Indexing Pensions to Life Expectancy: Keeping the System Fair Across Generations

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Abstract. Linking pensions to longevity developments and population ageing is one of the most common types of automatic adjustment mechanisms in pension schemes. Although this reform approach is primarily driven by cost-containment objectives, other dimensions of welfare restructuring are present, including pension adequacy, recalibration, introducing economic and actuarial rationality, recommodification, and blame avoidance for unpopular policies that involve retrenchments. This paper discusses how to index pensions to longevity developments and population ageing in a way that is consistent with actuarial fairness and neutrality across generations. We derive an intergenerational fairness and neutrality condition for pension reform and examine alternative policy options including modifying the contribution rate, updating the statutory retirement age, or introducing sustainability factors.

Keywords: Automatic adjustment mechanisms · Life expectancy · Pensions · Actuarial fairness · Risk-sharing · Longevity risk

1 Introduction

Pension schemes require regular adjustments to address the long-term affordability, fiscal sustainability and adequacy challenges posed by demographic (e.g., population ageing), economic (e.g., low productivity gains and economic growth, a rapidly shifting labour market) and financial (e.g., low-for-long interest rate scenario) shocks. These adjustments can be discretionary or follow some (fully or semi) automatic adjustment or stabilization mechanism (AASM), mechanically updating the scheme's parameters (e.g., retirement age) conditional on some triggering indicator (e.g., life expectancy). The introduction of automatic stabilizers replaces regular discretionary measures, contributing to enhancing the credibility of the system, social trust, and the support of the intergenerational contract by preventing otherwise unexpected public finance crises and major benefit cuts in the future [1]. About two-thirds of OECD countries employ some form of AASM in mandatory pension schemes [2].

M. Corazza et al. (Eds.): MAF 2022, *Mathematical and Statistical Methods for Actuarial Sciences and Finance*, pp. 31–37, 2022.
https://doi.org/10.1007/978-3-030-99638-3_6

Linking pensions to longevity developments is one of the most common types of AASM [3–6]. However, some studies pointed out several deficiencies in the way pensions have been indexed to life expectancy developments, including the use of inappropriate longevity measures, the adoption of uniform markers neglecting longevity heterogeneity and lifespan inequality, embracing compensation and obfuscation strategies such as sequencing, long-phasing in periods, and long indexation lags [7, 8]. Critical to this paper, they were not designed to keep the scheme fair across generations.

This paper extends Bravo et al. [9] and discusses how to index pensions to longevity developments and population ageing in a way that is consistent with actuarial fairness and neutrality principles. We derive the intergenerational fairness and neutrality condition for pension reform and discuss alternative automatic adjustment mechanisms including modifying the contribution rate, updating the statutory retirement age, or introducing sustainability factors, but the full policy option menu includes indexing pensions in payment, adjusting the penalties (bonus) for early (late) retirement, modifying past earnings revalorization rate. The structure of this article is as follows. Section 1 outlines the key concepts and research methods used in the paper. Section 2 presents the model setup, the intergenerational fairness and neutrality condition. Section 3 examines several alternative policy options. Section 4 concludes.

2 Intergenerational Fairness and Neutrality Condition

In this paper, we follow and extend Bravo et al. [9] and consider a stylized career average re-evaluated earnings-related non-financial defined benefit (NDB) pension scheme with entry pension actuarially computed based on the entire contribution effort. The approach is extended to account for population ageing (increase in the old-age dependency ratio) and the existence of external sources of funding in the pension scheme. The actuarial pay-as-you-go aggregate balance constraint in year t equals the revalued contribution effort and the pension wealth

$$A_t \cdot c_t \cdot V_t + EX_t = L_t \cdot \lambda_t \cdot P_{x_r(t)} \cdot a_{x_r(t)}^{\pi,y}, \tag{1}$$

where A_t is the number of active workers in the scheme; c_t is the contribution rate; $V_t \equiv V\left(x_{r(t)}, x_e, w, y_t\right)$ is the lifetime pensionable average salary w_t of all active workers, revalued using an (actuarial equilibrium, notional) rate of return y_t; x_e is the average labour market entry age; EX_t represents the external sources of funding (e.g., general or dedicated taxes); L_t is the number of pensioners; $\lambda_t \geq 1$ is the average number of pensions per pensioner (to account for the overlapping of old-age and survivor's pensions); $P_{x_r(t)}$ is the annual average pension benefit across all retirees, computed as follows:

