ARTICLE IN PRESS

European Journal of Political Economy xxx (xxxx) xxx

Contents lists available at ScienceDirect

European Journal of Political Economy

journal homepage: www.elsevier.com/locate/ejpe

Intergenerational consequences of gradual pension reforms

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A R T I C L E I N F O

JEL classification:
D63
D64
H55
I38

Keywords:
Pension reform
Ageing
Generational balance
Prospective incidence
Indexation
Fiscal balance
Gradualism

A B S T R A C T

Balancing the government budget in an aging economy may require adjusting gradually pension benefits. Such policy change can take two forms: adjusting the accrual rate (the rate at which individuals built-up pension entitlements while working) or the indexation rate (the rate a which accrued entitlements are linked to nominal wage growth). We compare the consequences of such gradual policies across cohorts. We identify a fundamental generational trade-off between democracy and equality. In particular, we show that for Belgium, 80% of the population alive at the time of the reform prefers the accrual to the indexation reform, with the implication that the youngest half of the population would bear 85% of the total adjustment cost. The indexation reform provides more generational equality because the phasing in over time has larger base and thus benefit cut can be smaller per capita. We then consider other reforms improving the generational equality, showing that all those reforms fail to gain majority support. Finally, considering labor incentives, we show that the indexation reform is also more efficient than the accrual reform. Efficiency meets generational equality.

1. Introduction

Many public pension schemes around the world involve Pay-As-You-Go (hereafter, PAYG) schemes. These are sustainable if the contributions from the workers cover the pension benefits of the retirees. For PAYG schemes to avoid running a structural deficit, it has to ensure that the revenue flowing into the scheme from current contributors covers the expenditure required for the payment of benefits to current retirees. The current retirement of the baby boom generations increases the ratio of current beneficiaries to current contributors, making PAYG scheme unsustainable. European countries have to undertake ambitious reforms and these should not only look at sustainability, but also at intergenerational fairness (European Commission, 2021). Our objective in this paper is to study in a transparent way the prospective consequences of pension reforms in terms of pension loss. Our goal is not only to analyze it for current retirees or near-retirees cohort, but for all generations alive at the time of the reform. By doing so, we avoid the mistake that consists of ignoring the pension burden adjustment to future generations.

The literature on reforming PAYG pension comprises several strands. A first strand examines the radical choice of switching from PAYG scheme (unfunded) to funded pension schemes (Kotlikoff and Burns, 2004). The drawback of this option is the high cost borne by the transitional generations who have to finance the two schemes at the same time (Miles, 1998). The second strand of the literature considers that there are three possible options to gradually assure the sustainability of PAYG schemes: adapting the contribution rate, changing the pension benefit or adjusting the retirement age. That literature often puts the focus on the choice (and the optimal mix) of those three options, without carefully analyzing the age and cohort specific consequences of those pension policies. In this paper, we follow the micro simulation approach to compare different benefit adjustments (Blanchet et al., 2016).

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https://doi.org/10.1016/j.ejpoleco.2022.102336
Received 27 April 2022; Received in revised form 9 August 2022; Accepted 13 November 2022
Available online 19 November 2022

Please cite this article as: Arno Baurin, Jean Hindriks, *European Journal of Political Economy*, https://doi.org/10.1016/j.ejpoleco.2022.102336

Benefit adjustment can be cohort-specific (a cohort with longer remaining life receives lower benefits than a cohort with shorter remaining life), or time-specific (changing indexing rule by simply reducing benefits over time relative to average earnings). A key difference between these two alternatives for adjusting benefit is that the cohort specific rule only applies the adjustment to the newly retiring cohort, whereas the time specific rule reduces initial benefits for the newly retiring as well as for the already retired. So, phasing in benefit cuts over time has larger base and thus benefit cut can be smaller per capita. Different cohorts will have different preferences over the cohort specific reform and the time specific reform.[1] A third strand of the literature, to which this paper also relates, considers the problem of heterogeneity. Bi and Zubairy (2022) shows that the heterogeneity in the phase-in period is important for making pension reform. They show that near-retirees individual could decide to retire sooner depending on the phase-in design.[2]

The focus of our paper is on the intergenerational lifespan inequality of different pension reforms aimed at securing financial sustainability. In doing so we will concentrate on alternatives gradual benefit adjustments via a reduction of the accrual or indexation rate, assuming a fixed contribution rate. The main reason for not considering the possibility to raise contributions is their well-documented harmful consequences on long-run employment, growth and welfare (e.g. Kotlikoff et al., 2007; Kitao, 2014). Another focus of our paper is the political support for the different pension reforms. Most pension systems rely on a contract between different generations, and such intergenerational agreements cannot be dissolved. The path dependence is structural. The past pension rights and promises already accumulated from entitlements put a stop to the more radical proposals. So we will concentrate on gradual reforms and we will impose the grandfather clause (no retrospective reform) so that reform can only affect future pension rights. Interestingly the political support for any reform is itself influenced by the aging process. Reforms that increase retirement age can be politically accepted when few people are near retirement age but impossible with a growing size of the cohorts close to retirement (Bütler, 2000; Bello and Galasso, 2020). Retirement age reforms are more tricky to assess because their effect on labor force participation is ambiguous. Li (2018) showed that increasing the normal retirement age causes a decrease of payroll tax revenue and an increase of disability insurance expenses offsetting about 40% of the decrease of pension expenses. In this paper we will not consider reforms that increase retirement age. Cremer and Pestieau (2000) argue that the pension reform is shaped by conflicting political forces. The retirees are willing to shift the cost on the workers but they need those workers to pay their pensions (Breyer and Stolte, 2001). With demographic change the median voter is ageing and the old people gets politically more powerful (Sinn and Uebelmesser, 2003). There is empirical evidence that countries have not treated cohorts equitably with their grandfathering approach in their pension reforms, namely reducing the entitlement for younger generations while sparing those near retirement (Börsch-Supan, 2013; Fouejieu et al., 2021). One particular exception is Sweden, which was able to implement its reform because, at that time, they were more winners than losers from it (Selén and Ståhlberg, 2007).

