VI. PUBLIC PENSIONS REFORMS: FINANCIAL AND POLITICAL SUSTAINABILITY

Javier Díaz-Giménez
IESE Business School
Julián Díaz-Saavedra
Universidad de Granada

ABSTRACT

A main reason of the future pensions unsustainability in many European countries is a failure to adapt to very long-run demographics trends. Thus, reform to address financing issues can also be an occasion to improve pension design. We use an overlapping generations economy with incomplete insurance markets to show that with an appropriate design, sustainable pay-as-you go systems can greatly outperform current outdated pension systems. We show this in a calibrated model of the Spanish economy, since Spain is a fairly extreme case of the aforementioned failures to introduce a dynamic pension design to face an ageing population. Moreover, by comparing the effect of its ageing transition under these different pension systems, we also show how a fast transition, from the current to a reformed PAYG system can be Pareto improving, while minimizing the risk of political reversal.

Keywords: Computable general equilibrium, social security reform, redistribution.

INTRODUCTION

A primary cause of the future pensions unsustainability in many European countries is a failure to adapt to very long-run demographics trends. For instance, Automatic adjustment mechanisms (AAMs) can be useful tools to prevent pension schemes from becoming increasingly unsustainable as populations age (OECD, 2021). Two of the AAMs seem to be specially useful to restore pension sustainability, and at the same time to act as intergenerational solidarity mechanisms. First, sustainability factors, which are adjustments on the initial benefit based on changes in life expectancy. And second, pension indexation rules, which are automatic balancing mechanisms aimed at ensuring a balanced budget of the pension scheme.

But the introduction of such AAMs can also generate sizeable political costs (Kitao 2017), so that these mechanisms used to restore financial balance are likely to be overturned when they lead to important short run losses in retirement income. Examples of this policy reversal are Poland (2016), Croatia (2019), Holland (2019), and Spain (2020 and 2021) (see Ageing Report 2021). Put differently, the existence of short run losers after this type of pension reform is an almost insurmountable obstacle, as the root of the policy reversal problem.

However, the risk of political reversal could be substantially reduced, if not eliminated, if this type of reform of the pension system were accompanied by any type of compensation from the government to those losers whit this reform. Specifically, the government could transfers resources in the form of liquid assets to the losers so that they become indifferent between the previous and unsustainable pension system and then new sustainable scheme. And, the increase in government expenditure brought about these once in time transfers, could be debt financed (Díaz-Saavedra *et al.,* 2023).

Additionally, a poor design of these systems contributes to amplify the problems of future sustainability. For instance, and as Jimeno (2003) points out, because the distribution of labor income is much more unequal in the later periods of working life, the resulting pension distribution is more unequal under systems that consider part of the contribution made during the working lifetime than it would be under a system that takes into account the contribution bases during longer periods of working life. This problem is present in some European countries with defined benefit pension systems such as Spain, Austria, France, Portugal, and Slovenia.

This paper analyzes the aggregate, distributional, and welfare consequences of introducing such parametric changes in the Spanish pension system. Specifically, we consider a pension reform that introduces a sustainability factor and an automatic balancing mechanisms aimed at ensuring a balanced budget of the pension scheme. Additionally, we also set an increase in the number of years used to compute the pension, from the last 25 to the entire working lifetime. Finally, we also assume that the government's eliminates the payroll tax cap in order to reinforce the solidarity of the system. We also study these parametric changes one at a time to explore which of them is quantitatively more important.

Thus, this reform represents a radical change, specially because it reduces significantly, the weight of the public pension as a source of income to finance consumption when old. The difficult political-economy of implementing this type of reform often calls for introducing it slowly. However, a slow transition fails to anticipate the fast increase in the ratio of retirees per worker. On the other hand, a fast transition would avoid this scenario by moving all active workers at the time of the implementation to the new PAYG system and hence go through the ageing process with a much lower stock of PAYG claims.

Evidently, this radical and fast reform increase the risk of policy reversal, as some households may face welfare looses, specially those who are near of retirement. To cope with this issue, we assume that those households who suffer welfare losses after this pension reform receive a government's transfers to overcome these losses, and that such transfer program is financed with public debt. Thus, every household alive at the moment of the pension reform is at least weakly better off in the reformed economy.

To do this, we simulate an enhanced version of the general equilibrium, multiperiod, overlapping generations model economy populated by heterogeneous households described in Díaz-Giménez and Díaz-Saavedra (2017). The model economy that we study here differs from the one that we used in that article in two fundamental ways. First, by assuming that Spain is a relatively small open economy where interest rates and wages that households face are taken as given. Second, we have updated our calibration year to 2018.

Our results are: i) This pension reform overcomes the sustainability problems that plague the current Spanish pension system by reducing pension benefits, and consequently, fostering private savings and longer working lifetimes; *ii)* This pension reform limits the tax increases that would have been necessary to finance the future pension system deficits, increasing household's savings and consumption; *iii)* a fast transition, from the current to a reformed PAYG system can be Pareto improving for those alive at the moment of this *radical* pension reform; iv) there are substantial welfare gains for the long run cohorts under the reformed pension scheme, even when accounting for the payments of public debt used to compensate initial losers because the reform. The debt needed to compensate those households alive in 2023 who lose with the reform, accounts until 33 percent of GDP.

The paper is organized as follows: section 1 presents the model economy; section 2 briefly describes the calibration procedure; section 3 describes the simulations; section 4 describes the demographic and macroeconomic scenarios used in our simulations; section 5 presents the results; and, lastly, conclusions.

1. THE MODEL ECONOMY

This section presents the model economy. We study an overlapping generations economy with heterogeneous households, a representative firm, and a government. We use the same model in related work in Díaz-Saavedra (2023)[1]. Time is discrete and runs forever, and each time period represents one calendar year. All model quantities depend on calendar time t, but we omit this dependence during the presentation. We begin with a description of household heterogeneity.

1.1. The Households

Households in our baseline economy are heterogeneous and differ in their age, $j \in J$; in their education, $h \in H$; in their labor market status, $e \in \mathcal{E}$, in their pension rights, $b \in B$ in their pension, $p \in P$ and in their assets, $a \in A$. Sets J, H, $\mathcal{E}$, B, P , and A, are all finite sets and we use $\mu_{j,h,e,b,p,a}$ to denote the measure of households of type (*j, h, e, b, p, a*). We think of a household in our model as a single individual, even though we use the two terms interchangeably. To calibrate the model, we use individual data of persons older than 20 in the Spanish economy.

[1] Differently from that version, this paper computes not only the steady states, but also the transitional dynamics among them.

Age. Individuals enter the economy at age 20, the duration of their lifetimes is random, and they exit the economy at age 100 at the latest. Therefore $J = \{20, 21, ..., 100\}$. The parameter ψ_{jh} denotes the conditional probability of surviving from age j to age $j + 1$, for those households with educational level h.

Education. Households can either be high school dropouts with $h = 1$, high school graduates who have not completed college $h = 2$, or college graduates denoted $h = 3$. Therefore $H = \{1, 2, 3\}$. A household's education level is exogenous and determined forever at the age of 20.

