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Political (In)Stability of Social Security Reform

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Abstract
We analyze the political stability social security reforms which introduce a funded pillar (a.k.a. privatizations). We consider an economy populated by overlapping generations, which introduces a funded pillar. This reform is efficient in Kaldor-Hicks sense and has political support. Subsequently, agents vote on abolishing the funded system and replacing it with the pay-as-you-go scheme, i.e. "unprivatizing" the pension system. We show that even if abolishing the system reduces welfare in the long run, the distribution of benefits across cohorts along the transition path implies that "unprivatizing" social security is always politically favored. This suggests that property rights definition over retirement savings may be of crucial importance for determining the stability of retirement systems with a funded pillar.

Keywords:
majority voting, pension system reform, welfare

JEL Classification
H55, D72, C68, E17, E27

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1 Introduction and motivation

A large number of countries has undertaken a reform from defined benefit pay-as-you-go (PAYG DB) pension systems to partially funded defined contribution systems (FDC) between mid 1990s and early 2000s (see Holzman and Stiglitz 2001, Bonoli and Shinkawa 2006, Gruber and Wise 2009). The reforms shared two key features. First, with no exceptions, the reforming countries honored all the pension obligations during a transition period for cohorts retired and close to the retirement who are unable to adjust to the FDC rules. Second, these systems typically consisted of two pillars: a mandatory PAYG DC pillar as well as a mandatory funded DC pillar.[1] These reforms were likely to deliver long-run welfare gains, even accounting for the transition costs, i.e. in a Kaldor-Hicks sense provided overall welfare improvement (see Nishiyama and Smetters 2007, on method of welfare accounting). Available study for Poland shows that these welfare gains are actually sizable, app. 3% of lifetime consumption (Makarski et al. 2016). Yet, a decade or so after introducing these reforms, a vast majority of these countries has reverted the reform, see (see Schwarz 2011). As surveyed by Jarrett (2011) as well as Schwarz et al. (2014), all of the Central and Eastern European countries have shifted the contributions to the mandatory pay-as-you-go pillar at the expense of the mandatory funded pillar. In addition, some of these countries – notably Hungary and to a smaller extent Bulgaria, Poland and Slovakia – have effectively nationalized the stock of savings accumulated in the funded pillars, further increasing the importance of the pay-as-you-go pillar.[2]

One should expect a reduction in capital accumulation as well as reduction in future benefits due to lower indexation in the state-run PAYG pillars when compared to the rate of return in funded pillars. In fact, Jarrett (2011) argues that the reduction in future pension benefits amounts to about 10% for Slovakia and as much as 21-22% for Hungary and Poland while leaving the contribution rates unchanged. Similar figures for Poland are suggested by Hagemejer et al. (2015). The main appeal of the "unprivatizations" is that they permit reducing current obligations of the state budget to the pension system. However, the effect is transitory and concentrated among few cohorts, thus it does not deliver a Hicksian welfare improvement and is detrimental to welfare of future cohorts (see Hagemejer et al. 2015, for an analysis for Poland). Yet – unlike the increase of the minimum eligibility retirement age introduced in roughly the same time – dismantling the funded pillars met nearly no social opposition. How come a policy, capturing private property by the state can occur in democracies with no social unrest? Given the noticeable number of such cases, in this paper we seek to offer an explanation of the phenomenon.

Majority of the literature on privatizing social security emphasizes (Hicksian) welfare

[1] In addition, voluntary funded pillars were equipped with tax incentives to encourage private old-age savings in the face of decreasing replacement rates in the obligatory pension system.

[2] Not a single country among the reformers considered abandoning the defined contribution feature of their pension systems.

improvement. It is achieved since gains of winners are larger than losses of losers over the long run.[3] Privatizing social security is unlikely to deliver immediate gains, because of the gap and its financing: it typically involves cohorts with a welfare loss to be followed by a continuum of cohorts with a welfare gain. Given this time structure, for a privatization to be politically viable it has to meet some additional criteria. The literature has developed a large number of studies and approaches in political economy tradition, starting from Browning (1975), with founding contributions of Cooley and Soares (1996), Cooley and Soares (1999).[4] This literature typically considers voting over the reform and shows how such policies gain contemporaneous political support. Political viability necessitates either between or within cohort redistribution. For example, Browning (1975) shows that any social security system is too large if working cohorts are more numerous than retired cohorts. In the overlapping generations setting, Cooley and Soares (1999) show that relatively large social security can emerge as an outcome of political equilibrium, a voting coalition between low-productivity youth and the old, who all benefit from the inherent redistribution. Casamatta et al. (2001) also show that the funding of the social security system would survive shocks to the demographic structure, such as the baby boom. Conesa and Garriga (2008) compare a variety of options for introducing a funded pillar implicitly with full political support.[5]

While there is substantial literature on political economy of *introducing* the funded social security, there appears to be no consideration so far on whether funded pillars, once introduced, are politically stable. One of the intuitions worth testing concerns the role of gains and benefits distribution across cohorts in determining the political stability: "privatization" usually entails immediate transition costs, while benefits appear gradually. Therefore, two effects are at play. On the one hand, as time passes, the losing generations (alive at the date of reform) pass away and new gaining generations are born, which gradually shifts the political support in favor of privatization among the contemporaneously living cohorts. This is the standard conclusion from the OLG literature. On the other hand, the stock of savings accumulated in the funded pillar is likely to affect the welfare effects of "unprivatizing". In contrast to the privatization, which implies immediate costs and delayed gains, "unprivatizing" implies immediate gains and delayed

[3]The general conclusion of welfare gains survives a number of sensitivity checks. Long-run gains are somewhat lower but still positive when taking into account idiosyncratic income uncertainty. For example Conesa and Krueger (1999), Nishiyama and Smetters (2007), Fehr (2009) demonstrate that it lowers the gains from privatization since the loss of insurance against bad income shocks lowers welfare. The generations alive during the transition periods lose since they have to both save for their pensions and pay higher taxes in order to finance pensions of agents who are old during reform, see for example Huang et al. (1997), which makes the reform politically challenging. Makarski et al. (2016) argues that public debt allows to smooth out the cost of transition among both current and future cohorts, reducing the welfare loss for the living generations.

[4]See overviews by Galasso and Profeta (2002), Mulligan and Sala-i Martin (2004) and de Walque (2005).

[5]Admittedly, most of the literature analyses the case of defined benefit systems, whereas under consideration in our study are defined contribution systems, but as we show in the reminder of this paper, this distinction is not crucial for the political economy mechanisms.

costs. The evidence from large number of countries over the past several years suggests that this distribution of gains may feed into an inherent political instability mechanism. We address this phenomenon. While majority of the literature on privatizations asks if a reform can gain sufficient political support to get implemented, we ask if it will sustain subsequently.

We construct a model of economy populated with overlapping generations. In the original steady state this economy has a defined benefit pay-as-you-go system, i.e. pensions are a fixed proportion of pre-retirement earnings. This economy introduces a reform to a two-pillar defined contribution system, keeping the contribution rates unchanged and honoring the obligations towards the older generations. The partial privatization of the social security improves welfare in Kaldor-Hicks sense and has political support in pure majority voting. Does privatization eventually become politically stable because gaining cohorts gain majority, as suggested by the intuition from the OLG literature? To test that we allow subsequent voting on abolishing the funded pillar. The living cohorts – even if they benefit from having the funded pillar in the future – may still prefer to capture the collected contributions in exchange for a contemporaneous gain from lower taxes. For such choice to be optimal, current gain must be higher than the loss due to the decrease of the future pension benefits of the living cohorts – not all cohorts. We run simulations in which we allow agents to vote at different dates (once in each simulation) on reverting the original privatization. Unexpectedly, agents get the opportunity to revert some of the reform features at given periods, an approach similar to Phelan (2006).