In this paper, we compare the prospective consequences for all generations alive at the time of the reform adjusting gradually pension benefits. To assess the generational balance of the different reforms, we will have to adopt a normative criterion of generational fairness. We will consider the inequality across cohorts of the pension loss (relative to no reform) when gradually adjusting the pension benefit to balance government budget in the long run (finite horizon).[3] To adjust the pension benefit, two parameters are available: the accrual and the indexation rates. Those are key parameters in most pension systems (either defined benefit, point system or notional defined contribution). The accrual rate is the rate at which someone builds up his rights to pension benefits, while the indexation rate guarantees that accrued benefits (during both the work and retirement years) stay in line with wage growth in the economy. Those pension parameters are widely used around the world.[4] Various papers analyze the budgetary consequences of indexing relative to wages or to prices (Blanchet et al., 2016) and the pre and post retirement indexation (Piggott et al., 2009; Whitehouse, 2009). Indexing partially erodes pension over time and can put older retirees at risk of poverty (Hohnerlein, 2019). We contribute to this literature by analyzing the heterogeneity of the impact on the different cohorts alive at the time of the reform. The closest paper to ours is Auerbach and Lee (2011), which analyzes the heterogeneity of the impact of pension reforms on different cohorts. However, their framework is different from us. They base their analysis on the whole lifetime of individuals (both retrospectively and prospectively) and do not study the political acceptability of the reforms. On the contrary, considering that pension reforms are generally not retroactive (grandfathering clause) we study the prospective effects of the reforms over the remaining lifetime of the generations currently alive. If we would like to study the effect of the reform over the entire lifespan we should limit our analysis to the cohorts not yet born, which is at odds with our objective to compare the political support for various reforms (Auerbach et al., 1994; Kotlikoff, 2003).[5] In a nutshell, the pension reform affects pension benefits, and so

[1] Bozio et al. (2019) compare the adjustment of a (point) pension system to economic and demographic shocks by means of different forms of indexation. However, they do not look at the heterogeneity of the impact on the different cohorts as well as the political preferences for those reforms among the different cohorts.

[2] Laun et al. (2019) and Devriendt et al. (2022) analyze the heterogeneity of the impact of pension reform for different income groups (within cohort heterogeneity) using OLG model with heterogeneous income abilities. To reduce intra-generational inequality, Devriendt et al. (2022) show that increasing retirement age reform should be combined with more progressivity of the link between earnings and benefits.

[3] Preserving the generational balance is of particular importance for new reforms because Chen et al. (2018) have shown that the young and the working individuals bear most of the cost of previous crises. Barr and Diamond (2008) and Kohli and Arza (2011) argue that reforms should aim to strike a balance between fiscal sustainability and generational balance.

[4] For instance, Poland indexes accrued pensions with respect to the inflation rate plus a fifth of the wage growth. In France, pensions are indexed relative to the wage growth minus the growth of the ratio of retirees to contributors (sustainability factor)

[5] Our approach has two key differences with generational accounting. First, instead of calculating the implicit tax burden from existing fiscal policy on generations not yet born given existing policy, we measure the unequal consequences of various pension reforms for the generations already born over their remaining lifetime. Second, we assess the impact of the pension reforms relative to the status quo over a finite horizon, instead of taking proper account of all age-related social transfers as in the generational accounting to compute the discounted lifetime net tax payment over infinite horizon (Banks et al., 1999).

computing the expected changes of pension benefits to balance the inter-temporal budget is an effective way of measuring the reform's effect for different generations. Since welfare analysis of pension reforms consequences on different cohorts with unequal remaining lifetimes is problematic (see Bommier et al., 2011), we limit our analysis to an actuarial (non welfare) evaluation. The reform is evaluated on a single dimension which is cohort-age. In doing so, we ignore within cohort heterogeneity in terms of income and needs. Extending the model in that direction would require additional within cohort distribution analysis of pension reforms but this would no change our main findings on the distributive analysis between cohorts. Lastly, we consider the employment response to the pension reforms.[6] The assumption is that the reform will reduce employment of different cohort proportionally to their pension loss and the employment elasticity. Given this assumption we calculate the expected reduction of pension benefits needed to balance the inter-temporal budget in the presence of employment response and compare the accrual and the indexation reforms. The indexation reform provides efficiency gain (relative to the accrual reform) because it has a larger base and the pension loss is partly supported by those already retired. Nevertheless we show that a majority still prefers the accrual reform.

This paper proceeds as follows. Section 2 presents the model. Section 3 illustrates the issues with a simple example. Section 4 describes the economic and demographic data used in our simulations of various pension reforms. We provide the prospective evaluation of accrual and indexation reforms in Section 5. Section 6 considers alternative pension reforms that improve generational equality. Section 7 considers longevity inequality and employment effects of pension reforms. Section 8 concludes with some comments.

2. The model

At time t, the set of working age cohorts s is denoted W_t and the set of retired cohorts (still alive) is denoted R_t. The size of each cohort s in time t is N_t^s. Cohort size evolves over time as:

$$N_t^s = (1 - \mu_t^s) N_{t-1}^s \tag{1}$$

where μ_t^s is the mortality rate of cohort s in time t. Total employment is:

$$N_t^E = \sum_{s \in W_t} e_t^s N_t^s \tag{2}$$

where $e_t^s \in [0, 1]$ is the employment rate of cohort $s \in W_t$ in time t, so the employment rate evolves over time and across cohorts. The total retired population is

$$N_t^R = \sum_{s \in R_t} N_t^s. \tag{3}$$

The dependency ratio in time t is:

$$D_t = \frac{N_t^R}{N_t^E} \tag{4}$$

Before retirement, for each working age cohort $s \in W_t$, the pension entitlement in time t, P_t^s, is the pension entitlement of time $t-1$ indexed at rate r_t^0 to the (nominal) wage growth, plus the pension entitlement earned in time t according to the accrual rate a_t.

$$P_t^s = P_{t-1}^s r_t^0 \frac{w_t}{w_{t-1}} + a_t w_t \tag{5}$$

After retirement, for each retired cohort s, pension benefit at time t is the pension benefit in $t-1$ indexed at rate r_t^1 to the (nominal) wage growth. In case of partial indexation of pensions on wage growth $r_t^1 < 1$, the replacement rates decreases with age. Note that the indexation rate may differ before and after retirement (e.g. dual indexation).

$$P_t^s = P_{t-1}^s r_t^1 \frac{w_t}{w_{t-1}} \tag{6}$$

We define the replacement rate ρ_t^s of the retired cohort $s \in R_t$ in time t as:

$$\rho_t^s = \frac{P_t^s}{w_t} \tag{7}$$

Note the difference between the *replacement rate* and the *benefit ratio*. The benefit ratio measures the average replacement rates among the retired population. At time t, the benefit ratio is:

$$\beta_t = \sum_{s \in R_t} \rho_t^s \frac{N_t^s}{N_t^R} \tag{8}$$

[6] French et al. (2022) using regression discontinuity of cohort-specific pension reform in Poland, find changes in labor supply involving employment elasticity with respect to the net return to work (including expected pension benefits) of 0.44.

