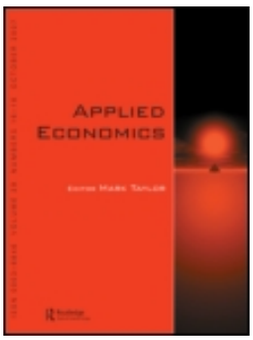

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Unprivatizing the pension system: the case of Poland

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In many countries, the fiscal tension associated with the global financial crisis brings about the discussion about unprivatizing the social security system. This article employs an Overlapping Generations model to assess *ex ante* the effects of such changes to the pension reform in Poland from 1999 as implemented in 2011 and in 2013. We simulate the behaviour of the economy without the implemented/proposed changes and compare it to a *status quo* defined by the reform from 1999. We find that the changes implemented in 2011 and in 2013 are detrimental to welfare. The effects on capital and output are small and depend on the selected fiscal closure. Implied effective replacement rates are lower. These findings are robust to time inconsistency. The shortsightedness of the governments imposes welfare costs.

Keywords: OLG; PAYG; pension system reform

JEL Classification: C68; E17; E25; J11; J24; H55; D72

I. Introduction and Motivation

With progressing longevity and lowering fertility rates, maintaining defined benefit schemes may actually become fiscally (and socially) nonviable. Indeed, policymakers and experts alike propose two types of solutions. One approach focuses on the fiscal side and proposes inevitably painful reforms to the pension system – be it systemic or parametric – aimed at raising contributions and /or lowering benefits to cut future expenditure. The alternative approach emphasizes the demographic component and favours fertility-fostering policies and/or stimulating economic activity, thus effectively raising current expenditure.

In fact, already in 1990s a variety of pension policy responses was observed throughout Europe. Many countries increase the retirement age in order to avoid stark reductions in the replacement rates (e.g. Denmark, Germany, Austria). Some countries (e.g. Italy and France) recently partially reduced the generosity of the social security system and attempted to raise contributions by increasing the participation and compliance. Other countries (e.g. Sweden and some of the Central and Eastern European countries) aimed at relieving the future generations by imposing so-called partially funded schemes at the expense of a considerable reduction in the effective replacement rates.

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This type of a systemic reform – partial 'privatizing of the social security' – was implemented among others in Poland in 1999. The reform introduced two mandatory pillars. The first pillar is a pay-as-you-go notionally defined contribution Social Insurance Fund (SIF), where current contributions are used to pay out current pension benefits, but the contributions are recorded in individual accounts and will serve as a basis for computing an annuity upon retirement. The contributions in that pillar are indexed annually according to payroll growth. The second pillar is a fully funded defined contribution one, where Open Pension Funds (OPFs) invest contributions in the name of participants, earning interest free of capital income tax. These contributions and interest, however, cannot be collected prior to the retirement.[1] Thus, the reform of 1999 effectively introduced two changes. First, the defined contribution scheme replaced the defined benefit scheme ($DB \Rightarrow DC$). Second, part of the system stopped being pay-as-you-go due to actual pre-funding of individual pensions ($PAY\ G \Rightarrow PAY\ G + FF$).

Pre-funding is believed to contribute to foster capital accumulation in the transition phase, but it also generates immediately a gap in the Social Insurance Fund. This gap either requires collateral funding or contributes to public debt.[2] The fiscal crises make this type of reform particularly vulnerable to subsequent changes in the pension system which adjust temporarily or permanently the extent of pre-funding and modify the property rights over the contributions. Indeed, among the European economies which introduced partial funding into their pension systems, during the recent financial crises, nearly all temporarily lowered the contribution rates to the funded pillar. In Hungary, the stock of accumulated contributions in the pension system was effectively nationalized and converted into a promise of annuity upon retirement. In Poland, the 'unprivatizing' of the social security happened in two steps – gradually reducing the contribution rates to the pre-funded pillar.

In this article, we develop a formal Overlapping Generations (OLG) model in order to analyse the welfare and the macro-economic effects of partial reform reversal that was implemented in 2011 and in 2013 in Poland. We carefully replicate the institutional features of the implemented/proposed pension system and simulate the behaviour of the economy subsequent to these changes. We compare the behaviour of this economy to the one with an identical starting point, but which has stayed with the institutional features as designed in the original 1999 pension system reform. The 'unprivatizing' unequivocally reduces the outstanding public debt, but may also imply lowering of the replacement rates and the rate of capital accumulation. We explicitly ask if the net effect of these changes is positive or negative from the welfare perspective and analyse the evolution of the key macroeconomic variables.

In addition to the policy relevance, this article is also motivated by an attempt to somewhat extend the understanding of the mechanics behind the OLG models related to the central role of the interest rate. Majority of papers in the field focuses on US, the UK, Germany and Japan. The literature has been relatively scarce for the catching-up economies. This is relevant for two specific reasons. First, typically catching-up economies are characterized by relatively higher rates of exogenous technological progress, which is relevant for determining superiority of policy alternatives depending on the interest rate and on the growth rate. Second – a consequence of the first one – (real) interest rates are typically higher in the catching-up economies, which may reflect on both higher growth rate and higher risk premiums. Empirical discrimination between these two causes remains a challenge. These characteristics of the catching-up economies are not likely to persist in the horizon relevant to analysing pension systems reforms. While typically OLG models have endogenous interest rates, their behaviour is dependent upon the calibration of the initial steady state and the

[1] The system is completed by a third pillar, where savings are also exempt from the capital income tax, but the contributions are voluntary and subject to a cap. Due to insufficient incentives, the third pillar is not popular, with about 1.3% of the working population contributing to any voluntary pension savings schemes.

[2] Originally, the gap was to be financed with revenues from privatization. In fact, despite sudden slowdown in the privatization rate as of 2005, for as much as nine years after the reform, the cumulative privatization proceeds exceeded the actual transfer to the OPFs. Due to political instability, this feature of the pension system reform was abandoned. In addition, some groups were successful in negotiating an exempt from the general pension system, which further deteriorated the balance in SIF.

inferred preference parameters. To address this point, in this model we introduce three economies that are subjected to 'unprivatizing' the pension system. In the first one, the (preferences in) initial steady state are calibrated closely to the values observed in the economy, that is, a relatively high real interest rate of approximately 7%. In the second one we do the opposite, driving the implied interest rate to levels similar to the advanced economies, that is, a relatively low real interest rate of approximately 4%. In the third one, we allow the interest rate to reflect the systemic risk associated with an economy, which we operationalize as a debt-dependent interest rate.

We find that the reversal of the pension reform provides transitory welfare gains but in the long run is detrimental to welfare and replacement rates. We also find that these results are not susceptible to the implicit assumption behind the interest rate. In fact, the cohort distribution of welfare gains and losses is independent of the interest rates.

The article is structured as follows. In the next section, we present general insights from the literature. In Section III, we discuss in detail how the pension system is designed and modelled, including the changes implemented in 2011 and in 2013. Section V describes the calibration of the model, while in Section VI presents the results of this study.

II. Insights from the Literature in the Field

When introducing the reforms to the pension systems, one should expect consequences to emerge over a long horizon. Unfortunately, majority of the economic models has trouble encompassing changes in the demographics as well as consequences of eventual catching up. A viable solution to these shortcomings is offered by the OLG models as proposed originally by Auerbach and Kotlikoff (1987) and developed since. In these models, subsequent generations get born and optimize lifetime consumption subject to a wealth (or lifetime income) constraint. Individual savings serve the firms to invest and investment facilitates increase in output *per capita*.

Pension reform is a complex policy change. While population aging turns the traditional defined benefit pay-as-you-go (PAYG DB) system fiscally unsustainable, the design of reformed, defined contribution system is debatable. Issues to be considered, among others, include: the short- and medium-run costs of the reform, ways to finance those costs, the effects of the reform on consumption patterns in short and medium run, labour market effects, extent of distortion resulting from the method of pension reform financing as well as the long-term level of capital. The studies of the reform need to be explicit on the two vital dimensions characterizing the system: the choice between the defined benefit and defined contribution on the one hand, as well as the choice of the degree of pre-funding and the intergenerational distribution on the other hand. Typically, reforms which adjust the parameters of the pension system but do not actually introduce changes along any of these two dimensions are considered parametric reforms. The most frequent type of a systemic reform concerns a shift from DB PAYG to a (partially or fully) funded DC system (see Fehr (2009)).

