Public pensions reforms: financial and political sustainability*

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Abstract

One main reason for the unsustainability of future pensions in many European countries is a failure to adapt to very long-term demographic trends. Also, a reform to address financing issues can also be an occasion to improve pension design. Sometimes, however, such pension reforms are likely to be overturned when they lead to significant short-term losses in retirement income. 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markets to show that, with an appropriate design, sustainable pay-as-you go systems can greatly outperform current outdated pension systems.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 deal with 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: Overlapping generations, social security reform, redistribution

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1 Introduction

A primary cause of the unsustainability of future pensions in many European countries is the failure to adapt to very long-term demographic trends, where the most important reasons behind these trends are the increase in life expectancy at birth and the decline in fertility rate. Consequently, the weight of the older groups of the population will increase over the coming decades. This implies that some unfunded pension systems can only mean a partial default in promised pension retirement and payments, or very high taxes to finance future pension claims. Governments in these countries, then, are doomed to change their public pension systems.

Automatic adjustment mechanisms (AAMs) can be useful tools to prevent pension schemes from becoming increasingly unsustainable as populations age (OECD, 2021). Two AAMs seem to be especially useful in restoring pension sustainability, and at the same time acting 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.

Also, a poor design of these pension systems contributes to amplifying the problems of future sustainability. For instance, as 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 systems that consider only part of the contribution made during the working lifetime, than it would be under a system that takes into account the contribution bases from all periods of the working lifetime. Moreover, systems that consider part of the contribution made during the working lifetime produce higher replacement rates for more educated workers. Consequently, this feature, which is present in some European countries with defined benefit pension systems, such as France, Malta, Slovenia, and Spain, contributes to increasing pension expenditure growth over the coming decades.

However, the implementation of a pension reform can also generate sizeable political costs (Kitao 2017), so that a reform aimed at restoring financial balance is likely to be overturned when it leads to important short-term losses in retirement income. Examples of this policy reversal are Poland (2016), Germany (2018), Croatia (2019), Netherlands (2019), and Spain (2020 and 2021).[1] Put differently, the existence of households facing short-term welfare losses after this type of pension reform is an almost insurmountable obstacle, and is the root of the policy reversal problem.

On the other hand, however, it is likely possible to reduce the risk of political reversal. Indeed, if, together with a reform of the pension system, the government implements a transfer programme targeting those socioeconomic groups that have been financially harmed by the reform, social rejection of it can be significantly reduced. Obviously, these transfers should be individualized,

[1] See The Ageing Report 2021.

taking into account the characteristics of each individual or socioeconomic group. The ultimate goal of this programme would be to make those individuals who ex-ante face welfare losses feel that, after receiving compensation from the government, they are no worse off under new pension system. In other words, it is about designing a Pareto-improving transition between the current and the new pension system. The question that then immediately arises is how much such a transfer programme would cost and how it would be financed.

This paper tries to give answers to these questions. Specifically, this paper analyses the aggregate, distributional, and welfare consequences of a policy pack given by a pension reform aimed at guaranteeing future pension sustainability, and a transfer scheme designed to implement a Pareto-improving transition between a current and a new, reformed, pension system. We also quantify the cost of this scheme and show how it might be financed. Our quantitative experiments rely on the Spanish social security system, since Spain is a fairly extreme case of the aforementioned failures to introduce a dynamic pension design to deal with an ageing population. For instance, after the reversal of those parametric changes implemented in the 2011 and 2013 pension reforms, several studies point out that the current Spanish pension deficit of more than 2 points of GDP could increase up to over 6 points of GDP by 2050.[2]

The pension reform that we study here combines changes in pension benefits, in payroll taxation, and a new transfer programme, as these policy changes are relevant in the current European policy and political context. Specifically, we consider a pension reform that introduces: *i)* a sustainability factor that changes the size of the initial pension benefit depending on life expectancy at the time of retirement; *ii)* an automatic balancing mechanism that uncouples annual pension updates from the Consumer Price Index (CPI) increases, but sets the annual increase in pensions on the basis of a formula derived from the balance between the system's revenue and expenditure; *iii)* an increase in the number of years used to compute the pension, from the last 25 years to the entire working lifetime, with the rationale behind introducing this parametric change being because, as already stated, it increases intragenerational equity. The previous changes of this pension reform are aimed at reducing the growth of pension expenditure over the coming decades. Additionally, we assume that the government is concerned with increasing the revenues of the system in order to guarantee pension adequacy for current and futures retirees.[3] Thus, we also assume that, *iv)* the government eliminates the payroll tax cap, but it continues to set a maximum retirement pension. The rationale for this change in taxation is twofold: first, because the Social Security base generates a regressive tax scheme above maximum taxable earnings, since low earners have a greater share of taxed earnings than high earners; and second, since eliminating the cap partially helps to restore the progressiveness of pension systems, which is eroded by the growing gap in the life expectancy

[2]See, for instance, De la Fuente (2023), and AIReF (2023).

[3]It can be also argued that the pension cuts would almost certainly be phased in slowly, which means they could not produce significant savings in pension expenditure in the short run.

of the elderly across educational groups (see Díaz-Saavedra 2023).[4]

Evidently, this pension reform represents a substantial change regarding the current status quo, mainly because it significantly reduces the weight of the public retirement pension as a source of income to finance consumption when elderly. Consequently, 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 (Aubuchon et al., 2011). Additionally, 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.

To make such a fast transition possible from a political point of view, however, some kind of setoff to the most affected households should be introduced. Thus, we also assume that the government implements, at the same time as this reform of the pension system, a transfer programme aimed at all those households that face welfare losses, so that these households, after receiving the transfer, do not see themselves as worse off under the new pension system. These transfers, in the form of liquid assets, are delivered only once and at the same time the pension system reform is implemented. And this transfer scheme is financed as follows: liquid asset subsidies are debt financed, and the consumption tax rate changes in order to clear the government budget. Finally, we also assume that debt is raised in the international capital market and is costly, with interest payments included in the expenditure side of the government budget constraint, so that consumption taxes must increase to also cover interest payments.[5]

To do this, we simulate an enhanced version of the multiperiod, overlapping generations model economy populated by heterogeneous households described in Díaz-Saavedra et al. (2023). The model economy that we study here differs from the one that we used in that article in six fundamental ways. First, this version introduces a detailed description of the Spanish public pension system, such as minimum and maximum pensions, early and normal retirement ages, penalizations for early retirement, and bonuses for delayed retirement. This is important if one wants to take the results caused by the reform that we study in this paper seriously.[6] Second, it also introduces a payroll tax cap. In this case, it is important to account not only for the number of capped workers, but also for their distribution by age and education. In Section 4.1 we show that our model economy does a good job in replicating the corresponding Spanish data. Third, our model economy assumes that households take into account the link between payroll taxes and pensions when making their consumption, savings, and retirement decisions. We model this feature because pension entitle-

[4] A common criticism of eliminating the cap, however, is that it would act as a disincentive to work, reducing the growth rate of output.

[5] Following Díaz-Saavedra et al. (2023), we assume that the real interest rate on the public debt financing transfer scheme is one percent per year.

[6] Despite we introduce very technical details of the Spanish pension system, our modelling choices can be easily adapted to replicate with great detail the performance of other public pension systems in Europe.

ments are a sizeable part of the compensation of workers, and because they play an important role in the labour decision, especially towards the end of working life. Fourth, this version introduces labour productivity growth and calibrates its growth process to the past long-term rate of the Spanish economy. This is important since labour productivity growth helps to cope with the sustainability problems that plague most public pension systems, as is the case of Spain.[7] Fifth, this article examines pension sustainability challenges in Europe, highlighting that many countries are projected to increase their pension expenditure-to-GDP ratios by 2070, according to The Ageing Report (2024). We also identify that many of them have not implemented automatic adjustment mechanisms (AAMs), therefore, we also suggest that it is advisable, in addition to introducing such mechanisms, the design of a targeted transfer program aimed to mitigate impacts on affected groups, enabling sustainable reforms with reduced risk of policy reversals. Sixth, and finally, the demographic scenario used in all our simulations corresponds to the latest Spanish demographic projection made by the Spanish National Institute of Statistics, (INE). This scenario shows a lower expected increase in the demographic dependency ratio over the coming decades in comparison to its previous projections.

Our results are: *i)* This pension reform overcomes the sustainability problems that plague the current Spanish pension system mainly by reducing pension benefits, and thereby encouraging private savings and extending working lifetimes; *ii)* this pension reform limits the tax increases that would have been necessary to finance the future pension system deficits, increasing household consumption; *iii)* a fast transition, from the current to the reformed PAYG system, can be Pareto-improving for those alive at the moment of this reform; *iv)* there are substantial welfare gains for the long-term cohorts under the reformed pension scheme, even when accounting for the payments of public debt used to compensate those who initially face losses due to the reform. The debt needed to compensate those households alive in 2023 that face losses due to the reform accounts for up to 28 percent of GDP; and *v)* when the government announces the pension reform in advance, the fiscal cost of financing the Pareto transition to the new system is lower, and this is because the public transfers necessary to compensate households harmed by the pension reform are also lower, since these households have more time to adapt their optimal consumption, savings and work decisions before the pension reform comes into force.

We think that our results could be extended to other European countries facing sustainability problems in their public pension systems in the medium and long term. Specifically, and according to the estimates of The Ageing Report 2024, 16 other European countries, apart from Spain, are projected to increase pension-expenditure-to-GDP ratio over the coming decades. According to these projections, the expected increases in this ratio range from 8.3 percentage points for Luxembourg to 0.1 percentage points for Bulgaria, between 2022 and 2070. These numbers thus

[7] This is so since most advanced economies mainly index pensions, and particularly pension rights, to the Consumer Price Index. Thus, this feature of pension systems means that productivity gains are transferred to pensions with a certain time lag, so the future financial burden of the system decreases.

indicate that some European countries have failed to adapt to very long-term demographic trends, so that, to a greater or lesser extent, these countries are in need of reforms to guarantee the future sustainability of their public pension systems, limiting the tax increases that would otherwise be necessary to finance their pension system deficits.

When looking at the fine print, we find that many of these countries failed to introduce at least one of the AAM, namely: Malta, Hungary, Slovenia, Spain, Belgium, Ireland, Czechia, Austria, and Bulgaria. The rest of the sampled countries only have one AAM, with the notable exception of Finland, which has two (see Section 8 for a detailed description). Of course, governments can also increase the revenues of the pension systems by increasing revenues through a rise in the effective rate of social security contributions. But this parametric change and the implied reduction in the pension replacement rate given by the introduction of AAMs are likely to be overturned given that they lead to losses in retirement income (see Section 2 for a review of pension policy reversals). Consequently, a transfer programme such as the one proposed here, targeting those socioeconomic groups that have been financially harmed, may be a useful tool to induce a Pareto welfare improving transition, reducing the risk of policy reversal. In Section 8 we conjecture that the fiscal cost of such a transfer scheme for the sampled countries could be lower that the number we report for Spain, as their projected increase in pension expenditure is below than the result we report for the Spanish case.