The short term cash flow budget balance in time t is given by

$$\beta_t D_t = \tau_t \tag{9}$$

where τ_t is the contribution rate. We adopt a long-term budget balance perspective. This means that the pension system should be in equilibrium on average over the period 2020–2100. We simulate a one-off permanent change in year 2020 in either the indexation or accrual rate. We initially assume equal indexation pre and post retirement $r_t^0 = r_t^1 = r_t$ (we relax this assumption later). The pension parameters are initially set at (a_0, r_0) and, depending on the reform, change to a_1 or r_1. We set r_0 to 1 (i.e. full indexation to the wage growth) and a_0 to achieve budget balance in 2019. We then consider either a permanent accrual cut $a_1 < a_0$ or a permanent indexation cut $r_1 < r_0$ so as to balance the long-term budget constraint. All future pension spendings must be equal to all future pension contributions (fixing contribution rate $\tau_t = \tau_0$).

$$\sum_{t=2020}^{2100} \sum_{s \in W_t} \tau_t w_t e_t^s N_t^s = \sum_{t=2020}^{2100} \sum_{s \in R_t} P_t^s(a_1, r_0) N_t^s = \sum_{t=2020}^{2100} \sum_{s \in R_t} P_t^s(a_0, r_1) N_t^s \tag{10}$$

Our budget approach is twofold. First, it is based on the intertemporal budget balance and not on short-term cash balance.[7] This enables the reform to be gradually phased in. One reason for gradual implementation is to avoid large differences of benefits between new retirees from one year to the next. We disregard short-term year-to-year adjustments not only to avoid the curse of dimensionality, but also to provide security of how the pension benefit will evolve in the mid/long run. Second, our budget approach is based on the principle of no perpetual deficit financing.

2.1. Relative pension loss

Pension systems provide retirees with benefit throughout their retirement which requires looking towards the value of expected lifetime benefits. With a lifetime benefit perspective, it is easier to view many of the trade-offs comprehensively, notably across generations. That perspective allows to distinguish between cohorts. For instance, indexation rules affect most the pension benefits of old retirees as the pension benefits of newly retirees are closely tied to most recent wages.

We will compare the pension losses of all the cohorts alive in 2020 for each of our pension reforms. Given that successive cohorts have different remaining life expectancy, we use the relative pension loss by expressing the expected lifetime pension benefit under the reform relative to the expected lifetime pension benefit without reform using the survival probabilities for the different cohort at different age. For simplicity we assume no discounting in the calculation.[8] Let us index each cohort s by its birth date so that cohort $s = t$ is the cohort born in year t. So cohort s reaches retirement age 65 in year $t = s + 65$. Retirement age is fixed throughout the analysis at 65 years and we further assume that nobody survives beyond 100 years. We define π_t^s as the probability of a member of cohort s to be alive in year $t \geq s + 65$. The expected lifetime pension loss for cohort s under accrual adjustment reform (a_1, r_0) is:

$$\Delta^s(a_1, r_0) = \frac{\sum_{t=s+65}^{100} \pi_t^s P_t^s(a_1, r_0)}{\sum_{t=s+65}^{100} \pi_t^s P_t^s(a_0, r_0)} \tag{11}$$

The expected lifetime pension loss for cohort s under indexation adjustment (a_0, r_1) is:

$$\Delta^s(a_0, r_1) = \frac{\sum_{t=s+65}^{100} \pi_t^s P_t^s(a_0, r_1)}{\sum_{t=s+65}^{100} \pi_t^s P_t^s(a_0, r_0)} \tag{12}$$

We do not provide social welfare evaluations of reforms because welfare analysis is controversial when people have different lifetimes (see Bommier et al., 2011). Social welfare would be biased in favor of the long lives cohorts. Indeed, given the concavity of the utility function and time separable utility, welfare is higher when the same pension benefit B is shared over longer lifespan $m+1 > m$, $(m+1)\, U\left(\frac{B}{m+1}\right) > m\, U\left(\frac{B}{m}\right)$. To measure intergenerational inequality, we will use the Gini index computed over the pension loss of each cohort. Note that the Gini index can be related to welfare measures under certain conditions. Consider a society of n individuals (n large) and individual aversion for inequality as in Fehr and Schmidt (1999). As Schmidt and Wichardt (2019) showed, simple aggregation leads to a social welfare function that can be approximated as a combination of aggregate income in society, μ, and a measure of inequality in society, namely the Gini index G.[9] If the Gini index arises naturally under certain conditions as welfare measure, it implies a very specific form to the social welfare function. The Gini social welfare function is linear in incomes with a clear structure of increasing welfare weights for lower income individuals (see e.g. Hindriks and Myles, 2013; Cowell, 2016). It is worth noting that our (relative) pension loss equality is akin to the equal sacrifice criterion.[10] When lifetime utility is the

[7] Pension reforms must take long-run revenues and expenditures into consideration and not depends upon perpetual, long-term, deficit financing at the expense of future unborn taxpayers. The problem with the cash balance approach is that it does not take into account that pension policy today will change pension commitments in the future and such budget impact ought to be measured at the time the policy is implemented (the deficit shows cash flows in the current period only).

[8] Note that discounting would introduce a cohort specific effect due to different lifetimes when the benefit cut phases in.

[9] Indeed the Gini index is independent of the total level of income whereas social welfare increases if total income rises. A similar result was established earlier in Sen (1974) and Porath and Gilboa (1994) without individual aversion to inequality.

[10] The equal sacrifice doctrine can be traced back to John Stuart Mill (1884, p. 804): "As a government ought to make no distinction of persons or classes in the strength of their claims on it, whatever sacrifices it requires from them should be made to bear as nearly as possible with the same pressure upon all...that means equality of sacrifice".

Table 1
Simple illustration.

Period	Demographic structure				Dependency ratio	Accrual adjustment		Indexation adjustment	
	Young workers	Old workers	Young retirees	Old retirees		Young retirees	Old retirees	Young retirees	Old retirees
0	8	10	5	5	55.56%	54.00%	54.00%	54.00%	54.00%
1	6	8	5	5	71.43%	43.01%	54.00%	44.63%	44.63%
2	6	6	4	5	75.00%	32.01%	43.01%	40.75%	36.88%
3	3	6	3	4	77.78%	32.01%	32.01%	40.75%	33.68%

time-separable sum of instantaneous utilities and the instantaneous utility is the Bernoulli utility function as Mill suggested, then every cohort sacrifices the same amount of (per period) utility under relative pension loss.

3. Example

Let us start our analysis by taking a simple example. Table 1 shows the demographic structure of some hypothetical ageing population. Individuals work for two periods and, then, with probability 0.5, retire during two periods. We assume a fixed contribution at 30%. Then the government will match the increasing dependency ratio by either adjusting the accrual or the indexation rate, so as to balance the average pension budget over periods 1–3. The pension reform consists of reducing uniformly and permanently the accrual rate or the indexation rate (i.e. over periods 1–3). The dependency ratio is 55.56% at time 0. We assume a wage growth of 2% per period.

The initial replacement rate is 54% at time 0 ($a_0 = 0.54$) given the initial (full) indexation rate $r_0 = 1$. The initial replacement rate equates the pensions payments to the contributions in period 0 assuming a contribution rate of $\tau_0 = 0.3$. We then consider pension reforms that balance the budget constraint on average over periods 1 to 3 (i.e. the sum of the contributions over these periods is equal to the sum of the pension payments over the same periods).