In a pioneer study, Auerbach *et al.* (1989) show using an OLG model that in four analysed OECD countries (Japan, Germany, Sweden and United States), maintaining the PAYG DB system in an aging economy requires a considerable increase in taxation and at the same time leads to a deterioration of national savings and hence the capital stock. Subsequent studies encompassed both hypothetical and actual reform scenarios employing the OLG framework. In addition, there are also numerous econometric and nonsimulative general equilibrium approaches to analyse the reform. For example, subsequent to the policy papers by The World Bank in mid-1990s, Chlon *et al.* (1999) describe in detail the framework of Polish pension system reform. In a similar spirit, Chlon and Mora (2006) discuss introduction of a Notional Defined Contribution (NDC) system in the Czech Republic, Orbán and Palotai (2005) for Hungary, Rasner (2005) in Germany, just to name a few. A common note in the majority of papers is the expectation of greater financial stability and increase in the savings rate with a positive impact on output as an effect of change from PAYG DB system to a partially funded DC system.[3]

Studies based on OLG, which explicitly model all these issues, have grown in numbers. Majority of the papers in the literature point to superiority of the fully

[3] More recently, Góra (2013) shed light also on a political economy concepts such as the conflict of interest between the working and the retirees and the inter-generational distribution of the costs of the reform.

funded pension scheme over the PAYG pension scheme. Kotlikoff (1998) analyse effects of privatization of the US social security scheme. He shows that privatization brings a positive long-run effect on output of at least additional 10% and sizable welfare gains to the future generations.[4] The overall welfare effects depend on the ability to compensate the current generations. In a companion paper, Kotlikoff *et al.* (1999) arrive at similar results, showing that the costs to the transition generations can be brought down by allowing their participation in the new system on a voluntary basis.

One of the alternatives to a fully funded DC system is a notionally defined contribution (NDC) system, that is, DC system with PAYG financing. Boersch-Supan (2004, p. 1) provides the overview of features of such a system and argues that while NDC system changes 'the microeconomics of labor supply and savings, it does not, however, change the macroeconomics of PAYG systems and thus does not substitute for the introduction of funded second and third pillars' if demography is deteriorating. Using a stochastic OLG model calibrated to the Swedish data,[5] Auerbach *et al.* (1989) show that NDC model can be an useful device to prevent excessive debt accumulation and, if designed correctly, can assure stability of the pension system. Using a microsimulation model, Borella and Moscarola (2010) show that in Italy the replacement of the unsustainable DB system by NDC should lead to the postponed retirement, thus keeping the effective replacement rates close the pre-reform levels. Actually, the financing of the reform can have an important bearing on evaluating the welfare effects of the reform. For example, Hagemejer *et al.* (2013) show that the original pension reform introduced in Poland in 1999 is welfare enhancing, stimulating also capital accumulation – yet, distribution of across cohorts depends crucially on the method of financing. In fact, they show that financing the reform via public debt yields highest welfare improvement, at the same time most equally distributed among the cohorts living in the transition period.

To the best of our knowledge, there is virtually no literature on the reversal of the reforms to the (partially) funded DC systems. This is the case for two reasons: (i) prior to the global financial crisis, this was not considered a policy option; and (ii) such reforms would typically be parametric, that is, modify parameters of the system and not the system itself. The changes to the pension system undertaken by Baltic States, Ireland, Hungary and Poland raised an important research question concerning the long-run costs of changes in the pension system driven by short-time fiscal pressure. Nationalization of the fully funded tier of the pension system occurred in Hungary for example, while the funds were directly used for current budgetary needs. The 2011 and 2013 reform in Poland reduce substantially the funded pillar of the pension system. In the spirit of the OLG models, one should expect the decrease in the speed of capital accumulation. However, the proposed reforms could, in principle, fulfil the officially stated objectives: easing the fiscal tension while preserving the value of the pensions. The objective of this article is to see if that indeed is the case.

III. The Pension System in Poland and its Reform

The original pension reform from 1999 consists of two important components.[6] First, defined benefit system was replaced by a defined contribution system for virtually all cohorts. Only those who already started collecting pensions and individuals less than 10 years ahead of the official retirement age were exempt from this rule. The major difference between the defined benefit and defined contribution system consists of how the benefits are computed. In the former, the benefit is an *ex ante*-known proportion of wage received before retirement. In the latter, pension consists of individual stock of savings divided by one's remaining lifetime. The second component of the reform was introducing partial funding. While the first defined contribution pillar works on a PAYG basis, the second defined contribution pillar was to be fully funded.

In order to implement the change from defined benefit to defined contribution scheme, the legislation specified the way that the so-called 'initial capital' was to be computed for all individuals. Otherwise, individuals short before retirement would have no chance to collect savings. The 'initial

[4] Typically in this literature, long run implies 30–100 years.
[5] For details on Swedish pension system, see Fredriksen and Stoelen (2011).
[6] In what follows, we only discuss the mandatory components of the pension system.

capital' was to be computed based on individual employment tenure, with algorithms differentiated across genders and educational levels. Naturally, there were no actual savings in the SIF, but this calculation permits establishing the calculation of pensions for the cohorts who were born too early to participate in the post-reform system.

The introduction of the capital pillar creates a gap in the pension system[7] because part of the contributions is transferred to be invested in the capital market rather than used for the paying out of the current benefits. This gap, accumulated over time, contributes to the public debt. The introduction of the pension system reform in Poland involved transition periods. The two pillar reform became effective as on 1 January 1999 and was obligatory for all cohorts born on 1 January 1969 and younger. For the cohorts born between 1949 and 1969, the change from pay-as-you-go to NDC was mandatory, but there was no obligation to participate in the second pillar. In other words, the way the benefit was to be calculated changed for these generations, but they could decide that the entire contribution is directed to the NDC pillar in SIF. Finally, generations born prior to 1949 (thus at the age of 50 or older at the moment of pension system reform) stayed in DB PAYG pillar in SIF. Indexation in the NDC pillar is related to the payroll growth (annually this is 25% of the payroll growth), whereas in the FDC pillar increase in value is related to the performance of the capital markets.[8] The 1999 reform maintained the contributions rate at 19.52% of the gross wage, splitting the part of the contributions that goes to two pillars unequally. The PAYG pillar in SIF received 12.22% to pay out the current benefits, while 7.3% of the contribution was forwarded to the Open Pension Funds (OPFs). While the choice of a particular OPF was individual, participation in OPFs in general is mandatory. The legislation mandated OPFs to maintain a balanced portfolio with approximately 60% of contributions invested in what the legislation considers 'safe' asset, that is, government bonds.

The system in this shape continued to operate without significant changes for 12 years, yielding

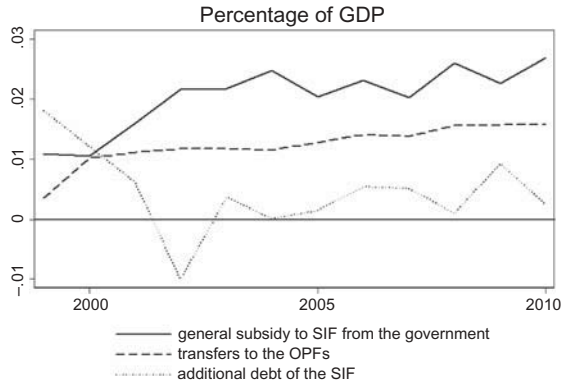

Fig. 1. The balance of SIF as a share in GDP
Source: Own elaboration based on the data from SIF annual reports.

an overall rate of return on savings invested by the OPFs at about 7.4% (net of transaction costs, in real terms). The gap in SIF was financed from the general budget, which used revenues from privatization, general taxes and debt to fill this gap. On average, the gap amounted to 1.2% of GDP each year, which is substantially less than the general subsidy for the SIF due to general imbalances (on average, 2.0% of GDP over this period) (Fig. 1).

Unprivatizing the social security – changes in the pension system

The changes in the pension system implemented in 2011 focused on reducing the share of contributions to be transferred to OPFs. The original 7.3% of the contribution was to be reduced temporarily to 2.3% in 2011 and raised in subsequent years to reach 3.5% from 2017 onwards. The legislation previewed that the contributions diverted away from the OPFs are to be recorded in separate individual accounts by the SIF, in addition to accounts already recording the general SIF contributions. The contributions diverted away from OPFs were to be indexed with the GDP growth rate (5-year moving average) rather than the payroll growth rate as in the case of the original individual accounts. Consequently, in 2011, the 4.9% of the gross wage was supposed to be directed

[7] Please note that the general balancing of the pension system is beyond the scope of this article, but has received adequate tackling in the model; refer to Section IV.
[8] According to Blake (2000), such design immunes the retirees to the business cycle fluctuations at the moment of retirement. Since capital markets are typically leading the business cycle, periods of high growth in the asset value precede periods of payroll growth and *vice versa*. In order for this mechanism to be effective, the proportion of social security contributions kept in the capital pillar and in the PAYG pillar should be fairly balanced.

to this dedicated additional account in SIF, whereas in the subsequent years, with the increase of the part of the contributions directed to the OPFs, this share was to be reduced to 3.7%.

