Studying the equilibrium of pension designs when shifting to funded pension schemes: economic theory and links to political factors

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Abstract
In this paper, we explain the evolution of pension systems due to political pressure. Such pressure has led to pension reversals in recent years in many of the countries of Central East Europe (CEE) and Latin America. We base our theory on exchange options and finance positions. We show that during the transition to a funded pension scheme, high earners benefit from the change, while the low earners’ position worsens. This type of unstable position will eventually lead to pension reversals. We suggest the minimum pension guarantee as a mechanism to create a financial equilibrium to stabilize the pension market. Based on the option characteristics, we analyse the boundaries of that equilibrium. We find that high-income inequality and poverty foster the convergence to a mixed pension scheme or the implementation of a minimum pension guarantee. In the second part of this paper, we show how the minimum pension guarantee has accounted for a major part of the pension designs across OECD countries. Funded schemes that did not implement an unfunded mechanism were reversed to put more weight on unfunded pillars.

Keywords  Social security · Pension · Risk · Minimum pension guarantee · Political pressure

JEL Classification  C18 · G18 · H55

Introduction
The global pension landscape evolves continuously. Since the 1990s, countries worldwide have introduced pension structural reforms transforming from the public ‘pay-as-you-go’ (PAYG)-defined benefit (DB) model to individual accounts...
(Ebbinghaus 2015). The main reason was fiscal constriction, due to low fertility and a longer period of retirement. Governments, particularly in aging Europe, could no longer meet the obligations towards an adequate pension level in PAYG DB schemes without raising taxes (Holzmann et al. 2008). This problem entailed diverting funds from the public pension system to individually funded accounts.

However, the financial market crash in 2008 challenged the merits of privately funded pensions, as their assets experienced a substantial decline within a short time (Grech 2018). Consequently, in recent decades, trust in the sustainability of the new pension pillar system has been shattered from the perspectives of both the government and the participants (Ebbinghaus 2015; Sokhey 2017). The pension reversal wave in CEE countries and Latin America over the last decade has taught us that political pressure plays an active role in economic systems, especially in pension markets (Natali 2008; Altiparmakov 2018; Ortiz et al. 2018). The political pressure due to pension conditions was shown also in the West by frequent changes in the pension conditions and rules (Van Dalen and Henkens 2018; Carone et al. 2016) and large street demonstrations as seen in Zurich, Madrid, and Paris in those 3 years. The ‘office-seeking’ effect pushes governments to strive for rapid benefit improvement through government insurance and an increasing social security role, alongside adapting the retirement age to account for longevity (Zandberg and Spierdijk 2013).

In the era of the post-Coronavirus pandemic crisis and governmental bailout waves, the public must re-evaluate the ability of the economic growth and financial markets to provide adequate benefits in old age (Feher and Bidegain 2020). The current crisis may also be an opportunity to investigate various pension designs, e.g., funded schemes as in the 1980s–1990s or deeper governmental intervention with dominant unfunded components. Currently, it is also crucial to understand the key mechanisms that may strengthen or weaken the modern pension system worldwide, which may include mixed funded and unfunded components.

In this composition, we claim that the pension system’s sustainability depends on satisfying the critical mass of participants relative to a predefined benchmark. Otherwise, political pressure could lead to a reversal as taught from the global experience, mentioned above. Although the government intends to transfer its fiscal risk to the individual dimension, it should structure healthy risk-sharing mechanisms among the players, which include across generations. The government itself will also have to compromise, as these mechanisms may realize by determining a decent level of public pension expenditures. As will be shown in this paper, theoretically, a sustainable equilibrium in the pension market has a higher probability of avoiding reversals and unexpected fiscal expenditures. This finding is also supported by global experience as will be discussed here.

From the financial perspective, our main argument is that any pension system would be appropriate if the link between the return and risk is being shared among the different players. More particularly, if the pension scheme shifts from a defined benefit (DB) model to a defined contribution (DC) model, the individual expects a risk premium for the new risk burden, which includes financial and non-financial risks (Novy-Marx and Rauh 2009). The total risk premium to society can assume many forms, such as imposing insurance components by increasing social security
financial transfers or implementing a minimum pension guarantee (Mabbett 2020; Mesa Lago and Valero 2020; Dorman 2017).

The demand for that premium varies among different earning cohorts, as for some, the risk exposure is in favour of others. In line with Wolf and Caridad (2021) and Sinn (2000), we suggest a compensation mechanism among the earning cohorts to increase their satisfaction with the risk premium size and, hence, with the funded pension scheme.

However, it is impossible to calculate this premium ex-ante or even to calculate a specific risk premium ex-post. Here, we try to evaluate an array of possible equilibriums, which involve a mixed pension system with compensation among earning cohorts. This type of system would satisfy a critical mass of participants and thereby avoid political pressure for reversals. We also empirically show that mixed balanced pension designs have the characteristics of the suggested equilibrium array.

This paper is distinguished from the literature by suggesting a new perspective of analysis. The traditional pension economy neglected the individual and related to society as a single player (Aaron 1966; Feldstein and Ranguelova 2001). In this paper, we suggest an equilibrium with multiple actors that considers the political power of subgroups in society. Because each subgroup stands in a different financial position, it has different interests, which must be considered when seeking a sound balance in the pension system.