We compare two alternative reforms: the cohort-specific reform changing the accrual rate and the time-specific reform changing the indexation rate. Let us start with the accrual reform. At period 0 (and before), the accrual rate is $a_0 = 0.54$ and the indexation rate is $r_0 = 1$. Fixing the indexation rate $r_0 = 1$ and the contribution rate at $\tau_0 = 0.3$, the new accrual rate a_1 should be set at 32.01% for the periods 1 to 3 so as to balance the budget on average, even if for each period pension liabilities do not exactly match contributions. To obtain the new equilibrium accrual rate, we proceed by iteration, reducing accrual rate progressively from $a_0 = 0.54$ until the sum of pensions payments over periods 1 to 3 equates the sum of the contributions. The resulting equilibrium accrual rate is $a_1 = 32.01\%$. This means that the young retirees in period 2 will have, given full indexation ($r_0 = 1$), a replacement rate of 43.01% ($(54\% + 32.01\%)/2$). In period 3, the young retirees will have their entire career under the new accrual rate and so will have a replacement rate of 32.01%. The transition from the old accrual rate (54%) to the new accrual rate (32.01%) is gradual.

Let us consider the indexation reform. We assume identical indexation before and after retirement. Fixing the accrual rate $a_0 = 0.54$ and the contribution rate at $\tau_0 = 0.3$, the indexation rate should be set permanently at 82.64% to balance the pension budget over the periods 1–3 (we use the same iteration method as for the calculation of the equilibrium accrual rate). In period 1, all the (young and old) retirees have the same replacement rate of 44.63% ($54\% \times 82.64\%$). The young retirees' replacement rate is reduced by the 82.64% pre-retirement indexation and the old retirees' replacement rate is reduced by the 82.64% post-retirement indexation. In period 2, the old retirees have a replacement rate of 36.88% (i.e. $44.63\% \times 82.64\%$) and the new retirees a replacement rate of 40.75% (i.e. $(54\% \times 82.64\%^2 + 54\% \times 82.64\%)/2$). A key feature of indexation adjustment is that the pension loss is greater for old retirees because the young retirees' pension benefit is tied to recent wage (time-specific adjustment). It is the opposite to accrual reform that better protects old retirees (cohort-specific adjustment).

4. Data

We use current cross sectional profiles to estimate the lifetime employment profiles of the current population by considering there are shifts in employment rates by age, that are driven by the assumption of a continuous expansion in female labour market participation, as well as in older worker labour market participation. So, unlike the generational accounting, we are not assuming that employment profiles by age are fixed over time. Our analysis uses two data sets based on such lifetime profiles. The first one is the projection of the Belgian population and employment rates by cohort, age and gender for the period 2020–2070. Those projections are done by the Federal Plan Bureau. We have the population and the employment rates projections by year and by "5 year age" bins. We expand the projection to 2100. We do so in order to cover the entire life cycle of those starting their career in 2020 (reform year). The dependency ratio in Fig. 1 is stable beyond 2060. We expand the projection to 2100 by assuming the same demographic structure from 2070 to 2100. Indeed, the population forecast gives a steady state near 2070. For example, the fertility rate in the forecast increases from 1.54 in 2020 to 1.58 in 2027; and then remain stable at 1.71 between 2050 and 2070. The net migration, is 41 800 in 2020 and decreases to 33 900 in 2027; and then remains stable at 23 600 between 2050 and 2070 (Conseil Supérieur des Finances, 2022). Given those employment and demographic projections, we compute the equilibrium indexation/accrual adjustments using (1)–(6) and (10).

The second data set is the survival probability of each age group as of 2019, taken from the Belgian Statistical Agency website (Statbel). Fig. 2 shows the survival probabilities for men aged 65 and 80. This second data set is used to compute the relative

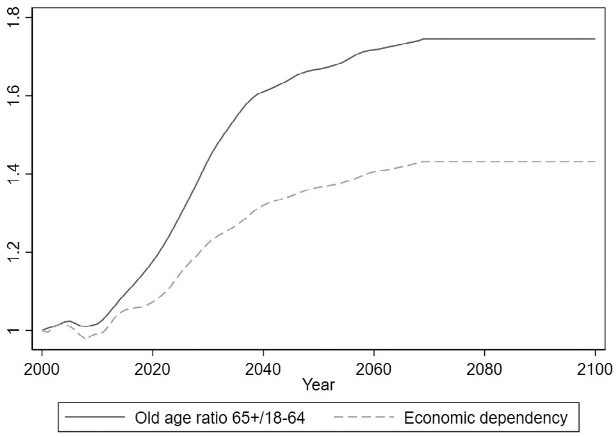

Fig. 1. Economic dependency and old-age ratio (base year 2000=100). Data source: Federal Plan Bureau.

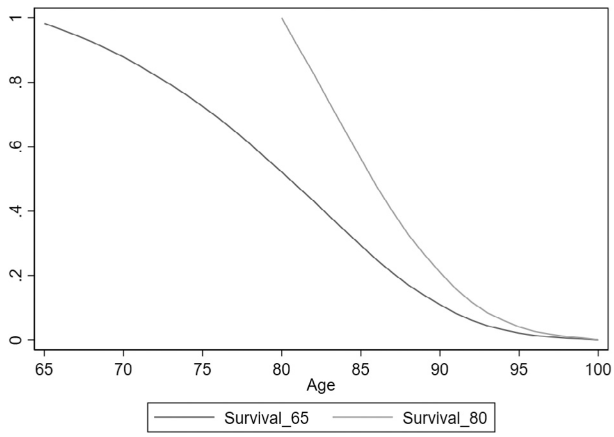

Fig. 2. Survival probabilities of men at 65 and 80. Data source: Statbel.

pension loss induced by equilibrium accrual and indexation reforms using (11) and (12). The current cross sectional profile of survival probability (in 2019) is assumed to retain the same shape for successive cohorts. That does not prevent life expectancy to increase since the survival probabilities by age group used for the new cohorts are higher than the survival probabilities of older cohorts.

5. Indexation versus accrual reforms

We calculate the prospective consequences of accrual and indexation adjustments for each cohort (each cohort s is associated with a representative agent born in year $t = s$ with cohort-age specific wage and survival probabilities). We assume that each cohort works a full career lasting 45 years (i.e. we do not consider pension policy extending the career requirement). We assume a wage growth of 2% per year and a contribution rate of $\tau_t = 30\%$. We will relax this fixed contribution assumption later to consider simultaneous adjustment of pensions and contributions. The pre-reform dependency ratio is 43.06% in 2019; and the pre-reform benefit ratio is set at 69.68% so that the pension budget is balanced in 2019. The dependency ratio is expected to rise on average from 43.06% to 54.93% over the period 2020–2100, inducing for fixed contributions an average decrease in the benefit ratio from 69.68% to 54.61%. Our analysis starts by analyzing the distributional effects of balancing the budget exclusively with indexation or accrual adjustments to match the predicted increase of the dependency ratio over the period 2020–2100.