In 2013, the government has proposed another set of reforms. Of the proposed set of four policy options, eventually one was chosen and passed in the form of new legislation. As a consequence, the share of contributions directed to the OPFs was further reduced for two reasons. First, the participation in the capital pillar, which was until now automatic and mandatory, has become voluntary with nonparticipation being the default option. Without expression of will, all accrued savings are transferred from OPFs to SIF and recorded in the form of NDC at individual accounts with SIF. Alternatively, part of the contributions can still be directed to OPFs, but this contribution was reduced to 2.92% of the gross wage. Open Pension Funds are supposed to gradually change the portfolio composition towards the risky assets (stocks) from the initial, balanced structure. Finally, the legislation converted all bonds in the possession of OPFs into NDC in individual accounts in SIF.

Table 1 summarizes the changes in the pension system. The objective of this article is to evaluate the effects of 2011 and 2013 reforms. Clearly, a reduction of contributions to the FDC pillar reduces the size of the gap generated in the SIF. On the other hand, it is not guaranteed that in the long run the indexation rates in the NDC accounts will be higher than the interest that would have been earned on capital in the FDC system. Also, capital accumulation should be slower, accompanied by less crowding out in the private savings. Due to these counteracting forces, the path of the interest rates may be higher or lower than in the baseline scenario of no changes to the 1999 reform. Given these ambiguities, the net effect on welfare and its distribution across cohorts remains an empirical issue.

Each of the reforms is modelled as a 'surprise' to the households, that is, we do not allow the households to make provisions *ex ante* for the changes in the pension systems. Thus, until 2010 (Year 11 of the simulation), economy follows the original 1999 reform path. As of Period 12, we design models for 2011 and for 2013 reforms. Two paths of simulations are used. First, we continue with the simulation of the original reform, which constitutes our *status quo*. In addition to this baseline scenario, we develop a simulation with features as described in Table 1 as of Year 12 of the simulation, following closely the legislation.

IV. Theoretical Model

We use an OLG general equilibrium model built along the lines of Auerbach and Kotlikoff (1987) and extended to match the features of the Polish economy by Hagemejer *et al.* (2013). Consumers can freely choose the level of labour supply up to retirement. Current income from labour and past savings can be either consumed or saved. In our setting, government collects taxes and balances the pension system. Our model features perfect foresight and – as is standard in the field – we introduce changes in the pension system as unexpected shocks.

Consumer choice

Consumers live for $j = 1, \ldots, J$ years and discount future with δ. Their goal is to maximize lifetime utility

Table 1. Overview of the analysed reforms

	Prior to 1999	1999	2011	2013
Contribution to PAYG DB (%)	19.52	0	0	0
Contribution to NDC[a] (%)	0	12.22	12.22	12.22
Contribution to NDC[b] (%)	0	0.00	4.9–3.7	4.38
Contribution to FDC (%)	0	7.30	2.3–3.5	2.92
Target portfolio (bonds : stocks)	none	60 : 40	60 : 40	0 : 100
Mandatory participation in FDC	n.a.	yes	yes	no

Notes: FDC denotes funded defined contribution, NDC denotes notionally defined contribution, PAYG DB denotes pay-as-you-go defined benefit.
[a]Indexed with 25% of payroll growth.
[b]Indexed with GDP growth.

$$U_j(c_{j,t}, l_{j,t}) = u_j(c_{j,t}, 1 - l_{j,t}) + \sum_{s=1}^{J-j} \delta^s \frac{\pi_{j+s,t+s}}{\pi_{j,t}} u_j(c_{j+s,t+s}, 1 - l_{j+s,t+s}) \quad (1)$$

where $c_{j,t}$ and $l_{j,t}$ denote, respectively, consumption and labour supply at age j in period t.[9] In our model, age $j = 1$ at which age agent is born corresponds to the age of 20 in the real world. Agents in our model live up to age of $J = 80$.[10] Additionally, the probability of surviving to period age j at birth is equal to π_j. We denote the size of the generation born in period t as N_t. In our model, there is heterogeneity across cohorts but not within. Between cohort heterogeneity stems from π changing with j and a cohort-specific productivity ω_j. Longevity is operationalized by mortality rates decreasing with t. Projected decrease in fertility is operationalized as a decreasing size of the 20-year-old cohort arriving in the model each period.

Consumers are free to choose their labour supply until the age of $\bar{J}$, when they are 'forced' to retire. Real wage is denoted as w_t (and is equal to the marginal product of labour). Additionally, individuals are characterized by age-specific productivity pattern ω_j and their gross labour income at age j is equal to $l_j \cdot w \cdot \omega_j$. Agents have to pay labour income tax and social security contributions at rates, τ_l and τ_ι, respectively, where ι denotes a pension system $\iota \in DB, NDC^1, NDC^2, FDC$ (see Table 1). Interest earnings on savings r_t are taxed with τ_k. In addition, there is a consumption tax τ_c as well as a lump sum tax/transfer Υ_t equal for all generations. Agents' savings $s_{j,t}$ constitute of a bundle of capital assets and government bonds which pays interest rate r_t, which is taxed with τ_k. Thus, the budget constraint at time t is given by

$$(1 + \tau_{c,t})c_{j,t} + s_{j,t} + \Upsilon_t = (1 - \tau_{l,t})[(1 - \tau_{\iota,t})\omega_j w_t l_{j,t} + b_{\iota,j,t}] + (1 + r_t(1 - \tau_{k,t}))s_{j,t-1} + beq_{j,t} \quad (2)$$

where $b_{\iota,j,t}$ denotes pension benefit for person at age j in time t. The unintentional bequests – denoted by $beq_{j,t}$ – are redistributed within cohort.

Production

Producers combine capital and labour to produce a consumption good. They have access to the Cobb–Douglas production function $Y_t = K_t^\alpha (z_t L_t)^{1-\alpha}$, where Y_t, L_t and K_t denote aggregate output, aggregate labour and aggregate capital, respectively. We allow for exogenous labour augmenting technological progress $\gamma_{t+1} = z_{t+1}/z_t$. The problem of the firm is standard and yields the following first order conditions for wages and interest rates:

$$w_t = (1 - \alpha)K_t^\alpha z_t^{1-\alpha} L_t^{-\alpha} \text{ and } r_t^k + d = \alpha K_t^{\alpha-1}(z_t L_t)^{1-\alpha} \quad (3)$$

Note that if the return on capital rate is r_t^k, then the rental rate r_t must be $r_t^k + d$, where d denotes capital depreciation.

Pension system and its reform

Prior to the 1999 reform, the pension system collects contributions from the working and pays benefits to the retired.

$$\sum_{j=\bar{J}}^{J} \pi_{j,t} N_{t-j} b_{j,t}^{DB} = \tau_t^{DB} \sum_{j=1}^{\bar{J}-1} w_{j,t} \pi_{j,t} N_{t-j} l_{j,t} + subsidy_t^{DB} \quad (4)$$

where $subsidy_t^{DB}$ is a subsidy/transfer from the government to balance the pension system (see Fig. 1). The pensions are computed as $b_t^{DB} = \rho \cdot \omega_{\bar{J}} w_t l_{t,\bar{J}}$.

After the 1999 reform, the DC-funded pension system collects contributions as individual stock of (mandatory) pension savings and at retirement converts them to annuity. For simplicity, we denote by τ^{NDC} the obligatory contribution rate in the PAYG

[9] Following Imrohoroglu et *al.* (2003), we have also analysed the consumers who discount future in a quasi-hyperbolic fashion, with $U_j(c_{j,t}, l_{j,t}) = u_j(c_{j,t}, 1 - l_{j,t}) + \beta \sum_{s=1}^{J-j} \delta^s \frac{\pi_{j+s,t+s}}{\pi_{j,t}} u_j(c_{j+s,t+s}, 1 - l_{j+s,t+s})$ and $\beta \leq 1$. It did not affect the conclusions. The detailed results are available upon request.

