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# Why are more redistributive social security systems smaller? A median voter approach

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One of the stylized facts of unfunded social security programs is that programs are larger in size, measured relative to the GDP, the tighter the link between pension claims and past earnings. We provide a political economy explanation of this stylized fact in a median voter model, where people vote on the social security tax rate. We compare pension systems with flat-rate and earnings-related benefit formulas. Only flat-rate benefits redistribute within a generation from high to low income groups. If labor supply is endogenous, they also imply larger efficiency costs than earnings-related schemes. Using data on eight European countries, we find that the median voter is typically middle-aged with high income. For these voters, earnings-related systems are more attractive both because of less intragenerational redistribution and lower distortions in labor supply. The median voter model is also able to account for a considerable degree of cross-country variation in contribution rates.

JEL classifications: H55, D72.

## 1. Introduction

Old-age pensions are at the core of public sector in almost all OECD countries. In 2001, the 15 EU member states spent on average 8.8% of their GDP on public old-age pensions (OECD, 2004). But while united in fiscal importance, pension systems are divided in how benefits are linked to past earnings. In earnings-related (Bismarckian) public pension programs, pensions are perceived as a form of postponed wage income, intended to replace earnings during retirement. Such benefit rules dominate in Continental Europe, including France, Germany, and Italy. In the competing tradition of rather flat-rate (Beveridgean) pensions, the alleged role of old-age benefits is to guarantee a reasonable standard of living for the elderly, and benefits are correspondingly flat-rate or close to it. Countries with close to flat-rate pensions include Japan, the United Kingdom, and the United States.[1] Since contributions are typically proportional to earnings, flat-rate benefit formulas imply more intragenerational redistribution than earnings-related systems.

Countries with earnings-related public pension programs have considerably higher contribution rates than those with flat-rate benefits. Disney (2004) reports that the effective contribution rates in the 10 OECD countries dominated by flat-rate systems varied between 14.7% in Australia and 23.7% in the United Kingdom in 1995. The range in the 12 OECD countries with more earnings-related benefits was between 22.4% in Germany and 57.7% in Greece. The average effective contribution rate was 19% in countries with flat-rate benefits, and 35% in countries with earnings-related benefits.[2]

In this paper, we analyse to what extent this stylized fact can be explained by an 'efficiency-redistribution' trade-off. We introduce a median voter model with individuals differing in age (young, middle-aged and old) and productivity (five productivity classes). Social security benefits encompass an earnings-related and a flat-rate component. Citizens vote for the social security contribution rate that would maximize their remaining lifetime utility, taking into account both the efficiency and redistributive effects of the voting decision. From the perspective of an individual voter, the cost of social security system consists of the net present value of remaining social security contributions and the efficiency losses due to distorted labor supply. The benefit is the net present value of lifetime benefits. Our theoretical model delivers the preferred social security contribution rates of voters of each age and productivity class. The political equilibrium social security contribution rate is then obtained numerically using data for Austria, France, Germany, Greece, Italy, Portugal, Spain, and the United Kingdom.

Identifying the pivotal agent is crucial to understand how efficiency and redistribution are balanced in the political process. The numerically solved median voter model predicts that the median voter is in all countries middle-aged with a relatively high income level. For this voter, an earnings-related social security system is more attractive than one with flat-rate benefits for two reasons. First, a voter with relatively high income loses from the intragenerational redistribution that a flat-rate system entails. Second, contributions towards earnings-related benefits cause smaller labor supply distortions as future benefits depend on past contributions. Thus, the efficiency cost of intergenerational redistribution that benefits the elderly and the middle-aged at the expense of younger generations is lower the smaller the redistributive flat-rate pillar. Both these mechanisms suggest that the political process would result in higher contribution rate in countries with more earnings-related public pension programs than in those with rather flat-rate benefits,

[1] In most countries, social security has both a flat-rate and an earnings-related component, the relative importance of which differs. We choose labels for countries according to which component is more pronounced, taking our classification from Disney (2004).

[2] In 2001, public spending on old-age benefits was on average 6.4% of GDP in countries with flat-rate benefits, and 9.4% in countries with earnings-related benefits (Disney, 2004; OECD, 2004).

when the median voter is a middle-aged citizen with a relatively high income. This prediction from the numerically solved model corresponds to the empirical pattern observed.

Although being a cornerstone in economic policy reasoning, the trade-off between efficiency and equity has (surprisingly for us) not been invoked in rationalizing why earnings-related systems are larger. The political economy literature has mainly focused on explaining the aggregate size of social security (proxied by the contribution rate). Therein benefits are usually assumed to be either perfectly flat-rate or earnings-related (see Galasso and Profeta, 2002, and Mulligan and Sala-i-Martin, 2004 for surveys; and the seminal contributions by Browning, 1975; Boadway and Wildasin, 1989; Cooley and Soares, 1999; Tabellini, 2000; and Boldrin and Rustichini, 2000). An explanation for the stylized fact which relies on borrowing constraints has been proposed by Casamatta *et al.* (2000). Our motivation for testing the role of labor supply distortions rather than the role of borrowing constraints in explaining the correlation derives from the observation that in particular young, low-productivity individuals face borrowing constraints. Analyses of voting behavior suggest that the politically decisive voter is advanced in age and not necessarily of low-income (e.g. Cooley and Soares, 1999 and Sinn and Uebelmesser, 2002)—a household type for which borrowing constraints play a diminished role. Thus, in our paper capital markets are perfect and, to capture the role of age for voting behavior more thoroughly, individuals work for two periods. The latter difference entails that even high-productivity individuals tend to support social security towards the end of their working life. When close to retirement, they view past contributions as sunk and prefer a continuation of social security (Cooley and Soares, 1999 and Boldrin and Rustichini, 2000). Furthermore, accounting for endogenous labor supply may qualitatively change conclusions that would be reached in models with exogenous labor supply.[3] This has been recently demonstrated by Sommacal (2006) who assesses the consequences of a pension reform for lifetime income inequality.[4]

Conde-Ruiz and Profeta (2007) analyse simultaneous voting on the type of social security system and on its size. In their model, a smaller flat-rate system is supported by a voting coalition of low-income individuals, who are in favor of a redistributive system, and high-income individuals, who also favor a redistributive system provided that the social security contribution rate is smaller, so that they can invest their resources in the private capital market, where they can earn higher returns. A large earnings-related system instead is supported by the middle-income individuals. Different to our paper, Conde-Ruiz and Profeta (2007) take labor supply to be exogenous. We show that labor supply distortions are sufficient to

[3] In our analysis, an exogenously fixed labor supply would unrealistically generate politically desired social security contribution rates reaching 100% (and even more if not capped) or 0%.

