	10.59%
North	5.113%
North West	10.92%
Scotland	9.383%
South East	16.3%
South West	9.835%
Wales	5.143%
West Midlands	7.218%
Yorkshire & Humberside	10.62%

2. AGE

What is your age (in years)?

3. GENDER

What is your gender?

Male	48.23%
Female	51.77

4. EDUCATION

What is your highest level of qualification?

no formal qualifications	9.802%
youth training certificate/skillseekers	0.371%
recognized trade apprenticeship	2.041%
clerical and commercial	2.566%
city and guild certificate	6.648%
city and guild certificate - advanced	2.721%
onc	1.33%
cse grades 2-5	1.701%
cse grade 1, gce o level, gcse, school	14.81%
scottish ordinary/ lower certificate	0.865%
gce a level or higher certificate	13.76%
scottish higher certificate	1.763%
nursing qualification (eg sen, srn, scm, rgn)	1.608%
teaching qualification (not degree)	2.257%
university diploma	3.741%
university or cnaa first degree (eg ba)	16.2%
university or cnaa higher degree (eg m.phil, ph.d.)	5.226%
other technical, professional or higher	10.79%
don't know	1.2%
refused	0.556%

5. MARITAL STATUS

What is your marital status?

married	49.62%
living as married	14.26%
separated (after being married)	2.392%
divorced	8.235%
widowed	2.785%
never married	22.71%

6. EMPLOYMENT STATUS

What is your employment status?

working full time (30 or more hours per week)	47.6%
working part time (8 - 29 hours per week)	13.09%
working part time (less than 8 hours a week)	1.451%
full time student	5.11%
retired	17.87%
unemployed	2.419%
not working	8.618%
other	3.84%

7. SOCIAL AND ECONOMICAL CONDITIONS

What is your type of work?

professional or higher technical work	21.53%
manager or senior administrator	17.67%
clerical	17.55%
sales or services	10.76%
foreman or supervisor of other workers	2.894%
skilled manual work	6.301%
semi-skilled or unskilled manual work	9.466%
other	11.97%
have never worked	1.896%

8. SIZE OF COMMUNITY

What is the size of the community you live in?

Live on a farm	0.751%
Village under 500 people	4.059%
500 to 1,000 people	5.292%
1,001 to 10,000 people	17.14%
10,000 to 50,000 people	17.23%
50,001 to 100,000 people	11.76%
100,001 to 500,000 people	13.71%
500,001 to 1,000,000 people	5.532%
Over 1,000,000 people	9.02%
Don't know	15.51%

9. ETHNICITY

What is your Ethnicity?

white british	92.067%
any other white background	2.851%
white and black caribbean	0.558%
white and black african	0.124%
white and asian	0.403%
any other mixed background	0.496%
indian	0.620%
pakistani	0.341%
bangladeshi	0.062%
any other asian background	0.279%
black caribbean	0.434%
black african	0.155%
any other black background	0.031%
chinese	0.403%
other ethnic group	1.023%
refused	0.155%

10. MEMBER OF RELIGION

Are you a member of any religion?

yes	48.42%
no	48.08%
not sure/don't know	2.702%
refused	0.798%

11. PERSUASION ATTEMPT

Talked to other people to persuade them to vote for a particular party of candidate?

Frequently	5.835%
Occasionally	18.59%
Rarely	19.58%
Never	55.16%
Don't know	0.842%

12. MEETING ATTENDANCE

Showed your support for a particular party or candidate by, for example, attending a meeting, putting up campaign signs, or in some other way?

Frequently	5.383%
Occasionally	8.571%
Rarely	10.41%
Never	74.8%
Don't know	0.842%

13. TAKE PART IN A PROTEST

Taken part in a protest, march or demonstration?

Yes	11.4%
No	87.13%
Don't know	1.473%

14. SATISFACTION ABOUT DEMOCRACY

On the whole, are you very satisfied, fairly satisfied, not very satisfied, or not at all satisfied with the way democracy works in Great Britain?

Very satisfied	5.713%
Fairly satisfied	44.68%
Not very satisfied	29.68%
Not at all satisfied	17.02%
Don't know	2.916%

15. JUDGMENT ON GOVERNMENT JOB

How do you judge the job done by present Government about the most important issue over the last 4 years?

there was no one most important issue	6.434%
very good job	6.164%
good job	21.44%
bad job	32.68%
very bad job	27.42%
don't know	5.863%

16. JUDGMENT HOW LABOUR GOVERNMENT HANDLED CRIME

How well do you think the present Government has handled crime in general?

