WHY ARE MORE REDISTRIBUTIVE SOCIAL SECURITY SYSTEMS SMALLER? A MEDIAN VOTER APPROACH

MARKO KOETHENBUERGER
PANU POUTVAARA
PAOLA PROFETA

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Abstract

We suggest a political economy explanation for the stylized fact that intragenerationally more redistributive social security systems are smaller. Our key insight is that linking benefits to past earnings (less redistributiveness) reduces the efficiency cost of social security (due to endogenous labor supply). This encourages voters who benefit from social security to support higher contribution rates in political equilibrium. We test our theory with a numerical analysis of eight European countries. Our simple, but suggestive median voter model performs relatively well in explaining the stylized fact and cross-country differences in social security contribution rates.

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Keywords: earnings-related and flat-rate benefits, social security, public pensions, median voter model.

Marko Koethenbuerger
Center for Economic Studies
at the University of Munich
Schackstr. 4
80539 Munich
Germany
marko.koethenbuerger@ces.vwl.uni-muenchen.de

Panu Poutvaara
Centre for Economic and Business Research
Copenhagen Business School
Porcelaenshaven, Bldg 65
2000 Frederiksberg
Denmark
panu-poutvaara@cebr.dk

Paola Profeta
Università Bocconi, IEP
Via Gobbi 5
20136 Milan
Italy
paola-profeta@unibocconi.it

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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 percent 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 stated aim 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, in flat-rate benefit formulas the pension system implies a higher intragenerational redistribution than in 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 percent in Australia and 23,7 percent in the United Kingdom in 1995. The range in the 12 OECD countries with more earnings-related benefits was between 22,4 percent in Germany and 57,7 percent in Greece. The average effective contribution rate was 19 percent in countries with flat-rate benefits, and 35 percent in countries with earnings-related benefits.[2]

In this paper, we ask whether a median voter model is able to explain the positive correlation between the size of the social security system and the degree to which pension benefits depend on past contributions. We first present a theoretical model where citizens vote on the social security contribution rate and then decide on their labor supply. In our model, citizens differ in two dimensions, age and productivity. There are three cohorts, the young, the middle-aged and the old, and five productivity classes within each cohort. As contributions towards earnings-related benefits cause smaller labor supply distortions, the efficiency cost of social security financing is lower than with flat-rate benefits. However, low productivity voters weigh the efficiency effect

[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) who labels earnings-related systems Bismarckian and flat-rate systems Beveridgean.

[2] In 2001, public spending on old-age benefits was in average 6,4 percent of GDP in countries with flat-rate benefits, and 9,4 percent in countries with earnings-related benefits (Disney, 2004; OECD, 2004).

against the reduction in intragenerational redistribution and a more earnings-related system may not be preferred by this group of voters. Thus, the model predicts that the correlation between the size of social security and the degree to which pensions are earnings-related depends on the identity of the politically-decisive voter.

In a second step we analyze whether our median voter model with endogenous labor supply is able to explain cross-country differences in social security contribution rates, when accounting for differences in their pension formula (earnings-related versus flat-rate). To do so, we perform a numerical analysis that delivers the values of the equilibrium social security contribution rates of our model for Austria, France, Germany, Greece, Italy, Portugal, Spain and the United Kingdom. For these countries, we use information on the income distribution taken from European Community Household Panel (ECHP) survey from the year 1997. In each country, we form three age groups: the young (aged between 21 and 40 years old), the middle-aged (aged between 41 and 60 years old), and the old (aged between 61 and 80 years old). We divide each cohort into five income-groups of equal size and calculate the relative productivity of the different groups for each country (based on the ECHP survey). Data on the earnings-related component of the pension transfer is taken from Conde Ruiz and Profeta (2004).

As the voting incentives crucially depend on expectations concerning future productivity growth and demographic development we consider two alternative scenarios. In the first scenario, we assume that citizens vote as if the current dependency ratio would reflect steady-state demographic development. For the second scenario, the data on the projected population growth rate are taken from the United Nations and refer to the situation in 2020. For each scenario, we estimate the contribution rate preferred by the median voter with alternative values of interest rate, productivity growth and elasticity of labor supply.

Studying two alternative scenarios is informative in two respects. First of all, it reveals how sensitive the predictions of the median voter model are to changes in various parameters. Second, it allows us to calculate to what extent different assumptions concerning the behavior of voters are able to explain cross-country differences in labor supply. Provided that the median voter model is a reasonable approximation of how contribution rates are politically determined, the different scenarios shed light on the set of expectations that voters appear to use when voting on social security. Our numerical analysis shows that, when applied to different countries, our model correctly predicts that in both scenarios countries with more earnings-related public pension programs have higher contribution rates than those with more flat-rate benefits. This relationship is strongest in the first scenario. The pro social security coalition is found not to be too dependent on low productivity voters. The reduced labor supply distortion in a more earnings-related system uncontestedly increases demand for social security, thereby providing an explanation for the empirical observation that less redistributive social security systems entail a higher contribution rate.

Previous contributions have addressed various economic and political implications of differences in the pension formulae. Jensen et al. (2004) computationally analyze the efficiency and redistributive effects of different social security rules with endogenous labor supply and human capital formation, taking the size of the social security system as given. The political economy literature, on the other hand, has mainly focused on explaining the aggregate size of social security (proxied by the contribution rate). Benefits are usually assumed to be either perfectly flat-rate or earnings-related (see Galasso and Profeta (2002), 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. (2000a).[3] Although the median voters' income is below average income, the preferred contribution rate may increase when the social security system redistributes less.[4] A discontinuity in the model's prediction arises for sufficiently earnings-related systems in which case the political equilibrium contribution rate drops to zero.

Our motivation for testing the role of labor supply distortions in explaining the correlation derives from the observation that in particular young, low-productivity individuals face borrowing constraints.[5] 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 allows even

[3] Casamatta et al. (2000b) analyze the effect of Bismarckian parameter on social insurance, but not on PAYG-financed old-age security. In their model income redistribution takes place inside each generation.

[4] The result is sensitive to the intertemporal elasticity of substitution. If it is below unity, a positive correlation between the size and type of social security may arise. For values above unity, the model's prediction of a negative correlation contrasts the empirical observation.

[5] Casamatta et al. (2000a) allow social security to distort economic decision captured by a quadratic efficiency term. The extension does not undo the impact of capital markets imperfections on voting incentives.

high-productivity individuals to support social security. 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).

Conde-Ruiz and Profeta (2004) analyze 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 are in favor of 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 (2004) take labor supply to be exogenous. We provide a different explanation for a positive relation between the degree of intragenerational redistribution and the size of the social security system. We show that labor supply distortions are sufficient to generate this positive relationship even with uni-dimensional voting. As a consequence, our explanation applies also to countries where the type of social security (earnings-related or flat-rate) has been historically given.

Our paper is organized as follows. Section 2 presents our theoretical model. Section 3 presents the numerical analysis and Section 4 concludes. All proofs are relegated to Appendix 2.

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 their 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 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 $a^m_{j,t} > 0$. Productivities satisfy $a^y_{j,t} < a^y_{j+1,t}$, $a^m_{j,t} < a^m_{j+1,t} \forall j$. All productivity parameters grow at the rate g. The number of workers being of a j type born in period t is n_t^j, with the total size of the age-cohort born in period t being $\sum_j n_t^j = n_t$. For simplicity, the proportion of each productivity type in the population stays constant over time, i.e. $\frac{n_t^j}{n_t} = \frac{n_{t+1}^j}{n_{t+1}} \forall j, t$. The cohort size evolves according to $n_{t+1} = (1+\eta)n_t$.

Preferences are given by a well-behaved utility function

$$U = u\left(c_{j,t}^y, c_{j,t+1}^m, c_{j,t+2}^o\right).$$

Consumption for a j-type individual born in period t is

$$c_{j,t}^y = (1-\tau_t-\tau_w)a_{j,t}^y l_{j,t}^y - \upsilon\left(a_{j,t}^y, l_{j,t}^y\right) - s_{j,t}^y, \tag{1}$$

$$c_{j,t+1}^m = (1-\tau_{t+1}-\tau_w)a_{j,t+1}^m l_{j,t+1}^m - \upsilon\left(a_{j,t+1}^m, l_{j,t+1}^m\right) + (1+r)s_{j,t}^y - s_{j,t+1}^m \text{ and} \tag{2}$$

$$c_{j,t+2}^o = p_{j,t+2} + (1+r)s_{j,t+1}^m. \tag{3}$$

$l_{j,t}^y$ ($l_{j,t}^m$) denotes working hours by a j-type individual being young (middle-aged) in period t which gives a gross wage income $a_{j,t}^y l_{j,t}^y$ ($a_{j,t}^m l_{j,t}^m$). Without loss of generality the wage rate each j-type individual receives per efficiency unit of labor supply, $a_{j,t}^y l_{j,t}^y$, is normalized to unity. In the first period of life an individual of j-type derives utility from private consumption $c_{j,t}^y$ which is the net wage income, $(1-\tau_t-\tau_w)a_{j,t}^y l_{j,t}^y$, minus the monetarized disutility of labor supply, $\upsilon\left(a_{j,t}^y, l_{j,t}^y\right)$, and private savings $s_{j,t}^y$.[6] τ_t and τ_w are the social security contribution rate and the general wage tax rate. The cost of labor supply $\upsilon(\cdot)$ is continuous, strictly increasing and convex in $l_{j,t}^y$ and $l_{j,t+1}^m$, respectively. An analogous structure applies to the second period of life. Individuals of type j born in period t retire in period $t+2$. Old age consumption, $c_{j,t+2}^o$, is financed out of pension payments, $p_{j,t+2}$, and private savings, $(1+r)s_{j,t+1}^m$ where r denotes the interest rate. There are no bequests.

Product and factor markets are perfectly competitive and market prices are exogenous for the economy. The fixity of prices may follow from a linear production technology or in a small open economy from factor price equalization in the presence of goods traded.[7]

[6] Modelling the disutility from labor supply as a reduction in instantaneous consumption is common in analyses of welfare programs, see e.g. Diamond (1998), Saez (2002) and Cremer and Pestieau (2003). An important implication of this modelling choice is that all income effects are shifted onto consumption demand.

[7] In this way, intergenerational linkages are exclusively formed by the unfunded social security system.

2.2 Social security system

We analyze a pay-as-you-go (PAYG) social security system. Thus, total pension payments in period $t+2$, P_{t+2}, equal contributions collected from the young and middle-aged in the same period[8]:

$$P_{t+2}=\tau_{t+2}\left(\sum_j n_{j,t+2}a^y_{j,t+2}l^y_{j,t+2}+\sum_j n_{j,t+1}a^m_{j,t+2}l^m_{j,t+2}\right). \tag{4}$$

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

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

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

$$b_{j,t+2}=\theta\left(x^y_{t+2}a^y_{j,t}l^y_{j,t}+x^m_{t+2}a^m_{j,t+1}l^m_{j,t+1}\right). \tag{6}$$

θx^y_{t+2} and θx^m_{t+2} denote how income as young and middle-aged translate into pension claims in period $t+2$. The proportionality factors decompose into a time-specific factor, x^y_{t+2} and x^m_{t+2}, allowing income earned as young and middle-aged to be treated differently in the pension formula, and a time-independent factor, θ, frequently referred to as the Bismarckian index. Straightforwardly, θx^y_{t+2} and θx^m_{t+2} are zero in pure flat-rate system ($\theta=0$) and are largest (ceteris paribus) in a pure earnings-related system ($\theta=1$).