[4] In particular, Sommacal (2006) shows that reallocating pension funds from an earnings-related pension to a flat-rate pension will reduce lifetime inequality with exogenous labor supply. Such an effect may however disappear once labor supply responses are taken into account.

explain the positive relationship between the degree of intragenerational redistribution and the size of the social security system, without needing to assume that high-income individuals can earn higher rates of return in the financial market than low-income individuals (as in Conde-Ruiz and Profeta). Also, we test our model by performing a numerical analysis, calibrated on income distribution and social security rules in different European countries. To the best of our knowledge, there exists no previous median voter analysis which empirically relates cross-country differences in social security contribution rates to the redistributiveness of social security.

Our paper is organized as follows. Section 2 presents our theoretical model underlying the empirical analysis. Section 3 presents the empirical results and Section 4 concludes.

## 2. The model

### 2.1 Economy

Individuals differ in two dimensions: age and productivity. In each period there are three overlapping generations: young, middle-aged and old. Each generation works for two periods, 1 and 2, and is retired in period 3. Individuals of each cohort differ in productivity. We index the productivity types so that the productivity is increasing in the index number, the lowest productivity being denoted by one. While our theoretical framework holds with any number $J$ of productivity types, we will restrict the number of productivity classes to five in each age group in the numerical part of the paper. The induced productivity is allowed to vary over the life-cycle. The productivity of a $j$-type individual, being young in period $t$ is denoted as $a^y_{j,t} > 0$. The productivity of a $j$-type individual who is middle-aged in period $t$ is analogously denoted as $a^m_{j,t} > 0$. All productivity parameters grow at the rate $g$. The number of workers being of a $j$ type born in period $t$ is $n_{j,t}$, with the total size of the age-cohort born in period $t$ being $\sum_j n_{j,t} = n_t$. For simplicity, the proportion of each productivity type in the population stays constant over time, i.e. $n_{j,t}/n_t = n_{j,t+1}/n_{t+1}$. The cohort size evolves according to $n_{t+1} = (1+\eta)n_t$. Throughout the analysis, we focus on a steady state of the economy in which productivities and cohort size grow at constant rates.

Preferences are given by a well-behaved utility function $U = u\left(c^y_{j,t}, c^m_{j,t+1}, c^o_{j,t+2}\right)$ defined over consumption when being young, middle-aged and old. Consumption of a $j$-type individual born in period $t$ is

$$c^y_{j,t} = (1-\tau_t-\tau_w)a^y_{j,t}l^y_{j,t} - \upsilon\left(a^y_{j,t}, l^y_{j,t}\right) - s^y_{j,t}, \tag{1}$$

$$c^m_{j,t+1} = (1-\tau_{t+1}-\tau_w)a^m_{j,t+1}l^m_{j,t+1} - \upsilon\left(a^m_{j,t+1}, l^m_{j,t+1}\right) + (1+r)s^y_{j,t} - s^m_{j,t+1} \text{ and} \tag{2}$$

$$c^o_{j,t+2} = p_{j,t+2} + (1+r)s^m_{j,t+1}. \tag{3}$$

$l^y_{j,t}$ ($l^m_{j,t}$) denotes working hours by a $j$-type individual being young (middle-aged) in period $t$ which gives a gross wage income $a^y_{j,t}l^y_{j,t}$ ($a^m_{j,t}l^m_{j,t}$). Without loss of generality the wage rate each $j$-type individual receives per efficiency unit of labor supply, $a^y_{j,t}l^y_{j,t}$, is normalized to unity. In the first period of life a $j$-type individual derives utility from private consumption $c^y_{j,t}$ which is the net wage income, $(1-\tau_t-\tau_w)a^y_{j,t}l^y_{j,t}$, minus the monetarized disutility of labor supply, $\upsilon\left(a^y_{j,t}, l^y_{j,t}\right)$, and private savings $s^y_{j,t}$. The disutility formulation is common in analyses of welfare programs.[5] $\tau_t$ and $\tau_w$ are the social security contribution rate and the general wage tax rate. An analogous structure applies to second-period consumption. Old age consumption, $c^o_{j,t+2}$, is financed out of pension payments, $p_{j,t+2}$, and private savings, $(1+r)s^m_{j,t+1}$, where $r$ denotes the interest rate. There are no bequests.

We solve the model for the constant-elasticity specification

$$v(a^i_{j,t}, l^i_{j,t}) = \frac{\gamma}{1+\gamma} a^i_{j,t} l^{i\frac{1+\gamma}{\gamma}}_{j,t}, \qquad \gamma > 0, \quad i = y, m. \tag{4}$$

$\gamma^{-1}$ is the elasticity of marginal disutility with respect to labor supply $l^i_{j,t}$. The disutility of labor supply positively depends on the individuals' productivity which captures the idea that high income households face a higher opportunity cost of labor supply, either because they value leisure more or because of diminishing marginal productivity in home production.[6] As will be shown below, the specification does not imply a monotone relationship between hours worked and productivity; a finding which is consistent with labor supply behavior described by the European Community Household Panel data (ECHP) which we use in the empirical part. Therein, the number of working hours sometimes increases and sometimes declines across income quintiles, but in general stays fairly constant across income quintiles when restricting attention to individuals who work on average at least 30 hours.

The production function is linear in efficiency units of labor. There exists a storage technology to move resources over time at a given rate of return $r$. For example, in a small open economy the storage technology may take the form of international capital markets.

We include general wage taxes for two reasons. First, labor supply reacts to the overall tax wedge, and wage taxes are a major part of this in all European countries. Omitting wage taxes would thus lead in the numerical analysis to a severe underestimation of the tax burden, and would thus predict extremely high preferred social security contribution rates. Second, different countries have different levels of wage taxes which will affect the incentive costs of social security. We assume that general tax revenues are used to finance a public consumption good and that private and public consumption are weakly separable in utility.