In the next section, we provide a short relevant literature overview. Then, we make an analogous link between the pension scheme and different financial positions. After presenting the interests of different players, we suggest a sustainable equilibrium array of the mixed pension system. We argue that a market not located in that equilibrium array will eventually revert to an unfunded pension design due to increasing political pressure. Section 4 strengthens the model’s findings based on global experience in funded pension markets. Section 5 discusses the consequences of the results and their effect on future pension designs. Finally, we summarize the main contributions and findings in the conclusion.

**Literature review**

This paper continues the new strand of literature in the footsteps of Barr and Diamond (2009) on sustainable and adequately funded pension designs. In their seminal work, Barr and Diamond argue that the funded pension scheme is not superior to the unfunded pension scheme, which is in contrast to the arguments of the ‘Washington Consensus’ and global economic institutes during the 1990s. The choice between the pension schemes connects to the socioeconomic value and targets. Sinn (2000) argues against the World Bank effort to convert countries to DC plans, pointing out that there is nothing to be gained from a transition to a funded system in the long term, even though the latter offers a permanently higher rate of return. Kubicek (2008) demonstrates the inferior conditions between the two edges of pension designs.

Following this strand of literature, several papers study the evolution in pension designs, arguing that pension design equilibrium is lacking in most markets, which
made reforms toward funded privatized pension designs. Lack of such equilibrium is mostly realized by the frustration of large population groups and consequently, political pressure to reverse back to unfunded pension schemes. For example, Gora (2013) describes the economic process of convergence to a funded system in European countries, which suffer from low fertility. She points out that funded pension schemes are linked to poverty risk in old-age and potential political pressure in the future. Hinrichs’s (2021) overview points to a new wave in pension reforms, abolishing the funded pillar or shifting to a mixed pension scheme such as a notionally defined contribution scheme or points. In other important researches, the pension changes wave was recognized as part of political economy pressure to adequate benefits and old-age conditions. For instance, Moury and Afonso (2019) analyse the pension reversals wave that has occurred in Southern Europe since 2016 due to political pressure to increase the benefits’ adequacy. These authors link that pressure to a wider challenge of labour protections and peer Western economies in Europe. Altiparmakov (2018) and Grech (2018) show that the experience in CEE countries over the last decade suggests that the outcome of levying unbalanced financial risks on participants due to fiscal considerations is political pressure for reversals. Naczzyk and Domonkos (2016) analyse domestic coalitions against pension privatizations in Poland, Slovakia, and Hungary. Based on a sample of thirty countries over the last two decades, Ortiz et al. (2018) describe the failure of mandatory private pensions to improve old-age income security and their underperformance in terms of coverage, benefits, administrative costs, transition costs, adequacy, and even fiscal conditions. Indeed, the authors claim that these issues were the incentive to political stress and re-reform pension plans in the aftermath of the financial crisis. Some related papers address the improvement of funded pension designs, however, focusing on the optimization of the portfolio of assets invested. Lin et al. (2019) use the recursive utility function to optimize the multi-period portfolio for retirees. They also consider withdrawal during the working phase. De Jong et al. (2011) optimize the risk allocation and the investment portfolio the expected utility of lifetime consumptions of a new entry cohort. They show that the optimal inter-generational risk sharing in social security is neither a pure DB type nor a DC type, but a state-contingent hybrid scheme. Bovenberg et al. (2007) and De Menil et al. (2006) use the standard utility function and optimize pension pillars sizes with an overlapping generation model. All these papersanalyse the transition to a funded scheme from the individual perspective and needs, neglecting the fact that the transition is naturally in favour of some groups and worse for others.

Recently, Wolf and Ocerin (2021) first addressed the problem of multiplayer equilibrium. Using an overlapping-generation model and maximizing the utility function, they point out a socioeconomic anomaly in the design of mixed pension systems in favour of high-earning cohorts at the expense of the economic loss of low-earning cohorts. This result shows that although the level of the total contribution rates and funded share are generally optimal for high-earning cohorts, these factors are not generally optimal for low-earning cohorts. In this paper, we continue this perspective, considering different groups of interest. We separate from Wolf and Ocerin by not optimizing the pension pillars but suggesting an analytical equilibrium among earning cohorts. First, we address the transition from the financial
position perspective and then we fully consider the political-economy perspective with a multi-player game. We discuss the economic and political incentives of each player in the field and model them from different perspectives, using exchange options and financial positions. This perspective may suggest an array of acceptable pension designs to all players, based on principles borrowed from the ‘Externalities’ theory, as will be shown below.

This paper also leaned on recent papers, dealing with the growing political pressure in funded pension schemes. Wolf (2021) claims that given the wave of pension reforms, the large voting power of people nearing or beyond retirement age could grow until it compels another recalibration of public pensions and regulation of private pensions. Bradley et al. (2016) and Altiparmakov (2018) also confirmed that assumption. In both studies, it was shown that if the electoral majority does not consider a system beneficial, i.e., if it does not help them maintain their preretirement living standards, it could be voted out. Hassel et al. (2019) strengthen that line of thought by claiming that due to the financial crisis, governments reassess individual accounts due to growing political pressure.