Residually determined, the flat-rate component $\overline{p}_{t+2}$ is

$$\overline{p}_{t+2}=(1-\theta)\frac{P_{t+2}}{n_t}. \tag{7}$$

2.3 Economic Equilibrium

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

$$\max_{l^y_{j,t},l^m_{j,t+1},s^y_{j,t},s^m_{j,t+1}} U=u\left(c^y_{j,t},c^m_{j,t+1},c^o_{j,t+2}\right) \qquad \text{s.t. (1) to (3), (5), and (6).}$$

Solving implicitly for the optimal labor supplies in the first and second period of life, $\widehat{l^y_{j,t}}$ and $\widehat{l^m_{j,t+1}}$, (see Appendix 2)

[8] Notice that individuals pay a unique social security tax rate (not two, one for the earnings-related part and one for the flat-rate part of the social security system).

$$\widehat{l^y_{j,t}} = \upsilon'^{-1}\left[a^y_{j,t}, \left(1-\tau_t-\tau_w+\theta\frac{x^y_{t+2}}{(1+r)^2}\right)a^y_{j,t}\right] \text{ and}$$
$$\widehat{l^m_{j,t+1}} = \upsilon'^{-1}\left[a^m_{j,t+1}, \left(1-\tau_{t+1}-\tau_w+\theta\frac{x^m_{t+2}}{1+r}\right)a^m_{j,t+1}\right]. \quad (8)$$

Labor supply is down-ward distorted by the general wage tax τ_w. The negative impact of the social security contribution rate τ_t is counteracted by the link between income and pension claims θx^y_{t+2} and θx^m_{t+2}.

Our model allows optimal labor supply to vary over the life-cycle and over productivity types of the same age-cohort. For analytical simplicity, we formulate social security rules and utility functions so that labor supply behavior is uniform over the life-cycle and across productivity types. In doing so, we invoke two assumptions. First,

$$\upsilon\left(a^y_{j,t}, l^y_{j,t}\right) = a^y_{j,t}\upsilon\left(l^y_{j,t}\right) \text{ and } \upsilon\left(a^m_{j,t+1}, l^m_{j,t+1}\right) = a^m_{j,t+1}\upsilon\left(l^m_{j,t+1}\right). \quad \text{(A1)}$$

The cost of labor supply linearly depends on the individuals' productivity which captures the idea that high income households face a higher opportunity cost of labor supply. Weighting the marginal costs and benefits of supplying one additional hour of labor, the influence of the individual productivity on labor supply is immaterial.[9] (A1) only gives a uniform intra-cohort labor supply as x^y_{t+2} and x^m_{t+2} may take different values.

Second, we assume that the link between income in the first and second period of life and pension claims satisfies

$$x^y_{t+i} = x^m_{t+i}(1+r), \qquad \forall i \in \mathbb{N}. \quad \text{(A2)}$$

The individual becomes indifferent between contributing one unit of income to the earnings-related pension system as young or as middle-aged. (A2) in combination with (A1) imply that labor supply behavior is uniform over the life-cycle.[10]

To clarify the implications of both assumptions note that the uniformity only applies to working time. Labor supply in efficiency units is heterogeneous for different productivity types of the same cohort and over the life-cycle if individual productivity changes over time. The simplifying formulation is flexible enough to capture a positive correlation between wage income and productivity in each working period and allows for an upward-sloping age-earnings profile. Individual preferences for social security are thus heterogeneous along both the productivity and age dimension.

[9] See (17) and (18) in Appendix 2.
[10] See (17) and (18) in Appendix 2.

The implications of social security for labor supply incentives follow from Lemma 1 and 2:

Lemma 1 *Keeping τ_t constant ($\tau_{t+i} = \tau_t$, $\forall i \in \mathbb{N}$), the link between income and pension claims is*

$$\theta x^y_{t+i} = \theta \tau_t \chi (1+r) \quad \text{and} \quad \theta x^m_{t+i} = \theta \tau_t \chi,$$

where the factor χ is independent of τ_t.

χ measures the ratio of total wage income out of which pension benefits are financed in $t+2$ over the aggregate life-cycle income of the contributor of the same age-cohort discounted to the second period of life $t+1$. If $\theta\chi > 0$, contributors ex-ante realize that their future pension payment will be a fraction $\theta\chi$ of their discounted lifetime wage income, multiplied by the social security contribution rate. The anticipated link will be stronger, the larger the earnings-related part of the social security system is (as measured by θ). In a pure earnings-related system ($\theta = 1$) pensioners will receive a positive rate of return on their past contribution equal to $\chi - 1$ while in a pure flat rate system ($\theta = 0$) pensioners will anticipate a zero rate of return.

In what follows we consider the case of a dynamically-efficient economy. Lemma 2 reports the implications for the rate of return on social security contributions.

Lemma 2 *In a dynamically efficient economy, χ is lower than $1 + r$. Thus, $\theta\chi - 1 < r$ for $\theta \in [0, 1]$.*

Using Lemma 1, (A1), (A2) and (8), individual labor supply in each working period is

$$\widehat{l(\tau_t)} = v'^{-1} \left[1 - \tau_w - \tau_t \left(1 - \frac{\theta\chi}{1+r} \right) \right]. \tag{9}$$

The effect of a marginal change in the contribution rate on labor supply is

$$\frac{d\widehat{l(\tau_t)}}{d\tau_t} = \frac{\partial \widehat{l(\tau_t)}}{\partial \tau_t} + \frac{\partial \widehat{l(\tau_t)}}{\partial \left(\tau_t \frac{\theta\chi}{1+r} \right)} \frac{\theta\chi}{1+r} \tag{10}$$

$$= -\left(1 - \frac{\theta\chi}{1+r} \right) \frac{\partial \widehat{l(\tau_t)}}{\partial (1 - \tau_w - \tau_t)} < 0. \tag{11}$$

The last step follows from $-\frac{\partial \widehat{l(\tau_t)}}{\partial \tau_t} = \frac{\partial \widehat{l(\tau_t)}}{\partial \left(\tau_t \frac{\theta\chi}{1+r} \right)} = \frac{\partial \widehat{l(\tau_t)}}{\partial (1 - \tau_w - \tau_t)}$. The first term in Eq. (10) reports the negative labor supply response to the contribution hike due to a lower wage income in the period in which labor is supplied. The second term gives the positive supply response since a higher contribution increases pension income at a rate $\frac{\theta\chi}{1+r}$. Implied by Lemma 2 labor supply decreases on net for any $\theta \in [0,1]$. The labor supply distortion is highest in a pure flat-rate system ($\theta = 0$) and decreases as the pension formula becomes more earnings-related (increasing θ).

In elasticity notation

$$\frac{d\widehat{l(\tau_t)}}{d\tau_t}\frac{\tau_t}{\widehat{l(\tau_t)}} = -\left(1 - \frac{\theta\chi}{1+r}\right)\frac{\tau_t}{1-\tau_w-\tau_t}\epsilon < 0 \ , \tag{12}$$

where $\epsilon := \frac{\partial\widehat{l(\tau_t)}}{\partial(1-\tau_w-\tau_t)}\frac{1-\tau_w-\tau_t}{\widehat{l(\tau_t)}} > 0$. The labor supply elasticity with respect to the contribution rate is influenced by the fraction of the contribution rate which is considered a wage tax, $1 - \frac{\theta\chi}{1+r}$, and the labor supply elasticity with respect to the net wage rate $1 - \tau_w - \tau_t$.[11]

3 Political Equilibrium

As voters, citizens not only evaluate the impact of social security on their individual labor supply, but also evaluate how aggregate labor supply and the PAYG budget is affected by a change in the contribution rate. Voting over the contribution rate takes place given the type of the social security system measured by θ.[12] In order to focus on issues arising in voting on social security we take τ_w as given. Citizens decide upon the social security contribution rate by a once-and-for-all voting. Appendix 3 shows how the identified political equilibrium can also be sustained in a repeated voting setting by resorting to a suitable trigger strategy.

Formally, a j-type voter young in period t maximizes:

$$u\left(\widehat{c^y_{j,t}},\ \widehat{c^m_{j,t+1}}, \tau_t\theta\ \chi\left((1+r)a^y_{j,t} + a^m_{j,t+1}\right)\widehat{l(\tau_t)} + \frac{1-\theta}{n_t}P_{t+2} + (1+r)\widehat{s^m_{j,t+1}}\right) \tag{13}$$

s.t. (1) to (3), (4), (9) and (17) to (19).

Variables with a $\widehat{}$ denote the optimal consumer choices derived from the household optimization problem analyzed in the last section. Young voters compare the costs arising from social security contributions, made as young and middle-aged, to the benefits they receive as old.

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

[11] Recall, the wage rate per efficiency unit of labor supply is normalized at unity.

[12] Similar to Casamatta et al. (2000a), the voting game is one-dimensional, since we assume that the type of social security is more stable over time than the contribution rate, which may well adjust annually.

$$u\left(\widehat{c^{y}_{j,t-1}},\ \widehat{c^{m}_{j,t}}, \tau_t \theta \chi \left((1+r)a^{y}_{j,t-1} + a^{m}_{j,t}\right) \widehat{l(\tau_t)} + \frac{1-\theta}{n_{t-1}} P_{t+1} + (1+r)\widehat{s^{m}_{j,t}}\right) \tag{14}$$

s.t. (2) to (3), (4), (9) and (18) to (19).

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

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

Preferences are single-peaked which renders the median voter politically decisive with a majority voting on the contribution rate.

We proceed by first characterizing voting incentives in the polar social security systems ($\theta = 1$ and $\theta = 0$) and consider a mixed system ($\theta \in (0, 1)$) afterwards.

3.1 Earnings-related social security system

Proposition 1 characterizes voting incentives in period t in the presence of a pure earnings-related social security system ($\theta = 1$).

Proposition 1 *(i) In an earnings-related social security system young voters prefer a zero contribution rate whereas middle-aged voters prefer a positive contribution rate if the increase in productivity over the life-cycle, measured by $a^{m}_{j,t}/a^{y}_{j,t-1}$, is not too pronounced. Pensioners prefer a strictly positive contribution rate independently of the income history.*

(ii) The contribution rate preferred by each middle-aged voter (if it is positive) and the pensioners is decreasing in ϵ and τ_w. Moreover, the contribution rate most preferred by each middle-aged productivity group (if it is positive) is decreasing in the ratio of their second period's productivity over the first period's productivity $a^{m}_{j,t}/a^{y}_{j,t-1}$.