Our paper is most closely related to the literature on the sustainability of Social Security systems in economies facing demographic transitions.[8] For instance, Kitao (2014) considers four options to make the U.S. Social Security system sustainable for the next few decades, and the options involve increasing taxes or decreasing benefits. She finds that all policy options make the system sustainable, although there are significant differences between the alternatives regarding the individual and aggregate consequences. Our paper, however, constructs a Pareto-improving transition in which no generation is worse off after the pension reform.

Another paper closely connected to our study is that by Conesa and Garriga (2008). They study the privatization of US Social Security in a Pareto-improving way, and find that the optimal design of this privatization exhibits sizeable welfare gains, arising because of the reduction in labour supply distortions. Our paper looks at reforming the existing Spanish public pension system, and in addition to the intensive labour supply decision, our model includes the retirement decision and the job search effort over the life cycle.

Finally, in a previous paper, Díaz-Saavedra et al. (2023) studied the elimination of the current Spanish pension system and a Pareto-improving transition into a Backpack system with debt issuance and initial backpack asset transfers to the existing cohorts. They show that the Backpack

[8]Some previous papers in the quantitative literature on Social Security reform are, for example, Huang et al. (1997), Imrohoroglu and Kitao (2012), Fehr et al. (2017), and Díaz-Giménez and Díaz-Saavedra (2017), to name a few examples.

system is a very good replacement of the public pension system and that it also dominates—in welfare and efficiency terms—other private or public funded systems. However, and apart of using an enhanced version of that model economy, our work departs in some other important aspects. First, this paper analyse the quantitative consequences of the introduction of parametric changes that are actually under discussion in the current European policy and political context. Second, and related, despite the higher efficiency and welfare gains that could report the replacement of the current unfunded public pension system by a Backpack employment fund, it seems difficult to implement such a reform when the public pension system in Europe is seen essentially as a tool to promote social cohesion and solidarity, so that its removal could undermine the principle of collective responsibility that have been integral to European societies for decades. Third, and finally, implementing a Pareto-improving transition to a Backpack system, financed with the issuance of new debt, entails a high fiscal cost which could casts concerns among investors about the government's ability to manage their public finances, potentially leading to a downgrade in its credit rating. Moreover, a downgrade would increase borrowing costs, which makes it even more difficult for the government to secure future debt issuance.

The paper is organized as follows: Section 2 describes the most recent episodes of policy reversal in Europe; Section 3 presents the model economy; Section 4 briefly describes the calibration procedure and presents the calibration results; Section 5 describes the simulations and Section 6 details the demographic and macroeconomic scenarios used in our simulations; Section 7 presents our quantitative results; Section 8 examines pension sustainability challenges in Europe; Section 9 shows a sensitivity analysis, and, lastly, Section 10 concludes.

2 Pension Policy Reversal in Europe

The age distribution in Europe is projected to change dramatically in the coming decades, and this demographic transition means important fiscal sustainability challenges in the medium and long term, especially for retirement schemes. Consequently, over recent decades, many European countries have implemented reforms to their public pension systems to cope with the demographic ageing.

These reforms, which were generally phased in gradually, are of a wide variety, although four types stand out: *i)* tight eligibility criteria, with higher statutory retirement ages, and/or more limited early retirement pathways, as seen in Belgium and Germany); *ii)* changes in the calculation of pensionable earnings, implemented in countries like Czechia and Greece; *iii)* raised contributions, as seen in Poland and Portugal; and *iv)* adopting automatic adjustment mechanisms (AAMs). The forms that can adopt AAMs are notional defined contribution schemes (e.g. Italy and Sweden), automatic links between the retirement age and life expectancy (e.g. Slovakia and Finland), sustainability factors that adjust initial pension benefits to gains in life expectancy (e.g. France

and Estonia), and automatic balancing rules that lower indexation (e.g. Spain and Lithuania).[9] Currently, 17 European countries apply one or more of the forms that these AAMs can adopt.

However, since the middle of the last decade, policymakers have started to worry about pension benefit adequacy. Specifically, a pension reform that reduces retirement income may induce a risk of increasing poverty rates over time among retirees. Consequently, some governments partially or fully reversed previous or already approved pension reforms. Some of the pension reform reversal took place in those countries that had approved a rise in the payroll tax rate. For instance, Macedonia and Lithuania approved raising the contribution rate in their public pension systems, although they decided to reverse these changes in 2008 and 2009, respectively.

In the case of Ireland and Poland, both countries decided to increase the statutory retirement age of their public pension systems in 2011 and 2012, but their governments then annulled or postponed these parametric changes in 2016 and 2020, respectively. Similarly, Czechia and the Netherlands linked the statutory retirement age to changes in life expectancy in 2011 and 2012. However, Czechia introduced a cap at 65 years in 2017, while in 2019 the Netherlands limited the link to life expectancy to two thirds of the gains. Finally, Spain and Germany decided to relax or eliminate, respectively, the implementation of their automatic balancing rules that lowered indexation.[10]

In conclusion, the reforms of the public pension systems in Europe were designed to reduce the growth rate of public expenditure on retirement pensions. To do so, however, they need reduced pensions and a retirement period that does not increase at the same rate as the increase in life expectancy. But some of these parametric changes have lessened the expected income of current and future retirees, especially in those cases where losers were not compensated by a targeted tax and transfer scheme. In such cases, the risk of pension policy reversal increased significantly, and, consequently, most these countries reverted to unsustainable public pension systems again.

3 The Model Economy

We study an overlapping generations open model economy with heterogeneous households, a representative firm, and a government. Our model economy is an enhancement of the model economy described in detail in Díaz-Saavedra et al. (2023). Since these modelling improvements are mainly introduced within the public pension system of the model, we describe this system in detail. How-

[9] Additionally, a measure that has also been implemented quite regularly is the introduction of penalties for early retirement and bonuses for late retirement, such as in France and Spain. See Carone et al. (2016) for a detailed description of the pension reforms in Europe.

[10] Some policy reversals came as a result of court decisions, as occurred in Greece, Portugal, and Slovakia. See Ageing Report (2024).

ever, and for the sake of brevity, we only briefly present the rest of our economic model.[11]

3.1 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 productivity level, $z \in \mathcal{Z}$; in their labor market status, $s \in \mathcal{S}$; in their pension rights, $b \in B$; in their pensions, $p \in P$; and in their private assets, $a \in A$. Sets J, H, $\mathcal{Z}$, $\mathcal{S}$, B, P, and A, are all finite sets and we use $\mu_{j,h,z,s,b,p,a}$ to denote the measure of households of type (j, h, z, s, 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.

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_j denotes the conditional probability of surviving from age j to age $j + 1$.

Education. Households can either be high school dropouts, high school graduates who have not completed college, or college graduates. 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, inactive, or retired. Among the unemployed, there are individuals who are eligible to receive unemployment benefits, and others who are not eligible (either because eligibility expired, or because they quit work). Worker decide when to retire, leaving the labor force permanently once they do. Upon entering the economy, individuals randomly draw a job opportunity and then decide to work or not during the first period. Similarly, in subsequent years the labor market status evolves according to both optimal work and job search decisions (described below), and exogenous job separation and job finding probabilities.

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, and a stochastic component. 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 quadratic functions, because it allows us to represent the life-cycle profiles of the productivity of workers in a very parsimonious way.

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

[11] Time is discrete and runs forever, and each time period represents one calendar year. During transitional dynamics, out of a steady state, all variables depend on calendar time t, but in this section we omit this dependence.

households, and we assume that it follows a first order, finite state, Markov chain. We assume that this stochastic component can take three values, and 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 also because we want to keep this process as simple as possible.

Finally, we also assume that workers face a probability of losing their job at the end of the period. This probability is age dependent, and we use it to generate the observed labor market flows between employment and non-employment states within age cohorts.

Unemployed. An agent may not have a job opportunity at the beginning of a period, because he lost his job last period, because he quit his job, or because he was unemployed last period and did not find (or did not accept) a new job offer. Without a job, agents may actively search for a job offer next period. If they do actively search we label them as unemployed. Unemployed agents can receive unemployment benefits. 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. Agents who have quit work are not eligible for unemployment compensation (we often refer to this group as unemployed non-eligible). Active job searchers receive a job offer at the end of the period according to some probabilities that depend of age, and we use it to generate the observed labor market flows between unemployment and employment. The offer is the productivity shocks, and 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 these shocks are determined by the conditional transition probabilities.

Non-Active. Agents without a job and who do not actively search for a new one are labeled non-active. Those agents are not eligible for unemployment benefits, and receive a job offer for next period with a lower probability than an unemployed agent. This probability is also age dependent, and we use it to generate the observed labor market flows between non-activity and employment.[12]

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 and inactive households who are R_0 years or older are forced to retire.

Pension rights. Workers, unemployed, and inactive also differ in the pension rights, and 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. Differently from Díaz-Saavedra et al. (2023), this version of the model economy assumes that households take this

[12]Those households who search for a job are more likely to find it, in comparison to non-active households.

mapping into account when they decide how much to work and when to retire.

Pensions. Retirees differ in their retirement pensions, and we assume that there exits minimum and maximum retirement pensions, in accordance with the Spanish Public Pension System.

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.[13]

Preferences. Households derive utility from consumption, and disutility from labor and the search effort. Labor is decided both at the extensive and intensive margins, while search is a discrete choice. Non-active and retired agents dedicate all the time endowment to leisure consumption.

Timing. At the beginning of each period, households' stochastic productivity component, is realized. When entering the economy (at age 20) agents additionally learn their education level and draw a job opportunity, that they can either accept or reject. For older households, if they start a period with a job opportunity, they decide whether to work and if so, by how much. If they lost job or decided not to work in the previous period, they choose whether to search for a new job or not. Depending on these decisions, individuals then spend the period working, unemployed or inactive. Wages and unemployment benefits are received, and decisions on consumption and savings are taken. At the beginning of the next period, workers observe the job separation shock, and unemployed or inactive learn if the found a job for next period. After reaching the first retirement age, workers can choose to retire at the beginning of the period, and once they do they leave the labor market permanently.

3.2 The Representative Firm

In our model economy there is a representative firm. Aggregate output at period t, Y_t, is obtained combining aggregate capital, K_t, with the aggregate labor input, L_t, through a Cobb-Douglas, aggregate production function which we denote by $Y_t = K_t^{\theta}(B_t L_t)^{1-\theta}$, where B_t is the labor augmenting growth factor, whose law of motion is $B_t = (1+g)B_{t-1}$, and where g is the labor augmenting growth rate. 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.