The model

The main difference between DB and DC pension schemes arises from exposure to different types of risks and how these risks are allocated among the employer, employee, plan sponsor, and government (Rappaport and Peterson, 2014). In a DC scheme, each participant contributes a fixed fraction of their earnings to an account. These contributions are accumulated in the account, as are the returns from those assets. As there is no redistribution across generations, a generation is constrained by its past savings. Hence, all pension risks (financial and non-financial) are placed on the individuals’ shoulders. In a DB pension scheme, a worker’s pension is based not on his or her accumulation but the worker’s wage history, possibly including the length of service. A key feature of this design logic is the way wages enter the benefit formula. The pension can be based on a person’s real or relative wages over an extended period, including the entire career. The worker’s contribution is generally a fraction of his or her wage; thus, the sponsor’s contribution is conceptually the endogenous variable in ensuring the scheme’s financial balance.

Here, a player is defined as an entity with sufficient political power to influence the government’s operations in the market. Political power in the pension market is divided not only among different field actors but also between periods. We introduce the actors’ expectations and the balance point in the process of implementing a funded pension scheme.

The government

The government acts as a mediator among different generations of participants and different players in the pension market (Tausch et al. 2013). The government is capable of bridging commitments and payments through the distributional mechanism of
public debt and tax. Naturally, like other actors in the field, the government wishes to decrease its fiscal obligations and future fiscal risks (Wolf and Caridad 2021); hence, it avoids prejudicing its other expenditure (G) by its intervention in the pension market. Consequently, the government consistently tries to shift the pension market to a funded design to minimize exposure to fiscal risk in the form of social security payment obligations.

In addition to minimizing fiscal risk, the government is constrained in its actions by political pressure. Hence, we assume that the government operates with some incentive to satisfy the current population that can vote so it can remain in governance. The government acts as a "central planner" by balancing the different players’ interests. Drazenivic et al. (2019) describe the political pressure of CEE countries after 2008 due to weak fund performance and inadequate pension benefits, which resulted in reversals of the second pillar and higher fiscal expenditures (see also Altiparmakov, 2018; Bielawska et al. 2017).

The society

If sufficiently many individuals have the same expectation and interests from the pension scheme, their group can create political pressure on the government to consider the individual interests. Additionally, the government has a larger perspective, as it considers both retired persons and contributors during the working phase. Naturally, society influences the central planner’s actions by its political power. Hence, we narrow society mainly to those grouped individuals who are of voting age or capable of pressing the government policy through demonstration and lobbying.

Society may consider shifting to a mixed pension scheme with 2 pillars: social security and a funded pillar with individual accounts. We define \( \tau \) as the total contribution rate from the participant’s wage. We split the contribution into two components: \( \gamma \) as the funded portion of the pension contributions and \( (1 - \gamma) \) as the contribution share, which finances the DB PAYG. The decision benchmark is the former DB PAYG pension scheme or a satisfying relationship between the individual’s wage and his or her old-age benefit.

The two forms of social security are detailed in Eq. (1):

\[
L(T_R) = \sum_{i=1}^{N} \sum_{t=1}^{T_{R-1}} \tau w_{i,t}(1 + g)^{-t-1} \ast RR \tag{1a}
\]

\[
L'(T_R) = \sum_{i=1}^{N} \sum_{t=1}^{T_{R-1}} \tau (1 - \gamma) w_{i,t}(1 + g)^{-t-1}(1 + n)^{-1} \tag{1b}
\]

Here, \( L(T_R) \) represents the former social security liabilities to participants at retirement, and \( L'(T_R) \) represents the social security liabilities in the mixed pension scheme after the transition to the mixed pension scheme. This equation sums the total contribution from the working population, which is denoted \( N \), until the last period before retirement, or \( T_{R-1} \). \( w_{i,t} \) is the individual wage of Participant \( i \) (out of \( N \)) at time \( t \), and \( g \) is the GDP per capita growth rate. In line with Wolf and Ocerin
(2021), Knell (2010), and Goiller (2008), we assume that \( g \) is also equal to the wage bill growth rate. In the long term, this assumption is reasonable. Here, \( RR \) is the average replacement rate of the former DB pension scheme equal to the population growth rate. For simplicity, we assume a constant rate. Society will shift to a funded pension fund if the participants’ position in the funded scheme is better than the current intergenerational risk-sharing mechanism of social security. Since that mechanism is financed by net government expenditures, if the improvement in society’s financial position in the funded scheme is more than the government’s negative flow, the total market position is improved, and the funded scheme is preferred.

In the case of shifting to the mixed pension system from the PAYG, the change in society’s position is:

\[
\Delta(PensionPosition) = \tau \gamma \sum_{i=1}^{N} \sum_{t=1}^{T} R_{i,t}(1 + r)^{t-1} + L'(T) - L(T)
\]  

(2)

Here, \( r \) is the rate of return of private pension accumulations.

At the macroeconomic level, the government’s net flow of old-age social transfers to the public can be described as follows:

\[
\Delta(Gov.NetFlow) = Expenditures - Revenues
\]

(3)

- The change in the government’s revenues from the transition is: \( -\gamma \tau \sum_{i=1}^{n+1} w_{i,t+1} \)
- The change in the government’s expenditures from the transition is: \( L'(T) - L(T) \)

Hence, if the contribution rate is constant during the transition, one can determine that

\[
\Delta(Gov.NetFlow) = L'(T) - L(T) + \tau \sum_{i=1}^{N+1} \sum_{t=1}^{T} R_{i,t+1}
\]

(4)

From (2) and (4), we ascertain that the intergenerational condition is as follows:

\[
\sum_{i=1}^{T} (1 + r)^{i-1} \geq \sum_{i=1}^{T} (1 + n)^{i-1}(1 + g)^{i-1}
\]

(5)

According to (5), the share of the funded pillar in the total benefits is not significant. As long as the market yield is higher than the GDP per capita, it is worth implementing a funded or mixed pension scheme. We derived Eq. (5) from an efficiency assumption that is close to the well-known Aaron (1966) condition to implement a funded pension scheme \((r > n)\).