Young voters prefer a zero contribution rate. The rationale is that an earnings-related pension system implicitly taxes contributions at a rate $1 - \frac{\chi}{1+r} > 0$ in a dynamically efficient economy - see Lemma 2. 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 of type j will vote for a positive contribution rate. These findings recoup the predictions in Browning (1975).

Voting incentives differ over the life-cycle but are nearly homogeneous within each age cohort. While voting incentives of the young cohort and the elderly are perfectly aligned across cohort members the preferred contribution rate of the middle-aged electorate is negatively influenced by the increase in their productivity over the life-cycle, $a_{j,t}^{m}/a_{j,t-1}^{y}$. Theoretically, the preferred contribution rate is unrelated to the productivity type and may be largest for high-productivity individuals. They may thus favor the highest contribution rate (if it is positive) among all middle-aged voters.[13] If voters prefer a continuation of social security, the preferred contribution rate is decreasing in ϵ and τ_w as both add to the efficiency cost of social security finance.

The identity of the median voter depends on the population distribution along the age and productivity dimension. If, as assumed in the paper, the productivity distribution within each age cohort is constant over time and population growth is moderate in the sense that the young generation cannot form a majority of voters, the political equilibrium may entail a continuation of the social security system although it is an unfavorable savings technology when viewed over the whole life-cycle.

3.2 Flat-rate social security system

Proposition 2 characterizes voting incentives in a pure flat-rate social security system. In what follows $\overline{a}_{t-1}^{y}$ denotes the weighted average productivity of the young in period $t-1$.

Proposition 2 *(i) In a pure flat-rate social security system the most preferred contribution rate is weakly increasing in age for all productivity types. For voters of the same age cohort the preferred contribution rate is weakly decreasing in the productivity type. Pensioners prefer a strictly positive contribution rate independently of the income history.*

(ii) If a voter's preferred contribution rate is strictly positive, it is decreasing in ϵ and τ_w. Moreover, the contribution rate most preferred by each middle-aged productivity group (if it is positive) is decreasing in the ratio of their second period's productivity over the average first period's productivity $a_{j,t}^{m}/\overline{a}_{t-1}^{y}$.

Young, low-productivity voters do not necessarily opt for a positive contribution rate although they benefit from intragenerational redistribution inherent in a flat-rate pension sys-

[13] Two period analyses of social security (one working period and one period of retirement) find voting incentives to be aligned over productivity types in an earnings-related system - see e.g. Casamatta et al. (2000a). With more than one working period this result may not hold as middle-aged voters may well face different productivity dynamics (measured by $a_{j,t}^{m}/a_{j,t-1}^{y}$).

tem. They do so only if their productivity relative to the weighted average productivity of the members of the same cohort is sufficiently low. The result is reminiscent of Tabellini (2000). A voter of an average productivity type ($a^y_{j,t} = \overline{a}^y_t$ and $a^m_{j,t+1} = \overline{a}^m_{t+1}$) thus strictly prefers a zero contribution rate while young. Low productivity voters only prefer a positive contribution rate if their life-time productivity is sufficiently low. The share of young voters who support a positive contribution rate depends on the skewness of the productivity distribution, supporters being a subset of those whose lifetime expected income is below the average of their cohort.

Since the first-period contribution is sunk, middle-aged voters evaluate the benefit against the contribution as middle-aged. The preferred level of social security is weakly higher than the level preferred by the young of the same productivity type.

Independently of age and productivity a voter's demand for social security is decreasing in the labor supply elasticity ϵ and the general wage tax τ_w. Both magnify the distortion in the labor supply margin following an incremental rise in τ_t.

The identity of the median voter depends on how the population is distributed in the age and productivity dimension. The elderly are joined first by the middle-aged with lowest productivity, and subsequently by groups with the lowest remaining discounted lifetime net income.

3.3 Mixed social security system

In a mixed social security system ($\theta \in (0,1)$) voting incentives are a combination of those under the polar social security systems. The next proposition gives a more detailed characterization of how voting incentives are influenced by the degree of intragenerational redistribution.

Proposition 3 *(i) For any given $\theta \in (0,1)$, the preferred contribution rate of all young and middle-aged voters is weakly decreasing in their productivity type, ϵ and τ_t.*

(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 strictly increasing in $\theta \in (0,1)$.

As with the polar cases of $\theta = 0$ and $\theta = 1$, voters who are still part of the workforce have heterogeneous preferences with respect to the social security contribution rate. On the one hand, the labor supply distortion arising from social security is decreasing in θ. The lower efficiency cost of running the social security system pushes voters to support a larger social security system. On the other hand, a lower degree of intragenerational redistribution reduces the distributional gains that in the first place young low-productivity voters derive from social security. Provided that the median voter is middle-aged and does not have a very low income, the net effect can be expected to be that a higher θ results in a higher social security contribution rate, an intuition that our numerical analysis in the following section confirms.

4 A Numerical Analysis

In this section we numerically compute the political-equilibrium social security contribution rates of the model presented above. The purpose is to relate the simulated contribution rate to the parameters of the model, in particular to the link between individual income and pension claims, θ, and the labor supply elasticity, ε. Thereby, we provide insight into the relation between the pension benefit formula (earnings-related *versus* flat-rate) and the size of the social security budget (proxied by the contribution rate) and the extent to which the correlation is shaped by cross-country differences in labor supply distortions brought about by different pension formulae.

We focus on a sample of European countries. Restricted by data availability, the sample includes: Austria, France, Germany, Greece, Italy, Portugal, Spain and the United Kingdom.[14]

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 individual in each age and income group and subsequently identify the median voter. Formally, we solve the "political" first order condition that determines the optimal choice of τ for each individual in each age and income group, applying country-specific values for the exogenous variables $(\varepsilon, r, \theta, \eta, g, \tau_w)$.[15]

We simulate the equilibrium social security contribution rate under two different scenarios: in the first scenario we use current data for population and productivity growth rate in each country, and in the second scenario we use projections for the population and productivity growth rates (see table 1). In scenario 1 parameter values are inferred from past performance during the last period of 20 years, while in the second scenario country-specific parameter values

[14] 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.

[15] The "political" first-order conditions are depicted in Appendix 2. In particular, (24) relates to the young voter, (26) relates to the middle-aged voter and (27) gives the first-order condition for the elderly.

are inferred from United Nations (UN) and EU projections for development during the following period of 20 years from the year 2000 onwards.

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, middle-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.

For the first scenario, the data on the current population growth rate are taken from the European Community Household Panel (ECHP), wave 1997.[16] 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 young and middle-aged individuals. Calling ξ the growth rate of population over one period, consisting of 20 years, the dependency ratio is equal to: $1/[(1+\xi)(2+\xi)]$, from which we can implicitly derive the value of ξ. Calling η the annual population growth rate and given that $(1+\eta)^{20} = (1+\xi)$, we derive the value of η shown in table 1. For the second scenario, the data on the projected population growth rate are taken from the United Nations and refer to the year 2020 - 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 5 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. By 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, middle-income, high-income, very-high income).

Data on g, the growth rate of average productivity, are obtained from EUROSTAT. Scenario 1 considers the average growth rate of per capita productivity in the period 1990-2003 and scenario 2 the projected growth rate of productivity from 2003 to 2020 - see table 1 for the data.

Data on the tax rate on income without social security τ_w (see table 3) are taken from

[16] For a detailed description of the ECHP data see Peracchi (2002) and Nicoletti and Peracchi (2001).

OECD Taxing Wages (2000) and refer to the average tax rate for a single person with no children earning average income.

Data on θ, the earnings-related component of the pension system, are derived from Conde Ruiz and Profeta (2004), who also used the ECHP data on wages and public pensions. The Bismarckian index is the correlation index between the level of post-retirement pension benefit and pre-retirement earnings and shown in table 3. Pension benefits include only public pensions. Theoretically, in a pure flat-rate system the correlation is zero and unity in an earnings-related system.[17] 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 simulations are obtained for different values of the elasticity of labor supply to net income ε. From Pencavel (1986) and Immervoll et al. (2004), we take $[0.3, 1]$ as the plausible range of labor supply elasticities.[18]

Finally, in table 4 we report the real value of the effective contribution rates to public pension programs in each country, calculated by Disney (2004).[19]

4.2 The Results

We first report the preferred contribution rate for individuals of all income and age groups (fifteen groups). Older individuals are in favor of sustaining the social security system and vote for the contribution rate which maximizes social security revenues. For middle-aged individuals, the preferred level of the contribution rate decreases with income. The theoretical ambiguity found in propositions 1 (*ii*) and 2 (*ii*) (which generalizes to a mixed system) is resolved in favor of a negative relation between productivity type and the level of contributions preferred by middle-aged voters. The same ordering applies to young individuals; yet in many cases, all young people prefer a zero contribution rate, except when intra-cohort redistribution is high

[17] Data on replacement rates for varying income groups (figure 3 in Disney, 2004) provide a congruent picture of the redistributiveness of social security (for the countries covered by both analyses). Also, qualitative classifications presented in Disney (2004) and Fenge and Werding (2003) are in line with the adopted quantitative measure of redistributiveness.

[18] These estimates refer to the overall elasticity, i.e. to the intensive (working hours) and the extensive (labor force participation) margin. Although we formally resort to one-dimensional labor supply behavior (only intensive labor supply), the use of the overall estimate is helpful in capturing all budgetary implications of social security related labor supply distortions.

[19] As in our model, Disney considers the contribution rate which balances the social security budget, i.e. without resorting to external financing via general taxation.

(for instance in the UK, a flat-rate system), in which case the low and very low-income young individuals choose a positive contribution rate. This result is in line to what we obtained in propositions 1 (i), 2 (i), and 3 (i). In a pure earnings-related system, all young would vote for a zero contribution rate, while in a mixed system this is certainly true at least for high-income young individuals.

Our numerical simulations deliver a matrix of preferred tax rates by age and income group. We aggregate preferences through majority voting, by identifying the median voter and his preferred tax rate. The results for the two scenarios are in tables 5 and 6.

Given our values of the growth rate of population, young individuals are never in the majority. If the young always choose the lowest tax rate among all groups, the median voter is a middle-aged individual. Depending on the growth rate of the population, the group to which the median voter belongs ranges from the low-income middle-aged (in case of a very low η), to the very high-income middle-aged (in case of a very high η). In the scenario 1 of our simulations, 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. In scenario 2, where the population growth rates are almost the same in all countries, the median voter is always a middle-income middle-aged, except in the United Kingdom, where he is a poor middle-aged.