[10] This reflects the availability of the demographic data, where individuals aged 99 years and older are collapsed to one group.

pillar and by τ^{FDC} the mandatory contribution rate in the funded pillar, whereas b^{NDC} and b^{FDC} denote benefits from these two components of the pension system. Following the 1999 reform, NDC component of the pension is thus coupled with a funded component

$$\sum_{j=\bar{J}}^{J} \pi_{j,t} N_{t-j} b_{j,t}^{NDC} = \tau_t^{NDC} \sum_{j=1}^{\bar{J}-1} w_{j,t} \pi_{j,t} N_{t-j} l_{j,t} + subsidy_t^{NDC} \tag{5}$$

$$b_{j,t}^{NDC} = \frac{\sum_{s=1}^{\bar{J}-1} \left[\Pi_{t=NDC}^{s} (1 + r_{t-j+\iota-1}^{NDC}) \right] \tau_{t-j+s-1}^{NDC} \omega_j w_{t-j+s-1} l_{j,t-j+s-1}}{\Pi_{s=\bar{J}}^{J} \pi_{s,t}} \tag{6}$$

$$\sum_{j=\bar{J}}^{J} \pi_{j,t} N_{t-j} b_{j,t}^{FDC} = \tau_t^{FDC} \sum_{j=1}^{\bar{J}-1} w_{j,t} \pi_{j,t} N_{t-j} l_{j,t} + subsidy_t^{FDC} \tag{7}$$

$$b_{j,t}^{FDC} = \frac{\sum_{s=1}^{\bar{J}-1} \left[\Pi_{\iota=FDC}^{s} (1 + r_{t-j+\iota-1}^{FDC}) \right] \tau_{t-j+s-1}^{FDC} \omega_j w_{t-j+s-1} l_{j,t-j+s-1}}{\Pi_{s=\bar{J}}^{J} \pi_{s,t}} \tag{8}$$

where $r_t^{FDC} = r_t$ and r_t^{NDC} is the payroll growth. In concordance with the legislation, after retirement pensions are indexed with 25% of the payroll growth in the NDC pillar, $b_{j,t}^{NDC} = (1 + 0.25 r_t^{NDC}) b_{1,j-1,t-1}$, and with the interest rate in the second pillar, $b_{j,t}^{FDC} = (1 + r_t) b_{j-1,t-1}^{FDC}$. By definition, DC systems are individually balanced, that is, the net present value of pensions received from the system equals the net present value of contributions to the system. However, at each point in time *t,* both SIF and the OPFs may record surplus or deficit, depending on the current population structure. In addition, SIF still carries the pensions calculated according to the DB mechanism for all generations born up to 50 years prior to the reform.

The analysed reforms consists of two important components: (i) changing the values for the τ^{ι} for $\iota \in NDC, FDC$ and (ii) creating a sub-account in the SIF (additional NDC pillar) with a different indexation rate. In fact, the reform implies that the new pillar is analogous to the original NDC pillar; so, τ^{NDC} in Equation 5 becomes τ^{NDC1}, twin τ^{NDC2} is established, with b^{NDC2} similar to Equation 6, but with growth rate of the economy instead of the payroll to pin down r_t^{NDC2}.

The government

Naturally, in addition to balancing the social security, the government collects taxes on earnings, interest and consumption and spends a fixed share of GDP on unproductive (but necessary) consumption. Labour income tax $\tau_{l,t}$ and social security contributions $\tau_{\iota,t}$ are deducted from gross income $\omega_j w_t l_{j,t}$ to yield disposable labour income. Interest earned on savings r_t are taxed with $\tau_{k,t}$. In addition, there is a consumption tax $\tau_{c,t}$ as well as a lump sum tax/transfer Υ_t equal for all generations, which we use to set the budget deficit in concordance with the data.

Given that the government is indebted, it also services the outstanding debt. The legislation considers the government bonds to be a riskless asset. Consumers in our model have no preference over risk, which implies the only interest rate relevant for decision-making is r_t as specified in Equation 2. Yet,

it is rather unrealistic that the government finances public debt at the same cost as firms. Also, with the prevailing real interest rate of approximately 7%, as was recorded in the first decade after the original pension system reform, the public debt would accumulate relatively fast. In fact, in 1999, the debt-to-GDP ratio amounted to 45%, whereas according to the Polish legislation, once the debt reaches 55% share in GDP the government is obliged to run a balanced budget. In the attempt to replicate the actual fiscal conditions in Poland closely, we chose to introduce a government 'riskless' rate of r_t^G.[11] Benchmarking to the literature and to the data, we consider that the government services the debt at approximately 33% of the market interest (see Nishiyama and Smetters (2007)).

Given that consumers have no preference over government bonds and assets, we assume that the demand for bonds is inelastic, whereas the demand for assets is residual. The savings thus earn the interest rate $r_t = \alpha_t \cdot r_t^G + (1-\alpha_t) \cdot r_t$, where α_t is determined endogenously and $r_t^G = 0.33 \cdot r_t$. Note, that we do not encourage excessive 'cheap' debt accumulation in our model. Quite to the opposite, to mimic the legislation, the overall debt-to-GDP ratio is not allowed to exceed 60% of GDP in the model, which is the constitutional limit in Poland. Once this threshold is hit, taxes immediately adjust to drive the debt back to the threshold. Thus, the supply of bonds is constrained in the model, as it is in the Polish economy.[12] We calibrate the initial data level and final steady state at 45% of GDP, which was the actual value of debt to GDP ratio in 1999. We calibrate Y_t in the steady state to match the deficits and debt to maintain long run debt/GDP ratio fixed and keep it unchanged throughout the whole path.

Summarizing, the government collects taxes (τ_k on capital, τ_l on labour and τ_c on consumption) and spends a fixed share of GDP on unproductive yet necessary consumption $G_t = \gamma * Y_t$.

$$T_t = \tau_{l,t}((1-\tau^{\iota})w_t L_t + \sum_{j=J_t}^{J} b_{j,t}^{\iota}\pi_{j,t}N_{t-j}) + (\tau_{c,t}c_t + \tau_{k,t}r_t s_{j,t-1})\sum_{j=1}^{J}\pi_{j,t}N_{t-j} \tag{9}$$

$$G_t + subsidy_t^{\iota} + r_t^G D_{t-1} = T_t + (D_t - D_{t-1}) + \Upsilon_t \sum_{j=1}^{J}\pi_{j,t}N_{t-j} \tag{10}$$

Our model also features a Lump Sum Redistribution Authority (LSRA) which we use to evaluate welfare effects of the reform. LSRA compensates the losers from the gains of the winners from the reform. Surplus or deficit in LSRA informs us about overall effect of the reform. We express it in terms of permanent consumption. The final net balance of LSRA contributes to government budget, which implies that LSRA redistributes the net present value of consumption equivalent – see Nishiyama and Smetters (2007) – discounted at the interest rate pertinent to the government, denoted as r_t^G.

Fiscal closures

From a theoretical perspective, there are two possible fiscal adjustments to accommodate for the 'unprivatizing' of the social security: a decrease in taxation or a reduction in the public debt.[13] Since taxes are distortionary, reducing the debt may in fact imply suboptimal welfare outcomes. Reduction of debt implies welfare improvement to younger/future cohorts (less debt overhang to be paid in the future). On the other hand, reduction of taxes implies welfare improvement for the older cohorts (debt overhang will be carried to the future generations, while the older ones pay lower taxes). Summarizing, it is

[11] Results for a calibration with one interest rate calibrated to approximately 7% are available upon request.
[12] In fact, model produces bond share in portfolios of approximately 15–25% in the baseline scenario.
[13] Clearly, in reality there is also a third option of increasing public expenditure, but that would be yet another policy change in addition to the pension system. Also, unless government expenditure has a direct bearing on utility of consumers, higher government expenditure implies more waste, as it would be in our model. We discard this scenario as unmotivated by data and uninteresting in our model.

possible that the government reduces the taxes gradually, keeping debt levels unchanged. Alternatively, it is possible that the government continues with lower debt, keeping the taxes unaffected.

We do not know which of the policy options will be selected by the government, neither can we decide *ex ante*, how the adjustment would have been in the baseline scenario. The nature of the 'unprivatizing' puts more pressure on the SIF in the future, providing a fiscal relief in the short run. Given these characteristics, we want to be conservative about the fiscal closures, giving the model a chance to produce welfare enhancement in relation to the baseline scenario.

Following this reasoning, we assume that in the baseline scenario of no policy change, debt cannot exceed the legal limit of 55% of GDP until the death of the last cohort born prior to the 1999 reform and tax adjusted accordingly.[14] To avoid sudden jumps in the taxes, we design a smoothening rule for the tax rate.

$$tc_{t+1} = \xi\tau_{c,T} + \psi\tau_{c,t} + \mu * (debt(t)/y(t) - 55\%) \tag{11}$$

The persistence parameter is $\psi = 0.85$, whereas the target debt level has a weight of $\mu = 0.03$.[15] In the baseline scenario, the debt has a natural tendency to exceed the 55% share in GDP, so the fiscal rule described in Equation 11 implies a gradual increase of the consumption tax to curb the growth of the public debt.

Once the youngest cohort born prior to the reform is gone, the debt slowly declines to its final steady state value of 45% debt-to-GDP ratio in the baseline scenario. The return to the final steady state follows a fiscal rule in which debt above the target value triggers a tax increase, but with targeting the final steady state value and smoothing *via* persistence parameter on taxes and debt. More formally, we replace the value of 55% with the value of 45% in Equation 11. We follow the slow convergence in the reform scenarios as well. This is consistent with the contention that fiscal policies should be analogous in the final steady state for the comparison of the reforms to remain meaningful.