**Existence of sub-groups**

The individual as an actor in the pension field is relevant only if he or she has bargaining legitimacy or political power. As individuals are more alike in their preferences and wage levels, the individual is less important for the equilibrium point, as
the ‘Society’ represents him or her (Wolf 2021). If individuals are different from one another, some subgroups of political pressure could change the equilibrium point. Political pressure depends on the size of the voters’ subgroup. For instance, if the dependency rate is higher, one may expect political stress on adequate pension benefits. This stress could be stronger in a market with a high poverty rate and high-income inequality in old-age.

The condition in (5) ignores exposure to market risk and the individual’s preference. Hence, this condition is valid on average or in the case of the equal income distribution, which makes it relevant for society and not for the individual. Practically, the distribution is not equal. As the income inequality level increases, the probability for low earners to be financially worse off increases because of their option position characteristics. In that case, consistent with the late evolutions, political pressure of the subgroups for a pension reversal may arise (Mabbett 2020; Blake 2008).

Individuals expect to retain their standard of living in old age in any pension scheme and to avoid poverty (Kuitto and Kuivalainen 2020). Naturally, the pension benefit must be positively connected to the wage level. Furthermore, if the individual’s accumulations in the funded scheme also depend on the market yield \( r \), they must be higher on average than \( g \), which is the wage bill growth rate. That gap of returns embodies a risk premium, which is the condition for society’s acceptance. However, the individual’s expectation of the risk premium is not homogenous because of different option positions.

As per the defined contribution plan, the pension’s value is equal to the individual’s accumulations at the time of retirement. The final amount of the funded capitalized pension fund can be expressed as a function of the funded asset accumulations \( (AT) \) through the participant’s career during the working phase, which is capitalized until death.

\[
DC(T_R) = \tau A_T = \sum_{i=1}^{T_R-1} \tau w_i \prod_{t=1}^{T_D-1} (1 + r_t)
\]  

(6)

Here, \( r_i \) is the average rate of return earned by the defined contribution (DC) plan on its portfolio of financial assets at time \( t \). \( T_R \) is the participant’s retirement year, \( t = 1 \) is the time of enrolment in the pension fund and \( T_D \) is the individual’s expected lifetime. For simplicity, this model avoids actuarial factors related to probabilities of survival and focuses on the financial aspect of the pension as a financial position. \( w_i \) is the gross earnings equivalent at the beginning of each year.

Notably, \( C_L \) and \( P_L \) denote the call and put exchange options, respectively, and their payoffs at retirement are as follows:

\[
C_{T_R} = \max(\tau A(T) - L(T), 0) \quad \text{(7a)}
\]

\[
P_{T_R} = \max(L(T) - \tau A(T), 0) \quad \text{(7b)}
\]

The European put option on fund assets includes liabilities, such as the strike price and a maturity corresponding to the retirement date. The put-call parity in future terms is defined as follows:
Hence, one can describe the DB scheme as

\[ DB(T) = L(T) = \tau A(T) + (P_{T_R} - C_{T_R}) \]  \hspace{1cm} (9)

Thus, the investment in a defined benefit scheme can be replicated by a position composed of three elements: a long position in the fund assets \( A \), a long put position \( P_L \), and a short call position \( C_L \) at the same strike price (Romaniuk, 2009). Systematically, a defined contribution’s benefits equal the investment in a defined benefit fund, buying a call option \( C_L \) and selling a put option \( P_L \) at the same strike price.

\[ DC(T) = DB + (C_{T_R} - P_{T_R}) \]  \hspace{1cm} (10)

Therefore, the defined contribution pension scheme grants an option to benefit from high accumulations and improve high earners (a long ‘call’ position). At the same time, this type of scheme abolishes the inherent insurance component embedded in the defined benefit pension scheme (a short ‘Put’ position). This characteristic may lead to the worsening of the financial position of low earners whose accumulations are lower and who do not have other hedging capabilities for their accumulations during the working phase.

The individual benefits from the transition if:

\[ \tau \gamma A(T_R) + L'(T_R) - (\tau A(T_R) + P_{T_R} - C_{T_R}) > 0 \]  \hspace{1cm} (11)

By reducing the total population indexation, one can determine that on average, the individual participant gains from the transition if the following condition is valid:

\[ \tau (1 - \gamma) w_i \left\{ (1 + g_t)^{t-1} (1 + n_t)^{t-1} - (1 + r_t)^{t-1} \right\} + C_{T_R} - P_{T_R} > 0 \]  \hspace{1cm} (12)

If (5) is valid, the expression in curly braces is negative but should be close to zero, as in the long term we have \((1 + r_t)^{t-1} = (1 + g_t)^{t-1} (1 + n_t)^{t-1}\). Consequently, one can determine that the individual expects to benefit from the transition if the minimum term is valid:

\[ C_{T_R} - P_{T_R} > 0 \]  \hspace{1cm} (13)

All participants shared the same financial position at the retirement of long call + short put. However, whereas some have ‘in the money’ long call and ‘out of the money’ short put, others have ‘out of the money’ long call and ‘in the money’ short put. As the participants’ old-age benefit becomes higher, their position improves relative to the others. Put differently, one may assume that high earning cohorts could benefit from the funded scheme, as the cap (‘RR’) on their old-age benefits is cancelled. For other earning cohorts, old-age benefit insurance is much more essential, as they may fall into poverty if yields are insufficient.
Using simulations of the utility function, Wolf and Ocerin (2021) found that low-earning cohorts wish to avoid extensive exposure to market risk in their old-age benefits.