The economic variables play the expected role in determining the equilibrium level of the social security contribution rate, and therefore the size of the PAYG budget-balanced social security system. A general result in the social security literature (Galasso and Profeta, 2002) is that a higher growth rate of productivity g, higher growth rate of population η and lower interest rate r increase the equilibrium social security contribution rate. Our results confirm these relations. When perturbating the population growth rate η two effects shape the political equilibrium. First, a lower population growth rate may change the identity of the median voter. The decisive group typically switches from a very high-income (or high-income) middle-aged individual to a middle-income middle-aged individual, who would choose a higher contribution rate. Second, the working generations' labor supply response w.r.t. τ becomes stronger, provided that $\theta > 0$. This lowers contribution rates preferred by all those voting for positive contribution rates. The overall effect is thus ambiguous, as it is evident by comparing scenario 1 and 2. We also obtain a negative relation between the general wage tax τ_w and the equilibrium contribution rate τ (as in propositions 1 (ii), 2 (ii) and 3(i)).

The new results that we obtain in this paper concern the role of the labor supply elasticity,

ε, and the role of the earnings-related component of the pension system θ. We can summarize these results as follows:

- Elasticity of labor supply ε: The preferred contribution rate decreases with the elasticity of labor supply. When labor supply is more elastic, the distortionary effect of the pension system is larger and the preferred contribution rate is lower.

- Earnings-related component of the pension benefit θ: The results show a positive association between the earnings-related component of the pension system and the contribution rate.

The simulation reveals a positive correlation between the earnings-related component and the equilibrium social security contribution rate. The contribution rate chosen by high-income individuals is most likely increasing in θ. Reduced redistribution makes social security more attractive to high-income middle-aged individuals, at the same time as it reduces its efficiency costs. High-income individuals are the group of the median voter in scenario 1, but not in scenario 2. This at least partly explains why the correlation between the earnings-related component and the social security contribution rate is stronger in the first scenario.

The correlation between θ and τ is reported in tables 5 and 6 for all scenarios. Two different effects arise: the first one relates to the distortion of labor supply, which is larger in a more flat-rate system, thus leading to the positive relation between θ and τ. If the median voter does not change across countries (for instance, he is always a very rich middle-aged individual), this would be the unique effect and the positive relation would be guaranteed. The second opposite effect is that the identity of the median voter changes, because flat-rate benefit systems provide more income redistribution from rich to poor (contributions are proportional to earnings and benefits are flat), and thus the median voter tends to belong to a group with lower lifetime earnings in earnings-related systems. A poorer median voter chooses a larger size of the social security system. The overall result shows that the first effect generally prevails and we observe a positive relation between the size of the social security system (measured by τ) and the earnings-related component (θ).

Figure 1 illustrates the relation between our simulated social security contribution rate (τ) and the earnings-related component (θ) in the first scenario for three different values of the elasticity of labor supply. Social security systems which redistribute less across income groups are larger. This result confirms that our model provides an explanation for why countries where the pension benefits are more earnings-related are associated with larger pension expenditures. This relation is weaker under scenario 2, as illustrated by figure 2, showing that differences in population and productivity growth rate across countries play a relevant role.

In tables 5 and 6 we also report the correlations between our simulated contribution rates and the real (effective) contribution rates calculated by Disney (2004). An obvious question arises: how close are our estimations to the real values?[20] The last lines of tables 5 and 6 show that our model performs quite well in explaining the real contribution rates. In the first scenario, the correlations between real values (see table 2) and our estimated values range from 0.427 (when $\epsilon = 0.5$ and $r = 0.045$) to 0.721 (when $\epsilon = 0.3$ and $r = 0.035$), while in the second scenario they range from 0.507 (when $\epsilon = 1$ and $r = 0.04$) to 0.590 (when $\epsilon = 0.5$ and $r = 0.035$). These values confirm that in all specifications our model is able to a certain extent to explain the real values and the cross-country differences in social security contribution rates.

Tables 7 and 8 report the results of a sensitivity analysis. We aim at isolating the role of θ in explaining the real values of social security contribution rates from the role of the other economic and population characteristics. In table 7 we report the estimated values for the social security contribution rate, when θ is set equal to 0.5 for all countries and the other parameters (g, η, τ_w, the productivity levels) have the same values as in scenario 1. For all specifications of r and ε, the correlations between the real and the estimated contribution rates are now smaller than when cross-country differences in θ were taken into account (table 5). This means that θ plays an independent role in explaining the real values and the cross-country differences in social security contribution rates, independent from the economic characteristics of the countries. However, when all countries are assumed equal with respect to economic characteristics (as in table 8, where for all countries we set a common value for g, η, τ_w and the productivity levels, which is equal to the average of the country-values), and countries differ only by θ, the correlation between real and estimated values increases in two cases ($r = 0.045$ and $\epsilon = 0.3$, $r = 0.045$ and $\epsilon = 0.5$) and decreases in the other ones. This result suggests that also the economic characteristics play an important role in explaining the level of the social security contribution rates in each country, independently of θ. Table 8 also shows that when θ is the only variable that differentiates the countries, the positive relation between θ and the social security contribution rate is very high (correlations close to 1). This last result arises from

[20] Notice that our numerical analysis does not aim at predicting the real values of the social security contribution rates. Rather, it aims at reproducing a stylized fact that social security systems which link benefits to past contributions are in average larger, as well as providing an explanation of this.

the critical role labor supply distortions have in accounting for the positive relation between θ and τ. It is maximum when all other differences across countries are neglected.

5 Concluding Remarks

Among European OECD countries, the average effective contribution rate in 1995 was 19 percent in countries with flat-rate benefits, and 35 percent in countries with earnings-related benefits (Disney 2004). 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 endogenous labor supply. 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 standard median voter model is able to explain the stylized fact that intragenerationally more redistributive social security systems are smaller.

The social security contribution rates predicted by the median voter model also have a strong correlation with the effective rates calculated by Disney (2004). This means that our median voter model is able at least in part to explain the levels of contribution tax rates and their cross-country differences. We find that the correlations between our estimated contribution rates and the effective contribution rates are quite high under both scenarios considered. Even though our analysis focuses on steady-state political equilibria, our main result that benefit formula significantly affects political equilibrium contribution rates can be expected to hold also outside of steady-states. This suggests that the political response to population aging may crucially depend on to what extent benefits are linked to past contributions.[21] Accounting for these dynamic responses is left for future research.

[21] Existing literature on social security voting under population aging includes Cremer and Pestieau 2000, Casamatta et al. 2001, Galasso 2002, and Sinn and Uebelmesser 2002.

6 Appendix 1: Structure of the earnings-related social security system

A fraction θ^y and θ^m of the pension budget in period $t+2$ which is spent on earnings-related pensions, θP_{t+2}, is allocated to meet pensioners' claims generated as young and middle-aged, respectively. Given by assumption (A2) the parameters θ^y and θ^m are such that, in equilibrium, the implicit tax imposed by the social security system is the same for income earned as young and income earned as middle-aged. Thus,

$$\theta^y = \frac{(1+r)\lambda^y}{\lambda^m + (1+r)\lambda^y} \text{ and } \theta^m = \frac{\lambda^m}{\lambda^m + (1+r)\lambda^y}, \tag{15}$$

where

$$\lambda^y = \sum_k a^y_{k,0} n_{k,0} \text{ and } \lambda^m = (1+g) \sum_k a^m_{k,0} n_{k,0}. \tag{16}$$

We can disentangle the earnings-related pension budget in two components:

$$\theta P_{t+2} = \theta^y \theta P_{t+2} + \theta^m \theta P_{t+2}.$$

Budget-balancing is guaranteed by the fact that θ^y and θ^m sum up to unity - see (15).

The first budget component $\theta^y \theta P_{t+2}$ must equal pension claims of pensioners generated when being young:

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

where x^y_{t+2} is endogenously determined so as to balance the budget.

Similarly, the second budget component $\theta^m \theta P_{t+2}$ must satisfy

$$\theta^m \theta P_{t+2} = \theta x^m_{t+2} \lambda^m (1+\eta)^t (1+g)^t \widehat{l(\tau_t)},$$

where x^m_{t+2} adjusts to balance the budget.

7 Appendix 2

7.1 Derivation of (8) and (9)

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

$$\max_{l^y_{j,t},l^m_{j,t+1},s^y_{j,t},s^m_{j,t+1}} U = u\left(c^y_{j,t}, c^m_{j,t+1}, c^o_{j,t+2}\right) \qquad \text{s.t. Eqs. (1) to (3), (5), and (6).}$$

The first-order conditions for labor supply in the first and second period of life become

$$l^y_{j,t} \quad : \quad \frac{\partial u}{\partial c^y_{j,t}}\left(\left(1-\tau_t-\tau_w\right)a^y_{j,t} - \upsilon'\left(a^y_{j,t}, l^y_{j,t}\right)\right) + \frac{\partial u}{\partial c^o_{j,t+2}}\theta x^y_{t+2}a^y_{j,t} = 0, \tag{17}$$

$$l^m_{j,t+1} \quad : \quad \frac{\partial u}{\partial c^m_{j,t+1}}\left(\left(1-\tau_{t+1}-\tau_w\right)a^m_{j,t+1} - \upsilon'\left(a^m_{j,t+1}, l^m_{j,t+1}\right)\right) + \frac{\partial u}{\partial c^o_{j,t+2}}\theta x^m_{t+2}a^m_{j,t+1} = 0, \tag{18}$$

$$s^y_{j,t} \quad : \quad -\frac{\partial u}{\partial c^y_{j,t}} + \frac{\partial u}{\partial c^m_{j,t+1}}(1+r) = 0 \text{ and } s^m_{j,t+1} : \; -\frac{\partial u}{\partial c^m_{j,t+1}} + \frac{\partial u}{\partial c^o_{j,t+2}}(1+r) = 0. \tag{19}$$

Inserting (19) into (17) (resp. (18)) gives after some manipulation optimal labor supply $\widehat{l^y_{j,t}}$ (resp. $\widehat{l^m_{j,t+1}}$) - see (8).

Inserting assumptions (A1) and (A2) into (17) - (19) and using Lemma 1, optimal labor supply reduces to (9).