3.3 The Government

The government has two roles in our model economy. First, it runs an unfunded defined benefit pension system. And second, it sets the fiscal policy. We describe these two roles in turn.

[13] 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.

3.3.1 The Pension System

Differently from Díaz-Saavedra et al. (2023), this version of the model economy introduces many of the institutional features of the current Spanish public pension system in very much detail. Consequently, we carefully describe this system below.

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.[14]

Payroll Taxes. In our model economy, as in Spain, the payroll tax is capped. Specifically, the payroll tax function is given by:

$$t_p(y^l) = \begin{cases} \tau_p y^l & \text{if } y^l < \overline{y}^l \\ \tau_p \overline{y}^l & \text{otherwise} \end{cases} \tag{1}$$

where parameter τ_p is the payroll tax rate, y^l is the gross labor earnings, and $\overline{y}^l$ is the maximum covered earnings. Finally, we also assume that eligible unemployed also pay social security contributions, so that the payroll tax function becomes $t_p(y^u) = \tau_p y^u$, where y^u is the unemployment benefit.

Retirement Ages. In our model economy the early retirement age is R_0, and the full entitlement retirement age is R_1. Workers who choose to retire early pay a penalty, λ_j, which is determined by the following function

$$\lambda_j = \begin{cases} \rho_0 - \rho_1(j - R_0) & \text{if } j < R_1 \\ 0 & \text{if } j \geq R_1 \end{cases} \tag{2}$$

where ρ_0 and ρ_1 are parameters which we choose to replicate the Spanish early retirement penalties.

Retirement pensions. A household of age $j \geq R_0$, 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 the *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 2 percent for each year worked after this age. Finally, the Regulatory Base is multiplied by a pension replacement rate, p_r, which we use to replicate the pension expenditures to output ratio.

[14] In 2018, this regime included 76.0 percent of all Spanish workers. See Díaz-Saavedra (2020) for a description of the Spanish Public Pension System.

Note that the Regulatory Base considers a relative long vesting period. Consequently, it can be relatively frequent that contribution gaps occur; that is, years during the vesting period 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, y^{fq}, are a constant proportion of per capita output.

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

$$p(b) = p_r(1.02)^v(1-\lambda_j)RB \tag{3}$$

where 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 given by:

$$RB = \frac{1}{N_b}\sum_{s=j-N_b}^{j-1} min\{y_s^l, \overline{y}^l\} \tag{4}$$

Note that in this expression, 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. Expressions (3) and (4) replicates most of the features of Spanish retirement pensions. The main difference is that in Spain the pension replacement rate depends of the number of years of contributions. We abstract from this feature of Spanish pensions because it would require an additional state variable. Finally, we require that the retirement pension is bounded by a minimum and maximum retirement pension, $\underline{p} \leq p(b) \leq \overline{p}$.

3.3.2 The Fiscal Policy

The government in our model economy taxes capital income, household total income (net of capital income taxes and social security contributions), and consumption, and it confiscates unintentional bequests. It uses its revenues to consume, and to make transfers to households other than pensions.

Similarly to Díaz-Saavedra et al. (2023), we assume proportional capital income and consumption tax rates. However, and differently from that paper, we model the household income tax with the following function:

$$\tau_y(y_t^b) = a_0\left\{y_t^b - \left[a_1 + (y_t^b)^{-a_2}\right]^{-1/a_2}\right\} \tag{5}$$

where y_t^b is the income tax base. This expression, where a_0, a_1, and a_2 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.[15]

3.3.3 The Consolidated Government Budget

The consolidated government and pension system budget constraint is

$$G + Z + P + U = T_k + T_y + T_c + T_p + E \tag{6}$$

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_p denotes the revenues collected by the payroll tax, and E denotes unintentional bequests.

In the initial steady state (our calibration target year, see below), we assume that government consumption adjusts to clear the government budget. Thereafter, instead, we assume that it is the consumption tax rate that varies to match expenditures and revenues in the consolidated government budget. As a result, the consumption tax is increased as much as needed, mainly, to cover the deficit of the public pension system over the next decades.

4 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. In Brogueira de Sousa et al. (2022) and Díaz Saavedra et al. (2023) we describe in detail the calibration procedure. However, and having in mind that our model economy is an enhancement of that model economy, in Appendix A we describe how we calibrate the new parameters that appear in this version.

4.1 Calibration Results

In this section we show that our calibrated, benchmark model economy replicates reasonably well both most of the Spanish statistics that we target, and also untargeted moments in our calibration procedure. To differentiate targeted from untargeted moments, we present the first group of Spanish statistics in bold face.

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

Macroeconomic Aggregates and Ratios. In Table 1 we report the macroeconomic aggregates and ratios in Spain and in the benchmark model economy for 2018. We find that the benchmark model economy does a good job in replicating most of the main Spanish macroeconomic aggregates and ratios. The main exception is the government consumption, and this is not surprising because it is determined residually to satisfy the consolidated government budget in the initial steady state.

Table 1: Macroeconomic Aggregates and Ratios in 2018 (%)*

	K/Y	C^a/Y	I^a/Y	G/Y	P/Y	U/Y	Tr/Y	T_y/Y	T_p/Y	T_k/Y	T_c/Y	E/Y
Spain	**2.94**	50.70	26.95	17.40	**12.28**	**1.32**	**0.83**	**7.05**	**10.20**	**2.24**	6.58	**0.20**
Model	3.05	47.18	32.69	11.39	12.46	1.37	0.80	7.15	10.27	2.24	6.15	0.20

*In this table, variable Y is GDP at market prices.
[a]Variables C and I denote private consumption and investment.

The Pension System. For the results from our model economy to be taken seriously, it should approximate some of the more important features of the Spanish public pension. Table 2 shows the proportions of retirees collecting the minimum and maximum pensions, the average retirement age, and the share of workers whose earnings are above the maximum contribution cap. We find that our model economy does a good job at replicating most of their empirical counterparts.

Table 2: The Spanish Pension System in 2018*

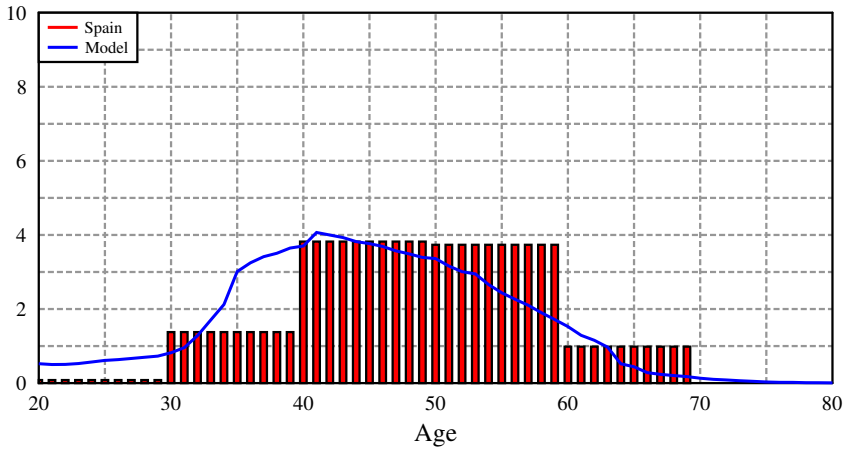
	$\underline{p}^a$	$\overline{p}^b$	Av. Age^c	Capped^d
Spain	24.8	4.4	64.2	11.2
Model	28.6	4.5	64.2	10.8

* : The source of Spanish data is the Spanish Social Security Statistics.
a : Share of retirees collecting the minimum pension.
b : Share of retirees collecting the maximum pension.
c : Average Retirement Age.
d : Share of workers with earnings above the maximum contribution cap.

Figure 1 shows the distribution of workers by age with earnings above the payroll tax cap. We find that the model does a good job at replicating the fact that most of these workers are between 30 and 60 years old. If we look at the fine print, we find that the model predicts more workers in the age range of 30 to 40 years old, and that it underestimates the share between ages 50 and 60.

Figure 2 shows the cumulative distribution of workers with earnings above the payroll tax cap by age and education, both in Spain and in our model economy. We find that the model is able to replicate the empirical cumulative distribution in great detail. Again, if we look at the fine print, we find that the model overestimates the share of dropouts and high-school workers, and it somehow

Figure 1: Distribution of Workers by Age with Earnings Above the Payroll Tax Cap (%)*



*The series of workers are the shares of workers by age in the sum of total workers with earnings above the payroll tax cap. We compute this share for Spain from the *Encuenta de Estructura Salarial (2018)*, reported by the INE.

underestimates the share of college workers. Overall, we find these results very encouraging since we did not target explicitly any of these statistics in our calibration procedure.

Inequality. In Table 3 we report the Gini indexes for earnings, income, and wealth in Spain and in our benchmark model economy. The source for the Spanish data of earnings and income are the Spanish National Institute of Statistics (INE) and the OECD. The source for the Spanish data of wealth is Anghel et al. (2018). Again, the model economy does a good job in replicating inequality in Spain, althought we also find that earnings is marginally more concentrated in Spain, and that income is more concentrated in the model economy.

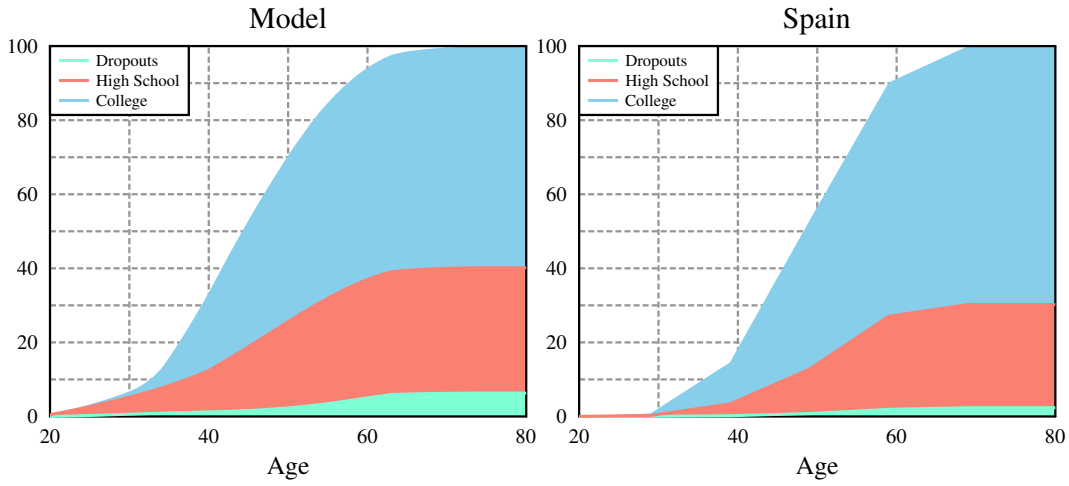
Table 3: Inequality in Spain and in the Model Economy in 2018*.