[5] See e.g. Saez (2002) and Immervoll *et al.* (2007). An important implication of this modelling choice is that all income effects are shifted onto consumption demand.

[6] Poutvaara (2006) suggests a model in which hours worked do not depend on the wage rate when the individuals divide their time between work in the official labor market and untaxed home production.

The individual pension payment in period $t+2$, $p_{j,t+2}$, consists of a flat-rate and an earnings-related component:

$$p_{j,t+2} = \overline{p}_{t+2} + b_{j,t+2}. \tag{5}$$

The pension budget is described by the following equation:

$$P_{t+2} = \tau_{t+2}\left(\sum_j n_{j,t+2}a^y_{j,t+2}l^y_{j,t+2} + \sum_j n_{j,t+1}a^m_{j,t+2}l^m_{j,t+2}\right). \tag{6}$$

We assume that a fraction $\theta$ of the pension budget is spent on earnings-related pensions, i.e.

$$\sum_j n_{j,t}b_{j,t+2} = \theta P_{t+2} \qquad \text{and} \qquad n_t\overline{p}_{t+2} = (1-\theta)P_{t+2}. \tag{7}$$

We denote the share of earnings-related PAYG benefits that goes to pay for the benefit claims accumulated as young (middle-aged) by $\theta^y$ $(\theta^m) > 0$.

We next define two auxiliary variables:

$$\lambda^y : \; = \sum_j a^y_{j,0}n_{j,0}$$
$$\lambda^m : \; = (1+g)\sum_j a^m_{j,0}n_{j,0}.$$

$\lambda^y$ and $\lambda^m$ capture the relative productivity of the average worker when being young and middle-aged, respectively. It is assumed that

$$\theta^y = \frac{(1+r)\lambda^y}{\lambda^m + (1+r)\lambda^y} \text{ and } \theta^m = \frac{\lambda^m}{\lambda^m + (1+r)\lambda^y}. \tag{8}$$

While at first sight the assumption may appear arbitrary, it guarantees that the earnings-related pension system is efficient in the sense that marginal distortions which the social security system imposes on labor supply by young and middle-aged individuals are equalized in steady state (see the appendix for a formal proof). It is thus optimal to levy a contribution rate which is uniform across age cohorts. In the earnings-related component, the benefit $b_{j,t+2}$ is indexed to wage income in period $t+1$ and $t$ according to the formula

$$b_{j,t+2} = \theta\left(x^y_{t+2}a^y_{j,t}l^y_{j,t} + x^m_{t+2}a^m_{j,t+1}l^m_{j,t+1}\right). \tag{9}$$

The parameters $x^y_{t+2}$ and $x^m_{t+2}$ are endogenous, time-specific factors. They allow income earned in the first and second period of life to be treated differently in the pension formula. $\theta x^y_{t+2}$ and $\theta x^m_{t+2}$ denote how income as young and middle-aged translate into pension claims in period $t+2$. Straightforwardly, $\theta x^y_{t+2}$ and $\theta x^m_{t+2}$ are zero in pure flat-rate system $(\theta = 0)$ and are largest (ceteris paribus) in a pure earnings-related system $(\theta = 1)$. Given $\theta$ and $\tau_{t+2}$, $x^y_{t+2}$ and $x^m_{t+2}$ adjust so as to balance the earnings-related pension budget while accounting for labor supply responses. $\overline{p}_{t+2}$ is determined subject to the constraint that the overall PAYG budget (6) is balanced.

The pension scheme is more complex than the systems considered by previous literature. Therein, old-age security involves an earnings-related and a flat-rate pillar ($\theta \in (0,1)$) when households work for one period (Casamatta *et al.*, 2000 and Conde-Ruiz and Profeta, 2007) or the pension system comprises only a flat-rate scheme when households work multiple periods (Cooley and Soares, 1999). Both specifications thereby circumvent the analytical complexity involved with earnings-related systems and multiple working periods. For instance, the pension formula (9) fixes how the pension payment is related to the income history, but leaves it unspecified how one euro collected in period $t$ (and devoted to the earnings-related pillar) is spent on pension claims gathered when being young and middle-aged. To fill the gap we assume that in any period the earnings-related budget $\theta P_{t+2}$ is used in constant proportions to satisfy claims of the pensioners gathered when being young and middle-aged as determined by (8).

## 2.2 Economic equilibrium

Individual labor supply and saving decisions in the first and second period follow from

$$\max_{l^y_{j,t},\, l^m_{j,t+1},\, s^y_{j,t},\, s^m_{j,t+1}} U = u\left(c^y_{j,t}, c^m_{j,t+1}, c^o_{j,t+2}\right) \quad \text{s.t. (1) to (3), (5), and (9).} \tag{10}$$

We omit utility from public consumption. Since preferences are weakly separable in private and public consumption, general public expenditures (being exogenous from each individual's perspective) do not affect savings and labor supply behavior. The individual first-order conditions can be written as

$$l^y_{j,t}: \ \frac{\partial u}{\partial c^y_{j,t}}\left((1-\tau_t-\tau_w)a^y_{j,t} - \frac{\partial \upsilon\left(a^y_{j,t}, l^y_{j,t}\right)}{\partial l^y_{j,t}}\right) + \frac{\partial u}{\partial c^o_{j,t+2}}\theta x^y_{t+2} a^y_{j,t} = 0, \tag{11}$$

$$l^m_{j,t+1}: \ \frac{\partial u}{\partial c^m_{j,t+1}}\left((1-\tau_{t+1}-\tau_w)a^m_{j,t+1} - \frac{\partial \upsilon\left(a^m_{j,t+1}, l^m_{j,t+1}\right)}{\partial l^m_{j,t+1}}\right) + \frac{\partial u}{\partial c^o_{j,t+2}}\theta x^m_{t+2} a^m_{j,t+1} = 0, \tag{12}$$

$$s^y_{j,t}: \ -\frac{\partial u}{\partial c^y_{j,t}} + \frac{\partial u}{\partial c^m_{j,t+1}}(1+r) = 0 \ \text{ and } \ s^m_{j,t+1}: -\frac{\partial u}{\partial c^m_{j,t+1}} + \frac{\partial u}{\partial c^o_{j,t+2}}(1+r) = 0. \tag{13}$$