Labor market status. Households in our economy are either employed, unemployed eligible for benefits, unemployed non-eligible, or retired. We denote workers by ω, eligible unemployed by $r{:}v$, non-eligible unemployed by υ, and retirees by ρ. Consequently, $\mathcal{E} = \{\omega, r{:}v, \upsilon, \rho\}$. Upon entering the economy, individuals draw a job opportunity. In subsequent years, the labor market status evolves according according to exogenous job separation and job finding rates, and also to the optimal retirement decision.

Workers. A worker provides labor services and receives a salary that depends on his endowment of efficiency labor units and his hours worked. This endowment has two components: a deterministic component, which we denote by $\mathcal{E}_{jh}$, and a stochastic component, which we denote by s.

The deterministic component depends on the household age and education, and we use it to characterize the life-cycle profiles of earnings. We model these profiles using the following quadratic functions:[2]

$$\epsilon_{jh} = a_{1h} + a_{2h}j + a_{3h}j^2 \quad (1)$$

We choose this functional form because it allows us to represent the life-cycle profiles of the pro- ductivity of workers in a very parsimonious way.

[2] In the expressions that follow the letters a denote parameters.

The stochastic component is independently and identically distributed across the households, and we calibrate it to match moments of the Spanish earnings and wealth distribution, following Castañeda *et al.* (2003). This component does not depend on the age or the education of the households, and we assume that it follows a first order, finite state, Markov chain, with invariant distribution given by $\pi(s)$, and with conditional transition probabilities given by Γ:

$$\Gamma\left[s'|s\right] = \Pr\left\{s_{t+1} = s'|s_t = s\right\}, \text{ with } s, s' \in S. \quad (2)$$

We assume that the process on s takes three values and, consequently, that $s \in S = s_1, s_2, s_3$. We make this assumption because it turns our that three states are sufficient to account for the Lorenz curves of the Spanish distributions of income and labor earnings in enough detail, and because we want to keep this process as simple as possible.

Every period agents receive a new realization of s. His labor productivity is then given by $\in_{jh}s$. A worker with education h and age j who supplies l hours of labor has gross labor earnings y^l given by:

$$y^l = w\epsilon_{jh}sl \quad (3)$$

where the economy-wide wage rate w.

Workers face a probability of losing their job at the end of the period, denoted φ_{jh}. This probability is education and age dependent, and we use it to generate the observed labor market flows between employment and non-employment states within age cohorts. We model these profiles using the following functions:

$$\varphi_{jh} = a_{4h} + a_{5h}j + a_{6h}j^2 + a_{7h}j^3 \quad (4)$$

Unemployed. Eligibility for unemployment benefits is conditional on having lost a job during the previous two years and not having started a new job yet. Eligibility expires when one the conditions is not met. An eligible agent with education h receive unemployment benefits given $y^u = \vartheta y_h^{\bar{l}}$, where $y_h^{\bar{l}}$ is the average labor earnings of those workers with education h, and where $\vartheta < 1$ is a replacement rate.

At the end of each period, an unemployed receives a job offer with probability ξ_{jh}. This probability is also education and age dependent, and we use it to generate the observed labor market flows between unemployment and employment. The offer is the productivity shocks. Therefore, its amount is either s_1, s_2, or s_3. Conditional on receiving an offer, the probability of receiving each one of the productivity shocks is the unconditional probability of each realization of that shock. Once a household is re-employed, the future values of *s* are determined by the process on *s*.

We model the probabilities to receive a job offer as:

$$\xi_{jh} = a_{8h} + a_{9h}j + a_{10h}j^2 + a_{11h}j^3 \tag{5}$$

Retirees. Workers who are R_0 years old or older decide whether to to retire and collect the retirement pension. They take this decision after observing their current labor productivity. If they decide to retire, they loose the endowment of labor efficiency units for ever and exit the labor market. Unemployed households who are R_0 years or older are forced to retire.

Pension rights. Workers and unemployed also differ in the pension rights. These rights are used to determine the value of their pensions when they retire. The rules of the pension system, which we describe below, include the rules that govern the accumulation of pension rights, and the rules that determine the mapping from pension rights into pensions. In our model economy households take this mapping into account when they decide how much to work and when to retire. We assume that pension rights belong to the discrete set $B = \{b_0, b_1, \ldots, b_m\}$, that $m = 9$, and that the spacing between points in set B is increasing. We also assume that $b_0 = 0$, and that $b_m = a_{12}y$, where $a_{12} > 1$, y is the model economy per capital output, measured at market prices, and $a_{12}y$ is the maximum covered earnings, following the Spanish Public Pension System.

Pensions. Retirees differ in their retirement pensions. We assume that retirement pensions belong to the set $P = \{p_0, p_1, \ldots, p_m\}$. Since this mapping is single valued, and the cardinality of the set of pension rights, B, is 10, we let $m = 9$ also for P. We also assume that $p_0 = a_{13}y$, and that $p_m = a_{14}y$, where p_0 and p_m are the minimum and maximum retirement pensions, in accordance with the Spanish Public Pension System.

Finally, we also assume that the distances between any two consecutive points in *P* are increasing. We make this assumption because minimum pensions play a large role in the Spanish system and this suggests that we should have a tight grid in the low end of *P*.

Assets. Households in our model economy differ in their asset holdings, which are constrained to being non-negative. The absence of insurance markets give the households a precautionary motive to save. They do so by accumulating real assets which take the form of productive capital, denoted $a \in A$.[3]

Preferences. Households derive utility from consumption, *c*, and disutility from labor effort, *l*, where labor is decided both at the extensive and intensive margins. The period utility is described by a utility flow from consumption and leisure, $u(c, 1 - l)$. Unemployed and retired agents dedicate all the time endowment to leisure consumption. Accordingly, lifetime utility is given by

$$\mathbb{E} \sum_{j=20}^{100} \beta^{j-20} \psi_{jh} \left[log\ (c) + \chi \frac{(1-l)^{1-\gamma}}{1-\gamma} \right] \tag{6}$$

where β is a time discount factor, *c* is consumption, χ is the relative utility weight on leisure, and γ is the labor elasticity.

1.2. The Representative Firm

In our model economy there is a representative firm. Aggregate output, *Y*, is obtained combining aggregate capital, *K*, with the aggregate labor input, *L*, through a Cobb-Douglas, aggregate pro- duction function which we denote by $Y = K^{\theta} L_t^{1-\theta}$. We assume that factor and product markets are perfectly competitive and that the capital stock depreciates geometrically at a constant rate, which we denote by δ.

[3] An important feature of the model is that there are no insurance markets for the stochastic component of the endowment shock nor for unemployment risk.