Very well	1.443%
Fairly well	20.05%
Neither well nor badly	28.56%
Fairly badly	24.71%
Very badly	22.7%
Don't know	2.526%

17. JUDGMENT HOW LABOUR GOVERNMENT HANDLED ASYLUM SEEKERS

How well do you think the present Government has handled asylum seekers in general?

Very well	1.323%
Fairly well	11.4%
Neither well nor badly	16.69%
Fairly badly	25.14%
Very badly	42.72%
Don't know	2.736%

18. JUDGMENT HOW LABOUR GOVERNMENT HANDLED THE NHS

How well do you think the present Government has handled NHS in general?

Very well	4.991%
Fairly well	26.43%
Neither well nor badly	20.54%
Fairly badly	27.42%
Very badly	18.49%
Don't know	2.135

19. JUDGMENT HOW LABOUR GOVERNMENT HANDLED TERRORISM

How well do you think the present Government has handled terrorism in general?

Very well	7.907%
Fairly well	33.13%
Neither well nor badly	24.38%
Fairly badly	15.63%
Very badly	14.85%
Don't know	4.089%

20. JUDGMENT HOW LABOUR GOVERNMENT HANDLED THE ECONOMY

How well do you think the present Government has handled the economy in general?

Very well	14.37%
Fairly well	36.35%
Neither well nor badly	24.35%
Fairly badly	14.22%
Very badly	6.584%
Don't know	4.119%

21. JUDGMENT HOW LABOUR GOVERNMENT HANDLED TAXATION

How well do you think the present Government has handled taxation in general?

Very well	3.788%
Fairly well	25.53%
Neither well nor badly	24.5%
Fairly badly	22.7%
Very badly	19.27%
Don't know	4.209%