7.2 Proof of Lemma 1

$\theta^y\theta P_{t+2}$ must satisfy (see Appendix 1)

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

where the left-hand side depicts the pension budget in period $t+2$ which is spent on pension claims generated when being young and the right-hand side gives the respective pension claims. Using Eqs. (4) and (15)

$$\begin{aligned} x^y_{t+2} &= \tau_t\frac{(1+r)\lambda^y}{\lambda^m+(1+r)\lambda^y}\frac{\left[\lambda^y(1+\eta)^{t+2}(1+g)^{t+2}\widehat{l(\tau_t)} + \lambda^m(1+\eta)^{t+1}(1+g)^{t+1}\widehat{l(\tau_t)}\right]}{\lambda^y(1+\eta)^t(1+g)^t\widehat{l(\tau_t)}} \\ &= \tau_t(1+r)\frac{\left[\lambda^y(1+\eta)^2(1+g)^2+\lambda^m(1+\eta)(1+g)\right]}{\lambda^m+(1+r)\lambda^y}. \end{aligned}$$

Similarly, noting

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

and using Eqs. (4) and (15) yields

$$\begin{aligned} x^m_{t+2} &= \tau_t\frac{\lambda^m}{\lambda^m+(1+r)\lambda^y}\frac{\left[\lambda^y(1+\eta)^{t+2}(1+g)^{t+2}\widehat{l(\tau_t)} + \lambda^m(1+\eta)^{t+1}(1+g)^{t+1}\widehat{l(\tau_t)}\right]}{\lambda^m(1+\eta)^t(1+g)^t\widehat{l(\tau_t)}} \\ &= \tau_t\frac{\left[\lambda^y(1+\eta)^2(1+g)^2+\lambda^m(1+\eta)(1+g)\right]}{\lambda^m+(1+r)\lambda^y} \end{aligned}$$

Denote

$$\frac{\lambda^y(1+\eta)^2(1+g)^2+\lambda^m(1+\eta)(1+g)}{\lambda^m+(1+r)\lambda^y}=:\chi. \tag{20}$$

x^y_{t+2} and x^m_{t+2} thus are:

$$\theta x^y_{t+2} = \theta\tau_t\chi(1+r) \tag{21}$$

$$\theta x^m_{t+2} = \theta\tau_t\chi. \tag{22}$$

7.3 Proof of Lemma 2

Inserting the expression for χ - see (20) - in the inequality $\chi - 1 < r$ 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, $(1+\eta)(1+g)<1+r$, the inequality holds.

7.4 Proof of Propositions 1 - 3

In proving Propositions 1 - 3 we first derive the young and middle-aged voter's first-order condition for the general case of $\theta\in[0,1]$. Subsequently we analyze the voting incentives for the polar social security systems $\theta=0$ and $\theta=1$ followed by the mixed system $\theta\in(0,1)$.

For $\tau_{t+i}=\tau_t\forall i\in\mathbb{N}$ (once-and-for-all voting), the tax rate preferred by a young, j-type voter follows from differentiating (13) subject to (1) to (3), (4), and (9). As an intermediate step we get

$$\begin{aligned}
&-a^y_{j,t}\widehat{l(\tau_t)}+(1-\tau_t-\tau_w)a^y_{j,t}\widehat{l(\tau_t)}'-a^y_{j,t}v'\left(\widehat{l(\tau_t)}\right)\widehat{l(\tau_t)}'\\
&+\frac{-a^m_{j,t+1}\widehat{l(\tau_t)}+(1-\tau_t-\tau_w)a^m_{j,t+1}\widehat{l(\tau_t)}'-a^m_{j,t+1}v'\left(\widehat{l(\tau_t)}\right)\widehat{l(\tau_t)}'}{1+r}\\
&+\frac{1}{(1+r)^2}\left[\theta\chi\left((1+r)a^y_{j,t}+a^m_{j,t+1}\right)+\frac{1-\theta}{n_t}\omega_{t+2}\right]\left(\widehat{l(\tau_t)}+\tau_t\widehat{l(\tau_t)}'\right),
\end{aligned}$$

where we have made use of the auxiliary variable

$$\omega_{t+2}=\lambda^y(1+\eta)^{t+2}(1+g)^{t+2}+\lambda^m(1+\eta)^{t+1}(1+g)^{t+1}. \tag{23}$$

Multiplying by $1/\widehat{l(\tau_t)}$, using (11) and (17) - (19) in addition to Lemma 1 yields:

$$\begin{aligned}
&-a^y_{j,t} - a^y_{j,t}\left(1-\frac{\theta\chi}{1+r}\right)\epsilon + a^y_{j,t}\frac{\left[1-\tau_w-\tau_t\left(1-\frac{\theta\chi}{1+r}\right)\right]}{1-\tau_w-\tau_t}\left(1-\frac{\theta\chi}{1+r}\right)\epsilon \\
&-\frac{a^m_{j,t+1}+a^m_{j,t+1}\left(1-\frac{\theta\chi}{1+r}\right)\epsilon}{1+r} + \frac{a^m_{j,t+1}\left[1-\tau_w-\tau_t\left(1-\frac{\theta\chi}{1+r}\right)\right]\left(1-\frac{\theta\chi}{1+r}\right)\epsilon}{(1-\tau_w-\tau_t)(1+r)} \\
&+\frac{1}{(1+r)^2}\left[\theta\chi\left((1+r)a^y_{j,t}+a^m_{j,t+1}\right)+\frac{1-\theta}{n_t}\omega_{t+2}\right]\left(1-\tau_t\frac{1-\frac{\theta\chi}{1+r}}{1-\tau_w-\tau_t}\epsilon\right)
\end{aligned}$$

Simplifying gives

$$\left(-a^y_{j,t}-\frac{1}{1+r}a^m_{j,t+1}\right)\left(1-\frac{\theta\chi}{1+r}\right)+(1-\theta)\frac{1}{n_t(1+r)^2}\left(1-\tau_t\frac{1-\frac{\theta\chi}{1+r}}{1-\tau_w-\tau_t}\epsilon\right)\omega_{t+2}. \tag{24}$$

Analogously, for $\tau_{t+i}=\tau_t\forall i\in\mathbb{N}$ (once-and-for-all voting), the tax rate preferred by a j-type voter, who is middle-aged in period t, follows from differentiating (14) subject to (2) to (3), (4), and (9). In doing so we get

$$\begin{aligned}
&-a^m_{j,t}\widehat{l(\tau_t)}+(1-\tau_t-\tau_w)a^m_{j,t}\widehat{l(\tau_t)}'-a^m_{j,t}v'\left(\widehat{l(\tau_t)}\right)\widehat{l(\tau_t)}' \\
&+\frac{1}{1+r}\left(\theta\chi\left((1+r)a^y_{j,t-1}+a^m_{j,t}\right)+\frac{1-\theta}{n_{t-1}}\omega_{t+1}\right)\left(\widehat{l(\tau_t)}+\tau_t\widehat{l(\tau_t)}'\right),
\end{aligned}$$

where the auxiliary variable $\omega_{t+1}$is

$$\omega_{t+1}=\lambda^y(1+\eta)^{t+1}(1+g)^{t+1}+\lambda^m(1+\eta)^t(1+g)^t. \tag{25}$$

Multiplying by $1/\widehat{l(\tau_t)}$, using (11), and (18) - (19) in addition to Lemma 1 yields:

$$\begin{aligned}
&-a^m_{j,t}-a^m_{j,t}\left(1-\frac{\theta\chi}{1+r}\right)\epsilon+\frac{a^m_{j,t}\left[1-\tau_w-\tau_t\left(1-\frac{\theta\chi}{1+r}\right)\right]\left(1-\frac{\theta\chi}{1+r}\right)\epsilon}{1-\tau_w-\tau_t} \\
&+\frac{1}{1+r}\left[\theta\chi\left((1+r)a^y_{j,t-1}+a^m_{j,t}\right)+\frac{1-\theta}{n_{t-1}}\omega_{t+1}\right]\left(1-\tau_t\frac{1-\frac{\theta\chi}{1+r}}{1-\tau_w-\tau_t}\epsilon\right).
\end{aligned}$$

Simplifying gives

$$-a^m_{j,t}\left(1-\frac{\theta\chi}{1+r}\right)+\theta\chi a^y_{j,t-1}\left(1-\tau_t\frac{1-\frac{\theta\chi}{1+r}}{1-\tau_w-\tau_t}\epsilon\right)+\frac{1}{1+r}\frac{1-\theta}{n_{t-1}}\omega_{t+1}\left(1-\tau_t\frac{1-\frac{\theta\chi}{1+r}}{1-\tau_w-\tau_t}\epsilon\right). \tag{26}$$

The old maximize P_t - see (4) - subject to (9) which gives the first-order condition:

$$\left(\sum_{j=l,i,h}a^y_{j,t}n_{j,t}+\sum_{j=l,i,h}a^m_{j,t}n_{j,t-1}\right)\widehat{l(\tau_t)}+\tau_t\left(\sum_{j=l,i,h}a^y_{j,t}n_{j,t}+\sum_{j=l,i,h}a^m_{j,t}n_{j,t-1}\right)\widehat{l(\tau_t)}'=0.$$

Using (11) and reorganizing gives

$$\left(1-\tau_t\frac{1-\frac{\theta\chi}{(1+r)}}{1-\tau_w-\tau_t}\epsilon\right)\omega_t=0. \tag{27}$$

Proof of Proposition 1: (i): Evaluating (24) at $\theta=1$ yields

$$-a^y_{j,t}\left(1-\frac{\chi}{1+r}\right)-\frac{1}{1+r}a^m_{j,t+1}\left(1-\frac{\chi}{1+r}\right), \tag{28}$$

which is negative in a dynamically efficient economy - see Lemma 2.

For a middle-aged, j-type voter in period t the preferred tax rate follows from setting $\theta=1$ in (26):

$$-a^m_{j,t}\left(1-\frac{\chi}{1+r}\right)+\chi a^y_{j,t-1}\left(1-\tau_t\frac{1-\frac{\chi}{1+r}}{1-\tau_w-\tau_t}\epsilon\right). \tag{29}$$

The second term is strictly positive which indicates that the middle-aged voter prefers a strictly positive contribution rate if the second term dominates the first term. Observe this occurs less likely the higher $a^m_{j,t}/a^y_{j,t-1}$ (divide (29) by $a^y_{j,t-1}$), the higher ϵ, and the higher τ_w.

The old prefer a contribution rate which satisfies (27) evaluated at $\theta=1$:

$$\left(1-\tau_t\frac{1-\frac{\chi}{(1+r)}}{1-\tau_w-\tau_t}\epsilon\right)\omega_t=0. \tag{30}$$

Comparing with (29) the preferred contribution rate is strictly larger than the contribution rate preferred by any j-type middle-aged voter.

(ii): If the contribution rate most preferred by the middle-aged voter is positive, i.e. (29) is equal to 0, it is decreasing in ϵ, τ_w, and $a^m_{j,t}/a^y_{j,t-1}$. Given by (30) the contribution rate most preferred by the elderly is decreasing in ϵ and τ_w.

Proof of Proposition 2: (i): Evaluating (24) at $\theta=0$ gives

$$-a^y_{j,t}-\frac{a^m_{j,t+1}}{1+r}+\frac{1}{n_t(1+r)^2}\left(1-\frac{\tau_t}{1-\tau_w-\tau_t}\epsilon\right)\omega_{t+2}. \tag{31}$$

Using the definition of ω_{t+2} - see (23) - and the assumption of a time-invariant productivity share $\left(\frac{n^j_t}{n_t}=\frac{n^j_{t+1}}{n_{t+1}}\ \forall j,t\right)$ (31) becomes

$$\left(-a^y_{j,t}-\frac{1}{1+r}a^m_{j,t+1}\right)+\left(1-\frac{\tau_t}{1-\tau_w-\tau_t}\epsilon\right)\left[\left(\frac{(1+\eta)(1+g)}{1+r}\right)^2\overline{a}^y_t+\frac{(1+\eta)(1+g)}{(1+r)^2}\overline{a}^m_{t+1}\right], \tag{32}$$

where $\overline{a}_t^y$ ($\overline{a}_{t+1}^m$) denotes the weighted (by productivity shares) average productivity of the young (middle-aged) workers in period t (t+1). With dynamic efficiency ($1+r > (1+\eta)(1+g)$) the preferred contribution rate is weakly decreasing in the voter's productivity type for any $\epsilon \geqslant 0$.