$$P_{x_r(t)} = \theta_t\left(x_{r(t)} - x_e\right) \cdot \overline{RE}_{x_r(t)} \cdot SF_{x_r(t)} \cdot b_{x_r(t)}, \tag{2}$$

where θ_t is a linear (usually flat) accrual rate for each year of service, $\left(x_{r(t)} - x_e\right)$ is the average contribution period with $x_r(t)$ the exit (retirement); $\theta_t\left(x_{r(t)} - x_e\right)$ is the scheme's target replacement rate; $SF_{x_r(t)}$ is a life expectancy coefficient (often called sustainability factor) introduced in some countries (e.g., Finland, Portugal) to adjust entry pensions to longevity increases; $b_{x_r(t)}$ are pension decrements $\left(b_{x_r(t)} < 1\right)$ or pension increments $\left(b_{x_r(t)} > 1\right)$ for early or delayed retirement, respectively; $\overline{RE}_{x_r(t)} \equiv \overline{RE}\left(x_{r(t)}, x_e, w_t, \upsilon_t\right)$ is the lifetime average revalued earnings of all active workers $\overline{RE}_{x_r(t)} = RE_{x_r(t)}/(x_r(t) - x_e)$ with

$$RE_{x_r(t)} = \left(w_t^{x_r(t)} + \sum_{x=x_0}^{x_r(t)-1} w_{t-x_r(t)+x}^{x_r(t)} \prod_{j=t-x_r(t)+x+1}^{t} \left(1+\upsilon_j\right)\right), \tag{3}$$

where υ_t denotes the rate at which each year contributions are revalued; $a_{x_r(t)}^{\pi,y}$ is the life annuity factor

$$a_{x_r(t)}^{\pi,y} := \sum_{\tau=1}^{\omega-x_r} \left(\frac{1+\pi_\tau}{1+y_\tau}\right)^t {}_\tau p_{x_r(t)}. \tag{4}$$

where π is the uprating rate for pensions, ${}_\tau p_{x_r(t)}$ is the τ-year survival probability of a population cohort aged x_r at time t, computed using a diagonal (cohort) approach. Let D_t denote the scheme's old-age dependency ratio - the ratio between the number of pensions $L_t\lambda_t$ and the number of active workers A_t -, $D_t = L_t\lambda_t/A_t$. The balance constraint (1) can be rewritten as

$$c_t \cdot V_t + EX_t/A_t = D_t \cdot P_{x_r(t)} \cdot a_{x_r(t)}^{\pi,y}, \tag{5}$$

If the longevity prospects of the population increase, the pension scheme parameters (e.g., the early and normal retirement ages, the contribution rate, the life expectancy coefficient, the accrual rate per year, the survivor pensions benefit formula, the indexation rate of pensions) must be updated to ensure the scheme remains actuarially fair and neutral across generations and does not require external funding. To ensure the scheme remains fair and neutral across the members of the initial (labelled 0) and the current (labelled t) generations, the following condition must hold:

$$\frac{c_t}{c_0} \cdot \frac{V_t}{V_0} + \frac{EX_t/A_t}{EX_0/A_0} = \frac{D_t}{D_0} \cdot \frac{\theta_t\left(x_{r(t)} - x_e\right)}{\theta_0\left(x_{r(0)} - x_e\right)} \cdot \frac{\overline{RE}_{x_r(t)}}{\overline{RE}_{x_r(0)}} \cdot \frac{SF_{x_r(t)}}{SF_{x_r(0)}} \cdot \frac{b_{x_r(t)}}{b_{x_r(0)}} \cdot \frac{a_{x_r(t)}^{\pi,y}}{a_{x_r(0)}^{\pi,y}}. \tag{6}$$

where we assumed the parameters that are not pension policy instruments (e.g., wages, labour market entry age) are kept constant.