We contribute to the literature by exploiting a new aspect of the pension system reform and political economy: we analyze whether the pension system reforms are politically stable – rather than just feasible. We show that in fact, privatization of the pension system is not warranted even if it has political support at the moment of the reform. The policy relevance of our study is immediate. Since the privatization of the pension system implies an unequal distribution of costs and benefits of the reform across cohorts it is crucial for such a reform to be politically stable. Otherwise it may be the case that before societies start enjoying the benefits of the privatization itself, the reform is reversed implying a massive inefficiency: costs without gains. As evidenced by the recent wave of changes to the pension systems, such risks are not theoretical, but have already materialized in a number of countries. This implies that if privatization of the pension systems is eventually be reversed, it makes the initial reform futile.

Our main findings are that in general privatization of the social security does not become politically stable as time passes. A majority of living cohorts wants the government to appropriate the accumulated stock of private savings in exchange for lower taxes. Majoritarian vote to "unprivatize" social security is detrimental to welfare in the long run. The main reason underlying their support for such a vote is the fact "unprivatizing" social security benefits living cohorts immediately, while it harms few young and

yet unborn cohorts (the aggregate welfare effect in Hicksian sense is so small that it may depend on very specific assumptions concerning e.g. speed of tax adjustment etc.).

The reminder of our paper is structured as follows. In section 2, we outline our overlapping generations model including the political economy component. In the next section, we describe calibration and analyzed policy options. Then, in section 5, we discuss results. Section 6 concludes the paper.

2 Theoretical model

We use the overlapping generations model in the spirit of Auerbach and Kotlikoff (1987) of the small open economy with exogenous productivity growth.[6] We assume that the defined contribution pension system with a pay-as-you-go and funded pillars is introduced unexpectedly in period 2. Period 1 – the first steady state – is used to calibrate the model to the case of the Polish economy prior to the any pension system reform, i.e. a defined benefit pay-as-you-go system.

2.1 International capital markets

Households have access to international capital markets in which they can borrow or lend at the interest rate r_t. As proposed by Schmitt-Grohe and Uribe (2003), the lend/borrow rate r_t equals the the international interest rate r_t^*adjusted for the risk premium[7] according to

$$r_t = r_t^* + \xi \frac{B_t}{Y_t}$$

where B_t is the level of foreign debt in the economy, Y_t denotes GDP and ξ is a constant. Following this standard formula, the ratio of foreign debt to GDP increases the interest rate at which domestic agents can borrow at international markets.

2.2 Firms

We assume a perfectly competitive production sector that uses labor L_t and capital K_t to produce output Y_t with the Cobb-Douglas technology:

$$Y_t = K_t^{\alpha}(z_t L_t)^{1-\alpha}, \tag{1}$$

where z_t captures exogenous labor augmenting technological progress. Hence, profit is maximized when return on capital $r_t - d$ (d denotes the depreciation rate of capital) is

[6] See Belan et al. (1998), Futagami and Nakajima (2001), Shakuno (2014) for a discussion on why the exogeneity of technological progress is not relevant in the context of the pension system reform analyses.

[7] We introduce this mechanism in order to accomodate the productivity decline on the transition path. With the domestic interest rate equal to foreign interest rate we would get unrealistically huge swings in Net Foreing Assets position.

equalized with marginal product of capital and real wage w_t with marginal product of labor:

$$r_t = \alpha K_t^{\alpha-1}(z_t L_t)^{1-\alpha} - d \tag{2}$$

$$w_t = (1-\alpha)K_t^{\alpha} z_t^{1-\alpha} L_t^{-\alpha} \tag{3}$$

2.3 Households

Each agent lives for up to J periods, with age $j \in \{1, 2, ..., J\}$[8]. Agents of the same age are homogeneous. We denote the size of cohort of age j in period t as $N_{j,t}$. Agents discount factor is denoted as δ, additionally agents may stochastically die in each period. The conditional probability that the agent alive in period t is alive in period $t+j$ is denoted as $\pi_{t,t+j}$. Agents choose consumption $c_{j,t}$, labor $l_{j,t}$ (for which they receive the real wage w_t) and savings $s_{j,t}$ (the interest rate on savings is denoted as r_t) to maximize the following utility function

$$U_t = \sum_{j=1}^{J} \delta^{j-1} \pi_{t,t+j-1} u(c_{j,t+j-1}, l_{j,t+j-1}), \tag{4}$$

where $u(c_{j,t}, l_{j,t}) = \ln c_{j,t} + \phi \ln(1 - l_{j,t})$, with $\phi \geq 0$. The budget constraint that agents face follows

$$(1-\tau_{c,t})c_{j,t} + s_{j+1,t+1} = (1-\tau_{l,t})\Psi_{j,t} + (1 + r_t(1-\tau_{k,t}))s_{j,t} + \Upsilon_t, \tag{5}$$

where τ_l denotes income tax, τ_c consumption tax, τ_k capital income tax and $\Psi_{j,t}$ current period income from labor or pension, which is given by the following formula

$$\Psi_{j,t} = \begin{cases} (1-\tau) w_t l_{j,t}, & \text{for } j < \bar{J}_t \\ b_{j,t} & \text{for } j \geq \bar{J}_t \end{cases} \tag{6}$$

In the above formula τ denotes the social security contributions, $\bar{J}_t$ exogenous retirement age, Υ_t lump sum taxes, and $b_{j,t}$ pensions, which we discuss below[9].

2.4 Pension system

In the initial steady state the economy is characterized by the pay-as-you-go defined benefit (PAYG DB) pension system and we change the system unexpectedly in the 2 period to a two-pillar, partially funded defined contribution (FDC). In the PAYG DB system contributions go into the public fund which are used to pay pensions of retired.

[8] We set $J = 80$ which corresponds to $j = 1$ to 20 years and 100 years as the life time limit in the data.

[9] We assume that unintended bequests are redistributed within the same cohort.

If there is deficit in the pension fund the government is obliged to finance it, denoted as $subsidy_t$. The budget constraint of the pension fund under PAYG DB is thus given by:

$$\sum_{j=\bar{\bar{J}}}^{J} N_{j,t} b_{j,t}^{PAYG-DB} = \tau \sum_{j=1}^{\bar{J}-1} N_{j,t} w_{j,t} l_{j,t} + subsidy_t. \tag{7}$$

In the DC system there are two pillars: the pay-as-you go pillar and the funded pillar, with τ^I denoting the contribution rate to the PAYG pillar and τ^{II} denoting contributions to the funded pillar with $\tau^I + \tau^{II} = \tau$. Keeping the total contribution rate constant allows to maintain the distortions unchanged after the pension system reform.[10] Similarly, b^I and b^{II} denote benefits from, PAYG and funded pillar, respectively.

