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Chapter

# Funded Pension Schemes in Aging Societies: A Pure Economic Argument?

*Ishay Wolf and Smadar Levi*

## Abstract

This study enables different angel to explore central planners' considerations regarding pension systems in a modern western market with aging influence. In particular, considerable weight has been given to the effect of the crisis due to the pandemic and frequent market turmoil. This study expands the number of players analyzed in the field and takes into consideration different interests among the current and future generations. In addition, we allow differentiation among earning cohorts. By using the overlapping generation model and Monte Carlo simulations, we find that in a wide macroeconomic range, pension equilibrium surprisingly stands with unfunded pension schemes despite the heavy aging influence. Contrary to the classic economic arguments by the World Bank and IMF that were widespread during the 1980s and 1990s, the choice of a pension system is much more complex. We find that the central planner must take into account not only the aging rhythm and market yield but also other parameters, such as the current and future utility perspective, the government's debt price, GDP per capita growth rate, risk aversion, and the possibility of market turmoil.

**Keywords:** pension system, risk sharing, social security, minimum pension guarantee, externalities, funded pension scheme

## 1. Introduction

The western world deals with continuous aging, low fertility, and debt crisis that push governments toward funded-capitalized pension schemes [1–3]. A common trend indicates a decline in public pension benefits [4]. Moreover, systemic reforms have changed the nature of pension provisions, shifting more risks onto pension earners. The privatization of pension plans worldwide and the global process toward the appearance of more funded plans raise important thoughts regarding the adequacy and sustainability of pension schemes, their benefits, and falls [5, 6].

According to Milev, "The sharp downturn in the value of financial assets between 2007 and 2009 and the current financial crisis due to the COVID-19 pandemic serve as sharp examples of how risky assets quickly lose a significant part of their value" ([7], p. 2). The financial crises and continuing concerns about retirement security have generated a new interest regarding the role of the country to provide adequate old-age benefits to its citizens. We are witnessing a great wave of pension withdrawals from funded-capitalized schemes, moving toward more

governmental intervention. Indeed, according to Altiparmakov, "most of the countries experiencing similar crises were the first to implement new liberal pension schemes during the 1990s" ([8], p. 4).

Late research has demonstrated the importance of balancing funded schemes with unfunded components to increase adequacy and sustainability [6, 9, 10]. These studies strengthen the expanding policy and efforts of worldwide governments to start the economies after the pandemic shocks and in parallel insure old participants from the turmoil markets [11, 12].

In conjunction with the current fiscal expenditures lies the classic economic argument that countries should shift to funded pension schemes due to low fertility [13]. "The shrinking tax base and negative influence of governments on markets are the flags of the Washington Consensus, the World Bank during the 1990s, and other economic institutes" ([14], p. 2).

This composition argues that, from a wide perspective, the rush of governments toward funded pension schemes due to low fertility and fiscal constraints may not be optimal. The current complex environment influenced by the pandemic strengthens this argument. We base this on simple equilibriums in the pension markets based on different macro-economic assumptions. The novelty of this research is demonstrated in the wide array of interests taken into consideration. We avoid treating participants as a single-player and allow intergeneration and intra-generational risk sharing. The adjacent generations allow us to examine the cyclical tax burden, the influence of fertility on future generations, and the statistical returns in the long term. The split to earning cohorts demonstrates different interests of hedging capabilities and different optimal contribution rates, considering tax burden and insurance components in old-age benefits [15].

We suggest balancing funded pension schemes with "unfunded boxes," which may increase the sustainability of the pension system, improving the utility of all players. It is found that in some cases, which are common in Western economies, the optimal pension scheme is surprisingly the pay-as-you-go (PAYG) pension system, even in aging societies.

The next section details the interests of the different players in the pension field as well as the assumptions to the economic model. In Section 3, we set the stochastic model of the pension system, which maximizes the participants' utility, and analyzes how it is best to finance the guarantee. Section 4 provides the main results of the simulations and sensitivity analysis. In Section 5, we discuss the results and their implications, and the last section provides the conclusion.

## 2. The government and the participants' interests

It is common to determine that the government wishes to decrease its fiscal risks and obligations and hence push for a shift toward an unfunded pension scheme. The fiscal exposure of the government is obviously levied on its citizens [1]. Consequently, it should be the interest of the citizens to shift from the comfort PAYG DB pension scheme to a funded pension scheme. Indeed, some scholars, mainly during the 1990s, supported the transition to a funded scheme, trying to convince people that the alternative is a heavy tax burden [2, 3].

Disassembling the answer to this question to society and different players seems much more complex and far from unambiguous. Since information is not a free asset but a risk in pension systems, framing the argument in the second-best terms starts from the multiple objectives of pension systems. "Policy has to seek the best balance between consumption smoothing, poverty relief, and insurance, and this

balance will depend in each society on the weights given to those and other objectives and to the different constraints that societies face" [5].