We next define an auxiliary variable

$$\chi := \frac{\lambda^y(1+\eta)^2(1+g)^2 + \lambda^m(1+\eta)(1+g)}{(1+r)^2\lambda^y + (1+r)\lambda^m}. \tag{14}$$

The auxiliary variable $\chi$ reports the ratio between the total wage income in the economy at time $t+2$ and the total lifetime wage income evaluated at time $t+2$ of the cohort born in period $t$. For $\tau_{t+i} = \tau_t \ \forall i \in \mathbb{N}$, $\chi$ shows how earnings-related pensions in period $t+2$ relate to wage income in period $t+2$ out of which pensions are financed. If the earnings-related pension system were actuarially fair, the ratio would be unity. In line with theoretical and empirical analyses we consider the economy to be dynamically efficient; see e.g. Abel *et al.* (1989) and Rhee (1991). Under dynamic efficiency[7]

$$\chi < 1. \tag{15}$$

We denote the optimal consumer choices derived from the household optimization problem by $\widehat{\ }$. When individuals expect $\tau_t$ to be constant over time, i.e. $\tau_{t+i} = \tau_t$ $\forall i \in \mathbb{N}$, optimal physical labor supply is

$$\widehat{l(\tau_t)} = [1 - \tau_w - \tau_t(1 - \theta\chi)]^{\gamma}. \tag{16}$$

Physical labor supply is independent of the productivity type. The uniformity result is not contradictory to observed labor supply behavior. For the selection of countries analysed in Section 4 working hours stay fairly constant across income groups (based on ECHP data). Note also that the uniformity only applies to working time. Labor supply in efficiency units, $a^{y}_{j,t}\widehat{l(\tau_t)}$ and $a^{m}_{j,t}\widehat{l(\tau_t)}$, is heterogeneous across productivity types of the same cohort and over the life-cycle provided individual productivity changes over time (a possibility the model accommodates). Individual preferences for social security are thus heterogeneous along both the productivity and age dimension.

(16) predicts that labor supply in physical and efficiency units is downward distorted by the general wage tax. The negative impact of the social security contribution rate $\tau_t$ due to a reduction in wage income is counteracted by the link between income and pension claims as captured by $\theta\chi$. In a dynamically efficient economy, the fraction of the contribution rate which is considered a wage tax, $1 - \theta\chi$, is strictly positive for $\theta \in [0, 1]$. Labor supply is thus decreasing in the contribution rate, where the distortion magnifies as $\gamma$ increases.

## 3. Political equilibrium

As voters, citizens do not only evaluate the impact of social security on their individual labor supply, but also consider how the PAYG budget is affected by a change in the contribution rate (in order to guarantee budget balancing). Voting over the contribution rate takes place given the type of the social security system measured by $\theta$. Similar to Casamatta *et al.* (2000), the voting game is one-dimensional; capturing the idea that the type of social security is more stable over time than the contribution rate which may well adjust annually. In order to focus on issues arising in voting on social security, we take $\tau_w$ as given. In period $t$ citizens decide upon the social security contribution rate expecting that the contribution rate stays constant thereafter (once-and-for-all voting), i.e. $\tau_{t+i} = \tau_t$, $\forall i \in \{0, 1, 2, \ldots\}$.

[7] See the Appendix for a derivation.

We solve here for the contribution rate preferred by the median voter in a once-and-for-all vote. Using the voting strategy developed in Poutvaara (2006), the results from once-and-for-all voting can be maintained with repeated voting.

Young voters compare the costs arising from social security contributions, made as young and middle-aged, to the benefits they receive as old. Formally, a $j$-type voter who is born in period $t$ maximizes:[8]

$$\max_{\tau_t} u\left(\widehat{c^y_{j,t}}, \widehat{c^m_{j,t+1}}, \tau_t\theta\chi\left((1+r)a^y_{j,t} + a^m_{j,t+1}\right)\widehat{l(\tau_t)} + \frac{1-\theta}{n_t}P_{t+2} + (1+r)\widehat{s^m_{j,t+1}}\right) \quad (17)$$

s.t. (1), (2), and (16).

Similarly, a $j$-type voter who is middle-aged in period $t$ maximizes remaining life-time utility:

$$\max_{\tau_t} u\left(\widehat{c^y_{j,t-1}}, \widehat{c^m_{j,t}}, \tau_t\theta\chi\left((1+r)a^y_{j,t-1} + a^m_{j,t}\right)\widehat{l(\tau_t)} + \frac{1-\theta}{n_{t-1}}P_{t+1} + (1+r)\widehat{s^m_{j,t}}\right) \quad (18)$$

s.t. (2) and (16).

For the middle-aged, contributions made in the previous period are sunk. They just compare the cost arising from social security contributions, made as middle-aged, to the benefits they receive as old.

Given $\theta \in [0,1]$, the benefit each pensioner receives is increasing in the social security budget. The elderly thus uniformly maximize utility by voting for the contribution rate $\arg\max_{\tau_t} P_t$.

For the empirical analysis that follows, it is helpful that we first give a characterization of how $\gamma$, $\tau_w$ and the degree of intragenerational redistribution $\theta$ influence voting incentives.

*Proposition 1* (i) For any given $\theta \in [0,1]$, the preferred contribution rate of young, middle-aged, and old voters is weakly decreasing in $\gamma$ and $\tau_w$.

(ii) The young and middle-aged voters' preferred contribution rate may be non-monotonic in $\theta \in [0,1]$ provided it is positive. The pensioners' preferred contribution rate is weakly increasing in $\theta \in [0,1]$.

Part (i) is straightforward and conforms to previous analyses of social security. Increases in $\gamma$ and $\tau_w$ encourage voting for a lower social security contribution rate as both increase the efficiency cost of social security financing.

Part (ii) shows that, provided the median voter is not an old voter, the model does not inherently give the prediction of a positive correlation between $\tau_t$ and $\theta$. A marginal increase of the earnings-related component of social security $\theta$ has two effects: it reduces the efficiency cost of social security financing at the expense

[8] For simplicity we omit utility derived from public consumption. Since households are assumed to value public consumption in the same way, introducing public consumption explicitly will entail a lower preferred contribution rate, but will leave the identity of the median voter in each country unchanged.

of less intragenerational redistribution. For instance, provided that the politically decisive voter is middle-aged with income at the very bottom of the income distribution, the net effect is that a higher $\theta$ tends to result in a lower social security contribution rate. Since the elderly uniformly vote for the contribution rate that maximizes current retirees' benefits, a higher $\theta$ unambiguously increases their preferred contribution rate.