Similarly, evaluating (26) at $\theta = 0$ gives

$$-a_{j,t}^m + \frac{1}{n_{t-1}(1+r)} \left(1 - \frac{\tau_t}{1-\tau_w-\tau_t}\epsilon\right) \omega_{t+1}. \tag{33}$$

Using the definition of ω_{t+1} - see (25) - and the assumption of a time-invariant productivity share $\left(\frac{n_t^j}{n_t} = \frac{n_{t+1}^j}{n_{t+1}}\ \forall j,t\right)$ (33) becomes

$$-a_{j,t}^m + \left(1 - \frac{\tau_t}{1-\tau_w-\tau_t}\epsilon\right) \left(\frac{(1+\eta)^2(1+g)^2}{1+r}\overline{a}_{t-1}^y + \frac{(1+\eta)(1+g)}{1+r}\overline{a}_t^m\right). \tag{34}$$

Again,with dynamic efficiency $(1+r > (1+\eta)(1+g))$ the preferred contribution rate is weakly decreasing in the voter's productivity type for any $\epsilon \geqslant 0$. Comparing (32) and (34) reveals that for each productivity type the preferred contribution rate is weakly increasing in age due to the first-period contribution being sunk as middle-aged.

The old prefer a contribution rate which satisfies

$$\left(1 - \frac{\tau_t}{1-\tau_w-\tau_t}\epsilon\right)\omega_t = 0. \tag{35}$$

which is strictly larger than the contribution rate preferred by any young and middle-aged voter.

(ii): Given by (31), (33), and (35), each voter's preferred contribution rate is weakly decreasing in ϵ and τ_w. Furthermore, the middle-aged voters' preferred contribution rate is weakly increasing in $\overline{a}_{t-1}^y / a_{j,t}^m$ (divide (34) by $a_{j,t}^m$).

Proof of Proposition 3 (i) Making use of the definition of ω_{t+2} (23) and the assumption of a time-invariant productivity share $\left(\frac{n_t^j}{n_t} = \frac{n_{t+1}^j}{n_{t+1}}\forall j,t\right)$ (24) is

$$\begin{aligned}&\left(-a_{j,t}^y - \frac{1}{1+r}a_{j,t+1}^m\right)\left(1 - \frac{\theta\chi}{1+r}\right)\\&+(1-\theta)\left(1 - \tau_t\frac{1-\frac{\theta\chi}{1+r}}{1-\tau_w-\tau_t}\epsilon\right)\left[\left(\frac{(1+\eta)(1+g)}{1+r}\right)^2\overline{a}_t^y + \frac{(1+\eta)(1+g)}{(1+r)^2}\overline{a}_{t+1}^m\right].\end{aligned} \tag{36}$$

Similarly, using (25) and the assumption of a time-invariant productivity share $\left(\frac{n_t^j}{n_t} = \frac{n_{t+1}^j}{n_{t+1}} \forall j, t\right)$ (26) becomes

$$-a_{j,t}^m \left(1 - \frac{\theta\chi}{1+r}\right) + \theta\chi a_{j,t-1}^y \left(1 - \tau_t \frac{1 - \frac{\theta\chi}{1+r}}{1 - \tau_w - \tau_t}\epsilon\right)$$
$$+ (1-\theta)\left(1 - \tau_t \frac{1 - \frac{\theta\chi}{1+r}}{1 - \tau_w - \tau_t}\epsilon\right)\left(\frac{(1+\eta)^2(1+g)^2}{1+r}\overline{a}_{t-1}^y + \frac{(1+\eta)(1+g)}{1+r}\overline{a}_t^m\right). \quad (37)$$

A young or middle-aged voter is more likely to prefer a positive contribution rate the lower the voter's own productivity relative to the average productivity (i.e. $a_{j,t}^y \ll \overline{a}_t^y$ and $a_{j,t+1}^m \ll \overline{a}_{t+1}^m$). For each productivity type, a voter when middle-aged prefers a weakly higher contribution rate than when being young which reflects the sunk cost character of the first period contribution.

Note, for young and middle-aged voters the preferred contribution rate is weakly decreasing in ϵ and τ_t.

(*ii*) Let $\tau_{j,t}^y$ denote the tax rate preferred by a young, j-type voter in period t (analogously, $\tau_{j,t}^m$ denotes the contribution rate preferred by a middle-aged, j-type voter in period t). Provided $\tau_{j,t}^y > 0$, differentiating (36), which is set equal to 0, w.r.t. $\tau_{j,t}^y$ and θ gives

$$\frac{d\tau_{j,t}^y}{d\theta} = -\frac{\begin{array}{c}\left(a_{j,t}^y + \frac{1}{1+r}a_{j,t+1}^m\right)\frac{\chi}{1+r} - \left[1 - (1-2\theta)\frac{\chi}{1+r}\right]\frac{\tau_t}{1-\tau_w-\tau_t}\epsilon \\ \left[\left(\frac{(1+\eta)(1+g)}{1+r}\right)^2 \overline{a}_t^y + \frac{(1+\eta)(1+g)}{(1+r)^2}\overline{a}_{t+1}^m\right]\end{array}}{D_y}. \quad (38)$$

D_y is the second derivative of the young voter's objective function w.r.t. the contribution rate which is negative at an interior optimum. Analogously, provided $\tau_{j,t}^m > 0$, differentiating (37), which is set equal to 0, w.r.t. $\tau_{j,t}^m$ and θ gives

$$\frac{d\tau_{j,t}^m}{d\theta} = -\frac{\begin{array}{c}\left(a_{j,t-1}^y + \frac{1}{1+r}a_{j,t}^m \frac{\tau_t}{(1-\tau_w-\tau_t)^2}\epsilon\left(1 - \frac{\theta\chi}{1+r}\right)\right)\chi + \theta\chi a_{j,t-1}^y \frac{\chi}{1+r}\frac{\tau_t}{1-\tau_w-\tau_t}\epsilon \\ -\left[1 - (1-2\theta)\frac{\chi}{1+r}\right]\frac{\tau_t}{1-\tau_w-\tau_t}\epsilon\left(\frac{(1+\eta)^2(1+g)^2}{1+r}\overline{a}_{t-1}^y + \frac{(1+\eta)(1+g)}{1+r}\overline{a}_t^m\right)\end{array}}{D_m}, \quad (39)$$

D_m is the second derivative of the middle-aged voter's objective function w.r.t. the contribution rate which is negative at an interior optimum.

A priori the responses can be positive or negative, as well as fluctuating in sign over $\theta \in (0,1)$.

Lastly, given by (27) the contribution rate most preferred by the old is strictly increasing in θ.

8 Appendix 3

This appendix shows how the results that we derived when voting with commitment can be generalized to voting without commitment.

Agents vote according to a stationary subgame perfect strategy profile. A strategy for an individual is a mapping from the history of the voting outcomes to the wage tax rate τ_t that the individual votes for, and is subject to $\tau_t \in [0, 1]$. Let s_t^k be the voting strategy profile over τ_t of all individuals belonging to generation k in period t. Here k can be either y (young), m (middle-aged) or o (old). Denote the first period when the game is played and when the equilibrium strategy may be established by 0. The history of the game at period t, h_t, reports τ_t chosen in all previous periods starting from $t = 0$: $h_t = \{\tau_0, \tau_1, ..., \tau_{t-2}, \tau_{t-1}\}$ when $t > 0$. The set of all possible past outcomes at time t is denoted by H_t. Define

Definition 1 *A voting strategy profile* $s = \{(s_t^y \cup s_t^m \cup s_t^o)\}_{t=0}^{\infty}$ *is a stationary subgame perfect equilibrium, if the following conditions are satisfied:*

(i) s *is a subgame perfect equilibrium.*

(ii) At every period t*, the equilibrium outcome associated with* s *is an equilibrium of the static game with commitment.*

(iii) In any period and for any history, $h_t \in H_t$*, the sequence of equilibrium outcomes induced by* s *is constant.*

Cooley and Soares (1999) assume a trigger strategy, specifying that the voting outcome converges to a complete abolition of the social security system in the case of the result in one period differing from the subgame perfect equilibrium with a once-and-for-all voting. In their example, voters make a binary choice on whether to maintain social security. In our framework with continuous choice, a threat strategy specifying that any deviation is punished by abolition of social security would not always maintain the subgame perfect equilibrium, resulting from voting with commitment, when there is instead repeated voting. The reason for this is that the high-productivity young citizens might find it optimal to deviate. When voting with commitment, they would prefer a lower social security contribution rate than the median voter. By voting for a higher social security contribution rate than the median voter, they would change the identity of the median voter. In this way, they would cause an upward deviation, triggering an elimination of social security. If the continuation value of social security would be negative for them also in the second period, then such a deviation would be optimal for them. In a similar way, a problem of deliberate deviations in the first period of life to undermine the equilibrium do not arise in Kotlikoff et al. (1988) and Boldrin and Rustichini (2000) as they model only two overlapping generations.

Poutvaara (2004) specifies a trigger strategy which allows the outcome of voting with commitment to be maintained also with repeated voting with three overlapping generations, intragenerational heterogeneity, and voting on two issues. The following definition and proof are simplifications to voting with one issue. Define

Definition 2 *In the implicit intergenerational contract voting strategy (IICVS) related to an equilibrium* $\widehat{\tau}$*, a citizen* i*, who prefers* τ_t^i *when voting with commitment, votes for this social security contribution rate in period* $t = 0$*, as well as in period* $t > 0$*, provided that the history for the previous periods satisfies* $\tau_j \geq \widehat{\tau}$ $\forall j \in \{0, 1, ..., t-1\}$*. If these conditions are not satisfied, the citizen votes for the* τ_t *he or she preferred in period* t*, assuming that the (other) young and middle-aged citizens no longer vote for a positive social security contribution rate due to the collapse of the implicit intergenerational contract. The individual-specific superscript* i *captures both age and productivity.*

IICVS states that any other deviation from the intergenerational contract except for a deviation to a higher social security contribution rate leads to the break-down of the intergenerational contract. If voting in some period would produce a higher social security contribution rate than in the equilibrium, then the IICVS specifies that this does not violate the contract. Neither does it give a reason for changing the τ specified by the contract. Intuitively, working generations are not punished by an abolition of future social security benefits if their voting would lead them to pay higher social security benefits than specified by the contract. This strategy supports the equilibrium with once-and-for-all voting also with repeated voting:

Proposition 4 *Any equilibrium which would exist when voting with commitment can be maintained also in repeated voting as a subgame perfect equilibrium.*

Proof of Proposition 4.