1.3. The Government

The government in our model economy taxes capital income, household income, and consumption, and it confiscates unintentional bequests. It uses its revenues to consume, and to make transfers to households other than pensions. In addition, the government runs a pay-as-you-go pension system. The consolidated government and pension system budget constraint is

$$G + Z + P + U = T_k + T_y + T_c + T_s + E \tag{7}$$

On the expenditure side, G denotes government consumption, Z denotes government transfers other than pensions, P denotes pensions, and U denotes unemployment benefits, And, in the revenue side, T_k, T_y, and T_c, denote the revenues collected by the capital income tax, the household income tax, and the consumption tax, T_s denotes the revenues collected by the payroll tax, and E denotes unintentional bequests. Finally, we assume that the government uses the consumption tax rate to clear the government budget.[4]

1.3.1. The Fiscal Policy

Expenditures. We assume that the amount of government consumption is given by $G = a_{15}Y*$, where $Y*$ is the model economy output at market prices. Transfers other than pensions are delivered to those households whose income is below a minimum income level, $\underline{y} = a_{16}y$. In this case, these households receive a transfer from the government, denoted by $t_r = \underline{y}$. We already defined unemployment benefits, and we describe pension expenditures in the next section.

Revenues. We assume that the proportional capital income and consumption tax rates are given by τ_k, and τ_c. Moreover, we assume that the assets that belong to the

[4] We also assume that there is no Pension Reserve Fund. This is because the stock of assets of this fund only represented 0.4 percent of GDP at the end of 2018, which is our calibration target year.

households that exit the economy are confiscated by the government. To model the household income tax, we use the following function:

$$\tau_y(y_t^b) = a_{17}\left\{y_t^b - \left[a_{18} + (y_t^b)^{-a_{19}}\right]^{-1/a_{19}}\right\} \quad (8)$$

where y_t^b is the income tax base. This expression, where a_{17}, a_{18}, and a_{19} are parameters, is the function chosen by Gouveia and Strauss (1994) to model effective personal income taxes in the United States, and it is also the functional form chosen by Calonge and Conesa (2003) to model effective personal income taxes in Spain.[5] Finally, we describe payroll taxes in the next section.

1.3.2. The Pension System

In our benchmark model economy we choose the payroll tax and the pension system rules so that they replicate as closely as possible the *Régimen General de la Seguridad Social* of the Spanish pay-as-you-go pension system in 2018, which is our calibration target year. See Díaz-Saavedra (2020) for a description of the Spanish Public Pension System.

Payroll Taxes. In our model economy, as in Spain, the payroll tax is capped and workers older than the full entitlement retirement age, which we denote by R_1, are exempt from paying payroll taxes. Specifically, the payroll tax function is the following:

$$t_s(y^l) = \begin{cases} 0 & \text{if } j > R_1 \\ \text{otherwise} & \begin{cases} \tau_{ss} y^l & \text{if } y^l < \overline{y}^l \\ \tau_{ss}\overline{y}^l & \text{otherwise} \end{cases} \end{cases} \quad (9)$$

where parameter τ_{ss} is the payroll tax rate and $\overline{y}^l = b_m = a_{12}y$ is the maximum covered earnings. Finally, we also assume that eligible unemployed also pay social security contributions, so that the payroll tax function becomes $t_s(y^u) = \tau_{ss} yu$.

Retirement Ages. In our model economy the early retirement age is R_0. Workers who choose to retire early pay a penalty, λ_j, which is determined by the following function

$$\lambda_j = \begin{cases} a_{20} - a_{21}(j - R_0) & \text{if } j < R_1 \\ 0 & \text{if } j \geq R_1 \end{cases} \quad (10)$$

[5] Additionally, Guner *et al.* (2014) conclude that this functional form generates a better statistical fit for average tax rates, in comparisons to other alternatives.

where a_{20} and a_{21} are parameters which we choose to replicate the Spanish early retirement penalties.

Retirement pensions. A household of age $j \geqslant R_0$, that chooses to retire, receives a retirement pension, $p(b)$, which we compute following the Spanish pension system rules. The main component of the retirement pension is its *Regulatory Base*, *RB*, which averages labor earnings up to the maximum covered earnings, during the last $N^b = 21$ years prior retirement. If a household has not reached the full entitlement retirement age, its pension is subject to an early retirement penalty. If the household is older than R_1, its pension claims are increased by 3 percent for each year worked after this age. The Regulatory Base is multiplied by a pension replacement rate, ϕ, which we use to replicate the pension expenditures to output ratio. Finally, retirement pensions are bounded by a minimum and a maximum pension.

Note that the Regulatory Base takes into account a long period of time. Consequently, it can be relatively frequent that contribution gaps occur; that is, periods to be taken into account to determine the amount of the pension in which the household does not credit any contribution. This is the case, for instance, of non-eligible unemployed. In order to mitigate the negative effects of these gaps, the Spanish pension rules establishes that these unlisted periods will be integrated with fictitious quotes. In our model economy, we assume that these fictitious quotes are $y^{fq} = a_{22}y$.

In our benchmark model economy we calculate the retirement pensions using the following formula:

$$p(b) = \phi(1.03)^v(1-\lambda_j)RB \tag{11}$$

where ϕ denotes the replacement rate, and v denotes the number of years that the worker remains in the labor force after reaching the full entitlement retirement age. The Regulatory Base, RB, is exactly equal to the pension rights at the time of retirement. Consequently, it is defined as:

$$RB = \frac{1}{N_b}\sum_{s=j-N_b}^{j-1} min\{y_s^l, \overline{y} \tag{12}$$

Note that labor earnings, y_s^l, is replaced by y_s^u or y_s^{fq} in the case of eligible or non-eligible unemployed households (see below). Expressions (11) and (12) replicates most of the features of Spanish retirement pensions. The main difference is that in our model economy the pension replacement rate is independent of the number of years of contributions. We abstract from this feature of Spanish pensions because it requires an additional state variable. Finally, we require that $p_0 \leqslant p(b) \leqslant p_m$.

The Pension Reserve Fund. Since the year 2023, Spain is building a pension reserve fund which is invested in fixed income assets and which is financed with part of the pension system revenues.

Specifically, and from 2023 to 2032, the contribution rate to the pension system increases by 0.6 percentage points to invest these revenues in the Pension Fund. Starting that year, however, the government will be able to use the assets of this fund to finance the pension system deficits when needed, until a maximum of 0.2% of output per year.

In our model economy, we assume that the pension reserve fund evolves between 2023 and 2032 according to

$$F^{'} = (1 + r^*)F + T_s \tag{13}$$

where F is the value of the pension reserve fund at the beginning of the next period, and T_{s+} are the payroll tax revenues collected by the additional 0.6 percentage points of the payroll tax rate.

After 2032, the law of motion of this fund is given by

$$F^{'} = \begin{cases} (1 + r)F - 0.002\,Y, & \text{if } T_s - P < 0. \\ (1 + r^*)F, & \text{otherwise.} \end{cases} \tag{14}$$

We require the pension reserve fund to be non-negative, so that when the pension fund assets ran out, the government changes removes this fund.