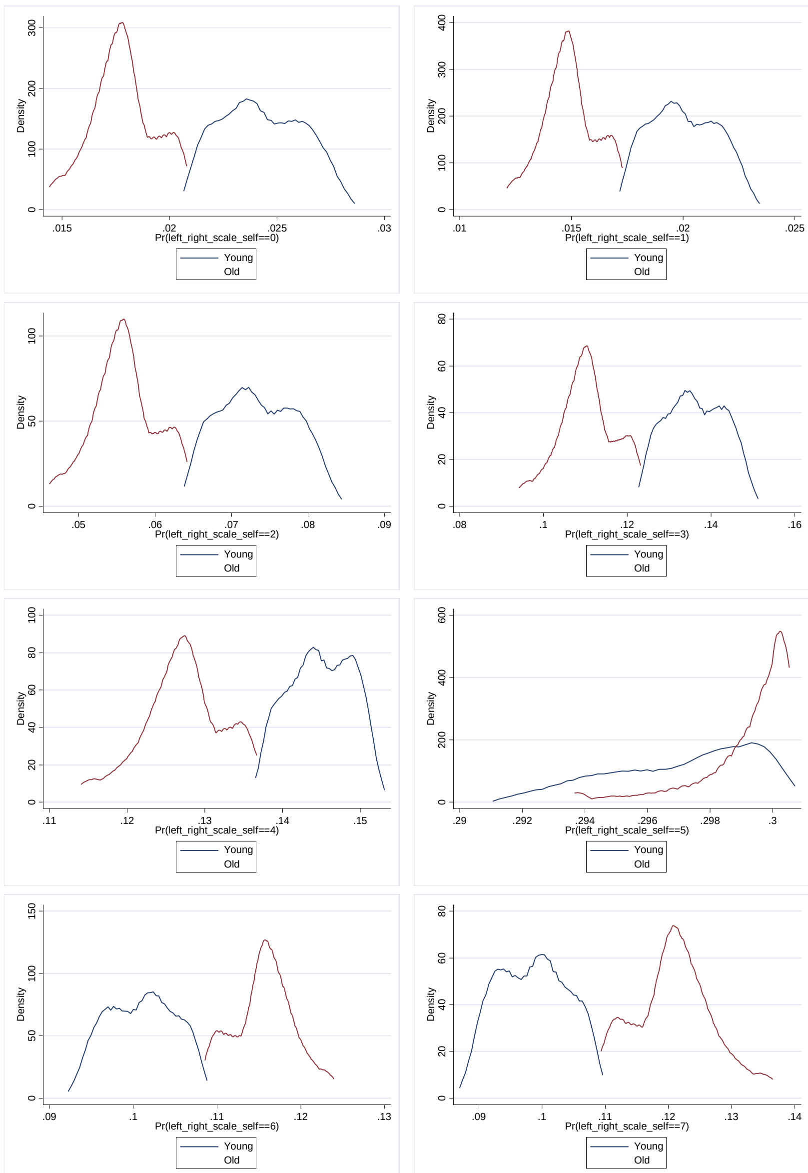
22. LEFT-RIGHT SCALE

Thinking to the 'left-right' scale. In politics people sometimes talk of left and right. Where would you place yourself on a scale from 0 to 10 where 0 means the 'left', and 10 means the 'right'?

0 – left	2.072%
1	1.720%
2	6.372%
3	12.197%
4	13.526%
5	29.867%
6	10.907%
7	11.063%
8	7.506%
9	2.541%
10 - right	2.228%