In the spirit of Butler (2002), contributions are effectively split up into implicit savings (by construction age-specific) and tax share part. Note that in a pure DC system, the entire contribution rate is implicit saving. However, if indexation rules depart from fairness, a part of the contribution may become a pure, distortive tax. The contributions to the the PAYG pillar are recorded and indexed at the rate r_t^I which is equal to the payroll growth in the economy. Contributions to the funded pillar are invested with return r_t^{II}=r_t. At retirement both stocks of contributions are converted to an annuity, but the difference between indexation in the PAYG pillar and accruing interest in the funded pillar remain[11]. Summarizing, the pension benefits are given by:

$$b_{j,t}^I = \begin{cases} 0, & \text{for } j < \bar{J}_t \\ \frac{\sum_{s=1}^{\bar{J}-1} \left[\Pi_{i=1}^{s} (1+r_{t-j+i-1}^I) \right] \tau_{t-j+s-1}^I w_{t-j+s-1} l_{s,t-j+s-1}}{\prod_{s=1}^{J-\bar{J}+1} (1-\pi_{\bar{J},\bar{J}+s}) s}, & \text{for } j = \bar{J}_t \\ (1+r_t^I) b_{j-1,t-1}^I & \text{for } \bar{J} < j \leq J \end{cases} \tag{8}$$

$$b_{j,t}^{II} = \begin{cases} 0, & \text{for } j < \bar{J}_t \\ \frac{\sum_{s=1}^{\bar{J}-1} \left[\Pi_{i=1}^{s} (1+r_{t-j+i-1}^{II}) \right] \tau_{t-j+s-1}^{II} w_{t-j+s-1} l_{s,t-j+s-1}}{\prod_{s=1}^{J-\bar{J}+1} (1-\pi_{\bar{J},\bar{J}+s}) s}, & \text{for } j = \bar{J}_t \\ (1+r_t^{II}) b_{j-1,t-1}^{II} & \text{for } \bar{J} < j \leq J \end{cases} \tag{9}$$

In the transition period, the pension fund pays out the PAYG DB pensions, but also starts paying out b^I, while a part of the contribution τ that used to serve the purpose of financing the pension benefits goes into the capital pillar (τ^{II}). Hence, there is a transitory deterioration in the balance of the pension fund. After the transition is complete,

[10] Such reform was introduced in Poland in 1999 and in many other countries of the Central and Eastern Europe as well as Sweden over the course of 1990s and 2000s (see Holzman and Stiglitz 2001, Orszag and Stiglitz 2001, Jarrett 2011, Schwarz 2011, Schwarz et al. 2014).

[11] Savings of pensioners who died earlier in the funded pillar are used to finance pensions of pensioners that live longer, e.g. are distributed equally within a cohort.

it becomes

$$\sum_{j=\bar{J}_t}^{J} N_{j,t} b^I_{j,t} = \tau^I_t \sum_{j=1}^{\bar{J}_t - 1} N_{j,t} w_t l_{j,t} + subsidy_t. \tag{10}$$

where $subsidy_t$is the part of pension fund imbalance that needs to be addressed by the government. Since this is a DC pillar, after the transition $subsidy_t$eventually becomes effectively zero. In the funded pillar, the collected contributions are invested, earning the return $r^{II}_t = r_t$. Therefore, the funded pillar savings of an agent aged j in period t evolve according to:

$$s^{II}_{j+1,t+1} = (1 + r^{II}_t) s^{II}_{j,t} + \tau^{II}_t w_t l_{j,t}. \tag{11}$$

The pension system reform as described above constitutes the baseline scenario. First, we establish the initial steady state of the PAYG DB economy. In period $t = 2$ social security system is unexpectedly changed to a defined contribution with a PAYG and funded pillars. Pension benefits of the living retirees are honored.[12] The analyzed scenarios will comprise changes to this pension system.

2.5 Government

Government collects taxes in order to finance some exogenously given government expenditure, pension system deficit and to service outstanding debt. The revenues of the budget are defined by:

$$T_t = \tau_{l,t}\big[(1-\tau)\sum_{j=1}^{\bar{J}} w_t l_{j,t} N_{j,t} + \sum_{j=\bar{J}_t}^{J} b_{j,t} N_{j,t}\big] + \sum_{j=1}^{J} (\tau_{c,t} c_{jt} + \tau_{k,t} r_t s_{j,t}) N_{j,t}, \tag{12}$$

which implies the government budget constraint of:

$$G_t + subsidy_t + r_t D_{t-1} = T_t + (D_t - D_{t-1}) + \sum_{j=1}^{J} N_{j,t} \Upsilon_t,$$

where G_t denotes government expenditure and D_t government debt. The budget constraint is financed *via* public debt whenever feasible, i.e. the debt cannot exceed certain threshold (as a percent of GDP). When this threshold is passed, consumption taxes adjust accordingly. The threshold for Poland is defined in the constitution, it is identical to thresholds defined in the Maastricht Treaty for all EU Member States at 60% of GDP.

In order to assure that the debt returns to the steady state in the long run we assume the following fiscal rule on the consumption income tax:

$$\tau_{c,t} = (1-\varrho)\tau_c^{final} + \varrho \tau_{c,t-1} + \varrho_D((D\tilde{/}Y)_t - (D/Y)^{final}) \tag{13}$$

[12]Replicating the actual features of the reform, the change in pension fomula affects cohorts born after 1948, i.e. cohorts of age $j \leq 49$ in period $t = 2$.

where ϱ[13] measures the autoregression of the tax rate, and ϱ_D[14] the strength of reaction to deviation of government debt from its steady state values. The values of τ_c^{final} and $(D/Y)^{final}$ denote in the new steady state values of consumption tax and debt share in GDP, respectively. Our fiscal rule is forward looking in a sense that $(\tilde{D/Y})_t$denotes debt share averaged over five subsequent years. This allows taxes to react to future changes in debt, not only to the contemporaneous change in government imbalance.

2.6 Closing the model

The model is closed with market clearing conditions for the labor market:

$$L_t = \sum_{j=1}^{\bar{J}_t - 1} N_{j,t} l_{j,t}, \tag{14}$$

and the capital market:

$$K_{t+1} + D_{t+1} = \sum_{j=1}^{J} N_{j,t}(s_{j+1,t+1} + s^{II}_{j+1,t+1}) + B_{t+1}. \tag{15}$$

the goods market:

$$\sum_{j=1}^{J} N_{j,t} c_{j,t} + G_t + K_{t+1} + NX_t = Y_t + (1-d)K_t, \tag{16}$$

where NX_t denotes current account. Net foreign asset position evolves over time according to the following formula

$$B_{t+1} - B_t = r_t B_t - NX_t.$$

3 Calibration

We calibrate the model to match the features of the Polish economy as an example of a country which implemented the partial privatization of the social security and continued with essentially unchanged features of the pension system for over a decade. To avoid bias due to the cyclical effects, we rely on averages for a decade prior to the pension system reform in 1999. We use the detailed demographic projection released by the Aging Work Group (AWG) of the European Commission to reproduce the arrival of new cohorts to the economy as well as annual survival probabilities for each cohort. The projection is available until 2060. We make the conservative assumption that the population stabilizes after that, so as of 2140 there are no changes in the size, nor the age structure of the

[13]To assure smooth adjustment and stability, we set $\rho = 0.85$

[14]For the same reasons, we set $\rho_D = 0.03$

living cohorts. We also use the projection for the exogenous technological progress from AWG as of 2010, whereas for the years between 1999 and 2010 we use the actual data on the TFP growth estimated for the Polish economy. The AWG scenario for productivity assumes gradual convergence to the average EU level of 1.7% *per annum* between 2010 and 2040 and a stable growth at this rate thereafter. These assumptions are used in both the baseline scenario and for simulating the outcomes of the policy change.

The retirement age $\bar{J}$ is calibrated to the actual data on effective retirement age collected by the OECD and was assumed to increase gradually. Thus it equals 61 in 1999. We use the actual data on employment rate from the Labor Force Survey to calibrate the preference for leisure ϕ. Subsequently, we seek the discount rate δ and the depreciation rate d that would be consistent with a domestic investment rate of app. 19% and overall investment rate of approximately 24.5%, as observed on average in the economy between 1990 and 1999. In calibrating net foreign assets we follow Schmitt-Grohe and Uribe (2003)and set a debt-elastic interest-rate premium. We start from data driven app. 80% NFA in 1999 and calibrate the interest rate adjustment parameters so that economy did not explode in the PAYG DB baseline (global interest rate to 3% and premium to $0.03 * D_t/Y_t$).