1.4. The Households' Decision Problem

Individuals with education *h* are heterogeneous in five dimensions *x* = {*j, e, b, p, a*}, where *j* is age, *e* is employment status, *b* is pension rights, *p* is pensions, and *a* is private savings. The households' problem is described recursively. Let $V_h(x)$ be the value function of an individual with education *h* in state *x*.[6]

Workers. We start with employed individuals that are younger than the minimum retirement age, specifically $j < R_0$. In this way we can abstract, for now, from the retirement decision. An individual of education level *h*, with age *j*, stochastic productivity *s*, pension rights *b*, and private savings *a*, faces the following optimization problem:

$$V_h(j,s,b,a) = \max_{(c,l,a')} \Big\{ \text{u(c,1-l)} + \beta E\Big[(1-\varphi_{jh}) \textstyle\sum_{s' \in S} \Gamma(s'|s) V_h(j+1,s',b',a') + \varphi_{jh} V_h(j+1,\varpi,b',a')\Big]\Big\} \quad (15)$$

subject to

$$(1+\tau_c)c + a' = y^l + (1 + r(1-\tau_k))a - t_s(y^l) - \tau_y y^b + I_{t_r}$$

where $y^b = (1-\tau_k)ra + y^l - t_s(y^l)$ is the income base of the personal income tax, and I_{t_r} is an indicator function that takes value 1 if households are eligible for public transfers other than pensions. In addition, the law of motion of pension rights is:

$$b' = \begin{cases} 0 & \text{if} \quad j < R_0 - N_b \\ b + (\min\{y^l, \overline{y}^l\}/N_b) & \text{if} \quad R_0 - N_b \leq j < R_0, \\ [b(N_b - 1) + \min\{y^l, y^{\bar{l}}\}]/N_b & \text{if} \quad j \geq R_0, \end{cases} \quad (16)$$

[6] When the household is not a retiree, we drop the variable describing retirement pensions, *p*. Conversely, when the household is a retiree, with drop the variable describing pension rights, *b*.

Eligible unemployed. A household currently unemployed and eligible for unemployment benefits, aged $j < R_0$, solves the following problem:

$$V_h(j,\varpi,b,a) = \max_{(c,a')} \left\{ \text{u(c,1)}\beta E \left[\xi_{jh} \sum_{s\in S} \pi(s) V_h(j+1,s,b',a') + (1-\xi_{jh}) V_h(j+1,u',b',a') \right] \right\} \quad (17)$$

subject to

$$(1+\tau_c)c + a' = y^u + (1+r(1-\tau_k))a - \tau_s(y^u) - \tau_y y^b$$

where $y^b = (1-\tau_k)ra$ and u is ϖ if the current period is the first period that the unemployed collects unemployment benefits, and u is υ if it is the second period. Note that eligible unemployed households do not receive public transfers other than pensions, since we assume that unemployment benefits are well above the minimum income level $\underline{y}$, which entitles families to receive these public transfers.

The law of motion for pension rights is in this case:

$$b' = \begin{cases} 0 & \text{if} \quad j < R_0 - N_b \\ b + (y^u/N_b) & \text{if} \quad R_0 - N_b \leq j < R_0, \end{cases} \quad (18)$$

Non-eligible unemployed. A household currently unemployed and non-eligible for unemployment benefits, aged $j < R_0$, solves the following problem:

$$V_h(j,\upsilon,b,a) = \max_{(c,a')} \left\{ \text{u(c,1)} + \beta E \left[\xi_{jh} \sum_{s\in S} \pi(s) V_h(j+1,s,b',a') + (1-\xi_{jh}) V_h(j+1,\upsilon,b',a') \right] \right\} \quad (19)$$

subject to

$$(1+\tau_c)c + a' = (1+r(1-\tau_k))a - \tau_y y^b + I_{t_r}$$

where $y^b = (1 - \tau_k)ra$ and the law of motion for pension rights is:

$$b' = \begin{cases} 0 & \text{if} \quad j < R_0 - N_b \\ b + (y^{fq}/N_b) & \text{if} \quad R_0 - N_b \leq j < R_0, \end{cases} \quad (20)$$

Retired. Retired individuals do not receive labor income. They finance consumption with past private savings and pension payments. The problem is a standard consumption-savings decision, with survival risk and a certain maximum attainable age, assumed to be J = 100. At age j = 99, the continuation value is zero because the agent exist the economy next period with probability one. Before that, the retired household solves:

$$V_h(j,\rho,p,a) = \max_{(c,a')} \left\{ \text{u(c,1)} + \beta\psi_j \left[V_h(j+1,\rho,p,a') \right] \right\} \tag{21}$$

subject to

$$(1+\tau_c)c + a' = p + (1 + r(1-\tau_k))a - \tau_y y^b$$

where $y^b = p + (1 - \tau_k)ra$. Retired households, similarly to eligible unemployed, are not eligible in any case to receive public transfers other than pensions, since we assume that the minimum retirement pension is well above the minimum income level.

Retirement decision. Recall that we assume that unemployed households who are R_0 years or older are forced to retire. On the other hand, a worker aged $j \geqslant R_0$ must decide if to retire or not from the labor market. In this case, she chooses the optimal plan after solving problems 15 and 21.

1.5. Equilibrium

A detailed description of the equilibrium process of this model economy can be found in the Appendix 1.

2. CALIBRATION

To calibrate our model economy, we choose 2018 as our calibration year. Then we choose the initial conditions and the parameter values that allow our model economy to replicate as closely as possible selected macroeconomic aggregates and ratios, distributional statistics, and institutional details of Spain in 2018.

More specifically, to characterize our model economy fully, we must choose the values of a total of 70 parameters. Of these 70 parameters, 20 describe the government policy, 21 describe the endowment of efficiency labor units profiles, 24 describe the employment and unemployment risk functions, 2 describe the production technology, and the remaining 3 describe the household preferences. To choose the values of these 70 parameters, we need 70 equations which formalize our calibration targets.

To determine the values of the 70 parameters that identify our model economy, we do the following. First, we assign values to 51 parameters that can be estimated directly using equations that involve either one parameter only, or one parameter and our guesses for (K, L). These include, for instance, the deterministic productivity profiles and the probabilities governing employment transitions. Second, we use the model and a system of 19 non-linear equations to calibrate the 19 remaining parameters. Most of these equations require various statistics in our model economy to replicate the values of the corresponding Spanish statistics in 2018.

We describe these steps and our computational procedure at Díaz-Saavedra (2022).[7] In that paper we show that our model economy succeeds in replicating most of the aggregate and distributional statistics that we target, and that it also replicates the retirement behavior of Spanish workers very accurately. This last result is particularly remarkable, since we intentionally exclude the statistics that describe retirement from our set of calibration targets.

3. THE SIMULATIONS

In this paper, we will study the consequences of the reforms of the Spanish social security.