5.1. Accrual reform

In case of an accrual adjustment, the new equilibrium accrual rate is $a_1 = 45.99\%$ (fixing the indexation rate at $r_0 = 100\%$ of the wage growth). The initial accrual rate is $a_0 = 69.67\%$. Fig. 3 shows the evolution of the replacement rate over time for (successive) cohorts reaching either 65, 80 or 95 years old in year t in case of an accrual adjustment. As illustrated in our example, the replacement rate decreases gradually over time. It decreases until 2065 for successive cohorts reaching 65 years. In 2065, the

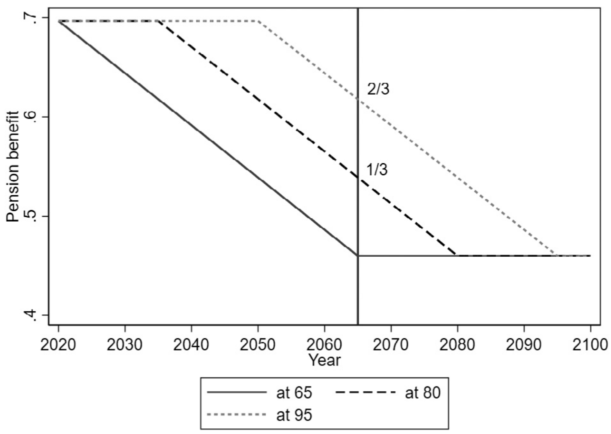

Fig. 3. Replacement rates at 65, 80 and 95 by year with accrual reform.

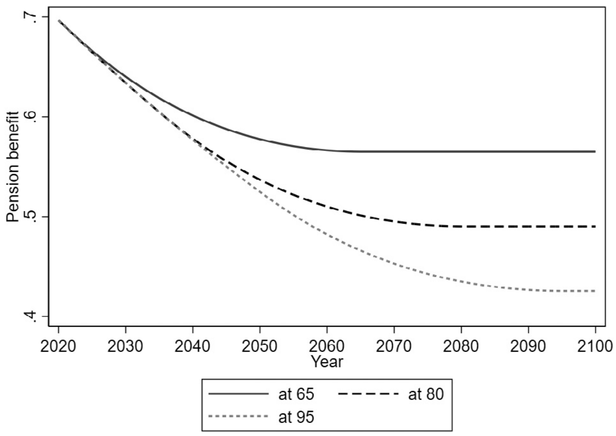

Fig. 4. Replacement rates at 65, 80 and 95 by year with indexation reform.

system is totally phased in given the career length of 45 years. The replacement rate stays constant from this point on, because the following cohorts will also have their entire careers with the reduced accrual rate (45.99%). There is a parallel evolution of the replacement rate for the successive cohorts reaching 80 and 95 years old in time t. The comparison of replacement rates across different age cohorts is as follows. Consider year 2065. The 65 years cohort will have a full career (45 years) with the new accrual rate producing a replacement rate of 45.99%. The 80 years cohort will have 1/3 of its career with the old accrual rate $a_0 = 69.67\%$ and the rest with the new one $a_1 = 45.99\%$. The 95 years cohort will have 2/3 of its career with the old accrual rate and the rest with the new one. As in our simple example, the adjustment through the accrual rate induces heterogeneous replacement rates for different cohorts of retirees during the transition. The older cohorts are the least impacted by this cohort-specific accrual adjustment.

5.2. Indexation reform

In case of a time-specific reform such as the indexation adjustment, the equilibrium indexation rate is 99.05% of the wage growth (fixing the accrual rate at its initial level $a_0 = 69.67\%$). Under indexation adjustment, the replacement rate also decreases gradually over time. However, unlike the accrual adjustment, all cohorts are impacted by the indexation adjustment. As mentioned in our simple example, indexation spreads the adjustment costs across all cohorts. In our simulation, the gap between the replacement rate at 65 years of the newly retired in 2020 and the future retirees in 2100 is 13.19 compared to a gap of 23.69 under the accrual rate adjustment. So, the "pension" gap is halved when adjusting the pension via the indexation rather then the accrual rate. The replacement rate across cohorts and over time is illustrated in Fig. 4. Under the indexation adjustment, the replacement rate of the newly retired at any time t is always higher than the replacement rate of the older retirees. The indexation adjustment reduces the pension inequality between cohorts already retired and newly retired cohorts at the cost of increasing the pension inequality among already retired (young and old) cohorts.

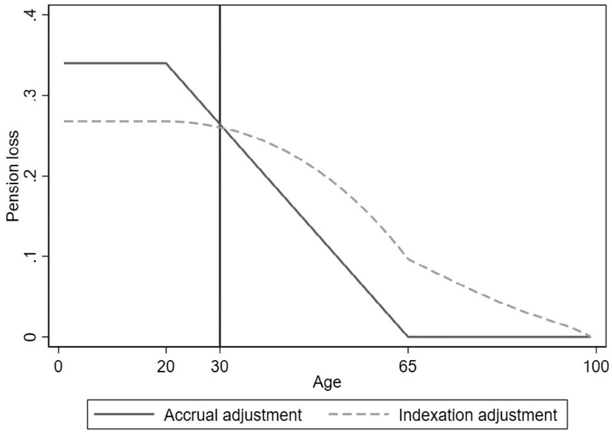

Fig. 5. Pension loss (relative to no reform) as a function of cohort age in 2020.

5.3. Comparing pension loss

Fig. 5 compares the pension loss of each cohort alive in 2020 under either the indexation reform or the accrual reform. Note that without reform there is full indexation both before and after retirement and all cohorts face the same accrual rate over their entire career. Therefore our baseline of no reform involves the same lifetime pension benefit across cohorts. The reform will impact differently the different cohorts producing a gap in lifetime pension benefit. When comparing the two reforms, Fig. 5 indicates that the pension loss is larger under accrual reform for cohorts below 30 years (in 2020) and larger under the indexation reform for cohorts above 30 years (in 2020). It means that if there was a vote on either of these two reforms, those younger than 30 years would support the indexation reform and those older than 30 years would support the accrual reform.[11] Since the median voter in 2020 in Belgium is 50 years old, a majority would support the accrual reform (in fact, a majority of 80% would support the accrual reform).

5.4. The democracy-equality generational trade off

The voting outcome over pension reforms looks unfair if we want to achieve some generational balance in the sharing of the aging cost (i.e. pension loss). The accrual reform is more "unequal" than the indexation reform. The Gini index of the pension loss is 43.07% for the accrual adjustment, whereas it is 21.56% for the indexation adjustment. To further illustrate the generational inequality we employ the Lorenz curve. We adapt the Lorenz curve in our generational framework to represent the proportion of the total pension loss (relative to the no reform baseline) born by the youngest $x\%$ of the population alive in 2020. As we see in Fig. 6, 85% of the total pension loss is born by the youngest half of the population under the accrual reform, whereas it is 65% under the indexation reform. The size of the generational inequality in sharing the burden of adjustment is striking because we impose a immediate and permanent adjustment (no procrastination cost) and also because we restrict the inequality to the generations alive at the time of the reform.[12] The democracy-equality trade off is driven by the gradual phase in of the reforms with the grandfather clause ruling out retrospective adjustments. The nature of the problem is not new. The problem of democracy is that representation is not proportional to the stakes (Brighouse and Fleurbaey, 2010). First, cohorts aged less than 20 and the future generations are not allowed to vote even though they are affected by current reforms. To reverse the voting outcome in favor of indexation reform, we should give to people under 20 and to all cohorts not yet born in 2020 at least until future cohorts born in 2036.[13] Second, there are people who have a vote, but their vote is not proportional to the stake in the current decision. This is a general concern with election that takes a very acute form with pension reform. In the following section, we will consider alternative pension policies that can improve the generational equality but still will face the fundamental democracy-equality generational tradeoff.