This composition focuses on the central planner, which has the responsibility to balance the interests of all players—recognizing a variety of earning cohorts and adjacent generations. That variety of actors throughout its length and breadth may represent the entire government perspective. With that, we continue with Altiparmakov [8] and Wolf and Ocerin [9], who suggest that stable pension systems must seek an equilibrium between earning cohorts. Otherwise, the chances are high for pension reforms and reversals [16].

We expand previous overlapping generations (OLG) models [17] by including debt. The consideration of cycle government debt obligates the central planner to make sure that future generations will not be used as a heavy tax source. In the current research, we take future generations' utility as part of the total preferences of the society by simply discounting them. One may claim that the weight for future generations in preferences equations does not necessary derives from the participant's discount factor and may suggest greater weight. We agree with that argument and claim that the equilibrium in that case should still be calculated specifically for every market separately.

The second dimension is the differentiation between high- and low-earning cohorts. Wolf and Del Rio [10, 11, 18] have shown that by shifting to the funded pension scheme, a socio-economic anomaly exists because of the high exposure of low-earning cohorts to market and credit risk without the ability to hedge themselves. They also claim that the optimal contribution rates are generally close to high-earning preferences (see also [9]). In that case, the funded pension market should be included as "externalities," where high earners compensate low earners by risk-sharing. That may include, for example, minimum pension guarantee, intergenerational/intra-generational risk sharing of social security benefits. These processes clearly justify differentiating the considerations and interests of earning cohorts.

## 3. Model setup

We employ a simple OLG model to characterize optimal pension pillars' sizes. In each period, a new generation of unit mass is borne. We employ this model for four generations. For simplicity, each generation includes three equal life periods cycle frameworks as in Knell [19]: "Individuals work during the first two parts of their life, while they are retired in the third part. The first pillar is unfunded social security, and the second is in the form of individual accounts" ([19], p. 6).

### 3.1 Consumers

The consumer works over two periods of 23 years each and retires at the age of 67 ($s = T_R$). They live for another 23 years, represented by the third period, and are assumed to die at the age of 90 ($s = T_D$).

During the first 46 years, consumers work and earn a real labor income of $W_{t1}$. We allow for differentiation in wage levels across earning deciles. From this wage, the individual contributes to social security tax and funded pension fund. The participant consumes the residual after contributions.

During the retirement period ($T_R \leq s < T_D$), the individual's consumption, $C_{t,T_R}$, is given by the benefits both from public and funded pension pillars. These benefits are collectively denoted by $P_t$. The consumption of the generation $t$ in time $s$ can be described as follows:

$$c_{t,s} = \left\{ \begin{array}{c} W_{t,s}(1-\tau), during\ work\ period \\ p^{U}_{T_R} + p^{F}_{T_R}, during\ retirement \end{array} \right\} \quad (1)$$

Individuals have a constant relative risk aversion (CRRA[2]) utility function defined over a single nondurable consumption good. Let us define $\delta$ as the discount factor; $\alpha$ measures the curvature of the utility function or risk aversion level, so the individual's preferences are then defined by

$$U_t = \sum_{s=1}^{s=2} \delta^{s-1} \frac{1}{1-a} \left(c_{t,t+s-1}\right)^{1-a} + \delta^2 \frac{1}{1-a} \left(c_{t,T_R} - mpg_{t,T_R}\right)^{1-a} \quad (2)$$

Here, $C_{t,s}$ is the consumption level of generation $t$ in period$s$, and $mpg_{t,s}$ is the level of government guarantee for generation $t$ in period $s$.

Consumption is a function of the participant's wage and deductions due to pension contributions (funded and unfunded) and taxes financing government debt. Government's debt can be made due to financing pension guarantees or financing intergenerational gaps in PAYG DB due to aging. These payments are detailed in **Table 1**. In fact, the aging effect realizes in twofold positions. First, by increasing the real debt cost of the government, as fewer people participate in a specified burden. Second, by reducing PAYG benefits per specified contribution rate.

Consistently with the life cycle model of Ando and Modigliani [20], the participant is aware of future interest rate risks and adapts his consumption during the working phase accordingly. If the government supposes to collect extra tax payments to finance the interests of its debts, the individual adapts his/her consumption accordingly.

### 3.2 Mix pension scheme with dominant funded pillar

Rates of returns are uncertain (*ex ante* expected utility). The GDP per capita growth rate approximates the aggregate wage income, following the same method of Masten and Thorgesen [21], and Wolf and Ocerin [9]. We also assume that the real PAYG rate of return, $g_{s+1}$, is equal to the growth rate of wages or the change in the GDP per capita.

| Consumption | Defined benefit | Mix pension scheme | Mix pension scheme with pension guarantee |
|---|---|---|---|
| During working phase | Wage-pension contributions—tax-financing aging effect (the cost of shrinking tax base) | Wage-pension contributions | Wage-pension contributions—tax-financing guarantee cost of earlier generations |
| During Retirement | Unfunded pillar with no aging effect | Funded + unfunded pillar | Funded + unfunded pillar + minimum pension guarantee up to the poverty line |

**Table 1.**
*Consumption in each pension scheme.*

[1] All variables used throughout this paper are expressed in real terms. It is assumed that wage inflation is identical to price inflation.