Following the standard in the literature, we assume the $\alpha = 30\%$. The share of government expenditure in GDP is set at 20% to replicate the actual proportions. The capital income tax τ_k is set at *de iure* rate of 19%. The labor income tax τ_l was calibrated to replicate the ratio between the labor income tax revenues and the labor revenue in the national accounts, thus at its effective rather than nominal rate. The replacement rate in the PAYG DB system was set as to replicate the share of pensions in GDP prior to the reform of 1999. Knowing the replacement rates, we set the overall contribution rate τ to reproduce the pension system deficit as observed in the years prior to the reform at 0.8%. The split between τ^I and τ^{II} follows the proportions set by Polish legislation. We also assume that the initial and final government debt to GDP ratio equals 45%, which corresponds to the value of government debt in the late 90s in Poland. With the calibrated value of the consumption taxes at 22% (VAT revenues over consumption), we obtain the necessary lump sum to complete the budget at 3% deficit. Parameters are summarized in Table 1.

The solution of an individual perfect foresight agent is computed recursively using the Gauss-Seidel algorithm. Once it is established for the initial steady state, it is also computed for the final steady states, depending on the scenario and policy options within the scenario. Thus, there are four possible final steady states. In the baseline scenario of no policy change we set the transition path between the initial and the adequate final steady state. We guess the path of capital per worker in each period and recursively, using the Gauss-Seidel algorithm find equilibria for each period. We compute w and r. Subsequently y is computed and used to calculate variables related to pension system and government sector, such as G, T, S, D, Υ as well as the individual benefits $b^I_{,j}$

Table 1: Calibrated parameters

α	capital share	0.30
τ_l	labor tax	0.11
ϕ	preference for leisure	0.527
δ	discount factor	0.997
d	depreciation rate	0.035
τ	soc. security contribution rate	0.0592
ρ	replacement rate	0.2375
ξ	adjustment in interest to foreign indebtedness	0.01
ρ	tax autoregression	0.85
ϱ_D	tax sensitivity to debt ratio deviations	0.03
		resulting
dk/y	investment rate	0.21
D/y	debt to GDP ratio	0.45

and b_j^{II}. From the computation of policy functions, choice variables c_j, s_j and l_j are computed. Finally, k is updated in order to satisfy market clearing. This procedure is repeated until the difference between k from subsequent iterations is negligible[15]. Once the equilibrium is reached, utilities are computed and discounted to reflect utility of the first generation in our model, i.e. 20-year old. We set the length of the transition path in order to assure that the new steady state is reached, i.e. last generation analyzed lives the whole life in the new demographic and policy steady state. The last voting takes place when all cohorts are already collecting pension benefits from the reformed system (i.e. 160 periods after the original reform of 1999), so the policy stabilizes at the latest in 2232. The population stabilizes in 2140. We thus set the length of the path to 450 periods.

4 Voting on reform reversal

We allow agents to (unexpectedly) vote on keeping the reformed pension system intact or to make some changes. We allow for different dates of such a voting to see how the political decision changes with the changing demographic structure and the progress of financing the initial privatization of the social security. We assume in each simulation that once there is sufficient political support for a given change, agents treat it as remaining intact henceforth (i.e. they never vote again and expect no subsequent votes).

We allow voters to vote on two elements of the pension system. First, voters can decide about diverting (part of) social security contributions away from the funded pillar to the PAYG pillar. Importantly, this does not reduce the overall contribution rate and in fact it increases the size of the public social security in the economy. We call such

[15]In each iteration, error is computed as the l_1-norm of the difference between capital vector in subsequent iterations.

change a shift of contributions and denote in the reminder of this paper as Policy 1. It mimics the type of changes that have been temporarily or permanently implemented by all Central and Eastern European countries in the aftermath of the global financial crisis. Since in most countries which followed policy of this type, some contributions continue to be transferred to the funded pillar, instead of completely removing it, we change the proportions. More specifically, prior to any voting $\tau^I = 2\tau^{II}$ whereas the vote changes to $\tilde{\tau}^I = 5\tilde{\tau}^{II}$ (with $\tau^I + \tau^{II} = \tilde{\tau}^I + \tilde{\tau}^{II} = \tau$). [16] Note that the total contribution rate remains unaffected. Hence, the predictions of studies such as Browning (1975), Butler (2000) do not apply to our case, see also Congleton et al. (2013).

Second, voters can decide that the assets in the funded pillar are nationalized (transferred from the funded pillar to the PAYG pillar and utilized to service current expenditure of the government). We call this policy appropriation and in the reminder of the paper denote as Policy 2. Such changes have been implemented by Hungary, Bulgaria, Poland and Slovakia, although to a differing extent. In Hungary the nationalization of accumulated assets was immediate and complete, whereas in the other countries it is more or less partial and gradual. Again, this reform does not reduce directly the size of the pension system in the economy[17], but affects negatively the capital stock. There is also an indirect positive effect to the capital stock – expecting lower pensions agents increase private savings, but this effect is of secondary order. Notably, the appropriation takes place only once – at the moment of voting. Hence, there is no long-term welfare effect of this change: when economy reaches its final steady state, all outcomes depend on the underlying preference and structural parameters, which are not affected by one-off policy change.

In some of the countries, both Policy 1 and Policy 2 were implemented. Thus, in our setting a third policy option is the combination of the two, i.e. voters can express support for both shift of contributions and shift of pensions in the same voting. We call this Policy 3.

Note that each of these policies has different effects on the welfare of the living as well as future cohorts. Policy 1 reduces the amount of contemporaneous deficit in the PAYG scheme at the expense of slower capital accumulation and lower pension benefits after the retirement. With general government consumption fixed, reduction in $subsidy_t$ allows for a contemporaneous reduction in taxes or debt, relative to the baseline scenario, thus yielding a moderate but immediate benefit. While future pension benefits are likely to be lower, this can be compensated for by the private voluntary savings of the agents. Note however, that interest earned on private voluntary savings is subject to capital income tax, whereas the contributions to the funded pillar are not.

[16] The considered proportions prior to the vote and subsequent the vote replicate the Polish case, but the analysis can easily be extended to any proportion of policy relevance.

[17] Some indirect effects come from the fact that PAYG pillar offers lower rate of return than the capital pillar, hence the accumulated pension obligations are lower. See e.g. Casamatta et al. (2001) for treatment.

Thus, distortions in the economy decrease due to lower consumption taxes, but increase due to higher effective capital income taxes. Policy 2 reduces immediately the debt of the government. This allows current and future taxes to be substantially reduced, because also the subsequent costs of servicing public debt are decreased. With the fiscal rule described in equation (13), taxes do not adjust immediately, but the reduction in consumption taxes is nonetheless large. Clearly, it is accompanied by a much lower path of pension benefits.

As a voting procedure we employ pure majority voting. Only agents living at the times of voting can vote and they follow in voting their individual utility assessment. An agent is in favor of a given policy if her subsequent lifetime utility is higher than in the *status quo*. We operationalize utility from a policy change as consumption equivalent, discounted to the age of $j = 1$. Also, agents have no altruistic bequest motives for their off-springs. Agents with a negative consumption equivalent are not in favor of a policy change, thus the change is implemented if at least 50% of the living cohorts, weighted by the size of the cohort, benefit from a policy change. The ordering of the voting is irrelevant for the final outcome (see Dhami and al Nowaihi 2010, for proof of transitivity, but we tested explicitly if the preferences are transitive in the case of our set up). Given the schedule of voting, after each round we implement the policy which had the highest support *vis-a-vis* the alternatives.