	GE	GI	GW
Spain	**0.34**	0.33	**0.67**
Model	0.33	0.36	0.67

GE: Gini Index of net earnings, *GI*: Gini Index of net income, *GWI*: Gini Index of net wealth.
*The source for the Spanish data of earnings and income are the Spanish National Institute of Statistics (INE) and the OECD. The source for the Spanish data of wealth is Anghel et al. (2018).

The Labor Market. Table 4 shows the shares of employed and unemployed households. When carrying out this comparison we must keep in mind that there are some fundamental differences between Spain and our model economy. In Spain, working-age people fall into one of five categories: employed, unemployed, retired, inactive, and other non-participants. In our model economy we only

Figure 2: Cumulative Distribution of Workers with Earnings Above the Payroll Tax Cap by Age and Education (%)*



* We compute this distribution for Spain from the *Encuenta de Estructura Salarial (2018)*, reported by the INE.

have four of these categories: employed, unemployed, inactive and retired. Since these differences necessarily would distort our comparisons, we opted for excluding other non-participants people from the Spanish data. Finally, Figure 3 shows the profiles of employee, unemployed, inactive and retired households by age. ´

Table 4: Labor Market Shares in 2018 (% of population).

	W	U	I	R
Spain	**59.59**	10.72	**5.16**	24.51
Model	59.00	13.04	2.97	24.99

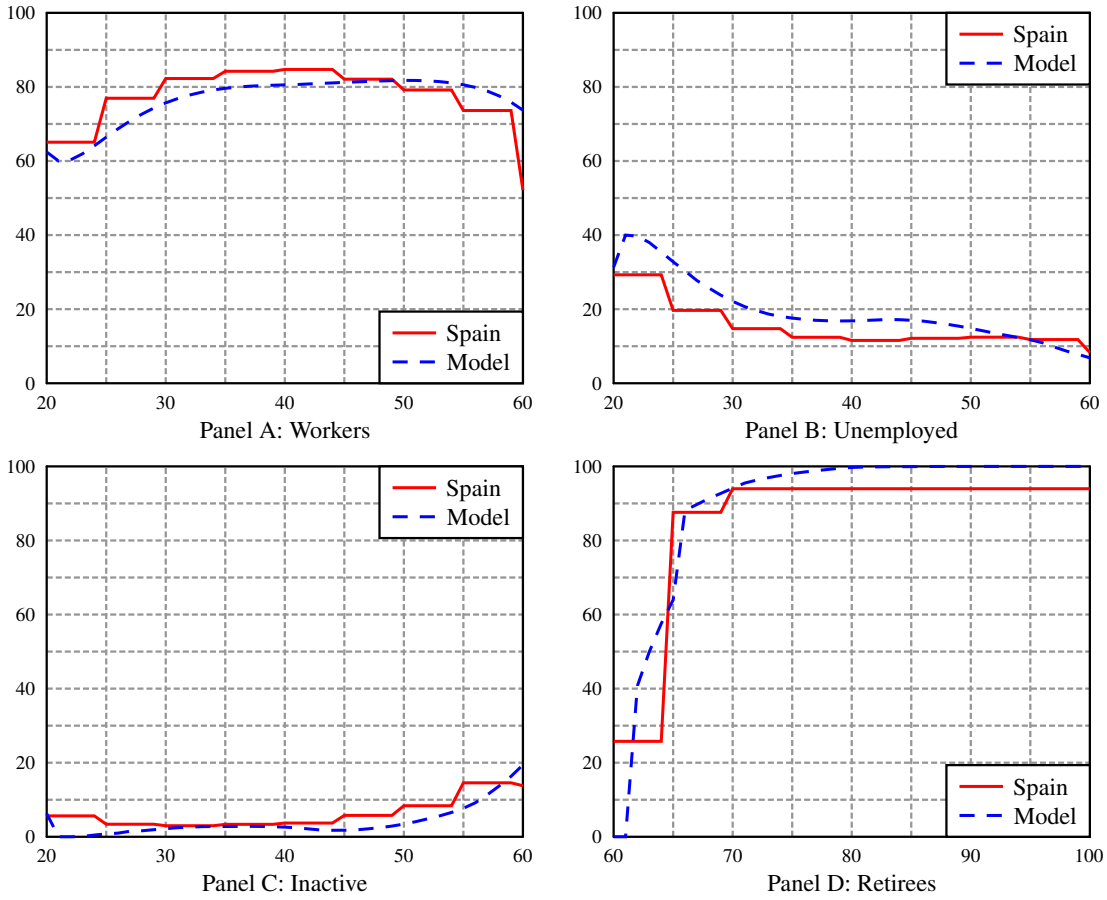
W: workers, U: unemployed, I: inactive, R: retirees.
Data source: Encuesta de Población Activa (INE).

5 The Simulations

In this section, we describe the different model economies that we simulated in this paper. The next section describes the demographic, educational, growth, inflation-rate, and fiscal-policy scenarios that our simulations share.

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 full entitlement retirement age is $R_1 = 66$, and the pension rights are computed taking

Figure 3: Labor Market Shares by Age in Spain and the Model Economy (%)*



*The shares of workers are the shares of workers in the sum of workers and unemployed. We compute this share for Spain from the *Encuesta de Población Activa (2018)*, reported by the INE.

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 re-evaluate the minimum and the maximum pensions so that their share of output per person remains constant at its 2018 value, and we assume that the real value of all other pensions does not change. [16]

The Reformed Model Economy. The reformed model economy addresses not only the sustainability issue but also the takes the opportunity to improve pension design by introducing features of intra- and intergenerational justice. The overall policy change involves a mix of changes to pension

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

benefits, payroll taxation, and government transfers, which we will now describe in detail.

- The Sustainability Factor (SF). One of the most important features of pension reform over the last two decades has been the introduction of mechanisms aimed at adjusting the key pension parameters to changes in life expectancy (Carone et al., 2016). Among these mechanisms, the introduction of sustainability factors, a factor that changes the size of the initial pension benefit depending on life expectancy at the time of retirement, has been the most widespread. The rationale for such a mechanism is that it is a way to combine old-age income sustainability with inter-generational equity (Carone et al. 2016).

  As we have stated, Spain adopted this factor in its 2013 pension reform, but it was later repealed in 2021. Specifically, the formula that was adopted for this factor is the following:

  $$SF_t = \varepsilon SF_{t-1} \tag{7}$$

  where ε is a time-varying measure of the relative life-expectancy at age 67. For instance, and for the period 2019–2023 the value of ε would be

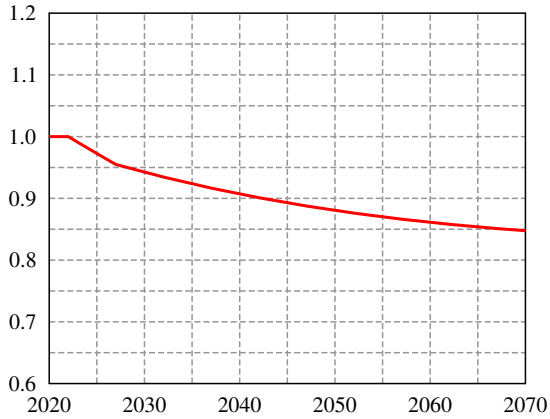
  $$\varepsilon = \left[\frac{e_{67,2012}}{e_{67,2017}}\right]^{1/5} \tag{8}$$

  and so on, where $e_{67,t}$ denotes the life expectancy at age 67 by year t.

  We assume that the reformed model economy recovers this automatic mechanism, and this factor is applied for the first time in 2023, and will apply to *new* pensions only. In Figure 4, we represent the values of the sustainability factor that we have computed using the 2022 mortality tables in Spain. It turns out that by 2070 the sustainability factor alone will have reduced the real yearly value of new Spanish pensions by 15.2 percentage points.

- The Pension Revaluation Index (PRI). Automatic balancing mechanisms ensure that the pension system will be able to remain financially sustainable by adjusting benefits' indexation when needed. This type of balancing mechanism was implemented in Spain in 2014, through a reduced indexation of pension benefits when there was a pension deficit. Specifically, real pensions were reduced in an amount that equates a moving average of past and expected future pension system outlays with a moving average of past and expected future pension system revenues. However, the loss in the purchasing power of pensions, along with the losses projected for the coming decades, caused growing concern in public opinion. Moreover, the main opposition parties as well as the two main trade union federations demanded that the Spanish government repeal this revaluation index and that the pensions in effect be newly revalued with the Consumer Price Index in order to maintain their purchasing power. Consequently, the Spanish government announced in April 2018 that it was going to temporarily skip the PRI, and that all Spanish pensions would be reevaluated with the CPI both in 2018 and 2019. Finally, Pension Revaluation Index was definitively eliminated in 2020.

Figure 4: The Sustainability Factor



In the reformed model economy, we assume that the Spanish Government recovers the revaluation index approved in 2013. And the specific formula that was finally adopted for this index was the following:

$$g_{t+1} = \overline{g}_{c,t+1} - \overline{g}_{p,t+1} - \overline{g}_{s,t+1} + \alpha(\frac{T^*_{s,t+1} - P^*_{t+1}}{P^*_{t+1}}) \tag{9}$$

where $\overline{x_i, t}$ indicates the moving arithmetic average of variable i computed between $t-5$ and $t+5$, $x^*_{i,t}$ indicates the moving geometric average of variable i computed between $t-5$ and $t+5$, g_{t+1} is the nominal indexation on pensions in payment at period $t+1$, $g_{c,t+1}$ 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, $T_{s,t+1}$ denotes the pension system revenues, and P_{t+1} denotes pension system expenditures. Finally, the pension revaluation index has two annual nominal bounds. The lower bound is 0.25 percent and the upper bound is 0.5 percent plus the inflation rate.

- Regulatory Base (RB). The regulatory base is the main component of the Spanish retirement pension, and since 2022 it has been computed using labour earnings from the last 25 years before retirement. However, as 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 made during longer periods of working life, as occurs in other European countries with defined benefit pension systems.[17] Consequently,

[17] In Europe, pension schemes in France, Malta, and Slovenia, similar to Spain, are based on a comparatively small fraction of career earnings to calculate benefits.

if a person's salary doubles in their final years, their pension will double, so that there is a subsidy from people whose earnings grow more slowly to those whose earnings grow rapidly later in their working lifetime, where the former group tends to be low earners, and the latter high earners. Thus, on average, final-earnings schemes redistribute from low to high earners. Therefore, extending the averaging period of the Regulatory Base should reduce retirement pensions, particularly for more educated workers, thus increasing intragenerational solidarity and reducing pension inequality.