[2] In the literature, it is common to use the coefficient of relative risk aversion, $RRA \equiv \frac{U''(c)}{U'(c)} * c$, for the utility function of the form.

The parameter $g_t$ describes the evolution of wage, $W$, which follows a Brownian motion of the following form:

$$\frac{dW(t)}{W(t)} = dg_t = \mu_g dt + \sigma_g dB^W(t), \tag{3}$$

where $\mu_g$ stands for the constant expectation of the instantaneous variation rate in the wage, $\sigma_g$ denotes its constant standard deviation, and $B^W$ represents a standard Brownian motion. The first phrase is a constant drift, and the second phrase is the volatility drift. The term $g_{t+1}$ is the growth of labor income or the return on human capital.

The individual pays a fixed contribution rate$\tau$. From that contribution, a share of $\gamma$ is invested in a private-funded pillar and a share of $(1-\gamma)$ finances in the unfunded pillar or the public social security. The pension benefit for generation $t$ in the retirement period is denoted by

$$p_{T_R} = p^F_{T_R} + p^U_{T_R}. \tag{4}$$

Here, $p^F_{t+2}$ and $p^U_{t+2}$ represents the funded fund and social security (PAYG), respectively.

We allow a correlation between the GDP per capita and the fund asset return rate, thus

$$dB^W(t)dB^A(t) = \rho_{w,A}dt, \tag{5}$$

with the condition $1 \geq \rho_{w,A} \geq -1$.

We assumed a constant social security benefit based on time of contributions. In each period, the working population's contributions are equal to the total benefit payments to retirees. Consequently, the public unfunded pension benefit is determined using the balanced budget condition of

$$\varphi\tau^U\left\{\overline{W}_{t+1,T_R}N_{t+1} * A + \overline{W}_{t+2,T_R}N_{t+2} * A^2\right\} = \sum_{n=1}^{N_{T_R}} p^U_t \tag{6}$$

Here, $\tau^U$ is the contribution rate to social security, $N_t$ is the size of the generation born in period $t$, and $p^U_t$ is the unfunded pension benefits paid to generation $t$ in the period $T_R$. The term $\varphi$ is the constant social security's old-age benefits/contribution ratio. The residual share $(1-\varphi)$ of contributions finance other social expenses pertaining to Medicare, means-tested, minimum pension guarantee, disability benefits, unemployment benefits, and other social expenses. The tax base in each generation is shrinking due to the aging of societies. Consequently, $A$ represents the aging factor of each contributor generation to social security.

Under the assumption of constant population growth, $ni_t$, the contribution $\tau^U w_{t,s}$ is paid by generation $t$ in time $s$; thus, there is a return of $g_{s+1} = (W_{t,s+1}/W_{t,s}) - 1$. In addition, we assume the economic principle of Aaron [22] that the notional interest rate or the population growth rate is set equal to the growth rate of wages: $ni_t = g_t$. Hence, the unfunded benefit at retirement can be described in the following reduced form:

$$P^U_{t,T_R} = \varphi(1-\gamma)\tau\sum_{t=1}^{T}\partial_d\overline{W}_{t+1,T_R} * \left(A + A^2\right), \tag{7}$$

where $\partial_d$ is a constant parameter per earning decile that adjusts the benefit to contribution level. This mechanism is similar to the Notional Defined Contribution

(NDC) pension scheme and ensures higher benefits for high earners in relation to their contributions.

The funded-capitalized pillar is a private collective defined-contribution (DC) system with a fixed contribution rate. Individuals start with zero initial asset holdings. Subsequently, the individual adds the fraction of $\gamma w_t$ to his accumulations during the working phase, which is invested in a constant portfolio mix of financial assets (equities, bonds, etc.). This accumulation earns an average annual rate of return of $r_t$. This rate of return also follows a Brownian motion of the following form

$$dr_s = \mu_r dt + \sigma_r B^A dt \tag{8}$$

Here, $r_t$ denotes the continuous rate expectation of the asset instantaneous return rate, $\sigma_r$ stands for its constant standard deviation, and $B^A$ indicates the standard Brownian motion. The first phrase from the left is a constant drift, and the second phrase is the volatility drift.