Prior to the convergence periods in the reform scenario, we design two possible behavioural rules for the fiscal authorities, which are extremes of the continuum of policy options that the fiscal authorities actually have. In the first one, we keep tax rates the same as in the baseline scenario of no reform and allow the debt to adjust downwards. We call this the debt closure.[16] Naturally, to avoid sudden jumps, debt adjusts with a persistence parameter. In the second one, we take the opposite assumptions. Namely, we keep the debt level at around 55% of GDP and allow the taxes to adjust (with a persistence parameter). We call this the tax closure.

At the time of the 'unprivatizing', both the tax closure and debt closure would experience sudden jumps in the couple variable, because the changes to the pension system from 2011 and from 2013 generate quite substantial immediate reduction in the extent of imbalance in SIF. In the tax closure, for example, keeping the debt unchanged implies a substantial reduction in taxes, which any fiscal rules can only smoothen.

Market clearing conditions and model solving

Market clearing in the goods market implies

$$\sum_{j=1}^{J} \pi_{j,t} N_{t-j} c_{j,t} + G_t + K_{t+1} = Y_t + (1-d)K_t \tag{12}$$

where G_t denotes government expenditure. This equation is equivalent in stating that at each point in time the demand for the goods from the consumers, the government and the producers would be met. Additionally, we have market clearing conditions for the capital market and labour market.

[14] In fact, in a year prior to 'unprivatizing' of the social security, in the data, the debt share in GDP amounted already to 54%, whereas in our preferred calibration of the model it was 52%.

[15] The results are robust to the choice of these parameters, but the computations are more likely to yield convergence if persistence is large and weight on debt departure is low.

[16] The reform of 2013 consisted also of converting the bonds in the possession of OPFs into NDC at individual accounts in SIF, that is, 'tearing' the bonds. Consequently, it is imperative that the immediate effect of the reform is the reduction of debt. We mimic that feature by reducing the debt path by the same amount in the debt closure.

$$L_t = \sum_{j=1}^{\bar{J}-1} \pi_{j,t} N_{t-j} \omega_{j,t} l_{j,t} \text{ and } K_{t+1} = (1-d)K_t + \sum_{j=1}^{J} \pi_{j,t} N_{t-j} \hat{s}_{j,t} \quad (13)$$

where $\hat{s}_{j,t}$ denotes private savings net of bond holdings as well as accrued obligatory contributions in fully funded pillar of the pension system.

We use the Gauss–Seidel algorithm. We solve the initial and the final steady states. We set the transition path to 400 periods. We solve each model three times. First, we solve it for the baseline scenario of no policy change. Second, we solve it for the reform scenario. We follow Nishiyama and Smetters (2007) in computing the transfer/tax for each cohort that would have been allocated by the LSRA. We distribute these transfers/taxes and solve the model for the third time.

V. Calibration

In our model, behaviour of population is taken from the demographic projection for Poland. As an input data we take the number of 20-year-olds for each period in time and we use mortality rates – as implied by the projection – in order to establish the number of agents in each cohort. Our model does not distinguish between sexes; therefore, we use the weighted average of the mortality rates for both sexes. The demographic projection is available until 2060. We assume that the population stabilizes at a new steady state afterwards. Stable population is obtained by keeping the birth rates and the mortality rates equal to the values projected for 2060. Since the lifetime span in our model amounts to 80 years, the population becomes stable at around the period 140 (10 years of data, 50 years of projection and 80 years for stabilization). Note that the assumption of stable population is conservative and favours systems based on PAYG schemes. Should the old age dependency ratio continue to deteriorate past 140 periods, this would be reflected in gradually worsening balance of SIF.

The growth rate of productivity growth for the next 50 years were taken from the projection by the Aging Work Group of the European Commission, which contains such projections for all EU Member States. It was constructed under the assumption that poorer countries will continue to catch up until around 2030 when productivity in all countries will be slowly converging towards the value of 1.7% *per annum.* We also set the leisure preference parameter ϕ so that the aggregate labour supply matches the participation rate of 56.8%, as observed in 1999. As it is common in the literature, $\alpha = 0.3$. Table 2 presents the values of the parameters.

We set the discount factor δ so that the interest rate in the economy matched the targeted values. As discussed earlier, catching-up economies are characterized by fairly high interest rates, which is not likely to persist in the future. To account for that, we develop three calibrations. In the first calibration, our target interest rate is approximately 7% annually, which mimics the data on real interest rate, net of transaction costs over the period 1999–2013. Once δ is set, we set the depreciation rate d so that the

Table 2. Calibrated parameters

	Parameters	Calibration 1	Calibration 2	Calibration 3
ϕ	Preference for leisure	0.560	0.499	0.560
δ	Discounting rate	1.008	1.04	1.008
D	Depreciation rate	0.043	0.01	0.043
τ_l	Labour tax	0.11	0.11	0.11
τ	Social security contributions.	0.061	0.061	0.061
ρ	Replacement rate	0.152	0.162	0.152
			Outcome values	
$\Delta k_{t+1}/y_t$	Investment rate	21.1	21.7	21.1
r	Interest rate	7.0	4.2	7.0

investment rate matches the one in the data, that is, approximately 21%.[17] The achieved calibrations are the closest feasible with the available input data.[18]

Please note that although discounting rate δ exceeds 1, consumers actually do prefer presence to future. First, in discounting, they take into account survival probability $\pi_{j,t}$ (see Equation 1). Longevity naturally implies that consumers become somewhat more patient. Second, this is calibration for an increasing age-productivity pattern. One unit of work brings higher revenue at older ages, which explains better why δ exceeds unity.

Although Nishiyama and Smetters (2007) calibrate interest rate in their model to 6.25% for the US economy, we consider this value high. Thus, in a second version of the model calibration we set the δ to target the interest rate of approximately 4% annually. This is at odds with the data for Poland AD 1999, but we treat this calibration as consistent with the following type of counter-factual thinking: what would Polish economy be like if it were an advanced, developed economy in 1999. Clearly, there is no value of depreciation rate *d,* that can satisfy the investment rate of 21% in that economy (see Table 2).

Finally, we develop a third specification where the interest rate depends on public debt. The government interest rate responds to the changes in public debt, increasing when debt-to-GDP ratio exceeds 45% and decreasing otherwise. The departure from the target debt share in GDP translates to the government interest rate at the rate of 0.05 (i.e. 1 percentage point (pp) departure from 45% translates to 0.05 pp increase in the interest rate). This assumption is particularly conservative from the perspective of the evaluated unprivatizing of the social security. Namely, decrease in public debt implied by the changes to the pension system translates to lower costs of servicing debt by the government. Conversely, in the baseline scenario, where the costs of transition from a PAYG to a partially pre-funded system accumulate, the government is servicing debt at a relatively higher cost.

The productivity across life cycle is a subject of a sizable body of literature. The major problem from an empirical viewpoint lies in disentangling the age effects from cohort and time effects. Although a number of the microeconometric studies provide estimates of an inverted U-shaped pattern,[19] controlling for cohort effects and self-selection makes the age-productivity relation fairly flat or – if anything – slightly increasing until the age of 65 (see Boersch-Supan and Weiss (2011)). We follow Deaton (1997) to decompose the differences in individual productivities into age, cohort and time effects. To this end, we use 16 years of consecutive quarterly Labour Force Survey data-sets. We standardize the age effects to average 1. Figure 2 (left panel) presents the obtained age productivity profile. This set of parameters is stable throughout time. Please note that this is a conservative assumption favouring PAYG systems, since a change in the population structure due to aging implies a boost to total labour productivity because of effectively changing weighting of ω_j than in the initial steady state.

Prior to 2009, *de iure* retirement age was 60 for women and 65 for men. However, due to numerous exceptions, the actual retirement age was much lower. These exclusions from the general rule were mostly removed as of 2009, and at the same time the legal retirement age was gradually increased and is supposed to reach 67 for men in 2018 and for women in 2040. To account for these facts, as long as data are available, we take the actual effective retirement age and for future years, we gradually increase $\bar{J}$ to mimic the increase in *de iure* retirement age. This path of $\bar{J}$ is implemented in baseline and reform scenarios alike. This assumption again is conservative, favouring the systems based on PAYG mechanism. The legislative and cohort effects are reflected in a path of retirement age in our model; refer Fig. 2 (right panel).

Finally, the 1999 reform introduced a two-pillar pension system comprising notional and funded accounts. This necessitated providing estimates of the stock of 'accumulated savings' for the generations who have already had work experience prior to the reform, but the contributions were not recorded with SIF, let alone accumulated with the OPFs. Following detailed legislation, SIF computed the initial capital for all cohorts subjected to the reform;

[17] Depending on the period over which the average is taken, it ranges from 20.8% for 5 years ahead and 5 years post reform, 23.1% for 2 years before–after span and 24.1% for a 1 year before–after span. Average for a period between 1995 (first reliable post-transition data) and 2010 amounts to 20.7%.
[18] Not all values of the parameters produce feasible solutions on the path.
[19] See, for example, Skirbekk (2004) and a forthcoming special issue of Labor Economics (volume 22, 2013).