6. Other pension policies

So far, we have analyzed the distributional effects of using either the accrual or indexation rate adjustment in response to the rising dependency. We have seen that both adjustments have their own drawbacks. The accrual adjustment increases the pension gap between current and future retirees. Indexation adjustment increases the pension gap between young and old retirees. In this section, we consider alternative adjustments to attenuate those pension inequalities. First, we consider a policy mix (i.e. combining

[11] We assume that people vote in favor of the reform minimizing their pension loss.

[12] Inequality would further increase if we considered the pension loss for the future generations not yet born in 2020.

[13] Alternative solution would be to use constitutional rules to protect future cohorts.

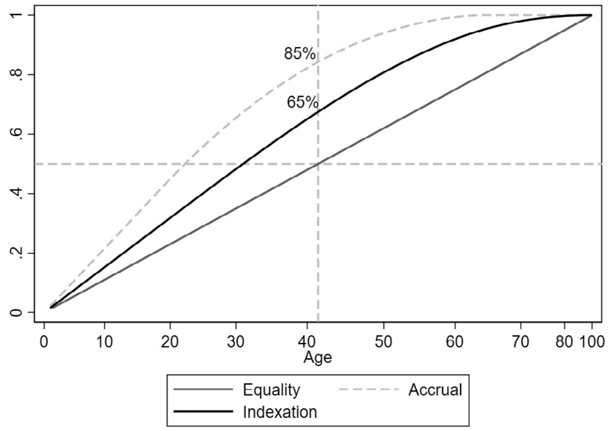

Fig. 6. Proportion of total cost born by the youngest $x\%$ of the population as a function of cohort age in 2020.

Table 2
Policy-mix reforms and generational pension loss inequality.

	Accrual rate	Indexation rate	Gini index of the pension loss
Accrual adjustment	45.99%	100,00%	43.07%
Indexation adjustment	69.67%	99.05%	21.56%
	80.00%	98.71%	16.26%
	90.00%	98.40%	13.32%
	100.00%	98.12%	11.90%

the accrual and indexation adjustment). Then, we analyze the dual indexation that allows to use different indexation rates before and after retirement. Third, we consider simultaneous adjustment of pension benefit and contribution rate tied down by the "Musgrave (1981) rule" requiring equi-proportional change in contribution and benefit rates.

6.1. Policy mix

It is possible to combine accrual and indexation changes in order to reduce the generational pension inequality. We know that cohorts already retired at the time of the reform do not contribute to the overall effort under accrual adjustment and that the pension loss is more equally distributed across cohorts with indexation adjustment. So in order to reduce the pension loss inequality, the policy mix option is to increase the accrual rate above its pre-reform level and to compensate by decreasing further the indexation rate. In doing so, cohorts already retired will face greater erosion of their pension during retirement. And the newly retired cohorts will benefit from the higher accrual rate. As a result, the generational pension loss inequality will decrease. Table 2 shows the Gini index for different policy mixes. The first two rows of the table indicate the benchmark cases, respectively accrual change only and indexation change only. The last three rows indicate various policy mixes with increasing accrual rate and decreasing indexation rate. The Gini inequality decreases as we shift more of the adjustment from the accrual to the indexation. Although those combinations decrease the inequality, they do not get more political support than a pure indexation reform. Fig. 7 shows the pension loss by age with the mix adjustment minimizing generational inequality. We see that the pivotal age for this mix adjustment against accrual adjustment merely increases from 30 to 32 . We still have a vast majority in favor of accrual adjustment. The generational democracy-equality tradeoff is persistent.

6.2. Dual indexation

Another solution to decrease generational inequality is to differentiate the pre-retirement and post-retirement indexation rates (dual indexation). We analyze this possibility in Table 3 given a fixed accrual rate at $a_0 = 69.67\%$. The first column indicates the ratio of the post-retirement to the pre-retirement indexation. To minimize pension loss inequality, the post-retirement indexation should be less than pre-retirement indexation (since the older cohorts are less impacted by the gradual reforms). We see that the Gini index decreases as the pre to post retirement indexation gap increases.

We compare the pension loss inequality under accrual reform and dual/uniform indexation reforms in Fig. 8. The figure assumes a dual indexation with a pre-retirement indexation of 1 and a post-retirement indexation of 0.96. The break even age is 36 years with those younger preferring the dual indexation and those older preferring the accrual reform. Switching to dual indexation shifts the burden from the younger cohorts to the cohort reaching retirement age at the time of the reform. Given the current median voter age, there is almost a fifty-fifty divide between the two indexation options. A large majority still prefers accrual adjustment to any form of indexation adjustment, confirming the generational democracy and equality tradeoff.

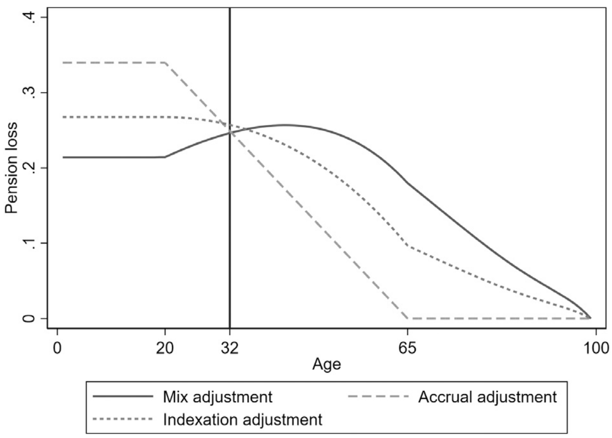

Fig. 7. Pension loss for the accrual, indexation and (best) mix adjustment.

Table 3
Dual indexation and generational pension loss inequality.

Ratio	Post-retirement indexation	Pre-retirement indexation	Maximum pension loss	Gini index
	100.00	98.35	30.05	33.81
1.01	99.62	98.63	28.83	28.75
1.00	99.05	99.05	26.77	21.56
0.99	98.47	99.46	24.63	14.67
0.98	97.86	99.86	22.44	8.04
0.976	97.61	100.01	22.08	5.94
0.97	97.23	100.24	24.92	7.07

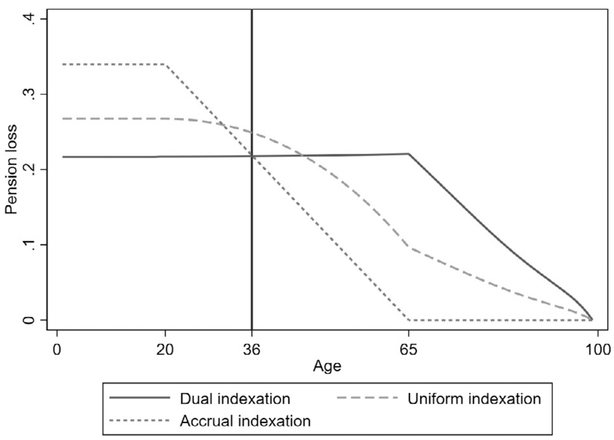

Fig. 8. Pension loss (relative to no reform) - Accrual, uniform and dual indexation reforms.