The funded pillar is equal to the accumulated capital from the contributions to the private collective defined-contribution fund during every working period until retirement ($T_R$). The real capital is given by

$$p_t^F = \left(1 - T^f\right)\left(1 - I^f\right)\tau^F \sum_{s=t}^{T_R} W_{t,s} r_t^{T_R - t} \tag{9}$$

Here, $T^f$ is the effective tax rate on old-age funded fund's benefits. $I^f$ is the fraction from the contributions that represent insurance contributed from the pension fund, such as disability. Funded fund's liabilities are based on the current and future retiree's benefit payments. The funded benefit can be described more specifically as

$$p_t^F = \gamma\tau W_t r_{s+1} r_{s+2} + \gamma\tau W_{t+1} r_{s+2} \tag{10}$$

Due to the assumption that there is only one period of retirement, it is not necessary to specify how the pension capital of the funded pillar is annuitized or amortized, that is, transformed into annual pension installments.

### 3.3 Pension guarantee

The government considers implementing a minimum pension guarantee when imposing the funded pension scheme. The periodical guarantee is at the poverty level, meaning 0.6 of the median earnings decile. We calculate the cost of the guarantee as

$$\textit{Guarante cost at time } t = p.\,l \textit{ at time } t - \left(p_t^F + p_t^U\right) \tag{11}$$

The poverty line itself is growing every period by the GDP per capita growth rate. However, the guarantee cost depends on the income inequality in the market and stays constant as a percentage from the GDP. The guarantee cost is financed by the government in the form of tax levied on future generations.

### 3.4 PAYG DB pension scheme

Pension benefits are calculated using the same method of the unfunded pillar described above. The difference is that total contributions are for the unfunded pillar ($\gamma = 0$). In addition, retirees benefit from the constant contribution level. The

government, through debt, finances the exposure of aging, which reduces the intra-generational financing base.

$$P_{t,T_R}^{DB} = \varphi\tau \sum_{t=1}^{T} \partial_d \overline{W}_{t+1} * 2 \tag{12}$$

As the government keeps benefit retirees at the same original level before transition, the shrinking tax base is translated to a fiscal expenditure. That expenditure is financed by future generations as tax payments in the amount of

$$P_{t,T_R}^{DB}\, government\ share = \varphi\tau \sum_{t=1}^{T} \partial_d \overline{W}_{t+1} * \left(2 - \left(A + A^2\right)\right) \tag{13}$$

### 3.5 Government debt

Government finances two different obligations through debt and future tax. The first is the guarantee cost in mix funded pension scheme. The second is the aging influence of the intra-generational tax base from generation to generation.

For each of these expenses, we assume a debt cycle of four periods. In the first period, the fiscal expense is realized. Over the next two periods, the working population pays the interest rate component as tax, while during the fourth period, return also the principle in addition to the periodical interest payment. In total, in each period, the working generation pays three interest rate components of past debts and a single principle of past debt.

### 3.6 Different earning cohorts

We allow different preferences among earning cohorts. In fact, this diversity is one of the most important novelties of this research. We assume that high-earning cohorts benefit from a higher share of GDP growth than low earners, in increasing order. In parallel, high earners levy a higher share of tax payments, progressively. For example, the tax burden on decile 4 is only 5% from payment, while it is 30% on the highest-earning decile. **Figure 1** summarizes the differentiation across different earning deciles.

We value the preferences of earning cohorts to the different pension schemes by the change of average utility computed according to each of the three pension schemes analyzed. For simplicity, we group these preferences by deciles 1–4 for low-earning cohorts and 7–10 for high-earning cohorts.

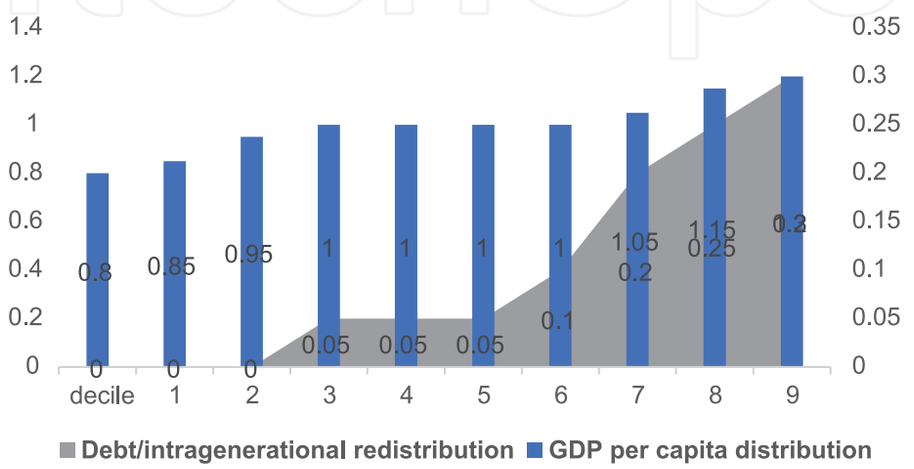


**Figure 1.**
*Earning deciles.*

## 4. Simulation and calibration

The GDP per capita stochastic yields turn to be stochastic the variables of periodic wage, poverty line, defined benefit pension scheme, and social security. The market yield affects the funded pension pillar stochastically. We use Monte Carlo simulations to simulate the level of the guarantee cost in each generation and the level of governmental debt due to imposing defined benefits in each generation. Another set of Monte Carlo simulations is conducted to compute the preferences of each earning cohort for each generation among funded pension schemes, funded schemes with guarantees, and defined benefit pension schemes.