The equilibrium rationale

Assuming the government seeks to shift the pension system to the funded design to balance all of the actors’ expectations, we relate to the equilibrium in two stages, viz., satisfying society and finding an array of potential balance points among the participants.

Politically and economically, a pension transition is possible if the condition in (5) is valid. Otherwise, the public as a group will continue to lean on intergenerational risk sharing in old-age benefits.

The next consideration after accepting the funded pillar is the weight of the pension pillars, which depends on the interests and political power of different subgroups or different earning cohorts. As explained above, if the participant’s benefit is lower, their financial position will worsen due to the higher risk burden. To meet an equilibrium of pension design, participants who benefit from the transition compensate those who did not. This compensation comes from the surplus of returns, which is why we signify it as intra-generational risk-sharing that belongs to a specified array of possible pension pillar designs.

According to (13), when participants’ underlying asset level is higher, they would prefer the funded scheme: the benefit’s position of the long call is higher, and the risk of the short put position is lower. To balance this position, a reverse financial position from high earners to low earners must be ensured. The equilibrium question is how and when.

Compensation or the reverse flow must be made during the working phase when low earners still have political power. If they wait for compensation during retirement, their financial security will be in the hands of high earners or another generation. A put option for high earning cohorts to sell to low earners during the working phase will balance the market, as it promises flows from side to side when exercised during retirement. The actual exercising of the option is a risk-sharing mechanism, which may include taxes, social security benefits, and means-tested programs. We will define this option as a minimum pension guarantee (mpg). Indeed, the literature recognizes that imposing a minimum pension guarantee is an important condition of any transition to a more funded-capitalized scheme to ensure the sustainability of pension schemes and their political acceptability (Marx, 2016). Almost all of the actual reform proposals have guaranteed current law-scheduled benefits (Antolin et al. 2011). A pension guarantee is becoming increasingly necessary in volatile markets.

This type of financial vehicle can balance the financial position towards an equilibrium. For instance, as the funded share increases, the guarantee’s volatility increases. Consequently, and according to option theory, the option value increases, and the compensation to low earning cohorts increases accordingly. Alternatively, as the social security pillar is higher, the participant has more certainty in their future
benefit at retirement. The consequence is a lower option value and a lower cost to finance the \( mpg \).

Figure 1 plots a standard distribution before and after the transition. The sum of the total premiums (which are marked by white arrows) must be high enough to ensure an adequate level of old-age benefits to other cohorts. Ultimately, the premium is levied on high-earning cohorts. However, the government, which is the central planner, must ensure that these cohorts eventually benefit from a comprehensive perspective during the working phase and retirement. In our scheme, high earning cohorts, i.e., cohorts 7–10, would pay any premium that is lower than the difference before and after the transition. In this model, the yellow range marks the volatility of benefits and losses concerning the previous scheme as a function of the wage and market yield.

However, the central planner does not have to satisfy all participants to avoid a pension reversal. The pension system should satisfy a minimum mass of participants to ease rejections. It is worthwhile for the market to satisfy the lower edge of the income distribution for social and financial reasons. Socially, low-earning cohorts have a higher chance of falling into poverty during retirement; they also have fewer resources to diversify risks, especially during systemic turmoil, which is why many countries determine the guarantee mainly as the poverty level. Financially, as the expected benefit is lower, it costs less to satisfy the participants with social transfers.

Accordingly, an unfunded box mechanism or minimum pension guarantee, as suggested, enables an equilibrium pension design that answers the constraint in phrases (12)–(13) if it follows the following conditions of a floor and a ceiling:

**The guarantee floor**

The bottom boundary is a political condition. Economically, the goal of the guarantee is to differentiate the individual from their peer group and reduce the motivation to unite, creating political pressure. Let us define \( \beta^l (\beta^l < N) \) as the critical mass of participants during the working phase who have sufficient combined political power to influence the pension design. Hence, during the early stage of the working phase, the guarantee must improve the financial position of \( \beta^l \) by financing from \( \beta^h \).
participants. In Fig. 2, the guarantee influences 25% of participants by improving their financial position and provides a cushion to another 20% in case there are low benefits. Hence, in our example, $\beta^t$ is at least 25% of the participants.

The old-age guarantee during the working phase, which ensures a certain cushion, is a put option with a strike price equal to the guarantee level.

$$\sum_{n=1}^{N} p_v(mpg) > p_v \left( \sum_{i=T_{R_k}}^{T} \sum_{n=1}^{\beta^t} w_{i,n} [RR - B_{n,T_R}^t]^+ \right)$$

(14)

Here, $B_{n,T_R}^t$ are the funded benefits in the mixed pension scheme.

**The guarantee cap**

The first constraint determines that $mpg < 'RR'$. In the edge case, when the guarantee line is at the former average level 'RR', the pension system is practically in the DB pension scheme. Hence, it is assumed that the guarantee’s exercise price cannot pass that line.