6.3. Musgrave rule

So far we have fixed the contribution rate at 30%. We now relax this assumption by considering a joint adjustment of pension benefit and contribution rate. The set of possible combinations of pension benefit and contribution adjustments is infinite so we will tie down the reforms using the Musgrave rule. The Musgrave (1981) rule requires to maintain constant the ratio of the pension benefit to the net wage. This means that to maintain budget balance when the dependency ratio increases, both the pension benefit β_t and the contribution rate τ_t should be adjusted in equal proportion so as to maintain the ratio $\frac{\beta_t}{1-\tau_t}$ constant. As we have different pension benefit, we apply this rule by considering that the ratio of the pension benefit of someone aged 65 compared to the net wage should be the same before and after the reform is fully phased in.

Following Musgrave rule, under accrual adjustment, the contribution rate increases from 30% to 37% and the accrual rate decreases from 69.68% to 62.71%. Under indexation adjustment, the contribution rate is 35.66% and the indexation rate is 99.62%.

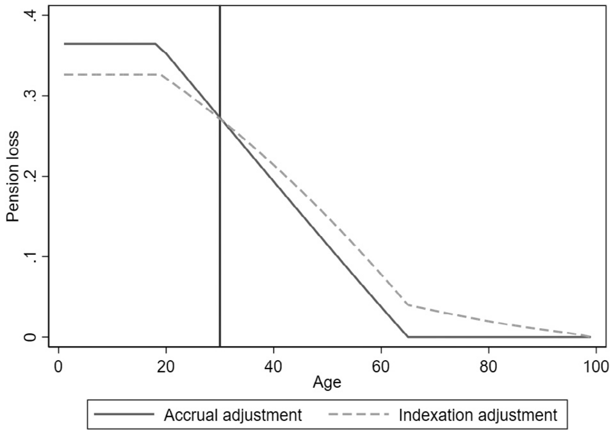

Fig. 9. Pension-net wage loss (relative to no reform) under Musgrave rule.

To compare the distributional effect of this "Musgrave" adjustment with the fixed contribution scenario, we need to add the contribution adjustment to the pension loss for those working at the time of the reform. Interestingly as shown in Fig. 9, the pivotal age (around 30 years) does not change with the Musgrave adjustment. The reason is that mixing contribution increase with benefit cut does not really change the relative preference over accrual and indexation adjustments. What it does is to scale down the size of the accrual/indexation adjustment, and so the size of the pension loss for those currently working. However this is offset by the increase of their contributions. So the Musgrave reform operates a lifetime shift for the working cohort between pension and contribution without changing the conflict of preferences across cohorts.

7. Extensions

7.1. Unequal longevity

We have assumed representative agent within each cohort. Introducing heterogeneity within cohorts is interesting but complex in our dynamic model.[14] Indeed forecasting the life-time income and employment rates profiles of future cohorts of low and high skilled workers based on the cross-sectional observations of the life-time profiles of the current population is problematic (Banks et al., 1999).

Unequal longevity is very relevant in our prospective analysis because when life is short cohort-specific or time specific gradual adjustment do not have the same effect as when life is long. We will provide a first-order approximation to the case of unequal longevity within cohorts. Chetty et al. (2016) find that in the US, the gap in life expectancy between the richest 1% and poorest 1% of individuals was 14.6 years (95% CI, 14.4 to 14.8 years) for men and 10.1 years (95% CI, 9.9 to 10.3 years) for women. Eggerickx et al. (2020) find that in Belgium, the probability to reach 65 years (retirement age) is 77% for the low income group and 93% for the high income group. We introduce within cohort unequal longevity in our simulation model by indexing mortality rates from Statbel by the income-specific coefficients in Eggerickx et al. (2020). Those longevity coefficients are the delta between the average mortality rates in the population and the mortality rates specific to the low/high income groups.

Fig. 10 compares the male survival probabilities in the low/high income groups. We can see that low income group faces a probability of 23% of not reaching retirement age against a probability of 7% in the high income group. The other gap is the difference in the pension duration.

Life expectancy for low socioeconomic status is 57.93 at 18 and 17.08 at 65 and is 65.83 at 18 and 20.87 for high socioeconomic status. Someone with a shorter life expectancy will prefer a higher retirement benefit at the beginning of retirement, and so she may prefer indexation adjustment to accrual adjustment. Let us compare the pension loss for both income groups. Note that the pension benefit is proportional to income and so only longevity gaps will influence the relative pension loss between income groups. First, the pension loss (relative to no reform) with the accrual rate is the same for both income groups. Indeed, the pension loss depends on the sum of the probabilities of being alive at a particular age π_t^s times the retirement benefit (P_t^s) at that age ($\sum \pi_t^s P_t^s$). With an accrual adjustment (and full indexation), the pension benefit profile does not change during retirement. As a result, the longevity gap has no incidence on the pension loss under accrual adjustment for either income groups. However, indexation adjustment erodes pension benefits during retirement and thus the long lived (high income group) are more affected by this adjustment. Inversely, the short lived (low income group) may prefer to trade off lower indexation for higher accrual. This conjecture is confirmed in our simulation results (using Eggerickx et al. (2020)'s income gap in mortality rates), with the pivotal age between indexation and

[14] See e.g. DeDonder and Hindriks (2003, 2007) for models of voting over social security with risk and income heterogeneity.

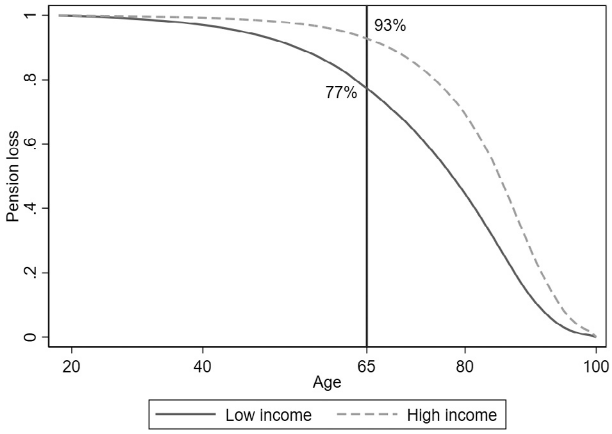

Fig. 10. Survival probabilities for male with low and high income. Data source: Eggerickx et al. (2020).