For each generation, the preference of pension scheme depends on the utility of each earning cohort in each generation. For comparability, we compute the relative preference of the mix pension scheme over the DB and respectively the preference of the mix pension scheme with a guarantee over the DB. Monte Carlo simulations simulate these pairs of ratios.

Analyzing the results, we make a differentiation between low- and high-earning cohorts. For each set of results, we discount the preferences of the four generations to a single number.

We calibrate the model as of the average western OECD country, using its updating database [4]. In the base scenario, the government capital cost is 0.5%, the GDP per capita is 1.6% per year, and the average net pension market yield is 3.74%. The contribution rates to pension pillars are derived from countries such as Denmark and Israel that run dominant funded pension schemes [4]. We take into consideration the aging trend in Western countries. We assume the high aging influence as conservative in analyzing the rush toward the funded scheme. In that case, similar to Germany and Spain, the dependency ratio increases by 0.4% every year. The sensitive analysis is conducted to map the trends of preferences as a

| **Wage and pension systems** | |
|---|---|
| Contribution rate | 0.3 |
| Funded rate from contributions | 0.75 |
| Annual Expected S.D. of funded pillar | 18% |
| Gross return [4] | 4.3% |
| Admin. Cost | 0.5% |
| The funded Benefit tax rate | 20% |
| Annual Expected GDP per capita – g | 1.6% |
| Annual GDP S.D | 2% |
| Social Security Benefit / Contribution coeff. | 60% |
| Insurances in funded pension funds from contribution | 25.00% |
| Macro-economic parameters | |
| Risk Aversion Coeff. (Base Scenario) | 3 |
| Annual Interest rate (Base Scenario) | 0.10% |
| Total population annual growth | 0.30% |
| Dependency ratio annual change | 0.4% |
| Annual discount factor | G + 1.3% |

**Table 2.**
*Calibration.*

function of risk aversion and interest rate gap. We summarize the calibrations variables in **Table 2**.

## 5. Results and insights

While there is no debt financing the funded pension scheme, there is small debt financing the DB pension scheme (the aging effect) with a constant percent from GDP. We map higher debt level financing the guarantee, reducing in time, if $> r_f$.

In the Western market, the government interest rate is generally lower than the GDP per capita rate, while the market yield ($r$) is higher than both. In times when the difference between the market yield and the GDP per capita increases, markets will prefer to shift to a funded pension scheme and vice versa. Here, we point out the government capital price as also an important factor as it affects the preferences of future generations. A coherent pension system, which considers multiplayers' preferences, cannot avoid the tax/PAYG burden levied on the working population or future generation in the form of cycle tax payments.

### 5.1 PAYG DB scheme vs. funded pension scheme

For each generation, we check the preferences between PAYG DB and the funded pension scheme via 2100 Monte Carlo simulations. Each simulation calculates the OLG model with the aforementioned assumptions. **Figure 2** describes these preferences by earning cohorts and as a function of the rate of returns gaps (GDP per capita minus the government interest rate). The more positive the preference value, the more the preference tends toward the funded scheme. By the same logic, the more negative the value, the more they prefer the DB pension scheme.

As expected, high earners prefer the funded pension scheme, while low earners tend to prefer the DB scheme. For high earners, the reasons for this are the potential for higher benefits and the avoidance of financing pension gaps of unfunded transfers due to aging and the shrinking labor force.

Low-earning cohorts prefer the DB pension system as it enables insurance although the benefits in the funded scheme are higher on average. As time goes by, in both earning cohorts, the attractiveness of the funded scheme increases as the average returns of the funded scheme is higher than the GDP per capita, and naturally, the insurance for the long term is less considered in the utility measure.

When increasing the risk aversion coefficient from 3 to 5, low earners become almost indifferent between funded and unfunded pension schemes. This is because, in high-risk aversion measures, participants put considerable weight on their current consumption more than their old-age benefits. Since consumption does not change, the total utility change is almost constant.

According to **Figure 3**, for high earners, the preferences concerning unfunded pension schemes are dramatic. That tendency is moderated with generations and when government debt cost increases. In other words, even when the tax burden due to aging is levied on high earners' consumption and their old-age benefits are lower than in the funded pension scheme, they will rather strongly prefer unfunded pension schemes along most of the returns gap array. Additionally, when risk aversion increases, high earners' preferences for the PAYG DB pension system increases as opposed to mix pension with pension guarantee. We explain that as of high insurance embedded in the first option and lower tax burden. That conclusion is highly important mainly in times of turmoil markets.