Assume that $\widehat{\tau}$ is an equilibrium with voting with commitment. It is sufficient to prove that with IICVS, the citizens either do not want to deviate or if they would like to deviate, then their deviation does not change the outcome of the voting in a way that would result in the collapse of the intergenerational contract. The elderly have clearly no interest in deviating from voting for the τ which would maximize their current social security benefits. Neither do the middle-aged have any incentive to deviate from the τ they would prefer with commitment. A deviation downward in the social security contribution rate would only result in them losing their social security benefits in the following period. The young who benefit from social security, on the other hand, already vote for the τ that would maximize their lifetime utility, so they have no incentive to deviate. The young citizens who would prefer a lower social security contribution rate than arising as political equilibrium are already voting for a lower social security contribution rate than the median voter, so that any deviation downward by them would not affect the outcome of the voting. The only way in which the young who prefer a lower social security contribution rate than that preferred by the median voter can change the outcome of voting is by voting for a higher rate. By the definition of IICVS, a deviation upward would not cause the abolition of social security. Therefore, the young who would like to have a lower social security contribution rate cannot gain anything by deviating from voting for their preferred rate with voting with commitment. The threat point of the voting equilibrium (0) following a punishable deviation is also a subgame perfect Nash-equilibrium. If the young and the middle-aged expect that social security benefits will not be maintained in future, they have no interest in maintaining them after a deviation. The old would still vote for $\tau > 0$, but they are in minority.

References

[1] Boadway, R.W. and D. E. Wildasin (1989), "A Median Voter Model of Social Security", *International Economic Review,* 30, 307-328.

[2] Boldrin, M. and A. Rustichini (2000), "Political Equilibria with Social Security", *Review of Economic Dynamics,* 3, 41-78.

[3] Browning, E. (1975), "Why the Social Insurance Budget is too Large in a Democratic Society", *Economic Inquiry,* 13, 373-88.

[4] Casamatta, G., H. Cremer, and P. Pestieau (2000a), "The Political Economy of Social Security", *Scandinavian Journal of Economics,* 102, 503-522.

[5] Casamatta, G., H. Cremer, and P. Pestieau (2000b), "Political Sustainability and the Design of Social Insurance", *Journal of Public Economics*, 75, 341-364.

[6] Casamatta, G., H. Cremer, and P. Pestieau (2001), "Demographic Shock and Social Security: A Political Economy Perspective", *International Tax and Public Finance,* 8, 417-429.

[7] Conde Ruiz, I. and P. Profeta (2004), "The Redistributive Design of Social Security Systems", Working Paper, Universitat Pompeu Fabra, FEDEA and The Pension Institute.

[8] Cooley, T.F. and J. Soares (1999), "A Positive Theory of Social Security Based on Reputation", *Journal of Political Economy*, 107, 135-160.

[9] Cremer, H. and P. Pestieau (2000), "Reforming Our Pension System: Is it a Demographic, Financial or Political Problem?", *European Economic Review*, 44, 974-983.

[10] Cremer, H. and P. Pestieau (2003), "The Double Dividend of Postponing Retirement", *International Tax and Public Finance*, 10, 419-434.

[11] Diamond, P.A. (1998), "Optimal Income Taxation: An Example with a U-Shaped Pattern of Optimal Marginal Tax Rates", *American Economic Review*, 88, 83-95.

[12] Disney, R. (2004), "Are Contributions to Public Pension Programmes a Tax on Employment", *Economic Policy*, 39, 267-311.

[13] EPC (2001), Report of the Economic Policy Committee, "Budgetary Challenges posed by Ageing Populations", 655/01, Brussels.

[14] European Commission Household Panel. Wave 1997.

[15] EUROSTAT, Statistics.http:/europa.eu.int/comm/eurostat/newcronos.

[16] Fenge, R., A. Gebauer, C. Holzner, V. Meier and M. Werding (2003), "Old-Age Provision Around the World: Revenues, Benefits, and Taxation" (in German), *ifo-Beiträge zur Wirtschaftsforschung*, No. 10, Munich.

[17] Fenge, R. and M. Werding (2003), "Ageing and the Tax Implied in Public Pension Schemes: Simulations for Selected OECD Countries", CESifo Working Paper No. 841, Munich.

[18] Galasso, V. (2002), "The US Social Security: A Financial Appraisal for the Median Voter", *Social Security Bulletin*, 64, n.2.

[19] Galasso, V. and P. Profeta (2002), "The Political Economy of Social Security: A Survey", *European Journal of Political Economy*, 18, 1-29.

[20] Galasso, V. and P. Profeta (2004), "Lessons for an Aging Society: The Political Sustainability of Social Security Systems", *Economic Policy*, 38, 63-115.

[21] Immervoll, H., H. Kleven, C.T. Kreiner, and E. Saez (2004), "Welfare Reforms in European Countries: A Microsimulation Analysis", CEPR Discussion Paper No. 4324, London.

[22] Jensen, S.E.H., M.I. Lau, and P. Poutvaara (2004), "Efficiency and Equity Aspects of Alternative Social Security Rules", *FinanzArchiv,* 60, 325-358.

[23] Kotlikoff, L., T. Persson, and L. Svensson (1988), "Social Contracts as Assets: A Possible Solution to the Time-Consistency Problem", *American Economic Review*, 78, 662-677.

[24] Mulligan, C. and X. Sala-i-Martin (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

[25] Nicoletti, C. and F. Peracchi (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. Peracchi (eds), *Pensions: More informations, Less ideology.* Kluwer, Dordrecht.

[26] OECD (2000), Taxing Wages.

[27] OECD (2003), OECD in Figures. Available online at http://www1.oecd.org/publications/e-book/0103061E.PDF

[28] Pencavel, J.H. (1986), "Labor Supply of Men: A Survey", in O. Ashenfelter and R. Layard (eds): *Handbook of Labor Economics*, Vol.1, Amsterdam, North Holland.

[29] Peracchi, F. (2002), "The European Community Household Panel: A Review", *Empirical Economics*, 27, 63-90.

[30] Poutvaara, P. (2004), "On the Political Economy of Social Security and Public Education", IZA DP 1408.

[31] Saez, E. (2002), "Optimal Income Transfer Programs: Intensive versus Extensive Labor Supply Responses", *Quarterly Journal of Economics*, 117, 1039-1073.

[32] Sinn, H.-W. and S. Uebelmesser (2002), "Pensions and the Path to Gerontocracy in Germany", *European Journal of Political Economy*, 19, 153-158.

[33] Tabellini, G. (2000), "A Positive Theory of Social Security", *Scandinavian Journal of Economics*, 102, 523-545.

[34] United Nations World Population Prospects 2002.

[35] US Social Security Administration (2003), Social Security Throughout the World, at: www.ssa.gov/policy/docs/progdesc/ssptw.

Table 1: Data on productivity and population growth rates

	Scenario 1		Scenario 2	
Country	η (%)	g (%)	η %)	g (%)
Austria	1.30	2.10	-0.79	1.80
France	1.39	2.00	0.07	1.80
Germany	1.76	1.60	0.00	1.80
Greece	0.52	3.00	-0.53	3.00
Italy	1.62	1.80	-0.56	1.80
Portugal	0.78	2.50	-0.59	3.00
Spain	0.91	3.00	0.15	1.80
UK	2.04	1.80	0.60	1.60

Source: η: *author's calculations from European Commission Household Panel (scenario 1) and from United Nations (scenario 2).* g: *from EUROSTAT.*

Table 2. Data on productivity levels

	Very low income	**Low income**	**Middle 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	1.509	0.945	1.573
Middle-aged	0.485	0.839	1.145	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

Table 3: Other data

Country	θ	τ_w
Austria	0.52	0.098
France	0.65	0.134
Germany	0.55	0.215
Greece	0.73	0.022
Italy	0.55	0.193
Portugal	0.80	0.067
Spain	0.70	0.121
United Kingdom	0.26	0.158

Source: θ taken from Conde Ruiz and Profeta (2004). τ_w: OECD Taxing Wages 2000 (tax rate on income without social security, average, for single, no child, earning 100% of average wage).

Table 4: Effective contribution rate

Country	*effective contribution rate* τ_{eff}
Austria	34.8
France	27.7
Germany	22.4
Greece	57.7
Italy	40.0
Portugal	35.4
Spain	45.0
UK	23.7
Corr (θ, τ_{eff})	0.57

Source: Disney (2004)

Table 5: Results. Scenario 1

Scenario 1								
		r = 0.045			r = 0.035			
		ε=0.3	ε=0.5	ε=1	ε=0.3	ε=0.5	ε=1	
Country	θ	τ	τ	τ	τ	τ	τ	**median voter**
Austria	0.52	0.42	0.32	0.2	0.56	0.46	0.32	middle-aged, high-income
France	0.65	0.54	0.45	0.32	0.65	0.58	0.45	middle-aged, high-income
Germany	0.55	0.43	0.35	0.23	0.54	0.46	0.34	middle-aged, very high-income
Greece	0.73	0.51	0.43	0.4	0.76	0.69	0.58	middle-aged, high-income
Italy	0.55	0.43	0.35	0.23	0.55	0.47	0.35	middle-aged, very high-income
Portugal	0.8	0.56	0.52	0.38	0.73	0.69	0.59	middle-aged, high-income
Spain	0.7	0.61	0.53	0.4	0.75	0.71	0.62	middle-aged, high-income
UK	0.26	0.32	0.3	0.2	0.48	0.4	0.3	middle-aged, high-income
corr(θ **,** τ **)**		0.907	0.851	0.844	0.897	0.888	0.847	
corr(τ **,** τ_{eff} **)**		0.488	0.427	0.657	0.721	0.676	0.662	

Table 6: Results. Scenario 2

Scenario 2								
		$r = 0.04$			$r = 0.035$			
		$\varepsilon = 0.4$	$\varepsilon = 0.5$	$\varepsilon = 1$	$\varepsilon = 0.3$	$\varepsilon = 0.5$	$\varepsilon = 1$	
Country	θ	τ	τ	τ	τ	τ	τ	**median voter**
Austria	0.52	0.44	0.36	0.27	0.49	0.39	0.26	middle-aged, middle-income
France	0.65	0.39	0.35	0.23	0.51	0.41	0.28	middle-aged, middle-income
Germany	0.55	0.31	0.27	0.17	0.42	0.33	0.22	middle-aged, middle-income
Greece	0.73	0.55	0.5	0.36	0.68	0.59	0.44	middle-aged, middle-income
Italy	0.55	0.24	0.21	0.12	0.38	0.29	0.19	middle-aged, middle-income
Portugal	0.8	0.59	0.55	0.41	0.71	0.6	0.5	middle-aged, middle-income
Spain	0.7	0.53	0.44	0.3	0.56	0.47	0.34	middle-aged, middle-income
UK	0.26	0.35	0.32	0.2	0.46	0.36	0.23	middle-aged, poor
corr (θ, τ)		0.667	0.667	0.670	0.705	0.718	0.753	
corr (τ, τ_{eff})		0.543	0.512	0.507	0.553	0.590	0.547	