Without loss of generality, assume now that individuals of both cohorts retire at the full old-age pension age (i.e., $b_{x_r(t)}/b_{x_r(0)} = 1$), that the life expectancy coefficient is constant over time (i.e., $SF_{x_r(t)}/SF_{x_r(0)} = 1$), and that the external funding per active worker EX_t/A_t is null or remains fixed over time. The fairness condition (6) simplifies to:

$$\frac{c_t}{c_0} \cdot \frac{V_t}{V_0} = \frac{D_t}{D_0} \cdot \frac{\theta_t\left(x_{r(t)} - x_e\right)}{\theta_0\left(x_{r(0)} - x_e\right)} \cdot \frac{\overline{RE}_{x_r(t)}}{\overline{RE}_{x_r(0)}} \cdot \frac{a_{x_r(t)}^{\pi,y}}{a_{x_r(0)}^{\pi,y}}. \tag{7}$$

Equations (6) and (7) offer a complete menu of automatic adjustment mechanisms and pension policy rules to absorb the impact of economic and/or demographic shocks and preserve actuarial fairness and neutrality across generations. Theoretically speaking, the policy interventions can take place at the three stages of pensions: accumulation (e.g., contribution rate), annuitization (e.g., retirement age, sustainability factor), and payout (pensions indexation rate), and may even combine multiple interventions in all three stages [3]. In real-world cases, it is well known that some reforms are politically and socially hard to approve and sustain over time, as recent empirical evidence shows in many OECD countries. Moreover, automatic adjustments may modify the way the cost (and the risks) of providing for pensions is shared among generations. In the next section, we summarize some of the policy options offered by the intergenerational fairness condition above.

3 Policy Options

3.1 Adjusting the Contribution Rate

In a pure NDB scheme, the natural control variable is the contribution rate. The individual benefits are defined by a set of rules and the social insurance premiums, contributions, or taxes paid to cover the benefits must adapt to accommodate to whatever is required to cover the additional costs generated by longer lives under the given set of rules including the retirement age and the benefit formula. From (7), keeping all other parameters fixed and assuming lifetime earnings are revalued at the scheme's internal rate of return (i.e., $\upsilon_t = y_t \; \forall_t$), the dynamics of the contribution rate required to cope with the population extended longevity prospects follows

$$c_t = c_0 \cdot \frac{a^{\pi,y}_{x_r(t)}}{a^{\pi,y}_{x_r(0)}} \cdot \frac{D_t}{D_0}. \tag{8}$$

From (8), we can conclude that the contribution rate updates required to cope with increasing survival rates and population ageing depend on two multiplicative factors: (i) the first is a ratio between the actuarial value of the annuity factor at time t and that of the corresponding benchmark value at time 0, $\left(a^{\pi,y}_{x_r(t)}/a^{\pi,y}_{x_r(0)}\right)$. If lower (higher) mortality is observed (and forecasted), the contribution rate must increase (decline). The second adjustment factor (D_t/D_0) captures the dynamics of the scheme's old-age dependency ratio. If the number of pensions relative to active workers augments, due to increased life expectancy and/or population ageing and/or a deterioration in the labour market conditions (reduced participation and/or higher unemployment rates), the ratio D_t/D_0 augments and the contribution must increase to keep the scheme fair and neutral across generations.

3.2 Adjusting the Retirement Age While Keeping the Replacement Rate Constant

Under this policy design, the contribution period is extended, and the retirement age increased while maintaining the macro replacement rate constant. This roughly means the additional contribution effort does not translate into higher pension entitlements.

To achieve it, the accrual rate per year must be reduced. From (7), keeping all other parameters fixed and assuming that lifetime earnings are revalued at the scheme's internal rate of return and that the uprating rate for pensions matches the discount rate (i.e., $\pi_t = y_t$ $\forall_t$), it can be shown that the dynamics of the retirement age follows

$$\frac{\dot{e}^{C}_{x_r(t)}}{\left(x_{r(t)} - x_e\right)} = \frac{\dot{e}^{C}_{x_r(0)}}{\left(x_{r(0)} - x_e\right)} \cdot \frac{D_0}{D_t}, \tag{9}$$

where $\dot{e}^{C}_{x_r(t)}$ is the cohort life expectancy at the retirement age. From Eq. (9), we conclude that to keep the pension scheme actuarially fair and neutral and the replacement rate constant when longevity increases, the retirement age must be updated such that the expected years in retirement relative to contribution years equal that of the benchmark (initial) generation reduced by the rate of increase in the scheme's old-age dependency ratio. In a scenario of population ageing the ratio D_0/D_1 declines ($D_0/D_1 < 1$) and future pensioners will enjoy a shorter fraction of their lives in retirement compared to previous generations.