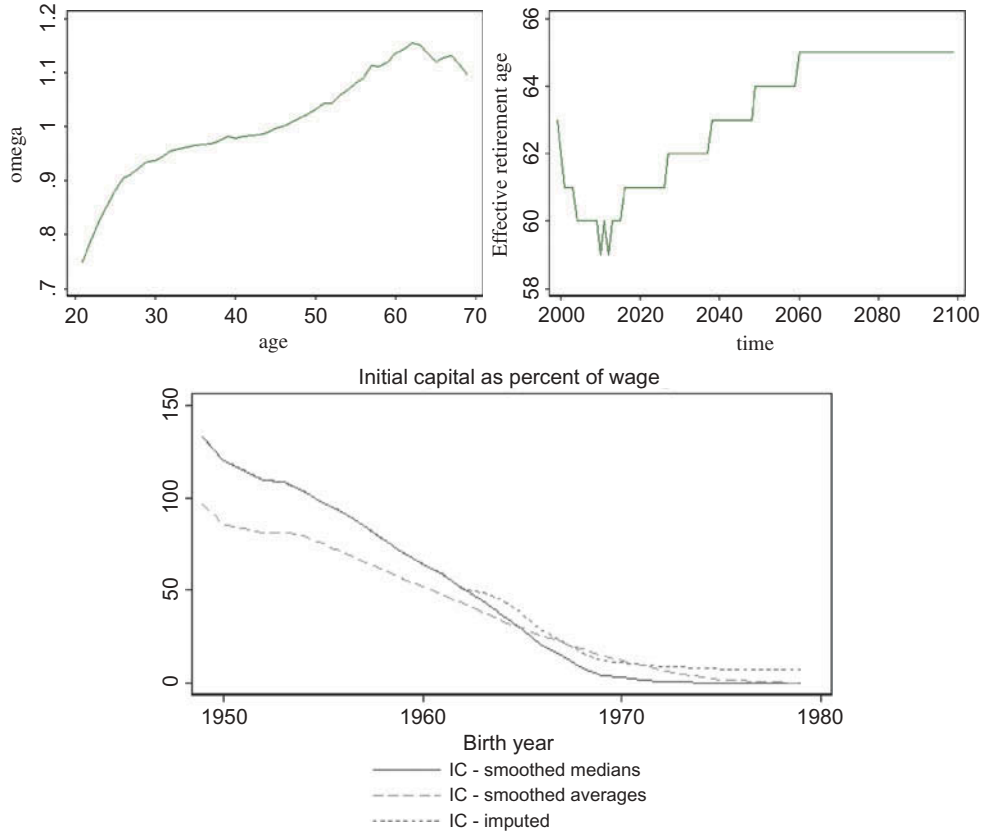

Fig. 2. Age-specific productivity multiplier (left), actual retirement age in economy, past values and forecasts (right) and initial capital as per cent of wage (bottom)
Source: For age-specific productivity multiplier, own computation according to Deaton (1997) decomposition using 16 years of LFS data for Poland. Effective retirement age based on SIF annual reports, own projection. For initial capital, own computation based on individual savings data from SIF.

see bottom panel of Fig. 2. Based on the microeconomic data-set, we computed the mean and median distribution of the initial capital across cohorts and expressed it in terms of the initial steady state wages. We use these values to impute the records in SIF for all cohorts born between 1949 and 1979.

Since the coverage for taxes and social security contributions is incomplete,[20] we set the labour tax rate and the social security contributions rates such as to match the macroeconomic aggregates of tax revenue. Thus, labour income tax is set at effective 11% (compare with *de iure* tax rates of 18% and 32%). We make the consumption tax rate equal to 11% to match the share of revenues from this tax in aggregate consumption in 1999. Since there are no tax exclusions for capital income tax, we set it at the *de iure* level of 19%. Additionally, we set the effective contribution rate such that the pension system deficit in percentage of GDP in the original DB steady state matches the one observed in the data. The effective contribution rate in our model turns out to be approximately 6% (compare with *de iure* 19.52% of payroll). We use the data on the FDC pillar participation in order to split contributions between pillars for the 1949–1969 generations accordingly.

Moreover, the pension reform implied that the SIF needs to compute the so-called initial capital for all cohorts participating in DC system. Intuitively, the initial capital reflects the counter-factual scenario on what would be the value of the records in the NDC individual account had the NDC system been instated already in the past. Based on the SIF

[20] The incomplete coverage is a consequence of differences of effective taxation of different forms of labour as well as a large number of exceptions, redemptions and caps in a tax system. All of which lowers the actual share of tax revenues in incomes.

reported, initial capital across cohorts' medians were computed (see Fig. 2). To assure comparability with the model, initial capital is expressed in terms of average wage.

VI. Results

For the model to be solved, we first establish the initial and final steady states on a path. The length of the path assures that the new steady state is reached slowly, that is, last generation analysed lives the whole life in the new demographic steady state. While eventually the length of the path was set to 400 periods, it is actually irrelevant for the results as long as it exceeds 220 periods (60 years of demographic projection plus 80 years of population stabilization plus 80 years of optimization of the first generation born in the new steady state). Following Holzman and Stiglitz (2001), we focus on comparing the reform scenarios along the paths, rather than initial and final steady states only.

First, we discuss welfare effects of the reform. As revealed in Table 3, regardless of the calibration, overall the 'unprivatizing' is welfare deteriorating. Understandably, the tax closure gives little room for the reform to play – immediate effects of fiscal improvement translate to temporarily lower tax rates, but in the end, economy is taken back to the same final steady state as in the case of baseline scenario. Welfare deterioration stems from somewhat lower replacement rates. Conversely, in the debt closure, the lower the initial interest rate, the less the room for welfare gain when debt decreases. In fact, the reform has most detrimental effects when the interest rate calibrated in the initial steady state is the lowest. The welfare based ordering is preserved across tax closures, which suggests that our results are fairly robust.

Table 3. Welfare effects of the reform

Fiscal closure	Calibration 1 (%)	Calibration 2 (%)	Calibration 3 (%)
	Consumption equivalent as % of permanent consumption		
Debt closure	−1.56	−2.58	−1.19
Consumption tax closure	−0.87	−0.78	−0.90

Notes: Calibration 1 is based on actual data and matches an interest rate of 7% in the initial steady state. Calibration 2 reflects a scenario of 'caught up' economy, with an interest rate at 4%. In Calibration 3 in the initial steady state, the interest rate is benchmarked to 7%, but subsequently follows public debt.

Interest rates have little bearing on the cohort distribution of welfare losses/gains, but naturally does affect the magnitude of these effects. In the case of the consumption tax closure, older cohorts gain because the extent of distortion is lower than in the baseline scenario with a fiscal rule adjusting taxes so that the debt never exceeds 60%. The winners mostly comprise cohorts who see no effect on replacement rates because their pensions come from the DB PAYG system. Losers recruit from all cohorts born at the time of the original reform or in the future and follow from lower replacement rates and – possibly – general equilibrium effects (lower output). The effects are the smallest in the case of Calibration 2, but preserve the same cohort pattern.

In the case of the debt closure, since distortions are similar to the baseline scenario of the original reform, cohorts living at the time of reform experience small welfare loss, possibly because of somewhat lower consumption due to the adjustment on capital and thus output. The winners comprise approximately 80 cohorts born at the moment of the 1999 reform and afterwards. These cohorts bear the costs of the pension reform due to increased taxes and reduced effective replacement rates in the baseline scenario. Once public debt is not accelerated by establishing a prefunded pillar, these cohorts gain. Yet, in the long run the effects associated with lower pensions and lower capital accumulation (and thus output) dominate, making the 'unprivatizing' welfare deteriorating in the long run.