Table 7: Sensitivity analysis (1)

		Sensitivity analysis (1)					
		r = 0.045			r = 0.035		
		ε = 0.3	ε = 0.5	ε = 1	ε = 0.3	ε = 0.5	ε = 1
Country	τ_{eff}	τ	τ	τ	τ	τ	τ
Austria	0.348	0.49	0.397	0.265	0.606	0.516	0,379
France	0.277	0.48	0.382	0.255	0.582	0.495	0.364
Germany	0.224	0.41	0.304	0.196	0.506	0.425	0.306
Greece	0.577	0.51	0.404	0.265	0.646	0.548	0.399
Italy	0.4	0.41	0.32	0.207	0.52	0.44	0.319
Portugal	0.354	0.49	0.395	0.261	0.615	0.52	0.378
Spain	0.45	0.51	0.412	0.28	0.62	0.538	0.406
UK	0.237	0.5	0.405	0.278	0.6	0.52	0.396
corr(τ , τ_{eff})		0.387	0.363	0.286	0.554	0.521	0.434

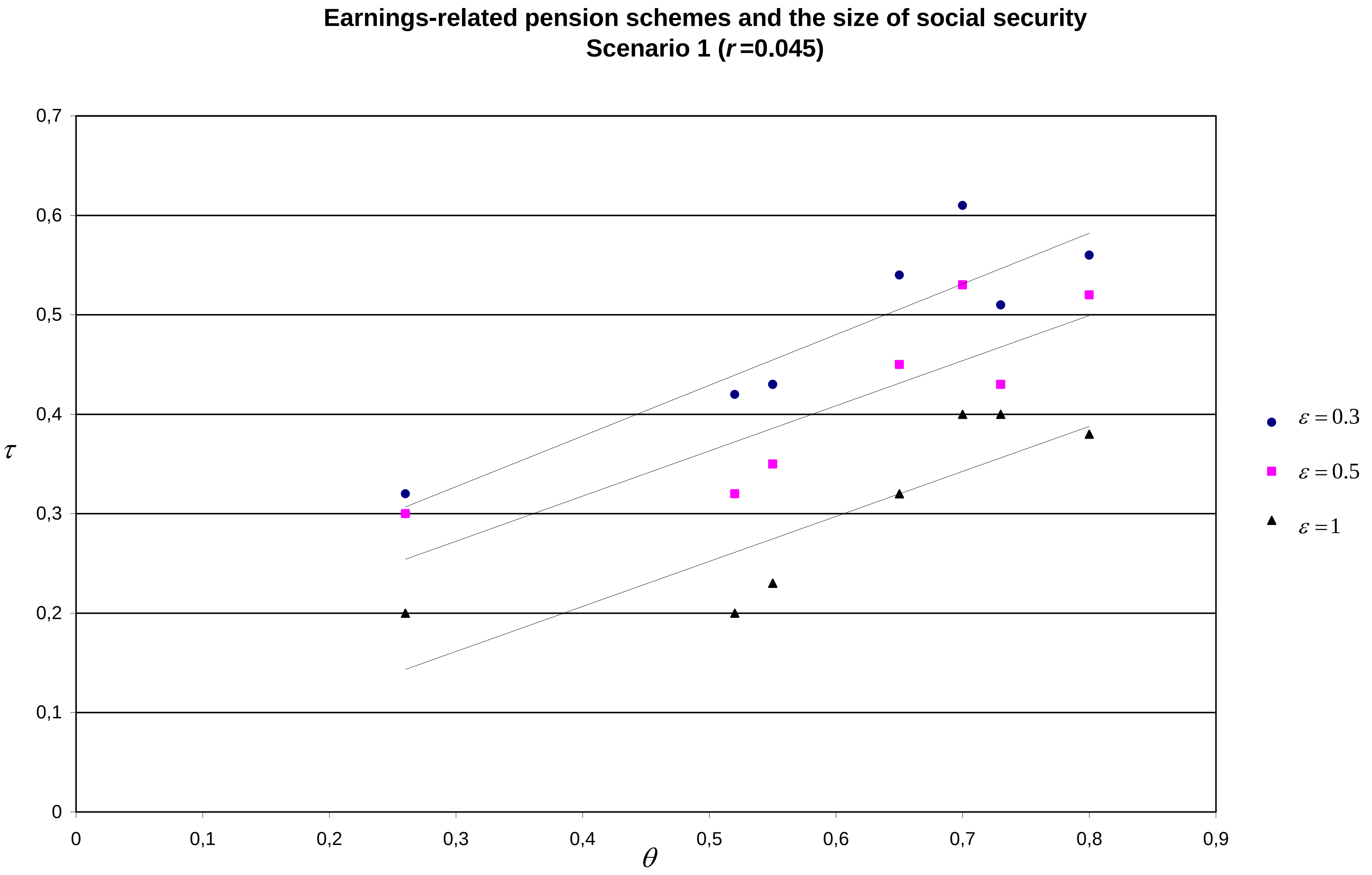
θ =0.5 for all countries. g and η from scenario 1. productivity levels from table 2. τ_w from table 3. τ_{eff} from table 4.

Table 8: Sensitivity analysis (2)

		Sensitivity analysis (2)					
		r = 0.045			r = 0.035		
		ε = 0.3	ε = 0.5	ε = 1	ε = 0.3	ε = 0.5	ε = 1
Country	τ_{eff}	τ	τ	τ	τ	τ	τ
Austria	0.348	0.524	0.429	0.297	0.618	0.536	0.406
France	0.277	0.567	0.478	0.345	0.675	0.605	0.484
Germany	0.224	0.534	0.44	0.307	0.63	0.55	0.421
Greece	0.577	0.595	0.51	0.378	0.715	0.656	0.547
Italy	0.4	0.534	0.44	0.307	0.63	0.55	0.421
Portugal	0.354	0.622	0.54	0.412	0.755	0.707	0.615
Spain	0.45	0.585	0.498	0.366	0.699	0.636	0.522
UK	0.237	0.47	0.342	0.24	0.569	0.474	0.33
corr (θ , τ)		0.987	0.998	0.98	0.961	0.9607	0.957
corr(τ , τ_{eff})		0.574	0.574	0.569	0.564	0.565	0.557

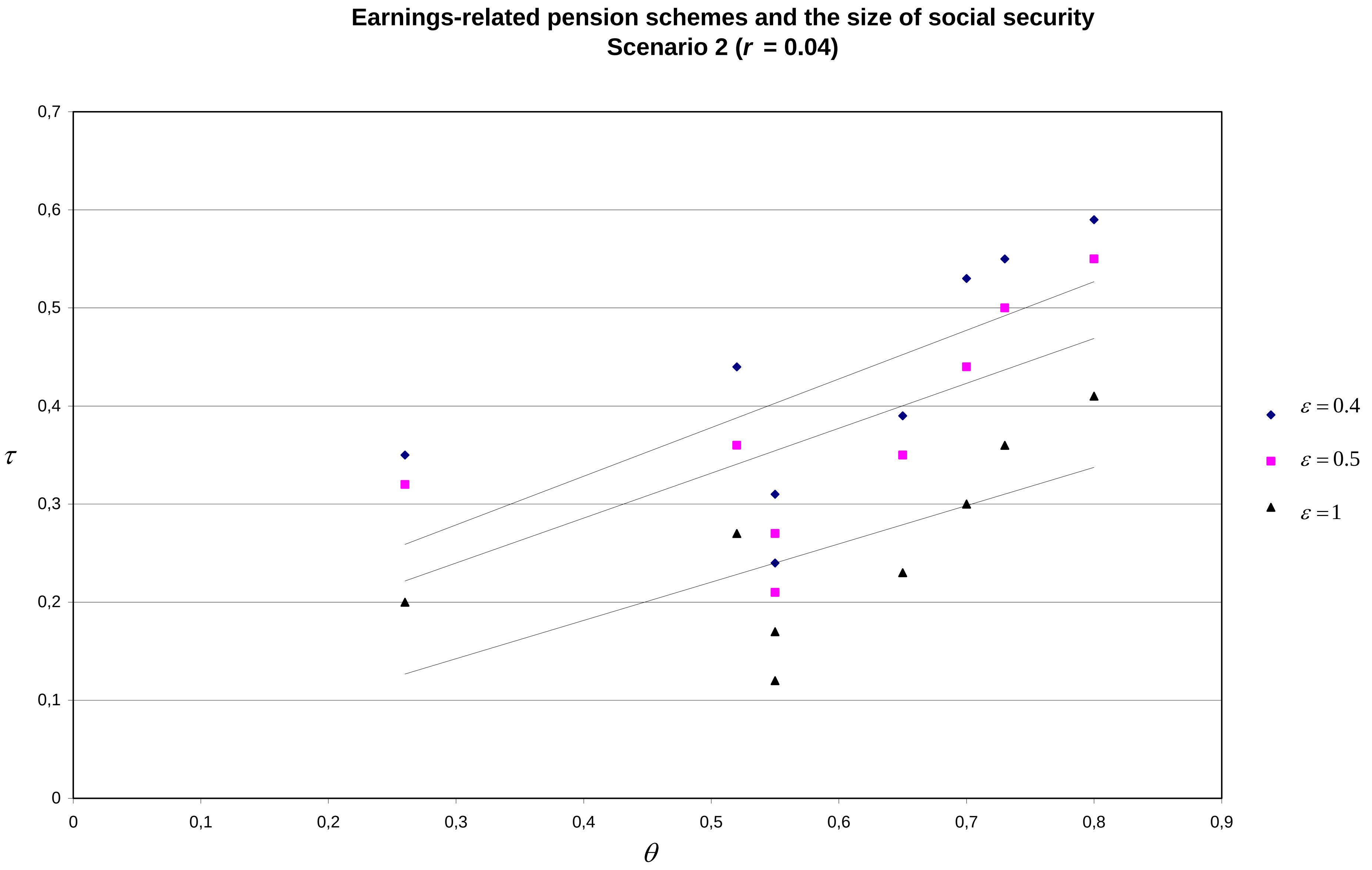
θ from table 3. η, g, τ_w, and the productivity levels are set for all countries equal to the the average of the country levels. τ_{eff} from table 4.

Figure 1



Earnings-related pension schemes and the size of social security
Scenario 1 (r =0.045)
0,7
0,6
0,5
0,4
0,3
0,2
0,1
0
τ
0
0,1
0,2
0,3
0,4
0,5
0,6
0,7
0,8
0,9
θ
ε = 0.3
ε = 0.5
ε = 1

Figure 2



Earnings-related pension schemes and the size of social security
Scenario 2 (r = 0.04)
0,7
0,6
0,5
0,4
0,3
0,2
0,1
0
τ
0
0,1
0,2
0,3
0,4
0,5
0,6
0,7
0,8
0,9
θ
ε = 0.4
ε = 0.5
ε = 1

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