- Payroll Tax Cap (CAP). The previous parametric changes directly affect pension expenditure. However, the cuts in pensions would be phased in slowly, which means they could not produce significant savings in pension expenditure, at least in the short run. Thus, increasing revenues would be necessary to reach equilibrium in the pension system budget constraint. A clear option, then, is to increase the payroll tax rate, which would affect all covered workers.

  Another alternative, however, is the change in the payroll tax cap. Social Security taxes are levied on covered earnings up to a maximum level, commonly referred to as the taxable earnings base. This taxable earnings base serves as a cap on contributions, and it establishes the maximum amount of a worker's earnings that is subject to the payroll tax rate. But the taxable earnings base also establishes the maximum earnings used to compute retirement pensions.

  Most public pension systems impose a taxable earnings base that is higher than the maximum retirement pension. This is justified as another element of intragenerational redistribution, in order to increase the progressivity of the system. Yet there are countries like Ireland and Sweden that do not have a cap on the payroll tax, in order to reinforce the solidarity of the system. Similarly, Díaz-Saavedra (2023) shows that the elimination of the payroll tax cap is a way to partly restore the pension system's long-term progressivity, when it is eroded by differences in life expectancy across different socioeconomic groups.

  Under the reformed model economy, we therefore assume that the government eliminates the cap on the payroll tax. This means that, first, all gross earnings face the payroll tax rate. Second, since we assume that the maximum covered earnings continue to be a constant and unchanged proportion of output per capita, the elimination of the payroll tax cap would not change pension benefits for top earners.

- Compensating the Losers. Evidently, this radical pension reform increases the risk of policy reversal, as some households may face significant welfare losses, especially those that are near to retirement, or the younger retirees. To cope with this issue, we also assume that those households that face welfare losses as a result of this pension reform receive a unique government transfer to overcome these losses, and that such transfer programme is financed with public debt held by foreign investors, at a one-percent yearly interest rate. Thus, every household alive at the moment of the pension reform is at least slightly better off in the

reformed economy.

In conclusion, the reformed economy involves a fundamental pension reform in Spain, with the objective of not only guaranteeing the future sustainability of the system, but also improving the intra- and intergenerational redistribution of the system. Additionally, the new pension scheme continues to have a minimum retirement pension, so that the reform continues to guarantee a minimum amount to finance consumption when elderly.

6 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.[18] In Panel A of Figure 5 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.[19]

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.[20] 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 dropouts, 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 1984 cohort.[21] In Panel B of Figure 5 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 2018 to 7.1, 64.7, and 28.2 percent in 2070.

The Growth Scenario. We assume that the annual labor productivity growth rate is 0.9 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.

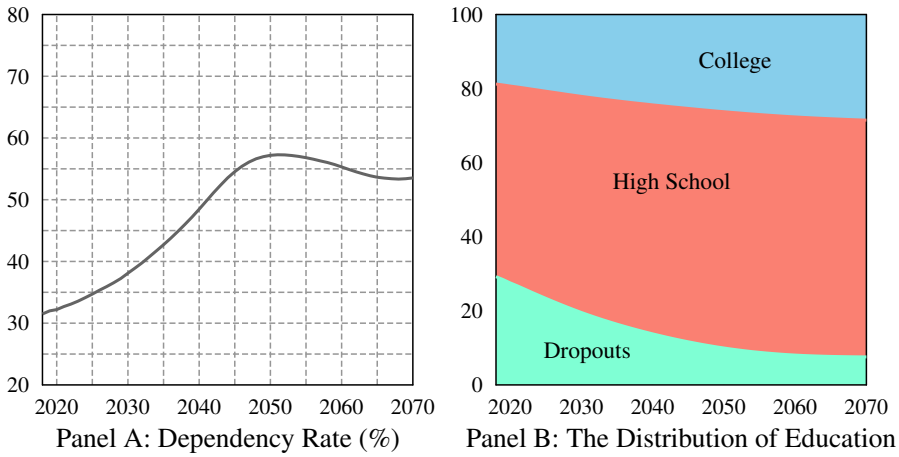
[18] These projections can be found at $https://ine.es/dyngs/INEbase/es/operacion.htm?c = Estadistica_C cid = 1254736176953 menu = resultadosidp = 1254735572981$.

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

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

[21] Conesa et al. (2020) also assume an increasing college attainment scenario.

Figure 5: The Dependency Rate[a] and the Distribution of Education[b]



[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 20–100 age cohort.

The Fiscal Policy Scenario. Recall that the consolidated government and pension system budget constraint in our model economy is given by:

$$G + Z + P + U = T_k + T_y + T_c + T_p + E \tag{10}$$

and that in the initial steady state, we assume that government consumption adjusts to clear the government budget. Afterwards, all the variables are endogenous.[22] 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 close the consolidated government budget after 2018. Every other variable in Expression (10) varies with time and differs across both economies because they are all endogenous.

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.

Timing. We assume that the reform of Spanish Public Pension is announced and implemented at the beginning of 2023, and that such changes were totally unexpected by the households that populate the model economy.

[22]We assume that during the transitional dynamics, public consumption, G_t, is a constant proportion of output at market prices.

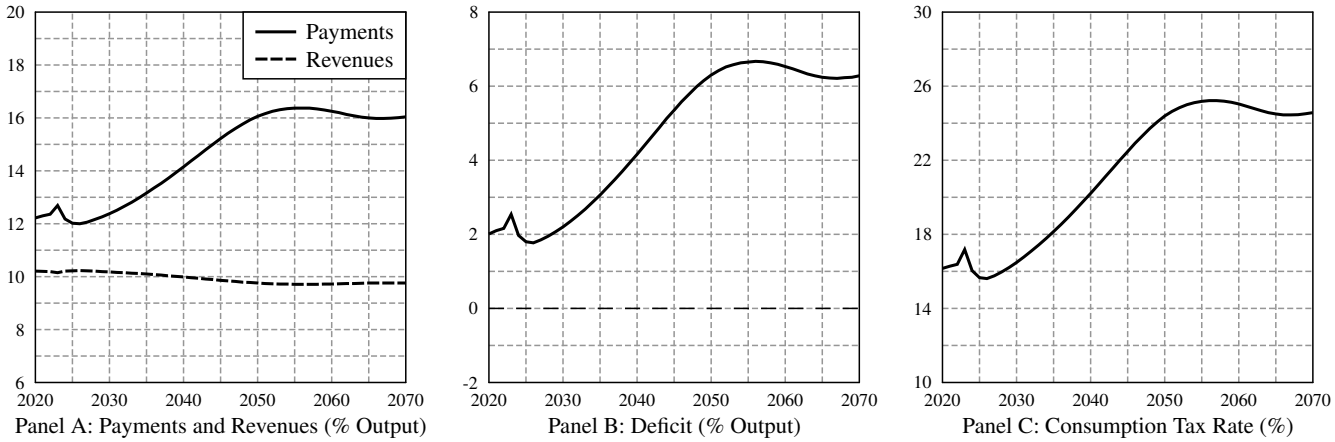
7 Results

We simulate these two model economies using the demographic, educational, and economic scenarios that we have described in Section 6. The results are shown in Figures 6 to 13, and in the Table 5.

7.1 The 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 6.2 percent of output by 2070 (see second block of Table 5 and Panel B of Figure 6). Moreover, the consumption tax rate that would be necessary to finance this pension deficit would be 24.6 percent that same year, 8.4 percentage points higher than its value in 2020 (see Panel C of Figure 6).

Figure 6: The Public Pension System under the Benchmark Model Economy



This sustained increase in the pension deficit is mainly structural. Specifically, we find that the pension system expenditures increase by almost 4 percentage points of output over the next few decades, from 12.2 percent in 2020 to 16.0 percent in 2070 (see Panel A of Figure 6). However, there is no significant variation in the pension system revenues, because payroll tax collections as a share of output are 10.2 percent in 2020 and 9.8 percent in 2070 (see Panel A of Figure 6).[23]

[23]The results presented here do not introduce the parametric changes approved in 2022 and 2023 by the Spanish government. These changes mainly involve an increase in the payroll tax collections, a reduction of the contributiveness of the system, and an increase in the incentives for workers to delay retirement. However, and according to De la Fuente (2023), these modifications bring about no significant variation for the pension imbalance over the coming decades.

7.2 The Reformed Economy

The reform that we analyse in this paper has significant consequences for both the generosity and sustainability of the Spanish public pension system. This is so because this pension reform brings about different micro- and macroeconomic effects, so that we first study these parametric changes one at time to explore which one is quantitatively more important in improving the sustainability problems that plague the Spanish Public Pension System.

7.3 The Changes One at Time

Recall that the pension reform that we study in this paper introduces a Sustainability Factor and a Pension Revaluation Index, modifies the computation of the Regulatory Base, and eliminates the payroll tax cap. We describe their quantitative consequences in turn.

Sustainability factor. The sustainability factor only reduces the value of new pensions. Consequently, the decrease in the average pension in payment is gradual and reaches 16.3 percentage points by 2070. Moreover, since the retirement pension is the opportunity cost of continuing in work, the introduction of this Sustainability Factor alone increases the average retirement age. Thus, the overall effect is a decrease in the long-term pension deficit of 1.8 percentage points of output, and a lower consumption tax rate by 3.7 percentage points (see Table 5).[24]

Pension Revaluation Index. The Pension Revaluation Index (PRI) replaces the Consumer Price Index (CPI) as a tool to revaluate pensions in payment, and this is bounded to be between 0.25 percent and 0.5 percent plus the inflation rate.[25] Our results show that this index would hit its lower bound for almost every year since 2023, so that the real annual revaluation of every pension in payment in those years is -1.75 percent (see Figure 7).[26] As we have said, the expected sustained increase in the pension expenditure over the next few decades is behind this finding, since it forces the index to reduce the revaluation of pensions in payments, in order to attain equilibrium in the Pension System budget constraint.

The negative real revaluation of pensions reduces the pension expenditure to output ratio for the coming decades. For instance, in 2070, this ratio is 10.6 percent, 5.8 percentage points of output lower then in the Benchmark Model Economy that same year. Thus, we find that the introduction of this new rule of indexation for pensions in payments substantially improves the sustainability of the Spanish public pension system, and limits the tax increases that would be needed to finance

[24] Regarding the macroeconomic consequences, the longer working period increases the number of work hours. Moreover, because households expect lower pensions at retirement, they also increase their saving rates to foster their stock of assets when old, to finance their future consumption. Overall, there is a small increase in the long-term output of 2.3 percent.

[25] Recall that the annual inflation rate that we assume in our simulations is 2 percent.

[26] There is an initial increase in the PRI as the legal retirement ages increase by one more year in 2024.