Preferences are single-peaked, which allows us to use the median voter approach to characterize the political equilibrium.

## 4. A numerical analysis

In this section we numerically compute the political-equilibrium social security contribution rates for a sample of European countries. Restricted by data availability, the sample includes: Austria, France, Germany, Greece, Italy, Portugal, Spain, and the United Kingdom.[9]

Each country's population is decomposed into three age groups and five income groups. For each of these countries, we numerically solve for the social security contribution rate preferred by each age and income group, given the exogenous variables $r$ and $\gamma$ and the country-specific values of $\theta, \eta, g$ and $\tau_w$. Since the labor supply distortion is convex in the sum of the general wage tax $\tau_w$ and the tax component of the social security contributions $(1 - \theta\chi)\tau_t$ (see (16)), it is essential to include country-specific values of $\tau_w$ when estimating the politically preferred social security contribution rates. We subsequently identify the median voter in each country.

### 4.1 The data

We consider three age-groups: young (aged between 21 and 40 years), middle-aged (aged between 41 and 60 years), old (aged between 61 and 80 years), and five income-groups of equal size (very-low income, low-income, intermediate-income, high-income, very-high income). Considering groups of equal size represents a 'neutral' criterion to divide the population in the same way in five income groups in all countries.

The data on the current population growth rate are taken from the European Community Household Panel (ECHP), wave 1997.[10] We calculate the number of individuals in each of the three age groups, and obtain the dependency ratio, defined as the ratio between the number of old individuals and the sum of the number of young and middle-aged individuals. Calling $\eta$ the growth rate of population over one period, consisting of 20 years, the dependency ratio is equal to: $1/[(1 + \eta)(2 + \eta)]$, from which we implicitly derive the value

[9] The data are taken from the European Commission Household Panel (ECHP). From the ECHP sample we exclude Belgium, Denmark, Ireland, and the Netherlands because we do not have all necessary information and Luxembourg, Finland, and Sweden because we have too few observations.

[10] For a detailed description of the ECHP data see Nicoletti and Peracchi (2001).

**Table 1** The data

| Country | $\xi$ (%) | g (%) | $\theta$ | $\tau_w$ | Effective contribution rate $\tau_{eff}$ |
|---|---|---|---|---|---|
| Austria | 1.30 | 2.10 | 0.793 | 0.098 | 34.8 |
| France | 1.39 | 2.00 | 0.536 | 0.134 | 27.7 |
| Germany | 1.76 | 1.60 | 0.771 | 0.215 | 22.4 |
| Greece | 0.52 | 3.00 | 0.957 | 0.022 | 57.7 |
| Italy | 1.62 | 1.80 | 0.960 | 0.193 | 40.0 |
| Portugal | 0.78 | 2.50 | 0.689 | 0.067 | 35.4 |
| Spain | 0.91 | 3.00 | 0.870 | 0.121 | 45.0 |
| UK | 2.04 | 1.80 | 0.304 | 0.158 | 23.7 |

*Source*: $\xi$ : authors' calculations from the European Community Household Panel. g: taken from EUROSTAT. $\theta$ taken from OECD (2005) as (1-progressivity index). $\tau_w$ taken from OECD Taxing Wages 2000 (average tax rate, excluding social security contributions, for a single person with no children earning average income). $\tau_{eff}$ taken from Disney (2004).

of $\eta$. Subsequently, we derive the value of the annual population growth rate $\xi$ from $(1+\xi)^{20} = (1+\eta)$—see Table 1.

From the ECHP data set, we obtain data on productivity (wage earnings divided by the number of hours worked) for each worker (young and middle-aged). For these two age groups, we divide individuals in five income groups of equal size and calculate the average productivity in each income group. We then calculate the overall average productivity for all young and middle-aged. Dividing the average productivity in each income/age group by the overall average productivity, we find the 'productivity matrix' for each country, as shown in Table 2. Rows correspond to age groups (young, middle-aged) and columns to income groups (very-low income, low-income, intermediate-income, high-income, very-high income).

We approximate *g*, the growth rate of average productivity, by the EUROSTAT data on the average growth rate of per capita productivity in the period 1990–2003 (EUROSTAT, 2004). The estimated value of *g* is used to infer the earnings history of the currently middle-aged cohort from the earnings of the current young cohort.

Data on the tax rate on income without social security $\tau_w$ are taken from OECD Taxing Wages (2000)—see Table 1. They refer to the average tax rate for a single person with average income and no children.

The value of $\theta$ is calculated as one minus the progressivity index of pension benefit formulae which is computed in OECD (2005) using microeconomic projections.[11]

[11] The OECD index of progressivity is calculated as 100% minus the ratio of the Gini coefficient of pension entitlements (considering only mandatory parts of public pension programs) divided by the Gini coefficient of earnings (expressed as percentages). Thus, one minus this index represents a synthetic measure of the degree of redistributiveness of public pension programs.

**Table 2** Data on productivity levels

| | Very low Income | Low income | Intermediate income | High income | Very high income |
|---|---|---|---|---|---|
| *Austria* | | | | | |
| Young | 0.422 | 0.703 | 0.859 | 1.0149 | 1.377 |
| Middle-aged | 0.613 | 0.88 | 1.0834 | 1.396 | 1.883 |
| *France* | | | | | |
| Young | 0.354 | 0.622 | 0.768 | 0.999 | 1.451 |
| Middle-aged | 0.539 | 0.783 | 1.023 | 1.364 | 2.098 |
| *Germany* | | | | | |
| Young | 0.375 | 0.736 | 0.895 | 1.076 | 1.456 |
| Middle-aged | 0.579 | 0.848 | 1.019 | 1.262 | 1.858 |
| *Greece* | | | | | |
| Young | 0.338 | 0.617 | 0.777 | 1.021 | 1.514 |
| Middle-aged | 0.397 | 0.793 | 1.13 | 1.446 | 2.129 |
| *Italy* | | | | | |
| Young | 0.407 | 0.705 | 0.862 | 1.031 | 1.341 |
| Middle-aged | 0.616 | 0.9207 | 1.133 | 1.353 | 1.774 |
| *Portugal* | | | | | |
| Young | 0.346 | 0.564 | 0.704 | 0.907 | 1.797 |
| Middle-aged | 0.411 | 0.677 | 0.891 | 1.284 | 2.727 |
| *Spain* | | | | | |
| Young | 0.249 | 0.554 | 0.945 | 1.145 | 1.573 |
| Middle-aged | 0.485 | 0.839 | 1.509 | 1.571 | 2.371 |
| *UK* | | | | | |
| Young | 0.257 | 0.715 | 0.905 | 1.164 | 1.725 |
| Middle-aged | 0.213 | 0.765 | 1.003 | 1.272 | 2.037 |