The overall welfare effects displayed in Table 3 integrate the bars displayed in Fig. 3 over time, with discounting at the prevailing interest rate. Lower interest rate implies that future losses are less important when compared to 'current' gains (be it living cohorts or cohorts who are just arriving to the economy). Thus, the interest rate may influence the sign of the welfare effects reported in Table 3. Yet, the cohort distribution of the welfare effects is fairly immune to the interest rate. Nishiyama and Smetters (2007) compare a scenario with endogenous interest rate to a one where interest rate is given exogenously. In the former, the interest rate decreases along with the capital accumulation – as in all our

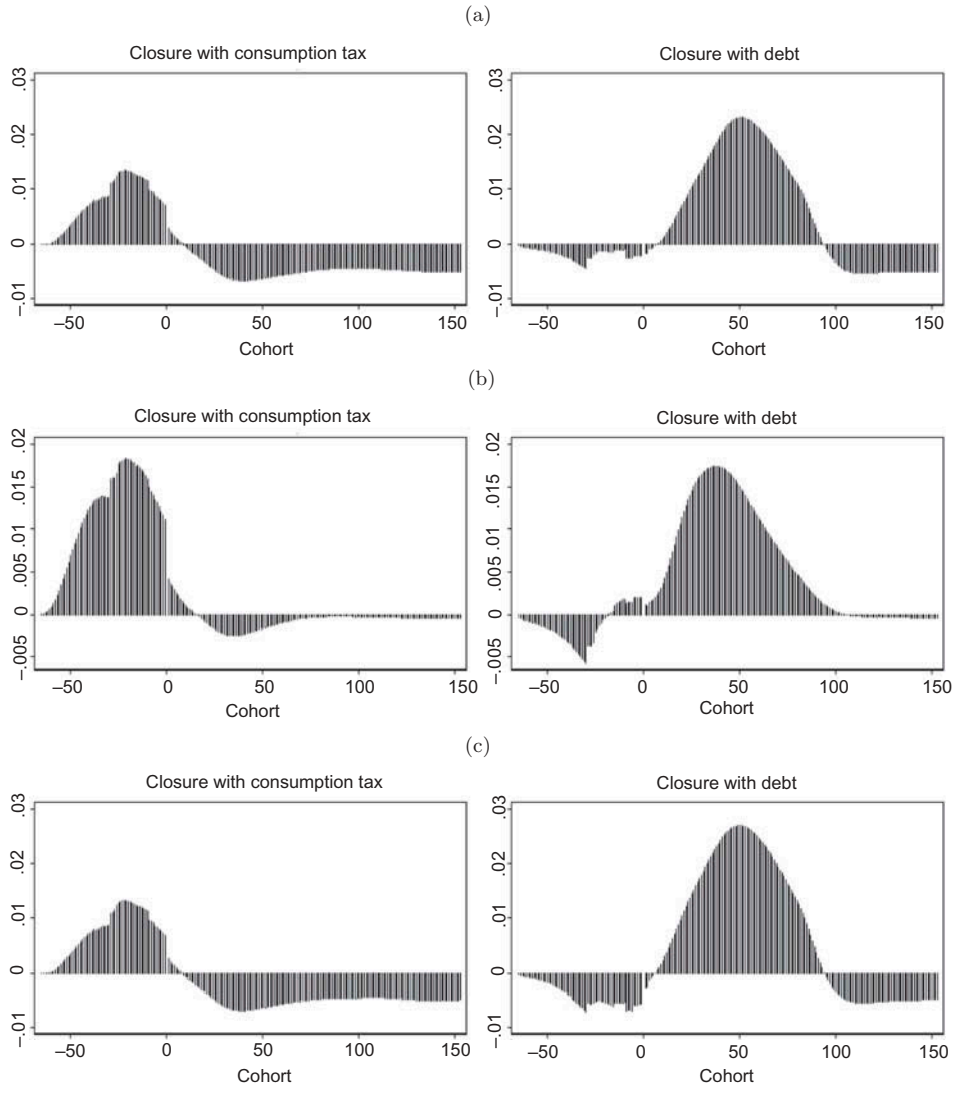

Fig. 3. Consumption equivalents (a) Calibration 1 (initial steady state interest rate calibrated to 7%) (b) Calibration 2 (initial steady state interest rate calibrated to 4%) (c) Calibration 3 (initial steady state interest rate calibrated to 7% and subsequently follows debt)

calibrations. In the latter, it does not change along the transition path and remains higher in the final steady state – discounting future happens at a relatively higher rate. Our comparison for the high and low interest calibration reveals that in general with lower interest rates, pension reforms have smaller welfare effects, but this reflects differences in preferences rather than actual level effect of interest rates *per se*, for example, privatization of the social security, introducing 'forced' savings in the pre-funded pillar, has a smaller effect on savings (and thus capital) if agents save much anyway.

In the reminder of this section, we discuss briefly the behaviour of the macroeconomic variables, as suggested earlier. All results show variables after the redistribution by the Lump Sum Redistribution Authority, but given the small size of the welfare effects, results with and without LSRA do not differ substantially. Importantly, negative balance of LSRA contributes to increasing the public debt.

Figure 4 reports the behaviour of the capital. Immediate effect of the reform consists of transforming the current private savings into future pension obligations. Consequently, the 'unprivatizing' implies a sudden drop in capital, relative to baseline scenario of continuing with the 1999 reform. In the case of the tax closure, where debt is unaffected by the reform, this initial shift continues to the final steady state

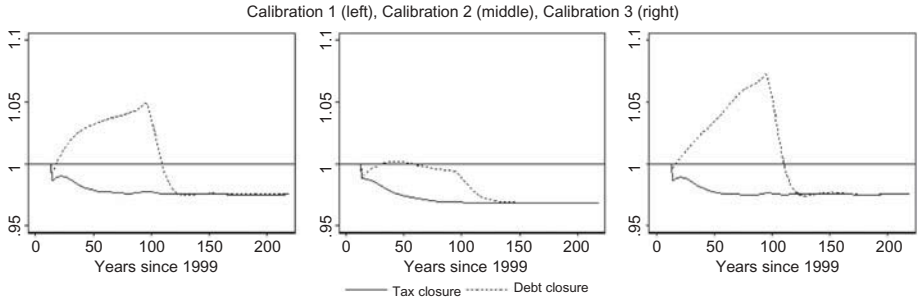

Fig. 4. Capital stock per worker (the ratio to the baseline)

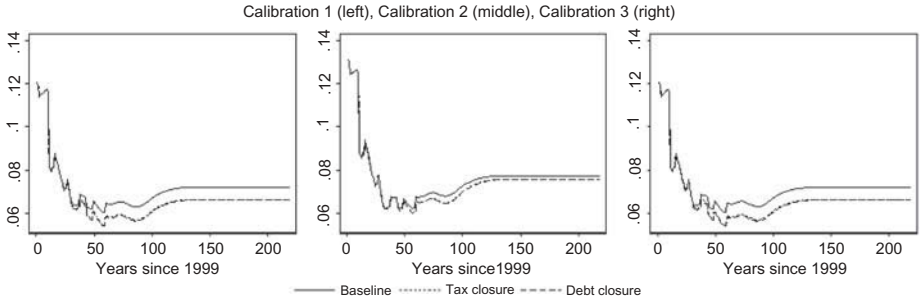

Fig. 5. Replacement rates

yielding a capital stock lower by approximately 3% than the baseline. Since the 'unprivatizing' consist mostly of adjusting the amount of savings in the capital pillar, the changes in the stock of capital are closely related to that of the debt. However, for capital, three effects interact. First, less public debt implies lower crowding out and higher overall rate of return. For these two reasons, private savings grow. Second, in our model agents have perfect foresight. Thus, expecting lower replacement rates they *ex ante* increase private savings to smooth life-time consumption.[21] The above effects exhibit in raising the capital stock relative to the benchmark of no policy change. Third, reduction of the savings in the OPFs causes the capital stock to drop (relative to baseline). In the debt closures, decrease of public debt necessitates lower crowding out, which increases the capital stock. Yet, this effect is transitory due to the assumption that in the final steady states debt levels should be the same in the baseline and reform scenarios. The overall decrease in capital stock due to smaller extent of pre-funding is definitive, but not large, given the relatively small extent of pre-funding in the baseline scenario.

Lower pre-funding implies also lower replacement rates, even in the scenario where the interest rate is lower than the GDP growth rate in the initial steady state (see Fig. 5). Majority of the decrease comes from the fact that a DB scheme is replaced with a DC one, displayed by the behaviour of the replacement rates in the baseline scenario. The effective replacement rate is expected to approximately halve due to longevity, despite the increase in the effective minimum eligibility retirement age in the baseline scenario. The 'unprivatizing' adds approximately 8% to that decrease in our preferred Calibration 1. In our economy, demography is unfavourable, which lowers the indexation in the NDC^2 pillar. In fact, indexation is lower than the returns offered in the OPFs (i.e. market interest rate). Please note that this is not an assumption concerning the ratio between productivity of capital and growth rate, but rather a feature associated with the deteriorating demographics.

Figure 6 portrays fiscal adjustments in baseline scenario and in the reform scenario for both closures. Reduction in pensions due to replacing DB with a DC scheme turns SIF balance from a deficit to a

[21] The latter is not likely to materialize strongly in reality.