Table 5: The Pension System in all the Model Economies

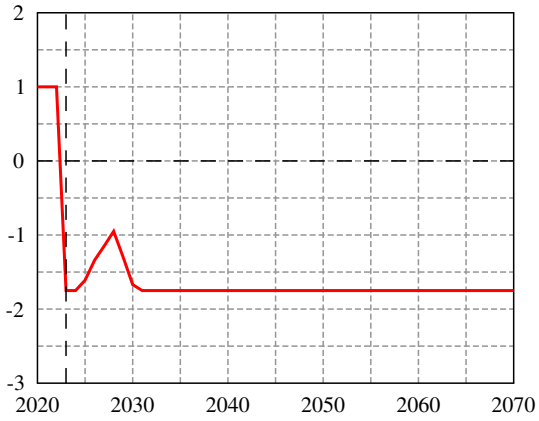
	2020	2030	2040	2050	2060	2070
Average Pension[a]						
Benchmark	100.0	108.3	118.5	131.1	145.9	162.9
SF	100.0	106.8	113.6	122.5	133.7	146.6
PRI	100.0	98.9	103.2	107.9	111.2	110.8
RB	100.0	107.3	113.0	115.5	122.4	137.0
CAP	100.0	108.4	118.4	130.8	145.7	162.6
Pension Expenditure[b]						
Benchmark	12.2	12.4	14.1	16.1	16.3	16.0
SF	12.2	12.2	13.5	14.9	14.8	14.3
PRI	12.2	10.4	11.4	12.5	12.1	10.6
RB	12.2	12.3	13.4	13.8	13.5	13.5
CAP	12.2	12.6	14.3	16.3	16.3	16.1
Pension Revenues[b]						
Benchmark	10.2	10.2	10.0	9.8	9.7	9.8
SF	10.2	10.2	10.0	9.9	9.8	9.9
PRI	10.2	10.4	10.2	10.0	10.0	10.2
RB	10.2	10.2	10.0	10.0	9.9	9.9
CAP	10.2	11.5	11.3	11.1	11.1	11.1
Pension Deficit[b]						
Benchmark	2.0	2.2	4.1	6.3	6.6	6.2
SF	2.0	2.0	3.5	5.0	5.0	4.4
PRI	2.0	0.0	1.2	2.5	2.1	0.4
RB	2.0	2.1	3.4	3.8	3.6	3.6
CAP	2.0	1.1	3.0	5.2	5.2	5.0
The Consumption Tax Rate (%)						
Benchmark	16.2	16.5	20.2	24.4	25.0	24.6
SF	16.2	16.4	19.2	22.2	22.2	20.9
PRI	16.2	11.8	13.6	15.6	14.8	11.2
RB	16.2	16.3	18.4	19.2	18.5	18.6
CAP	16.2	14.5	18.3	22.8	23.2	22.7

[a] Normalize to 100 in 2020

[b] Percentage of output at market prices

the pension system imbalances for the next few decades (see Table 5) .[27]

Figure 7: The Real Annual Revaluation of Pensions in Payments (%)



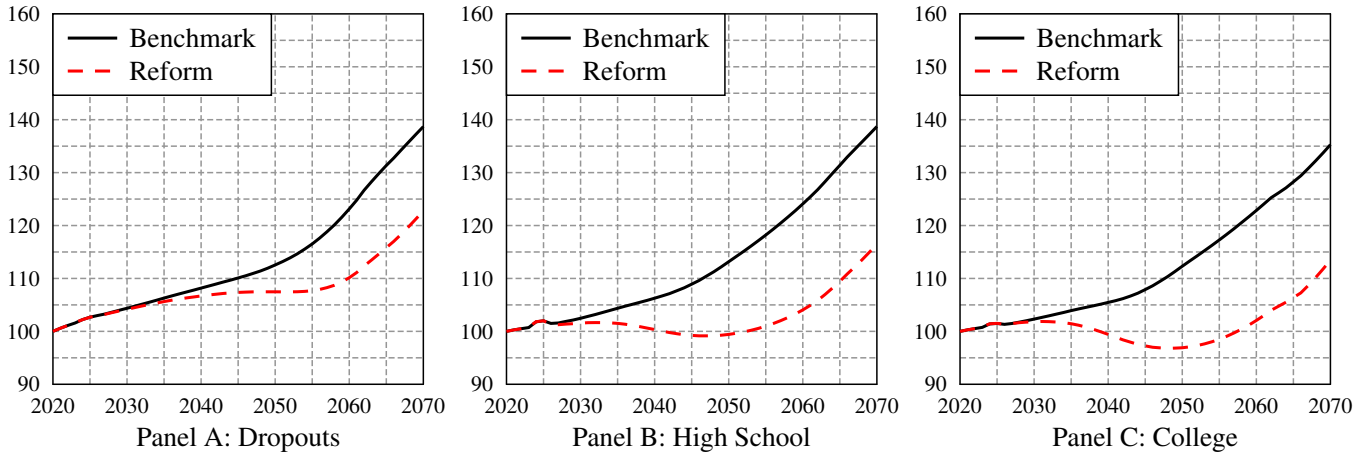
Regulatory Base. The increase in the number of years used to compute the Regulatory Base from the last 25 years to the entire working lifetime also reduces the average pension, particularly for more educated workers (see Figure 8). This is because labour income grows by more for this educational group over the working lifetime.[28] Thus, this reform also contributes both to reducing the long-term pension deficit and to increasing the long-term output, though to a lower extent in comparison with the previous parametric changes (see Table 5).

Payroll Tax Cap. Recall that the elimination of the payroll tax cap is also justified as a tool to increase the intragenerational solidarity of the pension system. Thus, this reform, as expected, increases the revenues of the system by more than 13 percent, mainly because of the higher tax collections derived from those workers on the top of the earnings distribution. Moreover, since there is no significant effect on the retirement pensions, we find that the elimination of this cap brings no significant variation on pension expenditure. Our results therefore show that the pension imbalance could be reduced by 1.2 percentage points of output in 2070 (see Table 5).

[27]The macroeconomic consequences of this change in the revaluation of pensions go in the same direction as those obtained in the case of the introduction of the Sustainability Factor, that is, there is both a longer working period which increases work hours, and higher saving rates that increase capital stock, so that output is more than 2 percent higher in the long run.

[28]Similarly, as Jimeno (2003) first pointed out, the increase in the number of years used to compute the pension reduces pension inequality. We find that this reform reduces the Gini Pension Index from 0.26 to 0.23 in 2070.

Figure 8: The Average Retirement Pension After the Change in the Regulatory Base



7.4 The Front-loaded Reform-transition to the New Spanish Public Pension System.

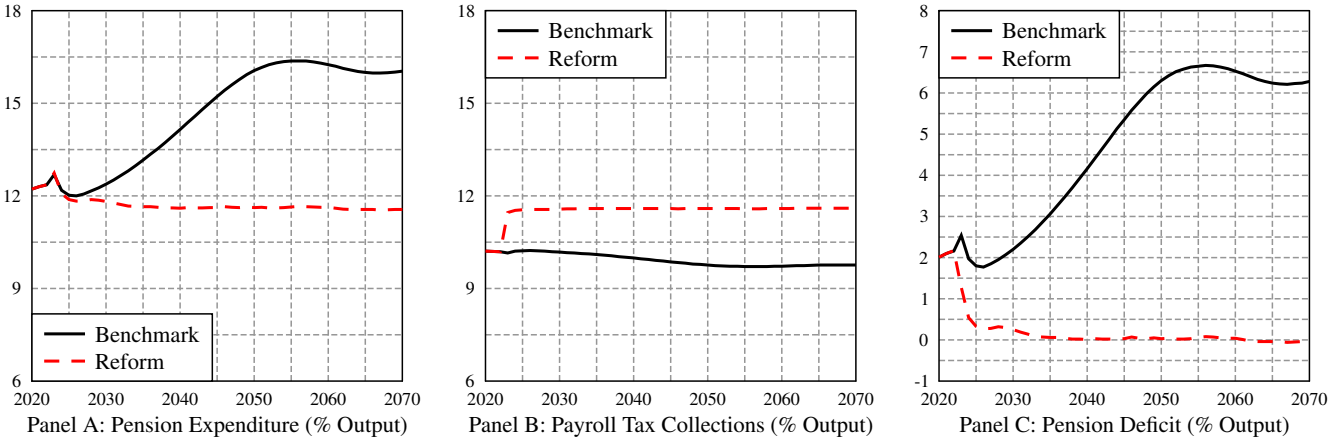
In the previous section, we showed the main differentiated consequences of all the measures that integrate our proposed fundamental reform of the Spanish public pension system analysed in this paper.

In this section we present the results that we obtain when we implement all the parametric changes at the same time on the Spanish public pension system, in the year of the reform, 2023. Specifically, a front-loaded transition is one in which all households move to the new system at the beginning of 2023:

- All retirees have their pensions indexed according to the Pension Revaluation Index, instead of the Consumer Price Index.
- All workers, unemployed and inactive households, are subject to the new regulations of the public pension system, which change the method of computing their pensionable rights, their initial pensions, and for high earners, their payroll taxes.
- We assume that the government has all the information needed to identify all those households that face welfare losses with this pension reform. Consequently, these households are compensated, on a one-time basis, with a single government transfer, in the form of liquid assets, so that they do not feel less well-off under the new public pension system.
- These public transfers to those who face welfare losses with this pension reform are financed through public debt, which is issued abroad, and has a real annual return of 1 percent.Similarly

to Díaz-Saavedra et al. (2023), we assume that in the final steady state, the government rolls over the reform debt in perpetuity and finances interest payments.

Figure 9: The Public Pension System



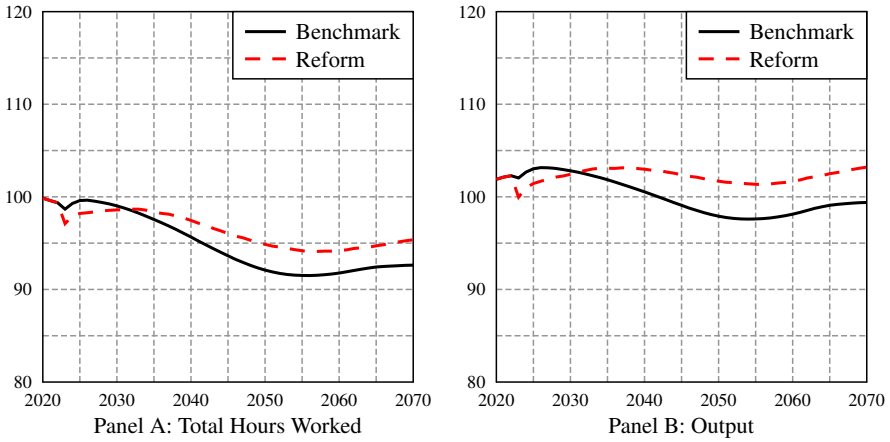
Aggregate Consequences. As expected, the reform reduces pension payments mainly due to the large reductions in the real value of pensions. For instance, in 2070 the average retirement pension is around 25 percent lower in comparison to the Benchmark Model Economy that same year. However, despite the reduction in pension payments being gradual, the pension deficit disappears almost immediately following the implementation of the reform, because of the initial increase in the payroll tax collections (see Figure 9). Consequently, this pension reform solves the sustainability problems that plague the current Spanish public pension system from the year of the reform onwards, so that the consumption tax rates needed to balance the consolidated government budget are significantly lower over the next decades.