By the Fisher Separation Theorem, we do not have to parameterize the utility function $u$ in (10) as there are no borrowing constraints. Differently, the elasticity of marginal disutility with respect to labor supply, $\gamma^{-1}$, enters the labor supply function which is decisive for political behavior. Calibrating $\gamma^{-1}$ is inherently difficult. Given (16), $\gamma$ is the elasticity of labor supply w.r.t. an increase in the discounted net-of-tax income where income comprises wage income and pension payments.[12] In the simulation analysis the parameter $\gamma$ relates to the labor supply elasticity over a time span of 20 years, over which intensive and extensive labor supply decisions are made (Krueger and Meyer, 2002, and Immervoll *et al.*, 2007). Thus, matching $\gamma$ with an empirical labor supply elasticity is not

[12] Formally,

$$\gamma = \frac{\partial \widehat{l(\tau_t)}}{\partial\left(1 - \tau_W - \tau_t\left(1 - \frac{\theta_\chi}{1+r}\right)\right)} \frac{1 - \tau_W - \tau_t\left(1 - \frac{\theta\chi}{1+r}\right)}{\widehat{l(\tau_t)}} > 0.$$

**Table 3** The results

| Country | $\theta$ | $r=0.05$<br>$\gamma=2$<br>$\tau$ | $\gamma=1.5$<br>$\tau$ | Median voter |
|---|---|---|---|---|
| Austria | 0.793 | 0.458 | 0.569 | middle-aged, high-income |
| France | 0.536 | 0.275 | 0.342 | middle-aged, high-income |
| Germany | 0.771 | 0.386 | 0.474 | middle-aged, very high-income |
| Greece | 0.957 | 0.723 | 0.884 | middle-aged, high-income |
| Italy | 0.96 | 0.580 | 0.714 | middle-aged, very high-income |
| Portugal | 0.689 | 0.350 | 0.435 | middle-aged, high-income |
| Spain | 0.87 | 0.690 | 0.738 | middle-aged, high-income |
| UK | 0.304 | 0.245 | 0.343 | middle-aged, high-income |
| corr$(\theta, \tau)$ | | 0.866 | 0.867 | |
| corr $(\tau, \tau_{\text{eff}})$ | | 0.899 | 0.910 | |

straightforward. As a pragmatic solution, we simulate the contribution rates for different values of $\gamma$.

## 4.2 The results

Our numerical simulations yield a matrix of preferred contribution rates by age and income group. We aggregate preferences through majority voting, by identifying the median voter and his preferred tax rate. The results are summarized in Table 3.

In general, earnings-related and flat-rate social security components generate voting incentives which differ across age and productivity. In a nearly pure earnings-related social security system (high value of $\theta$) young voters prefer a zero contribution rate. The rationale is that an earnings-related pension system implicitly taxes contributions at a rate $1-\chi$ in a dynamically efficient economy—see (15). The young would prefer to eliminate the implicit tax burden by voting for a zero contribution rate. If the continuation benefit outweighs the implicit taxation of the second period's contribution, the middle-aged will vote for a positive contribution rate. In a more flat-rate system (low value of $\theta$), on the other hand, the coalition supporting social security generally includes different cohorts. High-income young and middle-aged individuals may jointly vote for a lower contribution rate than e.g. low-income young and middle-aged individuals. In the simulation analysis it turns out that the median voter is always a high-income middle-aged individual, except in Italy and Germany where he is a very-high income middle-aged. The finding conforms to the presented reasoning that also high-income individuals have an incentive to support social security in a pension system with an earnings-related pillar. Also, we find that a higher level of wage taxation $\tau_w$ lowers the politically preferred contribution rate $\tau$ (Proposition 1 (i)).

The most interesting result relates to the role of the earnings-related component of the pension system $\theta$. The theoretical prediction of the correlation between $\theta$ and

$\tau$ is ambiguous (Proposition 1 (ii)); suggesting the need for an empirically-based analysis to identify the age and income attributes of the median voter. The simulation reveals a positive correlation between $\theta$ and the equilibrium social security contribution rate $\tau$ taking the value of $\sim 0.87$ (both when $\gamma = 2$ and $\gamma = 1.5$). The rationale for the empirical finding is that the median voter is middle-aged and of a higher income type. Reduced intra-generational redistribution makes social security more attractive to high-income middle-aged individuals, at the same time as it reduces its efficiency cost.

In Table 3 we also report the correlations between the simulated contribution rate and the real (effective) contribution rate calculated by Disney (2004)—see Table 1. The last line of Table 3 shows that our model performs quite well in explaining the real contribution rates. The correlations between the real (effective) values and the estimated values range from 0.90 (when $\gamma = 2$) to 0.91 (when $\gamma = 1.5$).[13]

We have performed sensitivity analysis with respect to the Bismarckian index $\theta$.[14] Based on ECHP data on wages and public pensions Conde Ruiz and Profeta (2007) compute the Bismarckian index as the correlation between the level of post-retirement pension benefit (excluding occupational pensions) [15] and pre-retirement earnings. Theoretically, in a pure flat-rate system the correlation is zero and unity in an earnings-related system. Using this index, our simulation shows a correlation between $\theta$ and the equilibrium social security contribution rate $\tau$ of 0.88 and a correlation between the simulated contribution rate and the real (effective) contribution rate of 0.91 (when $\gamma = 2$).