5 Results

5.1 Introducing the funded pillar

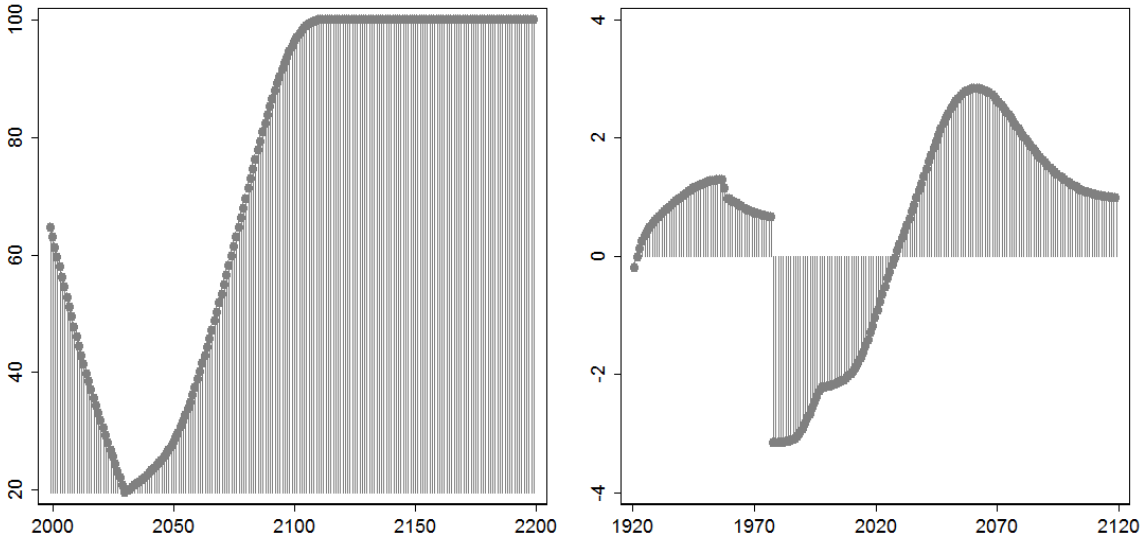
Originally, economy pursues on a PAYG DB path. Since there is no policy change, we keep the debt share in GDP fixed at initial steady state (necessitating adjustment in taxes due to the aging of the population). In 1999, unexpectedly, a DC system is introduced, partially a PAYG and partially funded. To provide flexibility in financing the transition costs of funding pensions, we allow for an increase in public debt share in GDP. This is obtained by replacing in equation 13 $(D/Y)^{final} = 45\%$ with an exogenously, steadily increasing higher threshold (we eventually reach 90% share in GDP).

Introduction of the funded pillar implies that some cohorts close to retirement would receive low pension benefits from that pillar. To mitigate this problem, most governments considered transitory cohorts, which remain in the old, PAYG DB system and cohorts which receive DC pensions but only from the PAYG pillar. Cohorts close to retirement in 1999 remain in the old system (aged 40 in 1999). Cohorts already working prior to the reform but far from retirement obtain DC pensions from the PAYG pillar (their contributions fully go the the PAYG pillar as well). We synthetically compute the counterfactual accrued stock of contributions that would have prevailed had the DC system been operational in the past to compute their pensions. Finally, cohorts born in

1999 or later all participate in PAYG and funded pillar.

Agents do not vote on whether they want it introduced, but we compute the welfare of each cohort relative to the scenario of no policy change. Based on these computations we are able to judge which cohorts will be in support of such reform and which will not. Overall, aggregate welfare effect expressed as consumption equivalent amounts to 0.04%, which implies that if all loosers were compensated by the winners, there would still be welfare gain left (i.e. Kaldor-Hicks welfare improvement). The cohort distribution of these welfare effects is such that in 1999 64.68 % of the population living at the moment of reform benefits from the reform and thus would support it, see Figure 1. In the long run, this partial privatization brings about gains: pensions are higher and taxes are lower.

Figure 1: Share of living population gaining from the reform, weighted by cohort size (left) and cohort distribution of welfare (right).



This is the baseline for the subsequent simulations.

5.2 Reverting the pension system reform

Following the intuition of standard OLG models without political economy eventually become universally welfare enhancing to all cohort - the loosing cohorts pass whereas the new ones benefit from increased overall efficiency. This implies that eventually demographic change and the cohort distribution of the reform costs allow for the privatization to become politically stable. "Unprivatizing" of the pension system in the form of diverting funds away from the capital pillar to the PAYG pillar, as was the case in many European countries, ultimately reduces welfare in the long run. The static comparison of final steady states reveals welfare effect of Policy 1 is -0.12% of permanent consumption.

Since Policy 2 involves one-off appropriation, it has no long-term effects. Hence, Policy 3 is in the long run equivalent to Policy 1. However, the distribution of the consumption equivalents over cohorts is not the same between the three Policies. In the reminder of this section we show if the three policy options obtain political support under both analyzed scenarios.

Note that as of 2042 all of the initial retirees with pensions set by PAYG DB rules are already deceased. Hence, we run simulations of voting every decade, thus taking into account that the initial costs of the reform fade away with time, while the age structure of population changes due to lower fertility and increased longevity. Each vote is unexpected. Voters expect that once the preferred vote is implemented, there will be no subsequent changes to the pension system. The results are displayed in Table 2. We observe some minor differences in timing, but ultimately, privatization of the social security never becomes politically stable. Voters support the "unprivatization" even though such a policy lowers long-term welfare - the consumption equivalent in the final steady state is unequivocally negative. Clearly, for the living cohorts there are welfare gains, which stand behind the outcomes of the voting rounds.

Table 2: Political support for the three analyzed policies - welfare effects in % of permanent consumption.

Year of voting	2012	2032	2052	2072
Winning scenario	3	3	3	3
Long term welfare effect	-0.12%			
Political support in % of the living cohorts	against *status quo* (against winning Policy)			
for Policy 1 (shift of contributions)	100 (42)	100 (40)	100 (35)	100 (33)
for Policy 2 in % (appropriation)	55 (3)	58 (3)	63 (3)	63 (3)
for Policy 3 in % (both changes)	100 (-)	71 (-)	76 (-)	78 (-)

Notes: results for all consecutive votes available upon request. Long term welfare effect refers to the final steady state.

In order to explain this result, below we present detailed analyzes of cost and benefits of "unprivatization" for a selected voting round. Since in both scenarios we adjust public

debt to the long-term share in GDP as of 2080, displaying results for the voting rounds past that date would confound the fiscal policy implemented even in the absence of voting and the direct consequences of voting. Thus, we show results for the a voting round sufficiently prior to the beginning of the fiscal adjustment, that is year 2052. As appears from the results in Table 2, voting outcomes stabilize already 5 decades after the privatization, that is sooner than stabilization of the age structure of the population.