More specifically, the upper boundary of the guarantee cost is dictated by the constraints of those who finance it. The central planner must ensure that those who finance the guarantee still benefit from the transition. This constraint can be described as follows:

$$p_v \left( \sum_{i=T_{R_k}}^{T} \sum_{n=1}^{\beta^h} w_{i,n} [B_{n,T_R}^h - RR]^+] + \text{risk} \right) > \sum_{n=1}^{N} p_v(mpg, \sigma)$$

(15)

In financing the guarantee, high earners give up a certain share of their pension returns. This situation is analogous to selling a call option. Consequently, the value of the guarantee at time 0 is equal to the call option value.

$$\sum_{n=1}^{N} p_v(mpg, \sigma) = \sum_{n=1}^{N} \text{call}(\beta^h, k^+)$$

(16)

The larger the group that finances the guarantee, the smaller the financial burden on the individual’s shoulders. Assuming a certain income inequality level, the risk premium is realized by the difference between the new strike

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**Fig. 2** Equilibrium convergence
price, which is denoted $k^*$, and the former price $RR'$, where $k^*>RR'>mpg$. The option’s strike price depends on the income distribution. As participants benefit from the funded scheme in the high part of the income distribution, the call option’s strike price can be higher. Alternatively, if the guarantee cost is distributed among more high-earning cohorts from the first dollar, the slope of the profit and loss graph will be more moderate.

The economy as a whole pays the price for the income inequality level: the higher the inequality level is, the higher the guarantee cost will be. At the high-income-inequality level, $\beta_1$ is higher and the option prices are higher. Therefore, it will be difficult to find a satisfying guarantee, as its implementation will be quite expensive.

**Finding the equilibrium array**

The potential equilibrium among pension designs will be set in a funded pension scheme when it satisfies Eqs. (14)–(15). Since the guarantee must satisfy a critical mass of participants, $mpg$ is first determined. Then, the future cost is distributed among $\beta_1$ participants. Accordingly, the call’s strike price is set. The guarantee cost could be excessively expensive due to high-income inequality and a long low tail. In that case, the cap condition may not be satisfying, as the cost burden would be too high to be distributed among the specific group of participants. Here, the central planner must lower the guarantee cost. Since the floor condition limits the strike price $mpg$, the cost will be reduced by $\sigma$, which is the underlying asset’s volatility.

Practically, to lower the volatility of the pension system, a greater weight of the unfunded pillar or social security must be borne. One may analyse this requirement as high earning cohorts compensating low earners for excessive risk-taking, by direct compensation as a minimum pension guarantee, or by increasing the insurance pillar (Wolf and Ocerin 2021; Knell, 2010). From another perspective, the time-decaying character of the option alleviates political pressure for pension reversal. Financially, as the time to maturity grows, the option value or the minimum pension guarantee increases. Figure 2 plots the equilibrium design-finding process in a mixed pension scheme.

This conclusion may be surprising. One could claim that to reduce the guarantee cost, participants must be exposed to greater market risk and higher returns by increasing the funded pillar weight. However, options theory suggests the opposite pattern. Therefore, one of the explanations is the time perspective. Consistent with the findings of Marchal et al. (2014), during the working phase, when participants contribute to social security and pay taxes, they have a better chance to change the pension system if they are united. When they receive benefits, their political power decreases. In our model, compensation is granted during the working phase in the form of a put option. In our terms, the option is most relevant during the working phase, as low earners still have significant political clout at that point.
Results

The model above shows that the dominant funded pension design can only be sustainable if an unfunded balancing mechanism is implemented to improve the financial positions of a critical mass of participants. The size of this mechanism depends on public expectations, market parameters, and income inequality levels.

Here, we do not target to find an equilibrium in each country. That kind of calculation should be made based on the specific market characteristics, history and most important participants’ expectation to old-age benefits. However, the following information can point on convergence of pension designs towards the mixed pension scheme, which includes the funded pillar with a public pillar of pension guarantee or an unfunded pillar. Four decades after the birth of the radical funded Chilean model and the pressure of economic organizations to embrace it, we learn of a different pension evolution process. This distinct process supports the above theory of risk expectations and political power.

We examine the pension designs of 53 developed countries with reliable and consistent pension data from world economic organizations such as the ISSA, the OECD and the World Bank. We provide a short description of the pension system in each country and the evolution of pension reforms. We divide these countries into three categories: Panel A includes those with funded privatized pension schemes, panel B plots those with mixed pension schemes, and panel C, those implementing predominantly DB pension schemes. OECD annual reports and the Global Pension Statistics Project of the OECD provide most of the analysed data and countries’ information.

We measure income inequality by the Gini coefficient. For each country, we specify the kind of guarantee (if any) and when it was implemented to learn about the convergence process. A basic guarantee is usually a flat rate for all retirees with specific residency conditions. The target guarantee is a specified wealth level (mostly higher than the basic level), which is means-tested according to the participant condition. Some countries define the guarantee in absolute terms or as a percentage of the minimum wage (MW), and others define it as a percentage of the average wage (AW).

Dominant individual accounts

In some cases, dominant-funded pension schemes include a large pillar of contributions to the funded pension scheme and high private pension entitlements in closing balance sheets (more than 40%). We count only 12 countries in this group. Israel, Denmark, and Iceland are in this group and have introduced radical liberal pension schemes. In other countries, the funded scheme is voluntary but is dominant in its size over social security or the public DB pillar.