## 5. Concluding remarks

The relationship between the level to which benefits depend on past earnings and social security contribution rate has received little attention in the political economy literature, despite its robustness. In this paper, we suggest an explanation based on a standard trade-off between economic efficiency and redistribution. The efficiency cost of redistributing income is lower when benefits are earnings-related, encouraging voters who benefit from social security to support higher contribution rates. Low-income voters weigh this effect against the reduced redistributiveness of more earnings-related systems. Our numerical analysis of several European countries suggests that the median voter model is able to explain the stylized fact that intragenerationally more redistributive social security systems are smaller.

[13] We tested other values of $\gamma$ (e.g. $\gamma$=2.5 and $\gamma$=3) for which the positive correlation between $\theta$ and the equilibrium social security contribution rate $\tau$ prevailed at nearly the same level.

[14] The detailed results are not reported in Table 3. They are available upon request.

[15] Occupational pension systems constitute the second pillar of old-age security whose financial importance significantly varies across countries. All firm-based systems are run on a funded basis (Fenge *et al.*, 2003) and in our setting are equivalent to private savings. The Bismarckian index thus need not, and should not, include occupational pensions.

The social security contribution rates predicted by the median voter model also have a strong correlation with the effective rates calculated by Disney (2004), although not being identical. This means that our median voter model is able, at least in part, to explain the cross-country variation in the levels of contribution rates, without the assumption of borrowing constraints as in Casamatta *et al.* (2000) or the assumption that high income individuals earn higher returns in the financial market than low-income ones, as in Conde Ruiz and Profeta (2007). Even though the analysis focuses on steady-state political equilibria, the result that the benefit formula significantly affects the equilibrium contribution rates can be expected to hold also out of steady-states. Thus, the political response to population aging may crucially depend on the extent to which benefits are linked to past contributions. Accounting for the dynamic responses is left for future research.

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## References

**Abel, A.B., Mankiw, M.G., Summers, L.H., and Zeckhauser, R.J.** (1989) Assessing dynamic efficiency: theory and evidence, *Review of Economic Studies*, **56**, 1–20.

**Boadway, R.W. and Wildasin, D. E.** (1989) A median voter model of social security, *International Economic Review*, **30**, 307–28.

**Boldrin, M. and Rustichini, A.** (2000) Political equilibria with social security, *Review of Economic Dynamics*, **3**, 41–78.

**Browning, E.** (1975) Why the social insurance budget is too large in a democratic society, *Economic Inquiry*, **13**, 373–88.

**Casamatta, G., Cremer, H., and Pestieau, P.** (2000) The political economy of social security, *Scandinavian Journal of Economics*, **102**, 503–22.

**Conde Ruiz, I. and Profeta, P.** (2007) The redistributive design of social security systems, *Economic Journal*, **117**, 686–712.

**Cooley, T.F. and Soares, J.** (1999) A positive theory of social security based on reputation, *Journal of Political Economy*, **107**, 135–60.

**Disney, R.** (2004) Are contributions to public pension programmes a tax on employment, *Economic Policy*, **39**, 267–311.

**EUROSTAT** (2004) Statistics.http:/europa.eu.int/comm/eurostat/newcronos.

**Fenge, R., Gebauer, A., Holzner, C., Meier, V., and Werding, M.** (2003) Old-age provision around the world: revenues, benefits, and taxation (in German), *ifo-Beiträge zur Wirtschaftsforschung*, No. 10, Munich.

**Galasso, V. and Profeta, P.** (2002) The political economy of social security: a survey, *European Journal of Political Economy*, **18**, 1–29.

**Immervoll, H., Kleven, H., Kreiner, C.T., and Saez, E.** (2007) Welfare reforms in European countries: a microsimulation analysis, *Economic Journal*, **117**, 1–44.

**Krueger, A.B. and Meyer, B.M.** (2002) Labor supply effects of social insurance, *Handbook of Public Economics*, **4**, 2327–92.

**Mulligan, C. and Sala-i-Martin, X.** (2004) Internationally common features of public old-age pensions, and their implications for models of the public sector, *Advances in Economic Analysis & Policy*, 4, Article 4. http://www.bepress.com/bejeap/advances/vol4/iss1/art4.

**Nicoletti, C. and Peracchi, F.** (2001) Aging in Europe: what can we learn from the Europanel? in T. Boeri, A. Börsch-Supan, A. Brugiavini, R. Disney, A. Kapteyn, and F. Perachi (eds) *Pensions: More Information, Less Ideology*, Kluwer, Dordrecht.

**OECD** (2000) Taxing Wages, OECD, Paris.

**OECD** (2004) OECD in Figures, OECD, Paris.

**OECD** (2005) *Pensions at a Glance. Public policies across OECD countries*, OECD, Paris.

**Poutvaara, P.** (2006) On the political economy of social security and public education, *Journal of Population Economics*, **19**, 345–65.

**Rhee, Ch.** (1991) Dynamic efficiency in an economy with land, *Review of Economic Studies*, **58**, 791–97.

**Saez, E.** (2002) Optimal income transfer programs: intensive versus extensive labor supply responses, *Quarterly Journal of Economics*, **117**, 1039–73.

**Sinn, H.-W. and Uebelmesser, S.** (2002) Pensions and the path to gerontocracy in Germany, *European Journal of Political Economy*, **19**, 153–8.

**Sommacal, A.** (2006) Pension systems and intragenerational redistribution when labor supply is endogenous, *Oxford Economic Papers*, **58**, 379–406.