5.3 Adjustment in pensions and fiscal effects

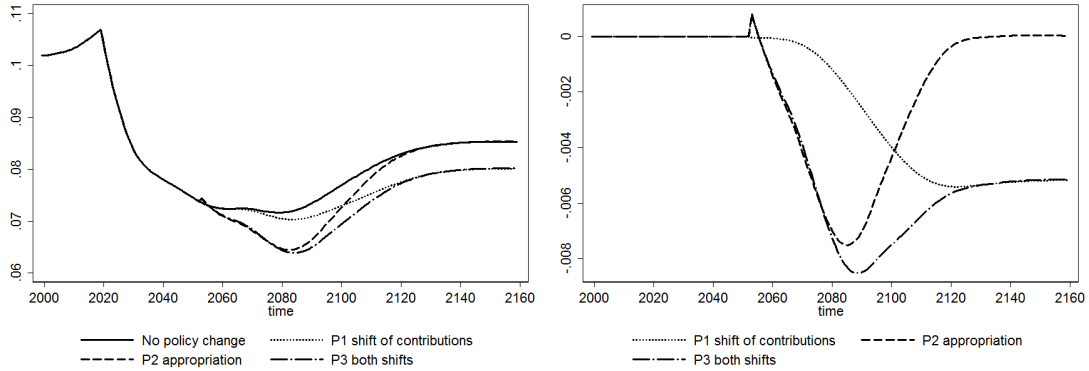
We show the effects of "unprivatizing" in 2052 as an example.[18] The "unprivatization" of the pension system reform improves long-term fiscal situation, which is equivalent to lower taxes over the long run. This comes at the expense of lower pensions and slower capital accumulation, hence lower output. The effect of the three analyzed policy changes on pensions differ, see Figure 2. Policy 1 redirects contributions from the funded pillar to the PAYG pillar. This shift lowers pension benefits for two reasons. First, the return in the PAYG pillar equals to the payroll growth, which is lower than the interest rate in the funded pillar (see: Figure A.2). This lowers the effective replacement rates. Second, the difference between the accrued interest in the funded pillar and the indexation in the capital pillar applies also to pensions. In addition to direct effects on pensions, there are also indirect effects through taxes. Shifts of contributions reduces the deficit in the public pension fund and results in lower consumption taxes.

Policy 2 means that accrued contributions in the funded pillar are shifted to the PAYG system and used to finance current government expenditure. Unlike Policy 1, the negative effects of this change increase as the number of cohorts participating in the funded pillar reaches maximum and the funded pillar collects the contributions from an entire set of working cohorts. Similar to Policy 1, deficit is reduced in the PAYG pillar, which benefits current generations as it allows to reduce consumption tax rates. The effects of Policy 1 and Policy 2 add up in Policy 3. Pension benefits are lower, but the decline in taxes is even larger.

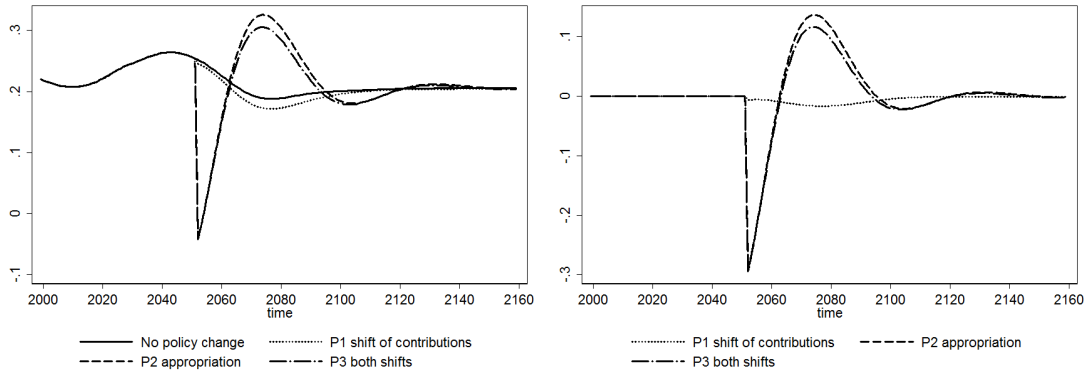
[18] results for each round of voting is available upon request.

Figure 2: The effect of "unprivatization" on pensions and fiscal variables

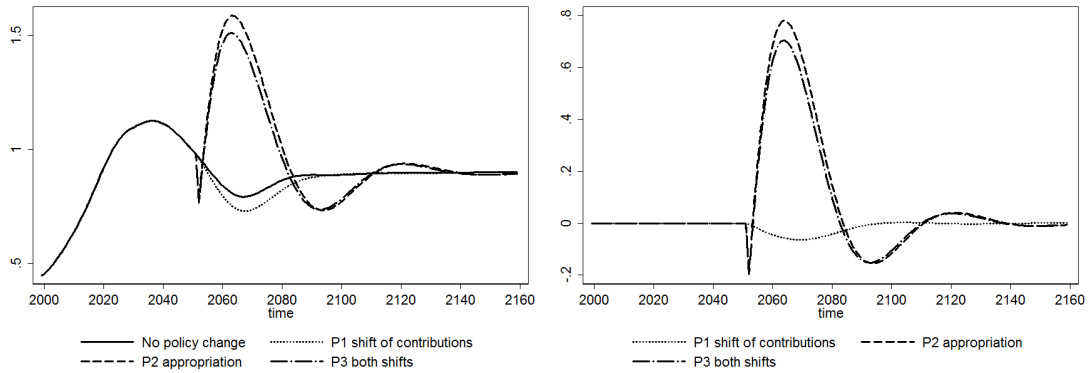
(a) Difference between baseline and policies, average pensions (left) and difference from baseline (right), voting in 2052



(b) Consumption taxes: level (left) and difference between baseline and policies (right) - voting in 2052



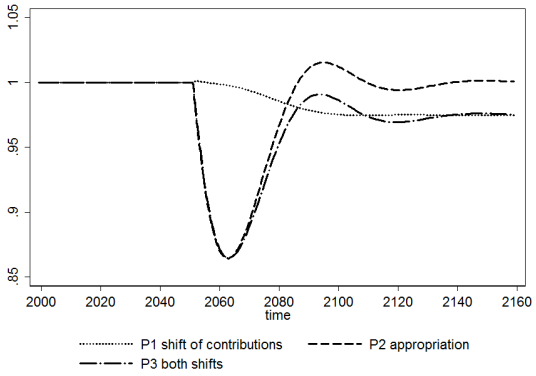
(c) Debt share in GDP: level (left) and difference between baseline and policies (right) - voting in 2052



The direct effects on consumption taxes are combined with indirect effects on overall capital taxation. While lower pensions due to lower forced savings may be counter-weighed with private voluntary savings, the former are exempt from capital income tax, while the latter is not. Consequently, with the reaction of private voluntary savings, there is an increase in the overall capital income taxation. This introduces a distortion to the

economy and affects additionally the capital/labor ratio. Lower consumption taxes create less distortions in the intra-temporal choice between consumption and leisure, so labor supply responds positively. Dismantling of the funded pillar leads to lower aggregate savings and lower capital, see Figure 3. Additionally, agents respond with higher savings to lower future pensions facilitated with lower taxes contemporaneously.

Figure 3: The effect of "unprivatizing" on labor supply (left) and capital (right), ratio relative to baseline, voting in 2052