According to the OECD report (Pension funds in Figs. 2021, P.2), countries in this group are characterized by low public spending on pensions, usually 3%-7% of the GDP, where the OECD average is approximately 8%. Additionally, these countries have developed their capital markets substantially and managed to accumulate
large financial assets in privately funded funds over the years. The Netherlands, for instance, has financial assets of pensions amounting to more than 210% of GDP, and Iceland has a similar figure of almost 200%. All of the other countries in this group have a high percentage of pension assets on private funds. This rate continues to increase every year.

As the theoretical model predicts, in most of these countries, a minimum pension guarantee is implemented as a reverse wealth flow to low earning cohorts. Some countries finance the guarantee through direct taxes or social security. As noted above, other countries finance the guarantee through a tax by means-tested programs.

It is easy to notice in this group that Mexico and Israel are a model of the radical version of the DC pension scheme. Both of these countries’ expenditures on public pensions are low, and both have high levels of poverty and income inequality. In these two cases, according to the above model, political pressure may arise and push for more government intervention and insurance and perhaps for a reversal. There is a high probability of such pressure increasing in the coming years when waves of participants will retire after being wedded to the new pension schemes and will realize poor benefits in old-age (see the microsimulation on the Israeli pension market by Wolf and Caridad (2021). This surprising conclusion comes against the background of a stable pension market. While rectifying these issues, the new Treasury minister, Mr. Liebermann, has promised to guarantee the pension of retirees with a lack of accumulations in the new pension scheme since 1995. In the UK, while poverty and income inequality are high, as in Israel, the country has a basic pension twice that of the basic Israeli pension.

In the US, UK, Ireland, and Israel, the liberal economic agenda is dominant with minimum government intervention (Williamson and Williams 2003). We believe this agenda has lowered the expectations of benefits compared to other developed countries. In addition, as the poverty rates and income inequality levels in these countries are high, we find it challenging for the government to increase the guarantee levels, as doing so would be quite expensive according to the above model.

**Dominant unfunded pension scheme**

Most of the sampled countries, mentioned in panels B and C, still implement a predominantly sorts of DB pension scheme with a significant redistribution mechanism or minimum pension guarantee. Panel C assembles 20 countries, in which, six are CEE countries that have reverted over the last decade from a dominant funded design to the dominant DB pension scheme. These countries include Romania and Bulgaria, which abolished the funded pillar after the financial crisis in 2008. The rest of the European countries in this category are Austria, Greece, Belgium, and Spain. Most Latin American countries are also included in this group. In all of these countries, public expenditures on pensions are above the average OECD level. Consistent with the theoretical model above, because of high levels of poverty and income inequality, it is difficult for Spain and Greece to shift to a funded scheme and cut fiscal expenditure on pensions. Still, because of the high ageing rate in these
countries, their governments will have to continue ensuring adequate benefits to avoid political pressure.

Some of this group’s countries were influenced over the last two decades by the pressure exerted by financial markets and international actors (the IMF and European Commission). This pressure “urged governments to neglect vote-seeking objectives within the well-known credit-claiming/blame-avoidance framework for the sake of attaining short-term savings on public expenditure” (Hinrichs 2021). This new reform pattern was implemented. However, when the policy space for domestic actors again expanded, the incumbent governments in several Southern European countries, such as Spain, Portugal and Greece, considered the past reforms partly as having “gone too far”. Thus, these governments reversed or at least attenuated those policies and attempted to claim credit for the “benefaction” (Moury and Afonso 2019).

Panel B introduces another 19 countries that have implemented mixed pension schemes. These schemes include the ‘Points’ system or a Notional Defined Contribution (NDC) scheme. The popularity of these models has increased over the last few years, especially in Europe (Nelson 2019). Public spending on pensions is roughly equal to the average OECD level.

Like the previous group, some countries made reversals from the funded pension scheme in the 2000s after realizing that the funded scheme is disappointing regarding the benefit adequacy and fiscal flexibility. Poland, Lithuania, Estonia, and Slovakia are in this subgroup (Natali 2008).

In connection with the model findings, it is interesting to observe that in addition to participating in pension risks, governments impose a minimum pension guarantee in these countries. Most of them at the same period of implementing quasi funded pension scheme. Their poverty and income inequality levels are low or moderate and support the implementation of the guarantee.

Comparing Germany with the US and the UK, the target pension is approximately 20% of the average wage. However, the pension design in Germany imposes less market risk on the participants while implementing a mixed pension system of ‘Points’. Hence, according to our model, political pressure should be lower in Germany in the long term.

Although the pension system is not necessarily linked to rational economic conditions, it is highly influenced by political pressure. For example, Israel does not have a low fertility problem and still implements a radical privatized funded pension scheme due to American pressure (Wolf and Caridad 2021). In contrast, Spain suffers from the lowest fertility in Europe and still sticks to the DB pension scheme, with increasing public expenses.

Discussion

According to the theoretical model, government intervention in the form of an unfunded pillar or minimum pension guarantee is needed to increase the sustainability of pension reform. This feature may seem odd prima facie, as the government tries to minimize expenses. The question eventually boils down to the
premium level the government is willing to pay to increase the sustainability of the funded pension system. Diversifying risks levied on the participants in the form of some weight for social security and a minimum pension guarantee can create an equilibrium, where fiscal expenses will be reduced and a substantial share of the population will benefit vis-a-vis the previous pension scheme.