**Tabellini, G.** (2000) A positive theory of social security, *Scandinavian Journal of Economics*, **102**, 523–45.

# Appendix

In a steady-state, the rate of return offered by the PAYG system stays constant over time. For any contribution rate $\tau_t$, chosen in the "initial" voting period $t$ and staying constant thereafter, we thus have $x^y_{t+i+2} = x^y_{t+2}$ and $x^m_{t+i+1} = x^m_{t+1} \forall i \in \{0, 1, 2, \ldots\}$. Denoting the values by $x^y$ and $x^m$, (4) and the first-order conditions (11) to (13) imply

$$\widehat{l(\tau_t)}^y = \left[1 - \tau_w - \left(\tau_t - \frac{\theta x^y}{(1+r)^2}\right)\right]^\gamma \quad \text{and} \quad \widehat{l(\tau_t)}^m = \left[1 - \tau_w - \left(\tau_t - \frac{\theta x^m}{1+r}\right)\right]^\gamma. \tag{A.1}$$

Now, suppose that for $\tau_{t+i} = \tau_t, \forall i \in \mathbb{N}$ we have $x^y = (1+r)x^m$. This implies that individual physical labor supply (A.1) is constant over time. Given the social security budget constraint (6) and that a share $\theta^y\theta$ of the budget is used to satisfy pension claims gathered when being young, we can write

$$\theta^y \theta P_{t+2} = \theta x^y \lambda^y (1+\eta)^t (1+g)^t \widehat{l(\tau_t)}. \tag{A.2}$$

Analogously,

$$\theta^m \theta P_{t+2} = \theta x^m \lambda^m (1+\eta)^t (1+g)^t \widehat{l(\tau_t)}. \tag{A.3}$$

Inserting (8) into (A.2) and (A.3) yields $x^y = \tau_t \chi$ and $x^m = \tau_t \chi (1+r)$ and thus $x^y = (1+r)x^m$ as initially assumed. Note also, inserting the values for $x^y$ and $x^m$ into the labor supply functions (A.1) give (16 ). Thus, (16) postulates a labor supply behavior in a steady state.

## Derivation of (15)

Inserting the expression for $\chi$ from (14) into the inequality $\chi < 1$ and rearranging gives

$$(1+\eta)^2(1+g)^2\lambda^y + (1+\eta)(1+g)\lambda^m < (1+r)^2\lambda^y + (1+r)\lambda^m.$$

If the economy is dynamically efficient, i.e. $(1+\eta)(1+g) < 1+r$, the inequality holds.

## Proof of Proposition 1

(i) Differentiating (16) w.r.t. $\tau_t$ gives

$$\frac{d\widehat{l(\tau_t)}}{d\tau_t} = -\frac{1-\theta\chi}{[1-\tau_w-\tau_t(1-\theta\chi)]^{1-\gamma}}\gamma < 0. \tag{A.4}$$

In the proof we repeatedly make use of the auxiliary variable

$$\omega_{t+i} = \lambda^y(1+\eta)^{t+i}(1+g)^{t+i} + \lambda^m(1+\eta)^{t+i-1}(1+g)^{t+i-1}, \qquad i \in \mathbb{N}.$$

For $\tau_{t+i} = \tau_t \forall i \in \mathbb{N}$ (once-and-for-all voting), the contribution rate preferred by a young, $j$-type voter is solved as follows. First, differentiate (17) subject to (1), (2), and (16). Using the envelope theorem, multiplying by $1/\widehat{l(\tau_t)}$, and inserting (A.4) yields

$$\left(-a^y_{j,t} - \frac{a^m_{j,t+1}}{1+r}\right)(1-\theta\chi) + \frac{1-\theta}{n_t(1+r)^2}\left(1-\tau_t\frac{1-\theta\chi}{1-\tau_w-\tau_t(1-\theta\chi)}\gamma\right)\omega_{t+2}. \tag{A.5}$$

By (A.5) and the non-negativity constraint, the preferred contribution rate of the young voters belonging to the ability group $j$ is given by

$$\tau^{y}_{j,t} = \max\left\{\frac{(1-\tau_w)}{(1-\theta\chi)} * \frac{\left(-a^{y}_{j,t} - \frac{a^{m}_{j,t+1}}{1+r}\right)(1-\theta\chi)\frac{n_t(1+r)^2}{(1-\theta)\omega_{t+2}} + 1}{\left(-a^{y}_{j,t} - \frac{a^{m}_{j,t+1}}{1+r}\right)(1-\theta\chi)\frac{n_t(1+r)^2}{(1-\theta)\omega_{t+2}} + 1 + \gamma}, 0\right\}. \tag{A.6}$$

Analogously, for $\tau_{t+i} = \tau_t \forall i \in \mathbb{N}$ (once-and-for-all voting), the contribution rate preferred by a middle-aged, $j$-type voter is solved as follows. First, differentiate (18) subject to (2) and (16). Using the envelope theorem, multiplying by $1/\widehat{l(\tau_t)}$, and inserting (A.4) yields

$$-a^{m}_{j,t}(1-\theta\chi) + \left[(1+r)\theta\chi a^{y}_{j,t-1} + \frac{1}{1+r}\frac{1-\theta}{n_{t-1}}\omega_{t+1}\right]\left(1-\tau_t\frac{1-\theta\chi}{1-\tau_w-\tau_t(1-\theta\chi)}\gamma\right). \tag{A.7}$$

Rearranging (A.7) and noting the non-negativity constraint, the preferred contribution rate of middle-aged voters belonging to the ability group $j$ is

$$\tau^{m}_{j,t} = \max\left\{\frac{(1-\tau_w)}{(1-\theta\chi)} * \frac{-a^{m}_{j,t}(1-\theta\chi)\left[(1+r)\theta\chi a^{y}_{j,t-1} + \frac{1}{1+r}\frac{1-\theta}{n_{t-1}}\omega_{t+1}\right]^{-1} + 1}{-a^{m}_{j,t}(1-\theta\chi)\left[(1+r)\theta\chi a^{y}_{j,t-1} + \frac{1}{1+r}\frac{1-\theta}{n_{t-1}}\omega_{t+1}\right]^{-1} + 1 + \gamma}, 0\right\}. \tag{A.8}$$

The old maximize $P_t$ subject to (16). Multiplying by $1/\widehat{l(\tau_t)}$, using (A.4) and reorganizing gives

$$\left(1-\tau_t\frac{1-\theta\chi}{1-\tau_w-\tau_t(1-\theta\chi)}\gamma\right)\omega_t = 0. \tag{A.9}$$

The preferred contribution rate of the old is given by

$$\tau^{o}_{j,t} = \min\left\{\frac{(1-\tau_w)}{(1-\theta\chi)(1+\gamma)}, 1\right\}. \tag{A.10}$$

Given by (A.6), (A.8), and (A.10), the preferred contribution rate of any voter group is weakly decreasing in $\tau_w$ and $\gamma$.

(ii) By inspecting (A.6) and (A.8) the preferred contribution rates of the young and middle-aged voters are non-monotonic in $\theta$, while, following (A.10), the preferred contribution rate of the old is weakly increasing in $\theta$.