| Panel A: Low Earning Deciles | | | | | | |
|---|---|---|---|---|---|---|
| Interest rate gap / Generation Preference | | A | B | C | D | Preference to end of genertion A |
| g-r | 1.50% | -2.21% | -1.31% | -0.73% | -0.39% | -3.7% |
| | 1.30% | -2.03% | -1.14% | -0.64% | -0.36% | -3.2% |
| | 1.10% | -1.77% | -1.05% | -0.59% | -0.31% | -2.8% |
| | 0.90% | -1.54% | -0.94% | -0.51% | -0.27% | -2.4% |
| | 0.70% | -1.38% | -0.80% | -0.43% | -0.22% | -2.1% |
| | 0.50% | -1.26% | -0.69% | -0.37% | -0.17% | -1.8% |
| | 0.30% | -1.06% | -0.58% | -0.28% | -0.12% | -1.5% |
| | 0.00% | -0.74% | -0.37% | -0.15% | -0.03% | -1.0% |

| Panel B: High Earning Deciles | | | | | | |
|---|---|---|---|---|---|---|
| Interest rate gap / Generation Preference | | A | B | C | D | Preference to end of genertion A |
| g-r | 1.50% | -3.34% | -2.74% | -3.82% | -2.91% | -8.5% |
| | 1.30% | -0.32% | 0.35% | -0.01% | 1.59% | 0.4% |
| | 1.10% | 3.23% | 2.67% | 1.93% | 4.43% | 7.1% |
| | 0.90% | 5.00% | 5.74% | 8.03% | 8.84% | 14.0% |
| | 0.70% | 8.88% | 9.22% | 10.96% | 12.91% | 21.5% |
| | 0.50% | 12.59% | 13.76% | 15.70% | 17.89% | 29.3% |
| | 0.30% | 16.14% | 18.00% | 19.92% | 22.19% | 35.8% |
| | 0.00% | 22.37% | 24.91% | 26.66% | 29.82% | 46.7% |

**Figure 2.**
*Generations' preferences of PAYG DB vs. funded scheme in the base scenario ($a = 3$).*

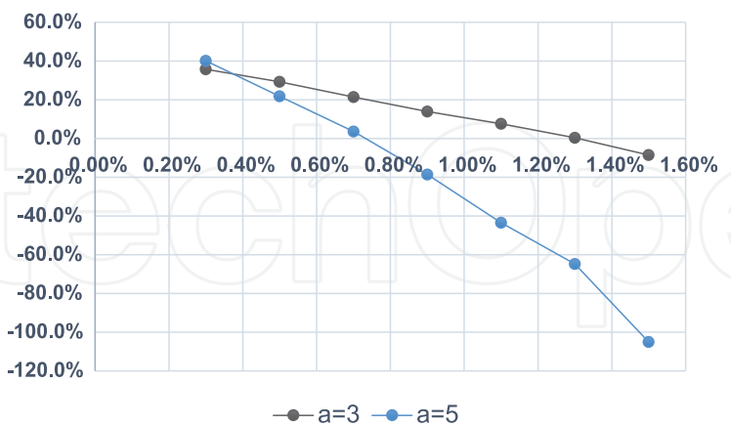


**Figure 3.**
*High earners' preference when risk aversion increases.*

## 5.2 PAYG DB scheme vs. mix pension scheme with pension guarantee

**Figure 4** compares along with the base scenario the preferences for PAYG DB scheme and mix pension scheme with pension guarantee. According to the results, there is not much difference between the two possibilities (the blue line) according to low earners. The benefit level is quite similar; in both cases, there is an insurance component, and in both cases, the tax burden does not fall on this earning cohort's

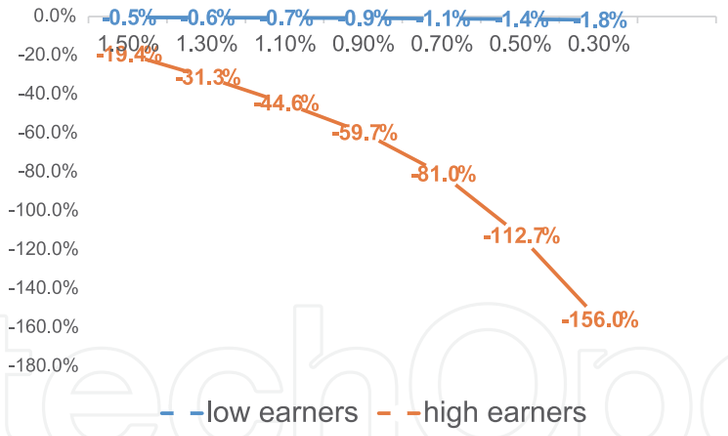


**Figure 4.**
*The preference between PAYG DB and mix pension system.*

shoulders. As the gap between the GDP per capita and the government's interest rate decreases, the discounting factor diminishes and the attractiveness of the PAYG DB decreases. It is most interesting to understand the results for high earners, who finance the insurance components in both of these pension systems. It is significant to determine that high earners would prefer the PAYG DB pension scheme over the alternative. The reason for this is mostly the high financing cost of the guarantee. **Figure 4** depicts that when government's interest rate increases (small gap), the preference for PAYG DB increases accordingly, avoiding a higher tax burden.