3.3 Adjusting the Retirement Age While Improving Pension Adequacy

Under this policy design, the retirement age is increased, and the extra contribution period translates into higher pension entitlements, improved pension adequacy, and an enlarged pension scheme. This is achieved by keeping the accrual rate per year constant and the other scheme's parameters unchanged. From (7), assuming again that lifetime earnings are revalued at the scheme's internal rate of return and that the uprating rate for pensions matches the discount rate, the new equilibrium retirement age follows

$$\dot{e}^{C}_{x_r(t)} = \dot{e}^{C}_{x_r(0)} \cdot \frac{D_0}{D_t}. \tag{10}$$

Equation (10) states that to cope with increased life expectancy at retirement ages and population ageing while improving pension adequacy and keeping the scheme fair across generations, the pension age must be updated such that the expected period in retirement is reduced by a factor equal to the rate of increase in the scheme's old-age dependency ratio. Under this policy design, all extra longevity is spent working and the required pension age adjustments are higher than that obtained with (9). Stated differently, to improve pension adequacy younger cohorts must accept a reduced period in retirement.

3.4 Amending Entry Pensions Through a Sustainability Factor

For a given retirement age, sustainability factors reduce pension entitlements to compensate for the extra pension expenditures that come with increased life expectancy [1]. Sustainability factors gradually reduce the replacement rate of pensions, which is often wrongly perceived as a measure of the scheme's generosity. In some countries (e.g., Portugal), the factor introduction was originally combined with flexible retirement age approaches, including the possibility of extending working life to offset the pension cuts introduced by the reduction factor. From (6), keeping all other parameters fixed (including the absence of external funding and a constant accrual rate per year) and considering the same assumptions as above, the dynamics of the sustainability factor follows

$$SF_{x_r(t)} = SF_{x_r(0)} \cdot \frac{a^{\pi,y}_{x_r(0)}}{a^{\pi,y}_{x_r(t)}} \cdot \frac{D_0}{D_t}, \tag{11}$$

From (11) it follows that in a scenario of increased longevity and population ageing, entry pensions must gradually be adjusted by a factor equal to the inverse of the product of the rate of change in the scheme's old-age dependency ratio and the rate of increase in the annuity factor, to keep the scheme financially balanced and fair across generations. This policy transfers, directly and indirectly, the financial burden of expanding lifetime prospects to pensioners, which are at the end of the day the main beneficiaries of longer lives.

4 Conclusion

This paper considers a simple stylized Bismarckian earnings-related NDB scheme to derive an intergenerational fairness condition on how to index pensions to longevity developments and population ageing in a way that is consistent with actuarial fairness and neutrality across generations. The results show that increases in life expectancy at retirement ages should be accompanied by either an increase in the contribution rate, by increasing the statutory retirement age while keeping the replacement rate constant or, alternatively, while expanding pension adequacy, by introducing a sustainability factor linking entry pensions to longevity gains at annuitization, or a combination of all of the above. Importantly, the results show that population ageing, as measured here by an increase in the pension scheme's old-age dependency ratio, demands an extra correction in the key parameters since this shock structurally affects the relationship between the contribution revenue and pension expenditure. Otherwise, countries will have to increasingly resort to external funding sources (or, worst, denying benefits) to restore financial balance. Further research will empirically investigate the magnitude of the adjustments prescribed by the above policy options.

Funding. This research was funded by the Spanish Ministry of Science and Innovation under grant PID2019-105986GB-C21 (M. Ayuso), by Secretaria d'Universitats i Recerca del departament d'Empresa i Coneixement de la Generalitat de Catalunya under grant 2020-PANDE-00074 (M. Ayuso), by Portuguese national science funds through FCT under the grant UIDB/04152/2020 - Centro de Investigação em Gestão de Informação (MagIC) (J.M. Bravo), and grant UIDB/00315/2020 (BRU-ISCTE) (J.M. Bravo).

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