The Benchmark Economy (BEN). Our Benchmark Economy is the economy that we modelled and calibrated to approximate the Spanish economy in 2018. Specifically, the early retirement age is $R_0 = 62$, the normal retirement age is $R_1 = 66$, and pension

[7] The current version of the model is an enhanced version of that model economy. Specifically, this version assumes that Spain is a relatively small open economy, and it also improves the measurement of key macroeconomic aggregates and ratios, such as the Pension Payments to GDP ratio. Additionally, this version includes as pension revenues the direct transfers from the Spanish Central Government, which will be 1.4 percentage points of GDP in 2023.

rights are computed taking into account the last 21 years of contributions previous to retirement. We then delay the early and the normal retirement ages to $R_0 = 63$ and $R_1 = 67$ in 2024, and we also extend the number of years of earnings that we use to compute the pensions, from the 21 years previous to retirement in 2018 to 25 in 2022, at a rate of one year every year. These changes are in line with what is happening in Spain as a result of regulatory changes enacted before 2018. We also revaluate the minimum and the maximum pensions so that their share of output per person remains constant at is 2018 value, and we assume that the real value of all other pensions does not change.[8]

The Reformed Model Economy. The pension reform that we simulate involves several changes that increase the contributivity of the system, and adopt a sustainability factor and a pension revaluation index that effectively transform the Spanish pension system into a defined- contribution pension system. We described these parametric changes below:

- Regulatory base: the regulatory base is the main component of the Spanish retirement pension, and since 2022 it was computed using labour earnings from the last 25 years before retirement. However, and Jimeno (2003) points out, because the distribution of labour income is much more unequal in the later periods of working life, the resulting pension distribution is more unequal under the current system than it would be under a system that takes into account the contribution bases or the contributions actually made during longer periods of working life, as occurs in other European countries with defined benefit pension systems.[9] Consequently, if a persons salary doubles in their final years, their pension will double. Thus, there is a subsidy from people whose earnings grow more slowly to those whose earnings grow rapidly later in their working lifetime. The former group tends to be low earners, and the latter the high earners. Thus, on average, final-earnings schemes redistribute from low to high earners. Therefore, extending the averaging period of the Regulatory Base should

[8] Note that in our benchmark economy, the pension system does not incorporate the intergenerational solidarity mechanisms approved by the 2011 and 2013 reforms, because such mechanisms were eliminated during the years 2020 and 2021.

[9] In Europe, similar to Spain, pension schemes in Austria, France, Portugal and Slovenia, are based on a compar- atively small fraction of career earnings to calculate benefits.

reduce retirement pensions especially for the more educated workers, thus increasing the progressiveness of the pension system, and increasing at the same time intragenerational solidarity.

- Payroll tax cap: most of the public pension systems impose contributions on salary income up to a maximum, which is usually higher than the maximum retirement pension. This is justified as one more element of intragenerational redistribution, in order to increase the progressivity of the system, or its solidarity. In the reformed model economy, we assume that the government's eliminates the payroll tax cap in order to reinforce the progressivity of the system. Note that this is the case of countries such as Portugal and Sweden.

- The Sustainability Factor. We introduce the factor approved in 2013 by the Spanish Government, and then repealed in 2021. Specifically, the formula that was approved for this factor is the following:

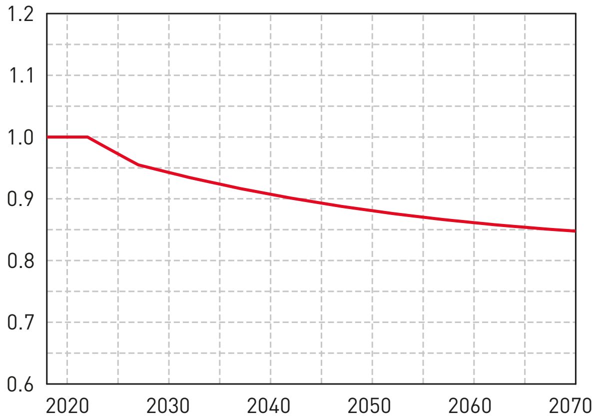
$$SF_t = \varepsilon SF_{t-1} \tag{22}$$

where ε is a time-varying measure of the relative life-expectancy at age 67. Specifically, for the period 2023–2028 the value of ε will be

$$\varepsilon = \left[\frac{e_{67,2018}}{e_{67,2022}}\right]^{1/5} \tag{23}$$

and so on. The sustainability factor will be applied for the first time in 2023, and it will apply to *new* pensions only. In Figure 1 we represent the values of the sustainability factor that we have computed using the 2022 mortality tables. It turns out that, by 2070 the sustainability factor alone will have reduced the real yearly value of Spanish new pensions in 15.2 percentage points.

Figure 1. The Sustainability Factor



- The Pension Revaluation Index. We also introduce the revaluation index approved in 2013 by the Spanish Government, and then repealed in 2020. The specific formula that was finally adopted for this index is the following:

$$g_{t+1} = \overline{g}_{c,t+1} - \overline{g}_{p,t+1} - \overline{g}_{s,t+1} + \alpha\left(\frac{R^*_{t+1} - E^*_{t+1}}{E^*_{t+1}}\right) \quad (24)$$

where $\overline{x}_t$ indicates the moving arithmetic average of variable x_t computed between t–5 and t+5, $x*$ indicates the moving geometric average of variable x_t computed between t– 5 and t+5, $g_{c,t+1}$ is the growth rate of the pension system revenues, $g_{p,t+1}$ is the growth rate of the number of pensions, $g_{s,t+1}$ is the growth rate of the average pension due to the substitution of old pensions by new pensions, $0.25 \leq \alpha \leq 0.33$ is an adjustment coefficient, R_{t+1} denotes the pension system revenues, and E_{t+1} denotes pension system expenditures. Finally, the pension revaluation index has two bounds. The lower bound is 0.25 percent and the upper bound is 0.5 percent plus the inflation rate.

This paper analyzes the aggregate, distributional, and welfare consequences of introducing all these parametric changes in the Spanish pension system, although we first study these parametric changes one at a time to explore which of them is quantitatively more important.

Evidently, this radical and fast reform increase the risk of policy reversal, as some households may face welfare looses, specially those who are near of retirement. To cope with this issue, and when we simulate all the parametric changes at the same time, we also assume that those households who suffer welfare losses after this pension reform receive a government's transfers to overcome these losses, and that such transfer program is financed with public debt. Thus, every household alive at the moment of the pension reform is at least weakly better off in the reformed economy.

4. THE SCENARIOS

In the next section, we will study the aggregate and welfare consequences of a fundamental pension reform aimed to improve both the future financial situation and the pension design of the Spanish public pension system. Both model economies have exactly the same initial conditions and share the demographic, educational, growth, fiscal policy, and inflation rate scenarios that we describe below.