Appendix 2

Kernel-Density estimation



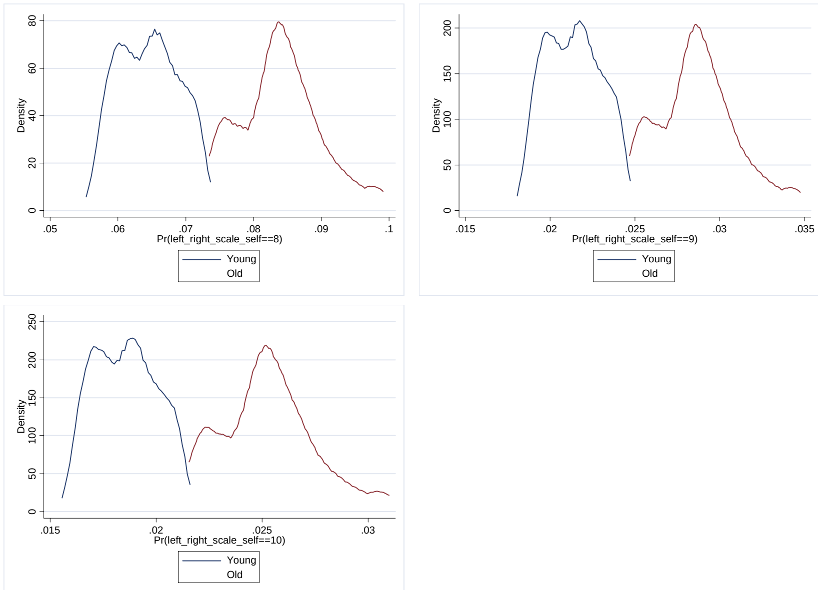


Figure 7.a: Positioning on the left-right scale

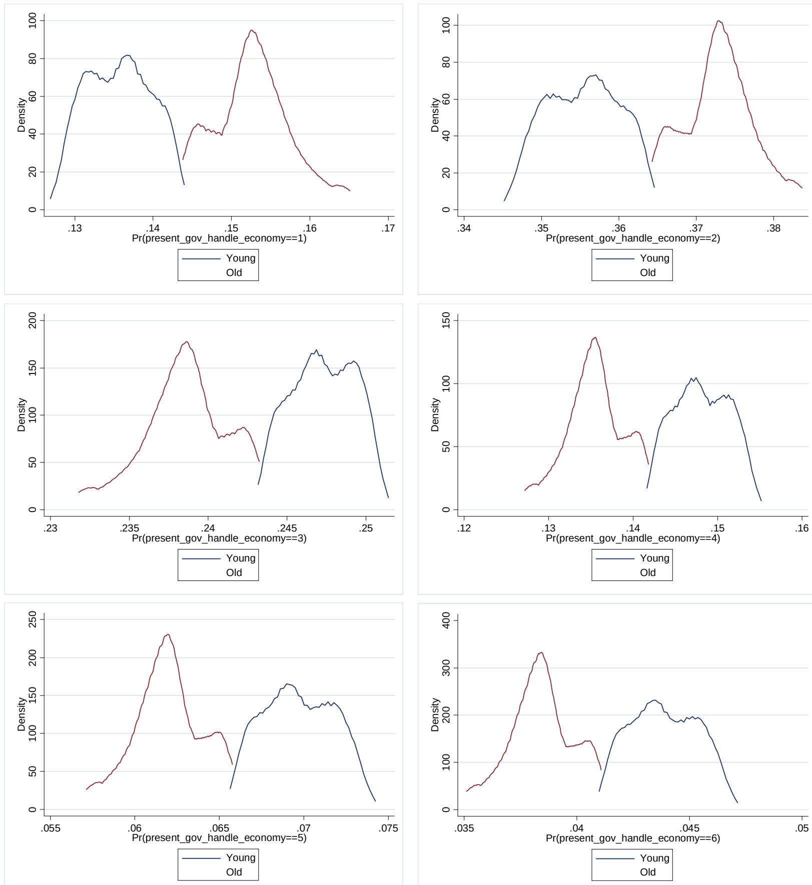


Figure 7.b: How government handled the economy

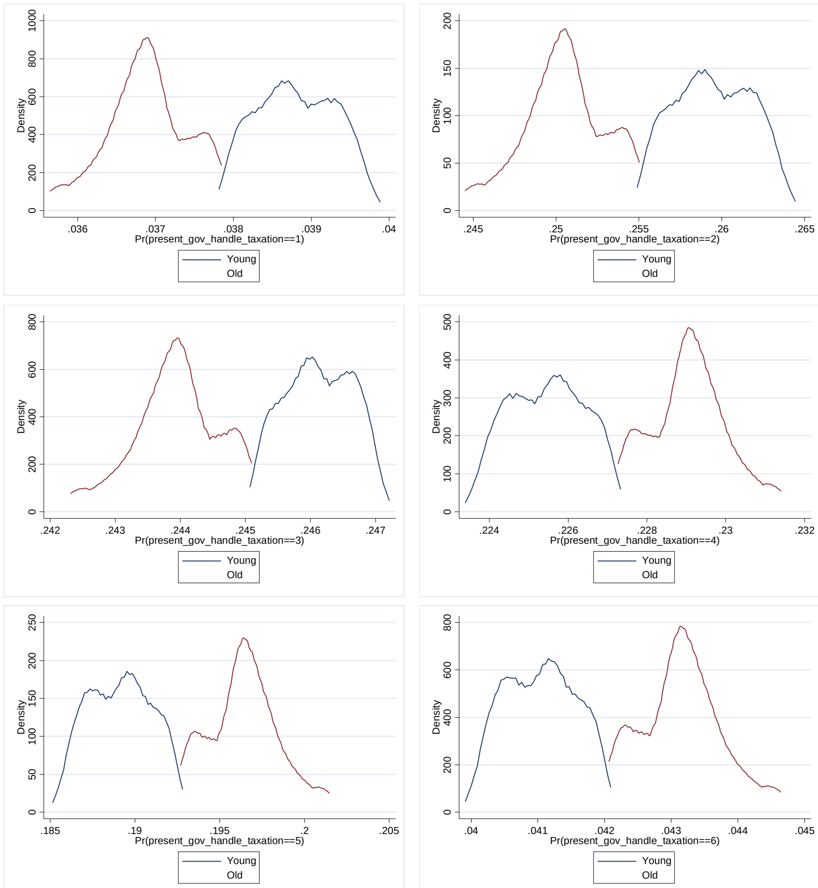


Figure 7.c: How government handled taxation

Notes

[1] Note that this is different with respect to Profeta (2002) who assumes that the two groups have different sizes.

[2] Note that Υ_t^j is a strictly concave function in a_t^{Ij}. The first order derivative gives $\frac{\partial \Upsilon_t^j}{\partial a_t^{Ij}} = -\frac{\tau\left(T+\left(a_t^{Ij}-1\right)\tau\right)^2-\psi^{I2}}{2\left(1+\left(a_t^{Ij}-1\right)\tau\right)^2}$ and the second order derivative gives $\frac{\partial^2 \Upsilon_t^j}{\partial\left(a_t^{Ij}\right)^2} = -\frac{\tau^2\psi^{I2}}{2\left(1+\left(a_t^{Ij}-1\right)\tau\right)^3} < 0$.

[3] Lindbeck and Weibull 1987 and Dixit and Londregan 1996 demonstrated that the Nash equilibrium obtained if candidates maximize their vote share is identical to that obtained when candidates maximize their probability of winning.