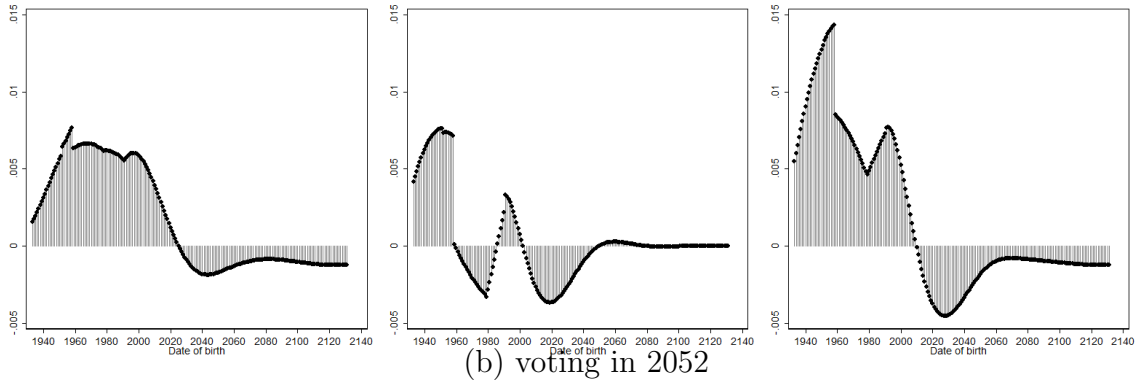


5.4 Voting results and welfare considerations

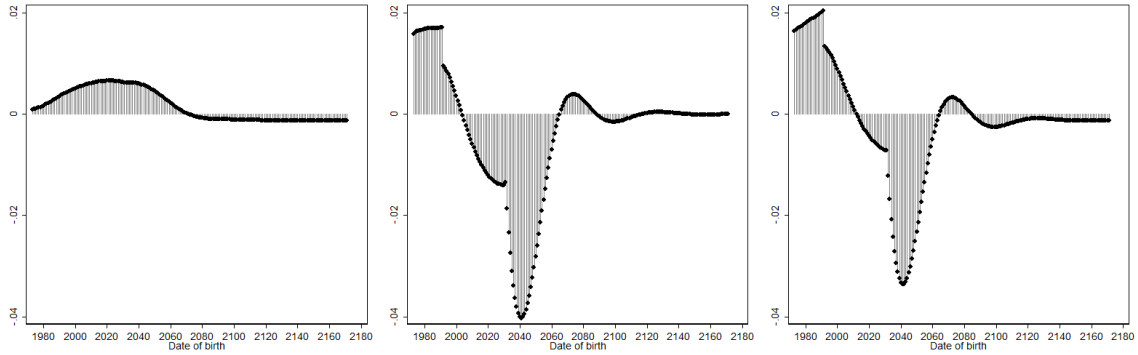
The distribution of welfare effects across cohort for subsequent voting rounds is presented in Figure 4 (we display consumption equivalents, discounted to the age of 20 for each cohort, i.e. adjusted for increase in longevity). We compute the consumption equivalents relative to the baseline of no changes to the original, 1999 reform. Positive values signify that a given cohort is willing to give up as much consumption in exchange for introducing respective policy changes. The effects of Policy 1 are relatively wide spread among the living cohorts, losses appear only for the young cohorts who have not yet had the chance to benefit from higher rates of return on their pension savings in the capital pillar. By contrast, the one-off appropriation from Policy 2 benefits mostly those, who do not loose from appropriation (they are already retired) and for whom reduction in taxes matters substantially because their consumption is already relatively low. The losses of welfare are the most pronounced for cohorts just prior to the retirement, whose stock of savings in the capital pillar is the largest. The two policies add up in Policy 3 in terms of welfare, revealing why a combination is usually preferred to just Policy 1 in early years. In the late years (e.g. voting in 2052) a share of population with savings accumulated in the funded pillar is already high. Hence, appropriation is more damaging to the welfare of working cohorts. However, a share of retirees is high in the population and their gains from the reform are immediate in the form of reduced taxation. Hence, even appropriation of accumulated stock of savings may continue to be politically favorable.

Figure 4: Consumption equivalent (% of lifetime consumption) for policy 1 (left), policy 2 (middle) and policy 3 (right)

(a) voting in 2012



(b) voting in 2052



As clear from the analysis of the cohort distribution, the long-run welfare effects of "unprivatizing" are negative with the exception of one-off appropriation (as in Policy 2), where the effects are clearly not lasting. Still, the political support is warranted by the welfare gains of the living cohorts. To infer that from the figures, consider the sign of the consumption equivalents for 79 cohorts left and right of the vertical lines denoting the displayed voting rounds. Although the winning policy options reduce welfare in the long-run, they improve the situation of the sufficient fraction of agents living at the period of voting at the expense of future generations. For the voting cohorts the gains from lower consumption taxes dominate welfare losses from lower pension benefits and higher taxation of interest from savings. The future generations, by contrast, have no fiscal gains (especially once the new equilibrium is reached), but the pension system permanently delivers lower pensions and higher taxation of private savings. Thus, for these cohorts the losses dominate gains, despite mechanics being the same.

An interesting insight from our findings concerns the nature of "unprivatizing". It appears that any policy that lowers the pension benefits in the future, but allows to lower general taxes immediately, especially in the periods directly after the policy change, will be preferred by the voters. Thus, such policies will gain political support despite increase in the implicit burden of pension benefits financing – as it is shifted to the future generations. Note also that agents have perfect foresight and are fully rational – expecting

lower pension benefits they make provisions for smoothening lifetime consumption by increased private savings. It is easier if contemporaneous consumption is cheaper due to lower consumption taxes. In a sense, one could interpret these findings as evidence that the original pension system per se was detrimental to welfare, i.e. economy would be better of with no public pensions. However, obligatory private savings in the pension system are exempt from capital income taxation, whereas voluntary private savings outside the pension system are not. This feature of many pension systems around the world creates room for welfare gains from having a pension system at all.

Clearly, the analyzed policies affect young (yet unborn) and old (already living) generations differently. However, despite these differences in distribution of welfare effects across cohorts, our study undermines a popular intuition that pension system reforms from a PAYG system to a multi-pillar system may become politically stable. In fact, reverting the overall welfare enhancing privatization gives the living (and thus voting) cohorts immediate additional gains at the expense of future generations. Hence, it appears that privatizations may be inherently politically unstable. Our model is fairly stylized: there is no social assistance (and minimum pension benefits) because of the representative agent within a cohort. With ex ante or ex post within-cohort heterogeneity, it is likely that the public pension system would not be balanced. Increasing the share of the public pillar in total pension system raises the share of imbalance that would have to be serviced with taxes. Hence, it is likely that the materialized gains from "unprivatizing" would be substantially lower in the real world.

6 Conclusions

The literature on the effects of privatization of social security with aging population is extensive. It mostly finds that even if such a reform is welfare improving in Kaldor-Hicks sense: it benefits future generations while cohorts working during transition usually incur a welfare loss. It means that as time passes the fraction of living agents benefiting from the reform is increasing. Hence an intuition that support for such a reform increases in time and at some point (partially) funded pension systems should become politically stable. In our paper we show that this intuition is not actually true.

We develop an OLG model with an exogenous pension system privatization in period 2, which introduces a partially funded two-pillar defined contribution system in the place of a pay-as-you-go defined benefit system. Because in the model the obligations associated with the pension benefits of cohorts already retired (or close to retirement) are honored, the reform generates fiscal costs, hence hurting the welfare of the living cohorts. While we allow the public debt to increase in response to this reform, we show that such reform may be introduced with political support exceeding 50%. As the initial retirees die, the funded pillar becomes beneficial to all living cohorts: it allows

for faster accumulation of capital and offers higher pension benefits. On selected dates we allow the agents to vote over shifting the contributions and/or appropriation by the government of the stock of accumulated savings away from the funded pillar towards the PAYG pillar, while maintaining the size of obligatory pension system unchanged. We gradually shift the date of the voting on these three options more and more towards the future. We find that the privatization of the pension system never becomes politically stable: even though the initial old cohorts have passed, the contemporaneously living cohorts always benefit immediately from capturing the resources accumulated in the funded pillar, while shifting the costs of this appropriation to the future. Hence, there is stable political support for "unprivatizing" pension systems, even many decades after the privatization. This support does not decrease with longevity and reduced fertility.

One possible interpretation of our findings is that the share of contributions addressed to the capital pillar has been set at excessively high level, so rational agents adjust it downwards to the preferred levels. However, the results of simulations would be qualitatively the same, had the initial share of the second pillar in total pension contributions was lower. Moreover, also complete abandoning of the capital pillar – not partial, as policy relevant and thus analyzed in this study – would yield qualitatively the same conclusions. The source of welfare effects does not come from improving the alignment of forced pension savings with the preferred profile of savings. In fact, forced savings in the funded pillar enjoy exemption from capital income tax, thus being a favorable vehicle for smoothening life-time consumption relative to the voluntary savings. Hence, with reducing the share of the contributions accruing to the funded pillar the scope of distortions in the economy increases: implicit taxation embedded in the pension system contributions grows and so does the role of capital income taxation, with consumption taxes only temporarily lowered. The source of the welfare gains that creates ground for "unprivatizing" lies in distributing welfare away from the future cohorts to the living cohorts – it is only the transitory fiscal adjustments that yield welfare gains. Hence, our findings should rather be interpreted as evidence that implementing a state-run multi-pillar pension system may suffer from the credibility shortage. The risk of "unprivatizing" is permanent and thus should be taken into account when designing pension system reforms. Notably, if pensions and/or contributions are shifted away from the capital pillar, such unstable reform generates only welfare costs, because the welfare gains do not materialize.