The Demographic Scenario. The demographic scenario replicates the demographic projections for Spain for the period 2018–2072 estimated by the *Instituto Nacional de Estadística* (INE) in 2022.[10] In Panel A of Figure 3 we plot the changes in the 65+ to 20–64 dependency ratio that result from this scenario. This ratio increases from 32.2 in 2018 to 52.8 in 2070.[11]

The Educational Scenario. The initial educational distribution of our model economies replicates the educational distribution of the Spanish population in 2018, as reported by the INE.[12] After 2018, we assume that the educational shares for the 20-year old entrants are 7.33 percent, 62.62, and 30.05 percent forever for drop-outs, high school graduates, and college graduates. Those shares are the educational shares of the most educated cohort ever in Spain, which corresponds to the 1980 to

[10] These projections can be found at *https* : *//ine.es/dyngs/INEbase/es/operacion.htm*?*c* = *EstadisticaCcid* = 1254736176953*menu* = *resultadosidp* = 1254735572981.

[11] We assume that the age distribution remains constant after 2072.

[12] The INE reports the educational distribution of the population by five-year age groups. We smooth this distri- bution through the estimation of polynomial curves.

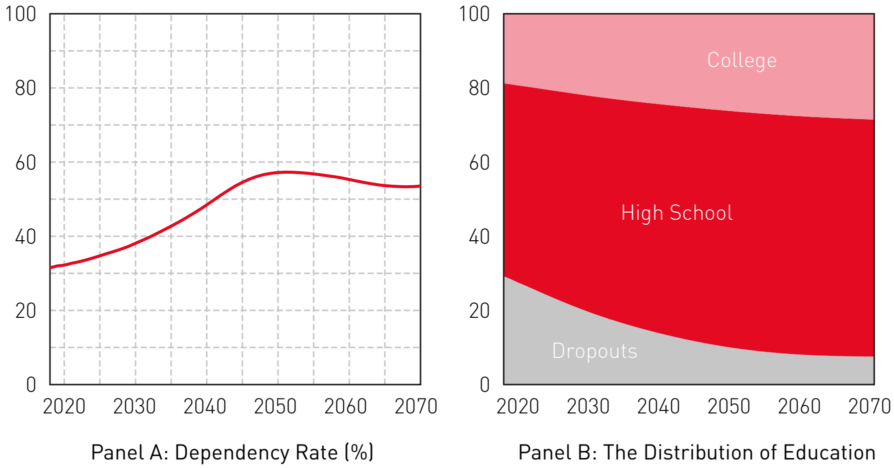
1984 cohort.[13] In Panel B of Figure 3 we plot the changes in the distribution of education shared by all model economies. The shares of high school drop-outs, high school graduates, and college graduates change from from 27.9, 53.0, and 19.1 percent in 2014 to 7.1, 64.7, and 28.2 percent in 2070.

The Growth Scenario. We assume that the labor productivity growth rate is 1 percent after 2018. The rationale for this choice is because the Spanish average annual labor productivity growth rate between 1995 and 2012 was 0.9 percent, according to the OECD.

The Fiscal Policy Scenario. Recall that the consolidated government and pension system budget constraint in our model economy is given in Expression (7) In that expression G_t is exogenous and the remaining variables are endogenous. In all model economies the capital income tax rates and the parameters that determine the household income tax function are identical and they remain unchanged at their 2018 values. The consumption tax rates differ across the economies because we adjust them to finance the pensions once the pension reserve fund is exhausted. Every other variable in Expression (7) varies with time and differs across both economies because they are all endogenous.

[13] Conde-Ruiz and González (2013) also use this educational scenario.

Figure 2. The Simulation Scenarios in All Model Economies



a This is the ratio between the number of households in the 65+ age cohort and those in the 20–64 age cohort.
b This is the distribution of education of the households in the 20–64 age cohort.

The Inflation Rate Scenario. We assume that the exogenous yearly inflation rate in our model economy after 2018 is 2 percent, because that is the inflation rate targeted by the European Central Bank. This inflation rate scenario has two implications: first, since 2023 the real value of the lower bound of the PRI −1.75(= 0.25 – 2.00) percent thereafter; and, second, the real value of the upper bound of the PRI from 2023 onwards is 0.5 percent.

Reform Announcement. We assume that all the reforms of Spanish pensions are announced and implemented at the beginning of 2023.

5. RESULTS

We simulate these two model economies using the demographic, educational, and economic scenarios that we have described in Section 4.

5.1. The pre-Reform Pension System (Benchmark Economy)

Our simulations show that the current pay-as-you-go, defined benefit pension system is completely unsustainable. We find that the pension system deficit in the Benchmark Model Economy would reach 6.3 percent of GDP by 2050 (see Panel C of Figure 6), and that the accumulated pension system debt, would have reached 100 percent of GDP that same year. In 2050, the consumption tax rate that would have been necessary to finance Spanish pensions would have been 27.3 percent, 12 percentage points higher than the value observed in 2020 (see Panel D of Figure 6).

This sustained increase in the pension deficit is mainly structural. Specifically, we find that the pension system expenditures increase by more than 4 percentage points of GDP during the next decades, from 12.3 percent of GDP in 2020 to 16.6 percent in 2050 (see Panel B of Figure 6). However, there is not significant variation in the pension system revenues since payroll tax revenues are 11.1 percent of GDP in 2020 and 10.3 percent in 2050 (see Panel B of Figure 6).[14] Overall, results are in line with those found by De la Fuente *et al.* (2023), since they show that the Spanish pension system imbalance could get over 6 percent of GDP by 2050.

5.2. The Changes in the Pension System

The proposed reform that we analyze in this paper has significant consequences for the generosity and sustainability of the Spanish public pension system. Moreover, and because workers decide optimally their contributions to individual retirement accounts, this reform brings about significant changes in the household's sector saving rates, hours of work, and consequently, output. Put differently, this pension reform implies several micro and macroeconomic effects, so that we study first the parametric changes one at time to explore their individual quantitative consequences.

Sustainability factor. Recall that the sustainability factor reduces the value of new pensions only. Consequently, the reduction in the average pension is gradual and

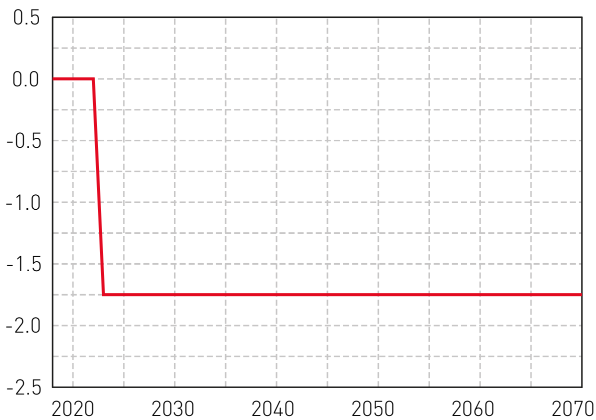
[14] In the pension system revenues we include the government's transfers to the system which account 1.4 percentage points of GDP.

reaches more than 6 percentage points by 2050. Moreover the decrease in the initial retirement pension increases somehow the effective working period, so that we found that the long run average retirement age is 0.2 years higher in the reformed economy. Thus, the overall effect is a decrease of the long run pension deficit of 2 percentage points of output, and a lower consumption tax rate of almost 5 percentage points.