[4] Second order conditions give $\frac{\partial^2 p_t^j}{\partial\left(a_t^{Ij}\right)^2} = \overbrace{\frac{\partial V_t^I}{\partial a_t^{Ij}}}^{\lesseqgtr}\overbrace{s^{-1}}^{>0}\overbrace{\frac{\partial s^I}{\partial a_t^{Ij}}}^{<0}\overbrace{\left(1+s^I s^{-1}\right)}^{>0} + \overbrace{s^I s^{-1}}^{>0}\overbrace{\frac{\partial^2 V_t^I}{\partial\left(a_t^{Ij}\right)^2}}^{>0}$ whose sign is undetermined.

[5] Note that group sizes do not determine the equilibrium because a larger group has more voters to be won, but the cost of winning them is also proportionately higher.

[6] An extreme case is when p_t^j is a strictly convex function on $\left[a_t^{\min}, a_t^{\max}\right]$. In this case each tax credit in the interval may be written as $a_t^{\min}\frac{a_t^{\max}-a_t^{Ij}}{a_t^{\max}-a_t^{\min}} + a_t^{\max}\left(1-\frac{a_t^{\max}-a_t^{Ij}}{a_t^{\max}-a_t^{\min}}\right)$ and have $d\left(a_t^{Ij}\right) \leq a_t^{\min}\frac{a_t^{\max}-a_t^{Ij}}{a_t^{\max}-a_t^{\min}} + a_t^{\max}\left(1-\frac{a_t^{\max}-a_t^{Ij}}{a_t^{\max}-a_t^{\min}}\right) \leq \max\left(a_t^{\min}, a_t^{\max}\right)$

[7] One may verify that indirect utility functions have two intersection points.

[8] Proposition 10 is applicable here because we are assuming that the solution deriving by the resolution of Kuhn-Tucker conditions under assumption of local concavity at that point is a maximum. If the function is not concave proposition 10 could not be applied because at that point a maximum (and thus equilibrium) does not exist.

[9] The problem is that we cannot say if the value function is concave, convex or neither concave nor convex, given the complexity of the expression. As a consequence, we cannot be sure if stationary points we found from first order conditions are maximum.

[10] see Jones (2007) and Keen (2007)

[11] In this model I do not take into account the impact of taxation on production.

[12] For a complete discussion on the Single Mindedness Theory see Canegrati (2006) and Mulligan & Sala-i-Martin (1999)

[13] The marginal utility of income is decreasing in the level of income.

[14] For a more in details explanation of these definitions, see Canegrati (2006).

[15] I assume that axioms of *Anonymity*, *Population Principle*, *Principle of Transfers*, *Monotonicity*, *Scale Invariance*, *Decomposability*, *Uniform income growth* and *Translation Invariance* (Cowell, 2000) are satisfied.

[16] The graph $C(F;q)$ against q describes the *generalised Lorenz curve*

[17] Occupational pensions include all pensions paid from non-social retirement schemes including employer-based pensions for private sector workers and public employees.

[18] Other cash income includes regular private transfers, alimony and child support benefits, other sources of regular cash income, not classified above.

[19] Social insurance transfers include: accident or short-term disability pay, long-term disability pay, social retirement benefits (old age and survivors), unemployment pay, maternity

allowances, military or veteran's benefis, other social insurance.

[20]Universal cash transfers include child and/or family allowances if paid directly by governments. Universal cash transfers paid as refundable income tax credits are counted as negative amounts in the income tax of some countries.

[21]Social assistance includes all income-tested and means-tested benefits, both cash and near-cash.

[22]Inter-generational indexes for all the other countries are available upon request to the author.

[23]In principle, one may study the impact of political communications on voters in order to assess how much the voting behaviour changes as a consequence of the exposure to messages. For instance, one may study the political *manifestos* and the way they are communicated to the audience and eventually calculate which party or candidate is directly favoured by messages form intermediaries. Unfortunately, this analysis is not very reliable because it must be inferred only via experiments; secondly, supposed that these experiments can be done, the message sent is not necessarily the message received by individuals and it is extremely difficult measuring the degree of exposure and the degree of perception of messages. For instance, the political bias should be measured at the source or at the receiver? What signal was sent? How can we measure the degree of exposure to a message?

[24]It is useful to remind that the voting age in the United Kingdom is 18.

[25]with respect to manifestos, press releases are more suited to give an insight into the patterns of communication over the course of campaign.

[26]The sample includes seven newspapers: the Sun, the Daily Mirror, the Daily Mail, the Daily Telegraph, the Times, the Guardian and the Independent.

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