Given these negative results, one may wonder about the general nature of the funded pillars. In advanced economies, these pillars are usually an element of a tripartite agreement between the employer, the pension fund and the worker. Consequently, property rights are set at par with other financial instruments. In emerging economies the agreement typically involves also government, even if only in the role of entity collecting and transferring contributions from workers to pension funds. The presence of the government in this contractual agreement makes funded pillars an element of social contract rather than a purely financial instrument. Given this discrepancy, an interesting avenue

of further research is analyzing the determinants of changes in the funded pillars also in advanced economies, with special emphasis to alternative policies facilitating the capturing of the assets accumulated in funded pillars by the living cohorts. These can comprise exceptional capital taxes or capital income gains taxes as well as other regulations addressing the ability to accumulate wealth by the pension funds. This could help to evaluate if our results may be generalized to private social security without government engagement.

References

Auerbach, A. and Kotlikoff, L. J.: 1987, *Dynamic Fiscal Policy*, Cambridge University Press.

Belan, P., Michel, P. and Pestieau, P.: 1998, Pareto-Improving Social Security Reform, *The GENEVA Papers on Risk and Insurance Theory* **23**(2), 119–125.

Bonoli, G. and Shinkawa, T.: 2006, *Ageing and pension reform around the world: evidence from eleven countries*, Edward Elgar Publishing.

Browning, E. K.: 1975, Why the social insurance budget is too large in a democracy, *Economic inquiry* **13**(3), 373–388.

Butler, M.: 2000, The political feasibility of pension reform options: the case of switzerland, *Journal of Public Economics* **75**(3), 389–416.

Butler, M.: 2002, Tax-benefit linkages in pension systems: A note, *Journal of Public Economic Theory* **4**(3), 405–415.

Casamatta, G., Cremer, H. and Pestieau, P.: 2001, Demographic shock and social security: A political economy perspective, *International Tax and Public Finance* **8**(4), 417–431.

Conesa, J. C. and Garriga, C.: 2008, Optimal fiscal policy in the design of social security reforms, *International Economic Review* **49**(1), 291–318.

Conesa, J. C. and Krueger, D.: 1999, Social Security Reform with Heterogeneous Agents, *Review of Economic Dynamics* **2**(4), 757–795.

Congleton, R., Batinti, A., Bose, F., Kim, Y. and Pietrantonio, R.: 2013, *Public choice and the modern welfare state*, pp. 362–381.

Cooley, T. F. and Soares, J.: 1996, Will social security survive the baby boom?, *Carnegie-Rochester Conference Series on Public Policy* **45**(1), 89–121.

Cooley, T. F. and Soares, J.: 1999, A Positive Theory of Social Security Based on Reputation, *Journal of Political Economy* **107**(1), 135–160.

de Walque, G.: 2005, Voting on pensions: A survey, *Journal of Economic Surveys* **19**(2), 181–211.

Dhami, S. and al Nowaihi, A.: 2010, Redistributive policies with heterogeneous social preferences of voters, *European Economic Review* **54**(6), 743–759.

Fehr, H.: 2009, Computable stochastic equilibrium models and their use in pension-and ageing research, *De Economist* **157**(4), 359–416.

Futagami, K. and Nakajima, T.: 2001, Population aging and economic growth, *Journal of Macroeconomics* **23**(1), 31–44.

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

Gruber, J. and Wise, D. A.: 2009, *Social security programs and retirement around the world: Fiscal implications of reform*, University of Chicago Press.

Hagemejer, J., Makarski, K. and Tyrowicz, J.: 2015, Unprivatizing the pension system: the case of poland, *Applied Economics* **47**(8), 833–852.

Holzman, R. and Stiglitz, J. E.: 2001, *New ideas about old age security*, Washington, DC: World Bank.

Huang, H., Imrohoglu, S. and Sargent, T. J.: 1997, Two Computations To Fund Social Security, *Macroeconomic Dynamics* **1**(01), 7–44.

Jarrett, P.: 2011, Pension reforms in poland and elsewhere: The view from paris, *CASE Network Studies and Analyses* (425).

Makarski, K., Tyrowicz, J. and Hagemejer, J.: 2016, Efficiency of the pension reform: the welfare effects of various fiscal closures, *Macroeconomic Dynamics* **forthcoming**.

Mulligan, C. B. and Sala-i Martin, X.: 2004, Political and Economic Forces Sustaining Social Security, *The B.E. Journal of Economic Analysis & Policy* **4**(1), 1–56.

Nishiyama, S. and Smetters, K.: 2007, Does Social Security Privatization Produce Efficiency Gains?, *The Quarterly Journal of Economics* **122**, 1677–1719.

Orszag, P. R. and Stiglitz, J. E.: 2001, Rethinking pension reform: Ten myths about social security systems, *in* R. Holzman and J. E. Stiglitz (eds), *New ideas about old age security*, Washington, DC: World Bank, pp. 17–56.

Phelan, C.: 2006, Public trust and government betrayal, *Journal of Economic Theory* **130**(1), 27–43.

Schmitt-Grohe, S. and Uribe, M.: 2003, Closing small open economy models, *Journal of International Economics* **61**(1), 163–185.

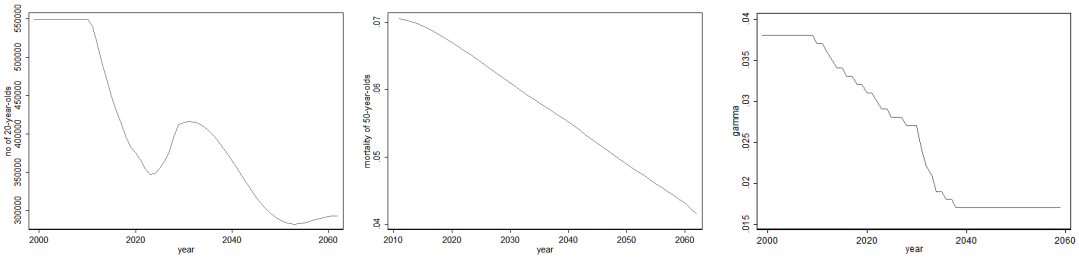
Schwarz, A. M.: 2011, New realities of pension policy in central europe, *Technical report*, European Bank for Reconstruction and Development.

Schwarz, A. M., Arias, O. S., Zviniene, A., Rudolph, H. P., Eckardt, S., Koettl, J., Immervoll, H. and Abels, M.: 2014, *The Inverting Pyramid: Pension Systems Facing Demographic Challenges in Europe and Central Asia*, World Bank Publications.

Shakuno, K.: 2014, Public education, endogenous fertility and economic growth, *TERG Discussion Paper 319*, Graduate School of Economics and Management, Tohoku University.

Appendix

Figure A.1: No of 20-year-olds arriving in the model in each period (left) mortality rates across time for a selected cohort (middle) and labor augmenting technological progress (right).



Source: EUROSTAT demographic forecast until 2060, technological progress rate following European Commission based on OECD, afterwards it is an assumption.

Figure A.2: Interest rate and payroll growth rate in no policy change scenario.