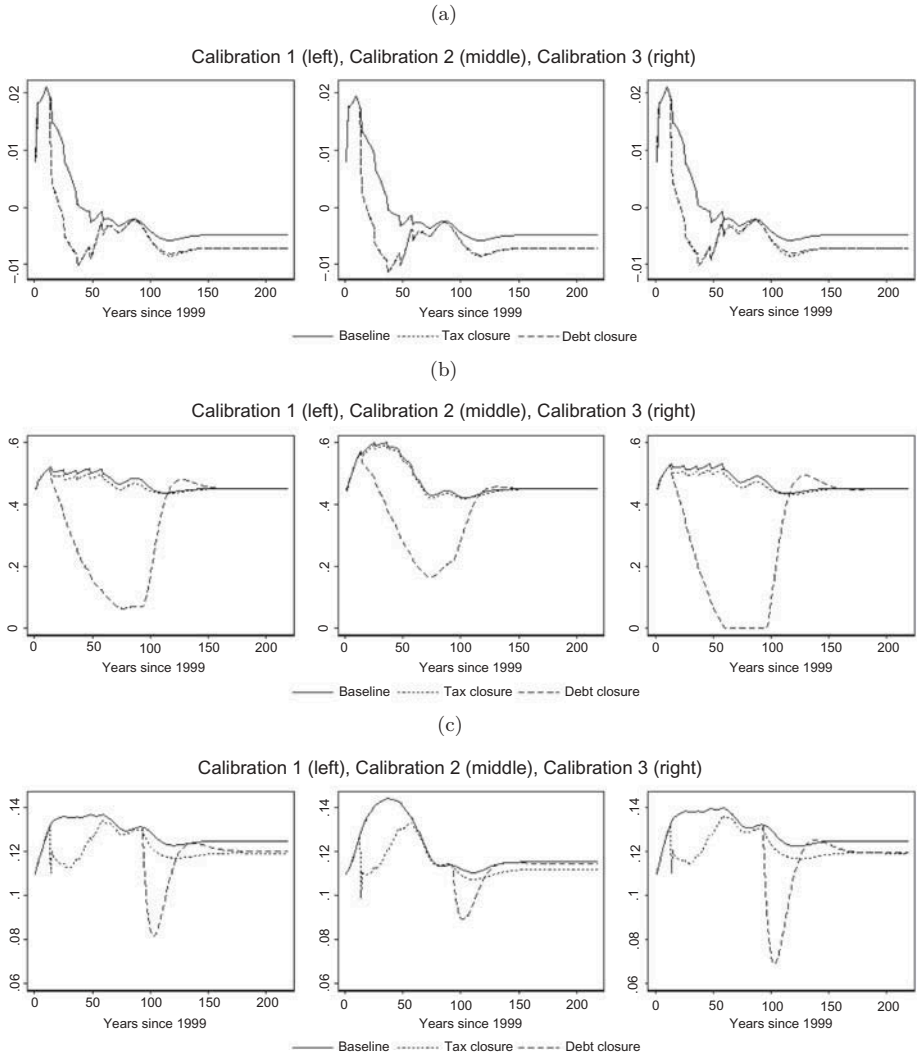

Fig. 6. Fiscal side (a) SIF deficit (% GDP) (b) Debt (% GDP) (c) Consumption tax

surplus as soon as DB PAYG pensioners disappear from the economy in the baseline scenario. It happens approximately two decades earlier in the reform scenario, because lower share of contributions is used for pre-funding and higher stays in the pay-as-you-go pension system. A surplus in SIF stems from the fact that at each point in time there are more cohorts contributing to the pension system than cohorts collecting the pensions, as discussed in Section V. Although DC systems pay out individually as much as was previously contributed, if dependency rate falls short of unity, overall contributions exceed pension benefits paid out. Indeed, the assumption about stabilizing population is conservative in a sense that it fosters the financial viability of the public pension schemes

The improvement in the balancing of SIF has major bearing on the public finances. Persistent surplus in SIF automatically translates to lowering public debt. Our consumption tax closure does not permit adjustment in debt, so taxes decrease by approximately 2 pp relative to baseline. In the debt closures, debt falls gradually. If the interest rate decreases with the decrease of debt, model produces zero share of public debt in GDP, because the two mechanisms (SIF surplus and debt dependent interest rate) reinforce each other. Once SIF surplus can no longer translate to public debt, that is, when the fiscal rule operates in the long run, taxes are slightly reduced. This effect is smallest where surplus yields least benefits (in terms of interest), that is, in Calibration 2.

VII. Conclusions

Subsequent to the global financial crisis, many countries have experienced fiscal difficulties and developed policies aimed at relieving that fiscal tension. In countries where pension systems are at least partially funded, increasing the PAYG pillar at the expense of the funded pillar became a considered policy option. If indexation rules in the PAYG pillar coincide with the interest rate earned in the funded pillar, such changes should be fairly neutral to the replacement rates, while it can help temporarily to ease the fiscal tension. Such shift of contributions from pre-funded to a PAYG pillar will have a negative (and lasting) effect on the capital accumulation, but if the original funded pillar was relatively small, the effect on capital accumulation is likely to be small too. The overall welfare effect will depend on the relative strength of changes in pensions, tax adjustments and general equilibrium effects stemming mostly from changes in capital.

In this article, we use an example of 'unprivatizing' the pension system – that is, a reduction in the size of the pre-funded pillar – that took place in 2011 and in 2013 in Poland. This case is interesting because Poland implemented a two-tier pension system only 12 years earlier, which implies that the majority of the fiscal costs associated with establishing *de novo* a pre-funded pillar are materializing contemporaneously. We develop an OLG model, closely calibrated to the Polish case and analyse welfare and macroeconomic effects of such change in the pension system.

Our baseline scenario describes an economy in transition from a PAYG DB to a partially funded DC system. We compare it to a policy change scenario, in which 'unprivatizing' happens, that is, part of contributions is diverted away from pre-funded scheme towards the pay-as-you-go scheme. We analyse two variants of this policy change. In the first one, the relief from the pension system translates to an immediate reduction in the public debt. In the second one, the savings in the pension system permit reduction in the taxes. We consider these to be two extreme policy options, with actual choices in the years to come falling somewhere in between of these two extremes. They differ substantially in welfare implications. 'Unprivatizing' allows to reduce taxation, thus attenuating distortion. On the other hand, it allows only few cohorts to benefit from lower taxes, whereas spreading the 'unprivatizing' over many generations may actually induce more equal distribution of welfare gains/losses.

The proposed changes reduce the funded DC component of the pension system. The reform from 2011 reduced the contribution rate to the pre-funded pillar, whereas the proposals from 2013 reduce the stock of savings accumulated in that pillar in addition to changing the effective contribution rates to the pre-funded pillar. We find that the 'unprivatizing' is welfare deteriorating, which implies that the transitory fiscal relief does not overweight lower pensions and lower capital in the future. The overall welfare effect, depending on the fiscal closure, ranges from 0.7% to 2.5% of permanent consumption. When compared to the overall effect of the original pension reform, which replaced DB with a DC scheme and introduced partial pre-funding, we find that these changes take away some of the economic gains of the original reform. Long run capital accumulation will be lower than it would have been without any subsequent changes. Consequently, output will increase by less. While clearly adjustment paths differ if the reform is complemented by tax adjustment from when it is complemented with public debt adjustment, the overall conclusions for the replacement rate and welfare remain essentially unaffected by the fiscal closure. The total long run effects are small.

Our result is also robust to the fiscal closure and a choice of initial steady state calibration. In addition to this policy motivation, our study also sheds some light on the level effects of interest rates in modelling reforms such as privatizing and 'unprivatizing' social security. In fact, gains from privatizing appear in two spheres. First, additional savings foster capital accumulation, but that may drive up the public debt too. Second, if pre-funded pillar offers in the long run a higher interest rate than the indexation in the public pay-as-you-go pillar, same level of pension contributions yields a higher future pension benefit. We try to contribute by comparing the welfare and macroeconomic effects with high and low – yet endogenous – interest rates in the initial steady state. One of our additional calibrations forces the initial steady state to start with rate characteristics for an advanced, developed economy, that is, 4%. In the second additional calibration, we force the interest to increase whenever debt level increases and allow it to fall when public debt share in GDP decreases. These two robustness checks reveal that actual level effects

are fairly negligible. Cohort distribution of the welfare effects remains roughly unaffected by the choice of the interest rate.

Given the negative *ex ante* evaluation of the reforms, our results suggest that models with explicit (and potentially myopic) government should be built into the OLG models of pension reforms. Effective capital pension systems posit a strong temptation to the governments. The more effective the pre-funded pension systems are in raising capital, the higher is the stock of wealth to be captured by a government under fiscal tension. A number of countries facing the crisis partially or totally suspended the contributions to the capital pillar, but only few decided to dismantle it. This article suggests that the shortsightedness of the governments imposes welfare costs.

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