The consequences of this reform for the saving rates, work hours, and output are straightforward. Households increase their savings to complement their reduced public retirement income. Similarly, the reduced pensions increase the working period, and consequently the work hours, as the average retirement age increases by more than one year in comparison to the Benchmark Model Economy over the next decades. Thus, output increases by more than 3 percent in the long run (see Figure 10).[29]

Welfare Consequences. We find that this reform improves the sustainability of Spanish pensions substantially, and that it limits the tax increases that would have been necessary to finance the future pension system deficits. But these results are mainly achieved at the expense of large

[29]Recall that physical capital increases in the same proportion as labour input, in order to keep the capital to labour ratio constant, as factor prices are also constant in an open economy.

Figure 10: Worked Hours and Output*



*Normalized to 100 in 2020.

reductions in the real value of the average pension. This reduction is progressive and, by 2070, the average pension is approximately 25 percent smaller in real terms than what it would have been under the Benchmark Model Economy. Thus, the welfare consequences of this pension reform ultimately depend of the final effect of these opposing forces.

Figure 11: Change in Expected Lifetime Utility by Age and Education (%, Alive in 2023)

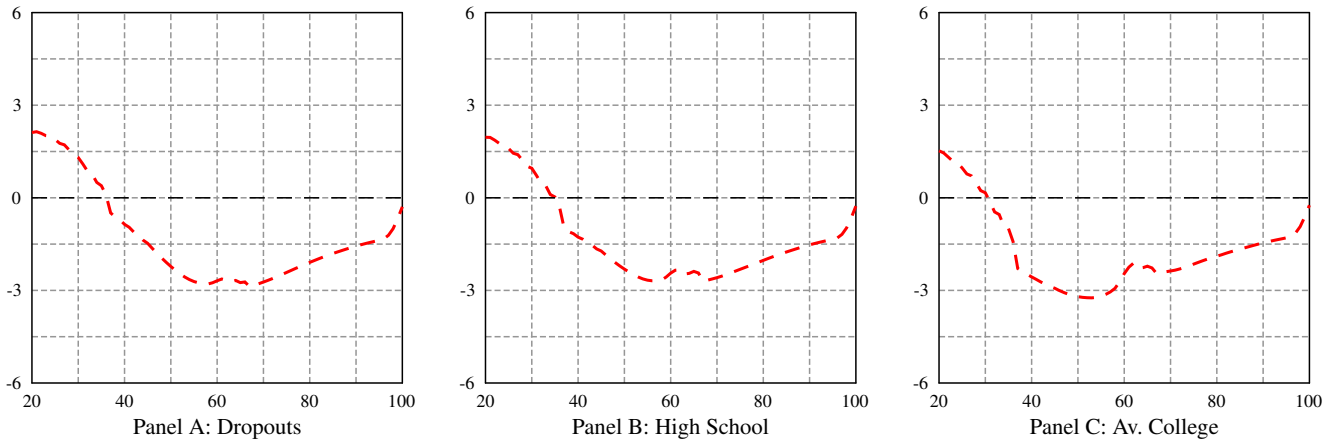
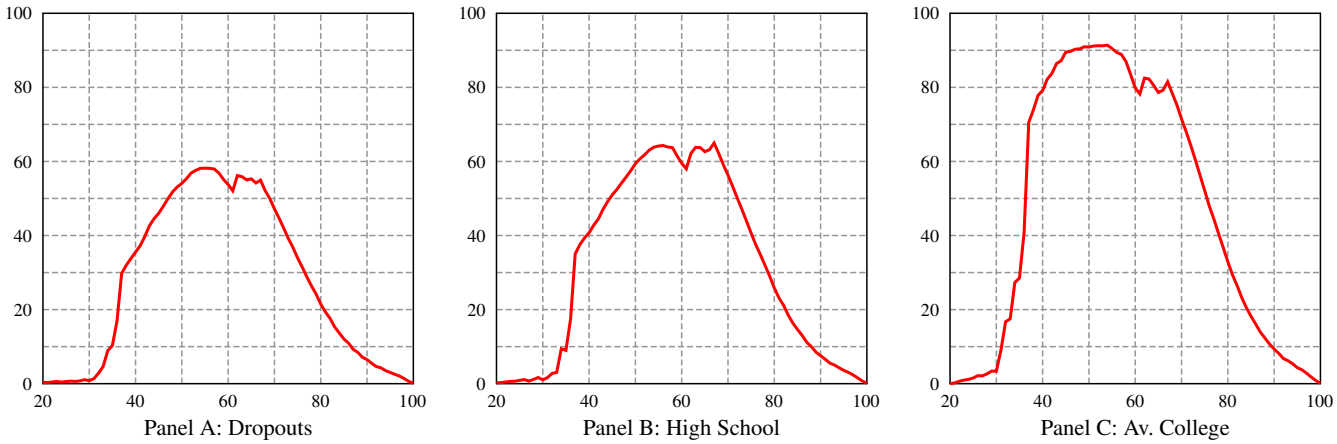


Figure 11 shows the welfare consequences by age and education of those alive at the moment of the implementation of the pension reform. We find that this reform is costly in welfare terms for those aged 30+ years old in 2023. Moreover, we also find that those households between 50 and 70 years old bear the highest welfare costs. This figure also shows that losses increase with education.

This is so since, besides the fact that the pension drop increases with education, the elimination of the payroll tax cap mainly affects more educated workers, especially those between 35 and 50 years old. In the case of unretired households, this is because they have limited time to adjust their optimal savings and work decisions in anticipation of lower public pensions during old age. And in the case of retired households, the longer their life expectancy, the greater the expected fall in the real value of their pensions due to the switch to indexation pensions in payments.

Figure 12: The Public Transfers to Compensate for the Welfare Looses (% of output per capita)



Two issues naturally emerge. First, the substantial reduction of pensions and the high welfare costs that this reform brings about for certain groups lead us to conjecture that it would likely be overturned. Put differently, the more extensive the pension reform, the more likely it is to be reversed, mainly due to the short-term losses entailed in retirement income. Consequently, to minimize the risk of policy reversal, the government could design a transfer program to compensate those currently alive households that face welfare losses, so that they would not, ex-post the government transfers, feel adversely affected under the reformed public pension system. Second, and more generally by considering also future generations, it could be also the case that there is an aggregate welfare gain after the pension reform, so that this gain could be distributed between present and future cohorts using some scheme to generate a Pareto improvement transition.

Accordingly, we analyse the fiscal cost for the Spanish government if it decides to implement such a tax a transfer programme.[30] To do so, two main options immediately arise. First, we could assume a Lump Sum Redistribution Authority (LSRA) that runs a lump sum tax and transfer

[30]The literature has identified many tools that policymakers have to compensate potential losers after a policy change, and governments have utilized each of these strategies to build support for pension reform. Among these tools, the most noteworthy are the power to exempt certain groups from the terms of the reform (Mexico in 1995); deliver cash benefits and tax relief (Poland in 1999, and Uruguay in 2014); make concessions or link reforms across multiple sectors (Argentina in 1993); and make political appointments to advance their reform efforts (Hungary in 2001). See James and Brooks (2001) for an extensive discussion).

programme. Specifically, the LSRA uses this programme to restore the expected lifetime utility of all currently living agents to their pre-reform levels, and it also applies this scheme to all future cohorts so that the sum of the present value of all current and future taxes and/or transfers equals zero. These taxes/transfers are set to reduce/raise their utility by a uniform amount. Consequently, if all future cohorts face welfare gains, the pension reform is Pareto improving. Unfortunately, these lump-sum transfers or taxes are hypothetical, so that if they were implemented, the post-reform expected lifetime utilities would be different from those obtained by the LSRA. This is the approach followed by, for instance, Auerbach and Kotlikoff (1987), Fehr and Habermann (2008), and Nishiyama and Smetters (2014).

Alternatively, we implement the approach followed by Conesa and Garriga (2008), McGrattan and Prescott (2017), and Díaz-Saavedra et al. (2023). Specifically, we consider a pension reform along with the provision of one-time compensatory transfers to those households alive at the moment of the reform, which transfers are financed with debt and the consumption tax rate, so that living cohorts do not face welfare losses while future cohorts enjoy welfare gains. In other words, the government initially issues debt to compensate current generations and then increases the consumption tax rate to cover interest payments from such government debt. Thus, this transfer scheme could result in a Pareto welfare-improving transition.[31]

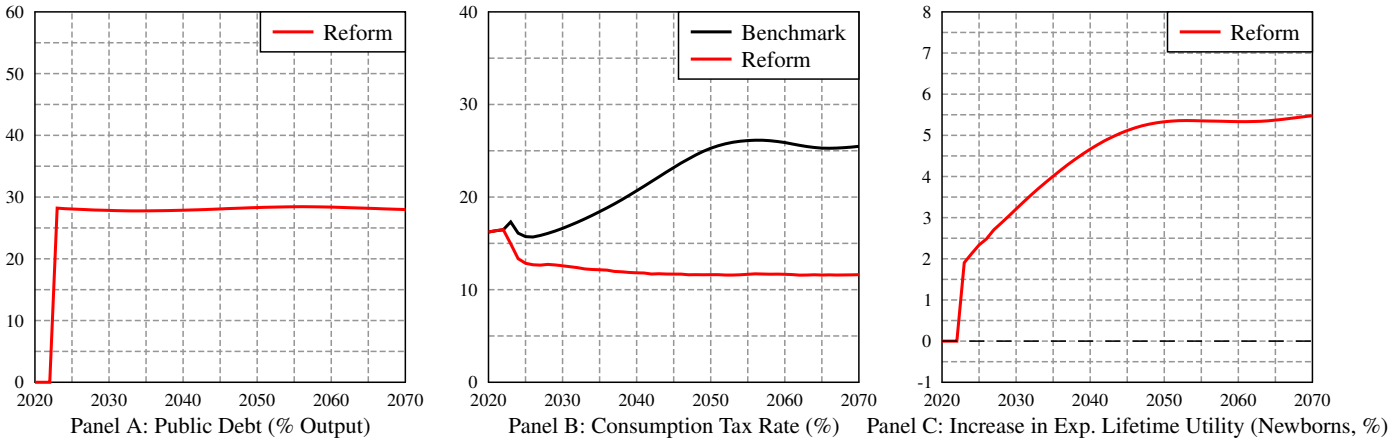
Figure 12 shows these transfers by age and education in 2023, as a share of per capita output, and it also shows that they follow a pattern similar to the welfare losses that we report in Figure 11, but, naturally, in an inverted shape. Moreover, our results show that the total amount that the Spanish government would need to compensate the aforementioned losers in 2023 reaches 27 percent of output (see Panel A of Figure 13).