Regarding the macroeconomic aggregates, the longer working period increase the number of work hours. Moreover, and because households expect slightly lower retirement pensions in the near future, they also increase saving rates to increase their private income when old to finance their consumption. At the end, there is a small increase in the long run output of almost 2 percent.

The Pension Revaluation Index. We find that the PRI is always negative between 2023 and 2050, because after the baby boom cohorts start to retire so that the PRI must compensate for the fact that the the increases in the legal retirement ages have been fully implemented and, consequently the pension cuts that they bring about have disappeared.

Figure 3. The Pension Revaluation Index



We find that this reforms improve the sustainability of Spanish pensions substantially, and that it limits the tax increases that would have been necessary to finance the pension system deficits. But these results are achieved at the expense of large reductions in the real value of the average pension. This reduction is progressive and, by 2050, the average pension is approximately 21 percent smaller in real terms than what it would have been under the pension system rules that prevailed in the Benchmark Model Economy.

This sustained reduction in the public pensions, increase both hours of work and saving rates. Specifically, workers increase the average retirement age by more than 6 months, and the long run aggregate stock of assets is 30 percent higher. Consequently, the long run output is 5 percent higher in this reformed economy.

Regulatory base. The increase in the number of years used to compute the Regulatory Base, from the last 25 years to the entire working lifetime reduce the average pension, specially for those more educated workers, and the reason for this is that inequality in labour income increases in the later periods of working life. Consequently, this change is successful in increasing the progressivity of the system, because, and following Jimeno (2003), the defined benefit Spanish retirement pension system with a short calculation period of the pension Regulatory Base produces higher pension inequality.

The consequences for the pension system are straightforward, since the growth rate of pension expenditure during the next decades decreases, so that the pension deficit is also lower. Moreover, there is another channel through which, although to a lesser extent, this reform affects pension deficit. This is the prolongation of the working lifetime of workers, which is due to the drop in the opportunity cost to keep working, which is precisely the retirement pension. Our results show that this reform could increase the average retirement age in almost one year. Overall, we find that this parametric change could reduce the long run pension deficit by 2 percentage points of GDP, and it also reduces the consumption tax rate needed to finance the pension deficit.

Finally, this reform also affects saving rates, since the lower public pensions foster the accumulation of private assets to finance consumption at older ages. Thus, higher savings and work hours (because the longer working period), increase long run output by around 4 percent.

Payroll tax cap. Recall that the elimination of the payroll tax cap is justified as a tool to increase the solidarity of the pension system. Thus, this reform, and as expected, increase the revenues of the system, although there is no significant effect on pension expenditure since this parametric change brings not significant variation on retirement pensions. Consequently, the pension imbalance is reduced in 1.2 percentage points of output in 2050, and the decrease in the consumption tax rate is 1.3 percentage points that same year. Finally, we found no significant variation in output, although the long run aggregate consumption decreases by 0.5 percent, mainly because the drop in the consumption of high earning workers.

5.3. Simulating the transition to the new Spanish Pension System.

This paper analyzes the aggregate, distributional, and welfare consequences of a fundamental pension reform in Spain. Naturally, and as it was shown in the previous section, this reform would reduce pension payments so that households should complement their retirement income with the retirement income provided by private assets. On the other hand, the solidarity of the new basic pay-as-you-go pensions will be guaranteed through a pension system minimum and maximum pensions, and is also be reinforced by uncapping contributions to the pay-as-you-go system, as it is the case in Sweden or Portugal.

Of course, this reform implies losers, especially those workers who are close to retirement. Therefore, the government, at the same time that it introduces into the pension system all the changes that we have presented, implements transfers to households, in the form of liquid assets, so that all those alive at the moment of the pension reform, prefer the new pension system to the pension system in place. In conclusion, the overall policy change involves mix of changes in taxation, benefits and government transfers.

As expected, the reform solve the sustainability problems that plague the public pension system, since in 2050 the pension system deficit decreases from 7 percent of output in the Benchmark Model Economy, to 0 percent in the Reformed Model Economy. Resulting from this improvement, the consumption tax rates needed to finance the pension system deficits decrease from 27.9 percent to 11.8 percent. And, this improvement in the sustainability of public pensions is mainly brought about with large reductions in the average public pension, since in 2050 the average pension is reduced by 30 percent.