It is challenging to ex ante evaluate the magnitude of the risk premium level from the transition or the sufficient political threshold. The former DB pension design does not have to be the benchmark for the premium, but the expectation from the government is to ensure adequate living standards in old-age or to avoid poverty. Naturally, such expectations are different among different countries.

The central planner will find it difficult and expensive to find the equilibrium with high levels of poverty and income inequality. That situation increases the probability of more earning cohorts being dissatisfied with the transition to the funded scheme. For example, Israel and Canada share similar public pension spending and close pension schemes. However, the poverty rate in Canada is half of Israel’s, suggesting that the latter country is at risk of fundamental fiscal spending soon. According to this theory, Denmark and Iceland can afford to maintain a sustainably funded pension scheme with limited government spending and a low risk of reversals.

Governments can design guarantees in a variety of ways, such as a minimum rate of return, means-tested programs, or mixed pension schemes. The design is secondary. The most important part is the option characteristics of the guarantee and its political-economic effect during the early stages of the working phase. The option characteristics of the guarantee reduce public resistance to pension reversals. By analysing individual preferences, Wolf and Ocerin (2021) found that this option has value to all participants, even the high-earning cohorts who finance insurance.

Although the sample country above can only point to a global trend at this time, we find that the popular mechanism of a minimum pension guarantee is a key feature for increasing the sustainability of the funded pension scheme. Furthermore, we posit that as a condition to transfer fiscal or longevity risk to the individual, the government has an interest in strengthening the sustainability of the funded scheme. Hence, the government should act to implement the guarantee.

According to the above, it is not surprising to notice a global shift in the implementing mechanisms of a minimum pension guarantee (Lachance et al. 2003; Arza 2008). Guarantees in DC schemes have recently become more common, especially in Latin America, which has been at the forefront of pension privatization (Mesa-Lago and Valero 2020). These countries join stable pension economies across Europe that implement minimum pension guarantees, such as Finland, Germany, Italy, Switzerland, Greece, Spain, and Portugal.

The difference in perspective between accounting and risk finance raises the exposure of the individual actor, who may gain political power as a function of the income distribution. Here, we claim that the income inequality level in the market affects the equilibrium pension design. Since the government transfers risks to the individual, the opposite risk sharing depends on the actor’s strength. As more individuals are in a close financial situation, the individual becomes stronger vis-a-vis the government, and the probability of a pension reversal increases.
Here, we mention that the strategy of governments as central planners may economically vary out of this risk-sharing model if one may expect an opportunity for an exogenous increase in GDP in the future. For example, some states in Europe have begun to offer facilities for the retired to live in or move to their country, as most of the pensions there are a source of taxation, resources (investments), and expenditures (local and international travel and purchases).

**Conclusion**

Funded assets are growing rapidly in the West, although the funded pension scheme changes slowly and with great caution. This study emphasizes the relevance of political subgroups in society as a key player in modern funded pension design, in addition to the public and the government, who are the traditional actors in the literature. We claim that as a function of the income distribution in the market, the individual may gain political power and may influence the pension mechanism. Consequently, any pension scheme equilibrium must consider the individual interest. Individuals’ financial position is not homogenous. Some benefit from the transition and some may lose money due to it. When seeking an equilibrium in the funded pension scheme, we find two junctions of decisions. The first junction is at the public society level and the second is among different earning cohorts.

The intragenerational equilibrium includes implementing a put option with clear boundaries of the strike price. This option has dual characteristics for the writers and buyers that make it an obligatory tool for the equilibrium. While from one angle, this option compensates for excessive market risk and provides insurance, from the other angle, it alleviates the political rejection of the funded pension design. The option’s strike price divides the population that could have been adversely affected by the transition and improves the financial positions of some of the groups. Therefore, the political power of individuals who reject the funded design decreases.

The global experience strengthens the model conclusion and implies an equilibrium design in funded pension schemes, which must include unfunded boxes and income redistribution mechanisms. Most of the countries still implement the dominant unfunded pillar model or at least the quasi-funded scheme. Regardless, countries avoid levying the full weight of financial risks on the participants. Over the last three decades, the experience of CEE and Latin American countries has demonstrated convergence to an equilibrium pension design. In such pension designs, the government recognizes its responsibilities in the risk-sharing framework and acts to diversify some of the traditional individual’s risks. The recent financial crisis due to the COVID-19 pandemic confirms this process, as we are witness to large governmental bailout programs due to political pressure. Global public assistance to the pension market and labour markets emphasizes the individual’s inability to bear high fluctuations in the market for a long time, mainly during old-age or when close to retirement.

We find this study highly relevant in the current times when governments seek exit strategies from the pandemic-related financial crisis. Policy-makers are moving somewhat beyond the narrow interpretation of pension system sustainability adopted
in previous decades. Although the link between the financial position of individuals and political pressure could be a novelty in the existing literature, it has been proven true in the case of pension reversals in CEE countries and Latin America.

The theory implies a higher demand for a risk-sharing mechanism among earning cohorts in markets with a high level of income inequality. Hence, countries with funded pension schemes that are characterized by high income inequality must address growing political pressure and balance their pension systems. According to the appendix, these countries may include Mexico, Israel, and Australia. Moreover, countries that implement funded pension schemes must ensure periodically that pension guarantee schemes are adequate and consistent with the income distribution level. Additionally, as financial and systemic shocks are accelerating public reactions, it will be interesting to examine pension system design after the coronavirus crisis.

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**Declarations**

**Conflict of interest** Not applicable.

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