As we allow differentiation in deciles' wealth growth, the income inequality increases with time. The poverty line is indexed to the GDP per capita while high-earning deciles' wealth growth faster. That makes the guaranteed price to be relatively lower along with generations, which comes to realize by decreasing percent from total GDP.

In general, if the GDP per capita is higher than the government interest rate, clearly, the central planner would prefer to accumulate debt and roll it over the years, as the principal and interest rate payment decrease as percent from the GDP. Along with generations, the preferences toward the DB pension scheme tend to decrease as the average return effect increases. However, for high earners, the attractiveness between the two pension schemes is not ambiguous. High earners prefer the DB pension scheme because of the lower tax burden during the working phase. In other words, they prefer to pay lower old-age benefits than to pay the relatively high tax burden due to the guarantee.

### 5.3 Finding an equilibrium point

Equilibrium in pension systems is not only dealing with a question of the economy but also involves social targets [23]. Even when poverty alleviation is highly weighted among the central planner's considerations, it is not straightforward to implement mix pension system with a minimum guarantee. Although low earners only slightly prefer the unfunded scheme over the mix with the guarantee, high earners significantly prefer the unfunded scheme and avoid financing the high costs of the guarantee. Consequently, among these two options, from a wider perspective of all players, the system should be set at the PAYG DB pension system.

That conclusion is certainly relevant in an aging society having clear economic characteristics of Western countries. In other words, the potential old-age benefits

for high benefits in the funded pension scheme are offset with the tax burden to fund social targets.

In this research, we show that the PAYG DB is a common equilibrium even when releasing the assumption of social targets. One can see that in **Figure 2**, wherein the gap between the GDP per capita and the government debt cost is large (1.5–1.3%), the players would prefer the PAYG DB. That simple equilibrium is also relevant when risk aversion increases or the yield's standard deviation increase. Naturally, in these situations, participants prefer safer benefits even in the cost of lower consumption during the working phase. That conclusion is most relevant when markets are not stable, for example, during the COVID-19 pandemic crisis.

More complex scenarios can be found when the gap between the GDP per capita and government debt price is narrowed. For example, in **Figure 2**, when the gap is at 1.1%, low earners prefer the unfunded pension scheme (measure of −2.8%). Similarly, high earners prefer the funded scheme (measure of 7.1%) while resisting the mix scheme (measure of −44.6% in **Figure 4**). The lack of preference of neither of the players toward the mix pension system suggests it's from the realistic equilibrium variety.

Between the unfunded and the funded pension scheme, we seek a point satisfying the players' interests, which in turn increases the chances to system

**Panel A**
**GDP per capita - government interst rate = 1.1%**

| Earning cohort | Box size (%GDP) | A | B | C | D | Preference to end of genertion A |
|---|---|---|---|---|---|---|
| The Base Scenario | | | | | | |
| low | 3.30% | -1.77% | -1.05% | -0.59% | -0.31% | **-2.8%** |
| high | 3.30% | 2.80% | 3.00% | 3.63% | 4.34% | **7.6%** |
| | | | | | | |
| Finding Equilibirium Point | | | | | | |
| high | **3%** | -7.63% | -8.82% | -8.45% | -9.00% | **-19.7%** |
| high | **2%** | -4.35% | -4.66% | -3.84% | -4.24% | **-10.3%** |
| high | **1%** | **-1.24%** | **-1.39%** | **0.27%** | **0.66%** | **-1.9%** |

**Panel B**
**GDP per capita - government interst rate = 0.9%**

| Earning cohort | Box size (%GDP) | A | B | C | D | Preference to end of genertion A |
|---|---|---|---|---|---|---|
| The Base Scenario | | | | | | |
| low | 3.60% | -1.77% | -1.05% | -0.59% | -0.31% | **-2.7%** |
| high | 3.60% | 2.80% | 3.00% | 3.63% | 4.34% | **7.2%** |
| | | | | | | |
| Finding Equilibirium Point | | | | | | |
| high | **2%** | **-1.71%** | **-1.59%** | **-1.02%** | **-0.71%** | **-3.3%** |
| high | **1%** | 3.08% | 2.48% | 3.61% | 4.81% | **7.3%** |

**Panel C**
**GDP per capita - government interst rate = 0.7%**

| Earning cohort | Box size (%GDP) | A | B | C | D | Preference to end of genertion A |
|---|---|---|---|---|---|---|
| The Base Scenario | | | | | | |
| low | | -1.38% | -0.80% | -0.43% | -0.22% | **-2.1%** |
| high | | 8.88% | 9.22% | 10.96% | 12.91% | **21.5%** |
| | | | | | | |
| Finding Equilibirium Point | | | | | | |
| high | **3%** | **-0.37%** | **-1.06%** | **-0.23%** | **-0.65%** | **-1.2%** |
| high | **2%** | 3.02% | 2.84% | 3.10% | 3.96% | **6.8%** |
| high | **1%** | 6.89% | 5.93% | 7.27% | 8.93% | **15.2%** |