Figure 4. The Average Pension, the Pension Deficit, and the Consumption Tax Rate

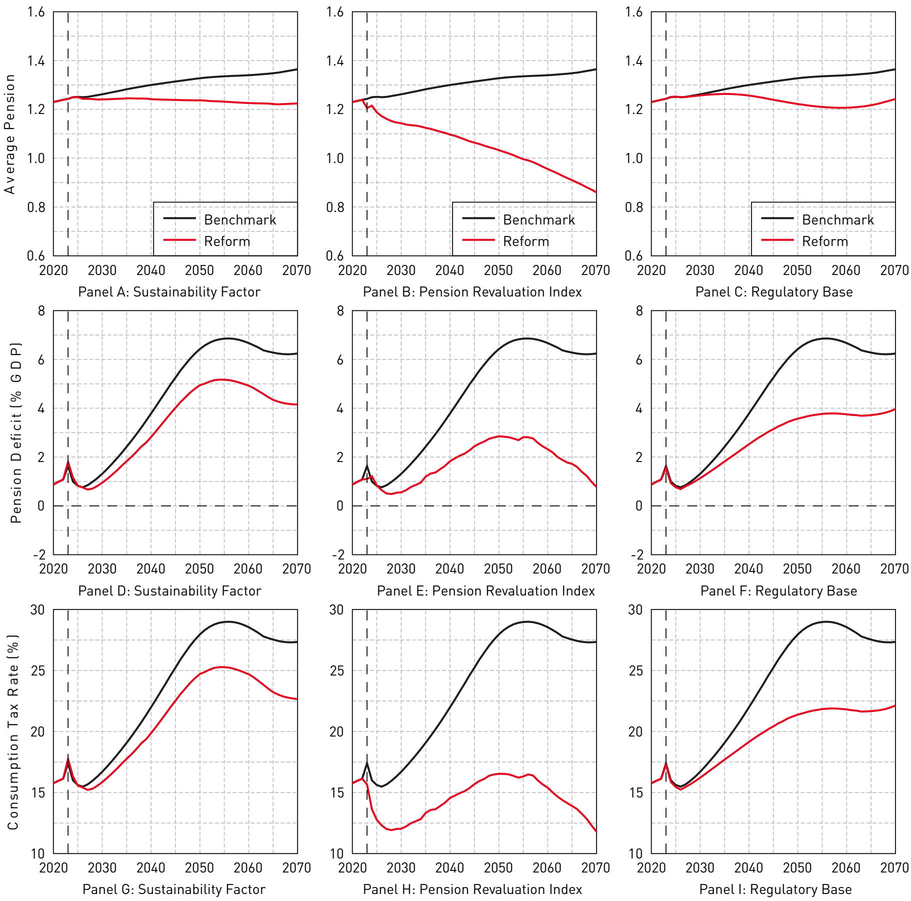


Figure 5. The Average Pension, the Pension Deficit, and the Consumption Tax Rate

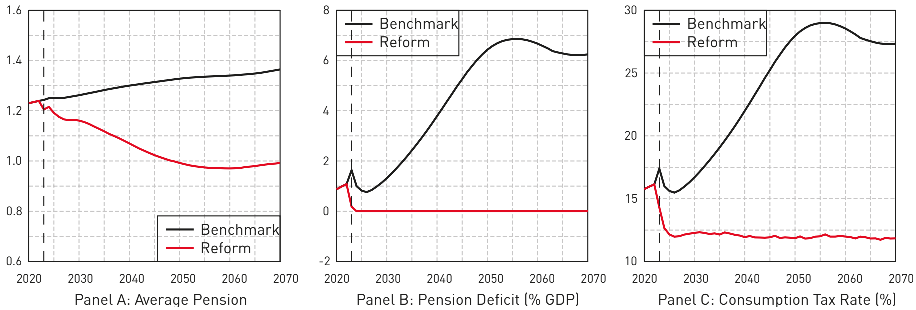
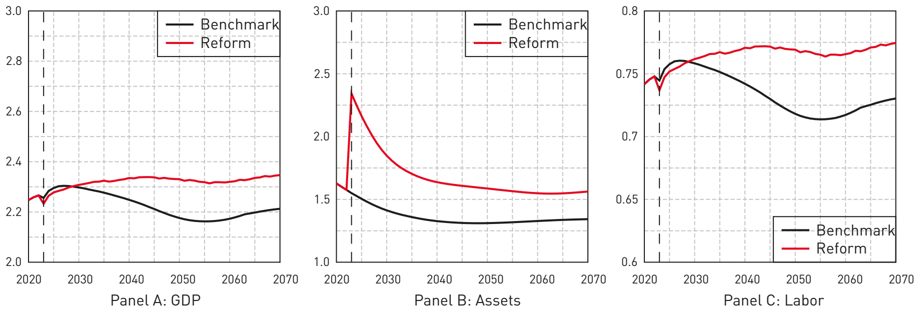


Figure 6. The GDP, Assets, and Labor

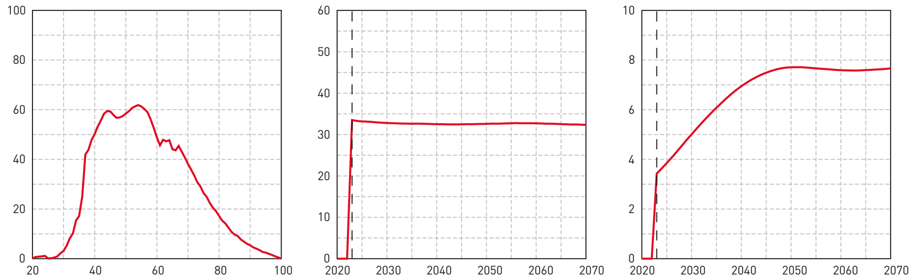


This pension reform, as has already been said, foster savings and, consequently, capital accumulation increase substantially, since long run private assets are 30 percent higher in the reformed economy. And since long run work hours also increase mainly because the longer working period, output is 7 percent higher in 2050.

Recall that this pension reform reduces pensions, but also the tax rate needed to close the government budget. And the final effect of these opposing forces may lead welfare losses in some households, who should be compensated by the government's transfers. In Panel A of Figure 7, we show the government's average transfer by age of liquid assets to those households who would be worst off alive at the moment of the reform in 2023. These transfer increase strongly with age mainly because these households are the ones who have less time to re-optimize labor and saving decisions during their working lifetime after the pension reform.

Put differently, and despite the lower tax rates brought about by the reform, older workers lose more with this reform because they can not afford enough additional private savings to compensate the future lower pensions. Finally, note that the older the retiree the lower the needed compensation as he/she will be the households least affected by the reform.

Figure 7. The Compensation, the Public Debt, and the Change in Welfare



Panel A: Av. Transfers by Age (% per capita GDP) Panel B: Government Debt (% GDP) Panel C: Increase in Utility (%, Newborns)

The total amount needed by the government to compensate looser reaches 33 percent of GDP, and we assume that the government pays 1 percent interest rate on this stock of public debt. Nevertheless, as Figure 7 shows, there is room to compensate the losses and construct a full Pareto improving pension reform transition, even after the interest payments. The large long run gains can make the reform a full Pareto improvement (i.e. without any losers) and robust to other specifications (such as general equilibrium effects not accounted for in the current analysis).

5.4. The long run

The first order effect of this pension reform is over the sustainability of the system, and consequently, over private savings and retirement behaviour. Reducing pensions provides a strong incentive to save during working years, in order to finance consumption after retirement. Also, the lower opportunity cost to kept working, encourages to delay retirement. Finally, the lower taxes and the higher savings increases private consumption.

Finally, and in order to interpret the magnitude of the welfare gains in the reformed economy, we use a consumption equivalent variation measure (CEV) that converts average welfare into consumption units. To convert the increase in welfare into a CEV, we compute the percentage change in a households lifetime consumption that equates its expected lifetime utility in the benchmark economy, to that in the reformed economy pension system. We find that all education types are at least 10 percent better off in the reformed economy, despite the lower pensions. The main reason for this is the lower taxation and the higher consumption.

Obviously, this reform represents a radical change in the current pension system, where the public pension reduces its weight as a source of income during old age. Thus, if in the Benchmark model economy, the public pension finances around 90 percent of the consumption of retirees, in the reformed economy, this number drops to 60 percent. Putt differently, the second pillar, the private assets accumulated during the working years, becomes an essential source to finance consumption during old age.

CONCLUSIONS

In this paper we have shown that it is possible to implement a reform of the existing Spanish PAYG pension system during a ageing transition that doubles the ratio of individuals older than 65 relative to the 20-64 group, that is welfare improving for all cohorts who enter the economy during the transition period, with the introduction of Automatic adjustment mechanisms. These intergenerational solidarity mechanisms can be useful tools to solve the sustainability problems that plague the Spanish pension system. Additionally, this reform would increase the weight of the second pillar, the capitalized one, as an additional source of income during old age.

Evidently, this reform represents a radical change, specially because it reduces significantly, the weight of the public pension as a source of income to finance consumption when old. The difficult political-economy of implementing this type of reform often calls for introducing it slowly. However, a slow transition fails to anticipate the fast increase in the ratio of retirees per worker. On the other hand, a fast transition would avoid this scenario by moving all active workers at the time of the implementation to the new PAYG system and hence go through the ageing process with a much lower stock of PAYG claims.

It can be argued, however, that this rapid implementation was the case in Spain, with its 2011 and 2013 pension reforms, and that the substantial reduction of pensions and the high welfare costs that these reforms brought about led the Spanish government to reverse them. However, we show in this paper that a fast transition where those households who suffer welfare losses receive a government's transfers to overcome these losses, can be sustainable from a political point of view.

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