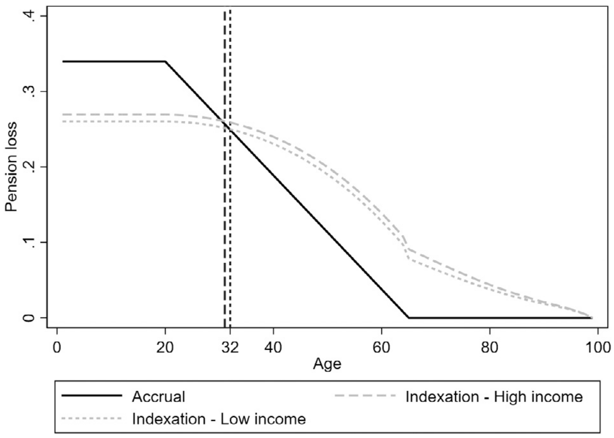

Fig. 11. Pension-net wage loss by income group (male) - Musgrave.

accrual reform being shifted up to 32 years (against 31 years for the high income group). What is striking is that the distribution of preference over accrual and indexation adjustment does not change much even though the longevity gap in our simulation is quite high. This suggests that our tension between democracy and equality is quite robust to (growing) longevity inequality (see Fig. 11).

7.2. Endogenous employment: efficiency and equity

So far we have assumed exogenous employment rates. We will introduce in our simulation model some assumptions on the possible impact of the prospective pension loss on labor supply. Indeed, we may reasonably expect the pension benefit adjustment to affect work incentives, which in turn will feed back in the pension budget constraint via the dependency ratio in (10). The pension reforms examined in the literature are disclosing a substantial overall labor supply effect on the labor of the seniors (Hernæs et al., 2016; Andersen et al., 2021). Pension reform in Poland involving a sharp cohort-specific discontinuity in the link between current contributions and future benefits, led to employment elasticity with respect to the return to work (including future pension benefits) of 0.44 (French et al., 2022). We will assume that the employment response for each cohort is proportional to their relative pension loss and the employment elasticity. We will further assume that the labor supply distortion is limited to the end of the career (young workers do not really adjust their labor supply to the change in their future pension benefit). We consider that the employment rate of the 60+ is related the pension benefit loss according to the following sufficient statistic:

$$\frac{e^0 - e^s}{e^0} = Elasticity \times Pension\,loss^s \tag{13}$$

where e^0 is the baseline employment rate. The percentage reduction in the participation rates of cohort s (60–65 years) is proportional to their pension loss (in %). Since the pension loss differ across cohort, the change in participation rate will also differ across cohorts. Younger cohorts receive lower future pension benefits inducing lower labor participation near retirement age

Table 4
Accrual and indexation reforms with work incentives near retirement.

Elasticity	Accrual rate	Employment rate (Age: 60 in 2065) Accrual adjustment		Indexation rate	Employment rate (Age: 60 in 2065) Indexation adjustment	
		Male	Female		Male	Female
0.5	44.06	56.30%	46.42%	98.97	59.10%	48.72%
0.4	44.47	59.00%	48.64%	98.99	61.20%	50.45%
0.3	44.87	61.63%	50.81%	99.01	63.23%	52.13%
0.2	45.25	64.13%	52.87%	99.02	65.17%	53.73%
0.1	45.63	66.58%	54.89%	99.04	67.12%	55.33%
0	45.99	68.96%	56.85%	99.05	68.96%	56.85%

60–65 (i.e. lower return to work). Table 4 shows the change in the accrual and indexation rates as a function of the employment elasticity using (1)–(13). A higher elasticity reduces employment rates. As a consequence, the accrual/indexation adjustments should be scaled up. A higher elasticity also increases the pivotal age (i.e. shifting preference for indexation adjustment). This is due to the fact that by sharing the adjustment cost with the cohorts currently retired, the indexation reform induces less distortion than the accrual reform. Interestingly, the indexation reform (compared to accrual reform) involves less generational inequality and less labor distortion. Generational equality meets efficiency. However a large majority of cohorts (everyone above 30–31 years in 2020) are still supporting the accrual reform. So the generational democracy-equality tradeoff extends into a generational democracy-efficiency tradeoff.

8. Conclusion

In this paper, we provide a first order approximation of the prospective consequences for all generations currently alive of different pension policies seeking to secure the long term budget balance of the PAYG pension schemes in an ageing population. The central finding of our simulation model is the tension between equality and democracy. Equality across cohorts requires in our model to adopt pension reforms minimizing the gap in the relative pension loss across cohorts currently alive. The relative pension loss is the change in the lifetime pension benefit relative to the no reform status quo. Our approach is in the spirit of generational accounting since we calculate how much in total each current and future retirees can expect to pay in terms of pension loss over their remaining expected lifetimes. We concentrate on incidence across cohorts, and so we assume representative agents within cohorts. We use a cross sectional prediction of future life-cycle income and employment profiles with updating for wage growth. We impose a term limit to the intertemporal budget balance to avoid the Ponzi perpetual roll over of the budget deficit to future generations.

We find that indexation is preferable to accrual reform both in terms of generational balance and efficiency, but that around 80% of the voters would oppose to the indexation reform. We find that as a result of the voting outcome, the youngest half of the cohorts currently alive will bear 85% of the total adjustment cost. We also show that it is possible to improve further the generational balance by combining accrual and indexation reform. In particular generational balance would require higher accrual rate combined with lower indexation rate to shift further the adjustment cost to the cohorts already retired. An alternative policy option would be to set before-retirement indexation to be higher than the after-retirement one. However these two policy options would be opposed by a majority of voters currently alive. We show that the tension between democracy and equality is robust to the introduction of unequal longevity within cohorts and also to the concern of work incentive for the seniors workers.

Our results are a first-order approximation of the prospective incidence of pension policies on all cohorts currently alive. To go further requires a more structural analysis of the impact of pension policy taking into account within cohort heterogeneity of lifetime income, employment and mortality profiles together with endogenous behavioral responses, by means of microsimulations. A central assumption that we made is that representative agent in each cohort is assumed to follow the same age profiles of mortality, earnings, employment and retirement which are the currently observed age profiles in the cross section data with updating for growth. This cross-sectional prediction of life-cycle profiles is problematic when there is heterogeneity within cohorts. This is an interesting avenue for future research.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data will be made available on request.

Acknowledgments

We are grateful to Antoine Bozio, Pierre Devolder, Petar Jevtic, Vincent Vandenberghe, Bruno Van der Linden, Alessandro Veneri and the audience at IPP Seminar (Paris, 2021), at the Winter Belgian Doctoral Workshop (Namur, 2021), at the 21st Journées André-Louis Gérard-Varet (Marseille, 2022), at the International Pension Workshop (Rabat, 2022) as well as two anonymous referees of the *European Journal of Political Economy* for their helpful feedback. We thank Thierry Eggerickx for providing us the mortality rates by socioeconomic status and the Federal Plan Bureau for the population and employment rates projections.

Funding

The research leading to these results received funding from the Belgian French-speaking Community (convention ARC n° 18/23-088 on "Sustainable, adequate and safe pensions: financial architecture, social justice and governance") and from the Fonds de la Recherche Scientifique - FNRS, Belgium (FRESH scholarship). The views expressed herein are exclusively those of the authors.

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