**Figure 5.**
*Finding an equilibrium point in the funded pension scheme.*

sustainability. With a given macroeconomic parameters, we seek a new mix pension system, which includes an "unfunded box," shifted from high earners to low earners, at retirement. That shift compensates low earners to excess market risk and their low abilities to hedge it. From another economic angle, high earners finance this compensation due to the characteristics of contribution rates being close to being optimal for high earners and sub-optimal for low earners [10, 11, 18]. In fact, this shift creates equilibrium as part of the "externalities" theory and alleviates the inherent socio-economic anomaly in funded pension schemes, which is in favor of high earners.

Finding the unfunded "box" size, we analyze the preferences while low earners benefit from it and high earners finance it. **Figure 5** plots the convergence process to equilibriums based on the funded scheme along with the unfunded box. We learn that even is a small amount of shifting (low box size), high earners would prefer to stay in the DB PAYG scheme. That is valid even for debt levels that are far lower than the PAYG DB base scenario. For example, in panel A, when the returns gap is 1.1%, high earners would prefer the PAYG DB even with a minimum level of the box (1% of GDP). In panel B, when the gap is shorter, the equilibrium will be set at the funded scheme with an unfunded box of 2% of the GDP. In these two cases, one can determine that the equilibrium is extremely fragile, meaning it is actually the PAYG DB scheme. In panel C, when the returns gap is at 0.7%, the suggested equilibrium is the funded scheme with an unfunded box of 3% of the GDP. From that gap level and lower, the model suggests equilibrium involving the funded pension scheme.

## 6. Discussion

The influence of aging is perceived as an intergenerational burden [24], which increases over the years. That was used in the base arguments of the World Bank in convincing economies to shift to funded pension systems during the 1990s [25]. The motivation to converge to equilibrium is first of the government's itself, avoiding fiscal expenses on reverting and ensuring political support from all players [26].

The fiscal concerns due to the aging process are indeed intuitive; however, it might push governments to endorse funded pension schemes too fast. According to the findings, the insurance effect of the unfunded pension scheme is beneficial even at the cost of a shrinking tax base. A low-interest rate environment and a sufficient gap between the GDP per capita and the government's interest rate mostly suggest keeping unfunded pension schemes. In markets with a narrowed gap, equilibriums can be established with a funded pension scheme with some unfunded box strengthening low earners pensions at retirement. One has to mention that the equilibrium with the funded scheme is mostly fragile, where a slight change in the macroeconomic variables, will cause even high earners to prefer the unfunded pension scheme. In addition, the preferences toward unfunded schemes are strengthened in times of unstable markets.

In addition to the results, supporting a mix pension design with a risk-sharing mechanism, we count another fiscal motive of the government to avoid extensive funded scheme, surprising, as it may be sound. Altiparmakov [8] shows that CEE countries revert to unfunded pension schemes to control all sorts of contributions and taxes of their citizens. In other words, in times of financial crisis, governments wish to raise chip money, and unfunded contribution is a fast way to do that.

## 7. Conclusion

The key feature of this research is the consideration of multiplayers in the field, as the pension system effects across generations and earning cohorts. By treating society as one single entity managing financial risks, we may lose the opportunities to disclose other interests and avoid potential equilibriums in the markets. Seeking stable pension markets is one of the top priorities of central planners, especially during the period of uncertainty in other markets due to the pandemic and global debt crisis.

While the preferences for low earners are clear toward the unfunded pension scheme, for high earners, it is most interesting to examine their preferences. Here, we consider the assumptions of mutual risk-sharing among earning cohorts, solving the inherent socio-economic anomaly in the funded scheme, which favors high earners at the expense of low earners [10, 11, 18].

The findings point that central planners must not rush for funded pension funds although societies are aging. The rush after funded pension schemes in aging markets must not be turned to way out of governments to consider multiplayers game and avoid other macro-economic parameters, such as debt level, debt price, and GDP per capita factors. Here, we mention the global trend of shifting to funded schemes even in non-aging markets, such as in Israel [27]. We find in this composition that the unfunded pension scheme should be considered as most efficient to all actors in a wide variety of macroeconomic conditions, especially when the interest rates are very low, as it is in this period.

In times of the pandemic, central planners have to minimize the possibilities of unstable pension markets and reversals. The period for itself increases the motive to find a sustainable equilibrium in the market. In addition, governments have to reconsider the frightened in the markets in these times. In our model, that comes to realize by the higher standard deviation of the market yield and higher risk aversion. Both realizations imply higher chances for equilibrium in the unfunded pension scheme. These results come despite the aging of societies.

## Classification

JEL: D14, E21, E61, G11, G18, G22, G32, H23

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