However, and despite the cost in terms of public debt, there is room to implement a full Pareto-improving pension reform transition. That is, even after the additional tax collections needed to pay for the interest payments brought about by the issuance of public debt, this reform implies a full Pareto improvement (i.e. without any losers) with respect to the benchmark public pension system, due to two main reasons. First, because – and by definition – the public transfers fully compensate those who face losses with the pension reform. And second, since those aged 20 years old at the year of the reform face welfare gains, the next generations of newborns are also better off after the reform (see Panel C of Figure 13).

Overall Assessment. The first order effect of this pension reform is over the sustainability of the system, mainly through lower pensions. Reduced pensions provide a strong incentive to save during the working lifetime in order to finance consumption after retirement, and the lower opportunity cost to keep working encourages delayed retirement. Consequently, the higher savings and work hours increase output.

[31] Kudrna et al. (2022) compare these two approaches after simulating a parametric reform of the Australian public pension system.

Figure 13: The Public Debt, the Consumption Tax Rate and the Change in Welfare



On the other hand, short-term retirement income losses increase the risk of policy reversal. Thus, in order to overcome this risk, governments should implement a tax and transfers programme for those households alive at the moment of the reform, so that each of these households would be at least as better off as in the status quo environment. This is a Pareto-improving transition that can be implemented (and financed) in a clear and easy way.

Obviously, this reform also represents a radical change over the current pension system, where the public pension reduces its weight as a source of income during old age. Thus, the second pillar, the private assets accumulated during the working lifetime, becomes an additional and essential source to finance consumption when elderly. Besides this, the solidarity of the new basic pay-as-you-go pensions would be guaranteed through minimum and maximum pensions, and it is also reinforced by uncapping social security contributions.

8 Discussion

The pension reform that we study here combines changes in pension benefits, in payroll taxation, and a new transfer programme, as these policy changes are relevant in the current European policy and political context. Consequently, this section discusses how the results we have just presented could be extended to other European countries facing sustainability problems in their public pension systems in the medium and long term.

Table 6 highlights the projected changes in pension expenditure over the coming decades, as outlined in the Ageing Report 2024. It focuses on countries expecting increases in pension expenditure and examines key design features of their systems.

Table 6: Projected Pension Expenditure in some European Countries[a]

Country	Pension Expenditure[b]			Automatic Adjustment Mechanisms			Earnings Reference
	2022	2070	Δ(%)	Automatic Balancing Mechanism	Sustainability Factor (Benefit Linked to Life Expectancy	Retirement Age Linked to Life Expectancy	
Luxembourg	9.2	17.5	8.3	x			Full career
Malta	6.2	10.6	4.4				Last 10 years
Hungary	7.7	12.0	4.3				Full career
Spain[c]	12.3	16.1	3.8			*	Last 25 years
Slovenia	9.8	13.6	3.8				Best 24 years
Cyprus	8.2	11.8	3.6				Full career
Belgium	12.7	16.2	3.5			*	Full career
Lithuania	6.4	9.6	3.2	x			Full career
Slovakia	8.5	11.3	2.8			x	Full career
Ireland	3.8	6.6	2.8				Full career
The Netherlands	6.5	8.5	2.0			x	Full career
Czechia	8.7	10.4	1.7			*	Full career
Norway	10.8	12.5	1.7		x		Full career
Finland	12.8	14.2	1.4		x	x	Full career
Germany	10.2	11.4	1.2	x		*	Full career
Austria	13.7	14.1	0.4				Full career
Bulgary	9.5	9.6	0.1				Full career

[a] Source: Ageing Report 2024 and Pensions at Glance 2023.
[b] As a percentage of GDP.
[c] The numbers presented here are those obtained after simulating our Benchmark Model Economy.
* These countries legislate an increase in legal retirement ages, where this increase is determined independently of the growth rate in life expectancy.

According to the projections of the Ageing Report 2024, the expected increases in the public expenditure to GDP ratio between 2022 and 2070 range from 8.3 percentage points in Luxembourg to 0.1 percentage points in Bulgaria, and the average increase in this ratio is 2.9 percentage points for that same period. The projections clearly indicate that these European countries have failed to adapt to very long-term demographic trends, so that, to a greater or lesser extent, these countries need reforms that guarantee the future sustainability of their public pension systems, limiting the tax increases that would otherwise be necessary to finance their pension system deficits.[32]

Most of the countries in that table should have an integral reform plan consisting of both parametric changes and of the introduction of Automatic Adjustment Mechanisms (AAMs) that can in particular deal with demographic trends. Looking at the fine print, and not in order of importance, most of the countries use the full career to determine the main component of the retirement pension. Only in the cases of Malta and Slovenia is the vesting period shorter. This is inconvenient because, apart from generating less intragenerational solidarity and more pension

[32]Other European countries have successfully introduced substantial reforms to their pension systems so that their pension expenditure is expected to decrease over the coming decades. Of these countries, those that have introduced at least two or more AAMs stand out, such as Italy, Latvia, Poland, Portugal, and Sweden.

income inequality, the replacement ratio is higher so that pension expenditure increases. Thus, a movement from a short to a long vesting period is advisable for these countries.

Second, and more important, many countries fail to introduce al least one of the Automatic Adjustment Mechanisms: Malta, Hungary, Slovenia, Spain, Belgium, Ireland, Czechia, Austria, and Bulgari. For the rest of the sampled countries, they only have one AAM, with the significative exception of Finland. Evidently, prioritizing AAM adoption is crucial for countries with high projected expenditure increases. For instance, a Sustainability Factor that adjust the amount of the initial retirement pension to changes in life expectancy across cohorts improves pension sustainability. Nowadays, only Finland and Norway (among the sampled countries) have such a factor in their public pension systems.[33]

But sustainability factors alone can be insufficient to guarantee the future financial sustainability of public pension systems. In other words, these factors should be implemented jointly with by an automatic balancing mechanism, since this ensures a balanced budget of the pension scheme. Unfortunately, only Germany and Lithuania have introduced these tools in their retirement schemes, and many other countries still revalue their pensions in payment with the consumer price index, wage growth, or a blend of these.

Furthermore, countries may also decide to automatically link the statutory retirement age to life expectancy. Cyprus, Slovakia, Netherlands, and Finland have opted for this choice. However, this option faces some important criticism. For instance, it may have an unequal impact within generations on different social groups because it is linked to average life expectancy. Put differently, if life expectancy gaps between, say, educational groups widen, then linking the retirement age to life expectancy perverts the redistributive objectives of pension systems.[34]

Finally, in addition to a reduction in the pension replacement rate, governments could also rise pension revenues through an increase in the effective rate of social security contributions, for example by eliminating the cap on the payroll tax rate. Currently, only Slovenia and Ireland set an uncapped payroll tax rate and at the same time establish a maximum retirement pension. Evidently, this option improves financial sustainability at the expense of reducing the contributivity of the system. An alternative option to this parametric change is to increase the gap between the maximum covered earnings and the maximum retirement pension, as undertaken by the last pension reform in Spain (see De la Fuente 2023 for a detailed description).

In conclusion, the sample countries will, sooner or later, have to implement far-reaching reforms in their public pension systems. However, such structural pension reforms aimed at restoring

[33] Another advantage of this factor is that it increases intergenerational equity by considering for differences in the length of benefit receipts.

[34] A thorough analysis of the possibilities and limitations of AAMs is beyond the focus of our paper. The reader is referred to Ageing Report 2021, chapter 2, for guidelines for designing automatic adjustment mechanisms based on OECD countries' experiences.

financial balance could likely to be overturned, as we showed in Section 2, given that they lead to losses in retirement income. Yet, as we have already stated, it might be possible to reduce the risk of political reversal if, together with a given structural pension reform as suggested here, governments implement a transfer programme targeting those socioeconomic groups that have been financially harmed. The ultimate goal of this programme is about designing a Pareto-improving transition between the current and the new pension system.

The compensation mechanism proposed here is simple and transparent since it entails a unique wealth transfer at the beginning of the reform. The question that then immediately arises is how much such a transfer programme would cost and how it would be financed. With the notable exception of Luxembourg, plus Malta and Hungary, the rest of the sample countries are projected to increase their pension expenditure to GDP ratios by a lower amount than the value predicted for Spain. This means that the introduction of a transfer scheme to compensate those who lose out with a hypothetical structural pension reform would potentially be less costly, in terms of GDP, than the numbers that we report in this paper for Spain. Put differently, it should not be very difficult for these countries to get the capital markets to finance such a transfer programme, especially when that pension reform could indefinitely guarantee its future sustainability. Our results also show that a good strategy would be to announce in advance the proposed pension reform (see Section 9.4).

Luxembourg, on the other hand, has the highest increase in the pension-expenditure-to-GDP ratio of European Union (EU) countries, and more drastic reforms could be needed to address this there. Specifically, the required future decrease in the benefit and coverage ratios indicate that to compensate the potential losers, public transfers of considerable magnitude would be needed.[35] [36] Thus, the access to private funding to finance public transfers could be substantially more difficult.[37]

9 Sensitivity Analysis

In this section we conduct a sensitivity analysis on some of the assumptions of our previous simulations.

[35] Bouchet et al. (2017) analyzes pension reforms in Luxembourg, and they show that a single parametric reform would involve severe difficulties and that the suggested pension reform consists of a policy mix including taxation, benefits and the effective retirement age.

[36] The benefit ratio indicates how the average pension evolves relative to average earnings. The coverage ratio is the share of the number of pensioners relative to those aged 65+.

[37] Additionally, it is expected that with a high public-debt-to-GDP ratio, the risk premium required by private investors would rise substantially.

9.1 Minimum Pensions

In the previous simulations, we assumed that the Pension Revaluation Index affected the revaluation of all pensions in payment, which also included the minimum retirement pension, $\underline{p}$. Thus, since the average annual PRI between 2023 and, say, 2050, is -0.4 percent, the minimum retirement pension in Spain would decrease from the current 783 euros to 667 euros in 2050 in real terms. This reduction of the real value of minimum pensions is large, and therefore raises doubts about whether this guaranteed minimum would continue to be a key instrument for protection of elderly people against poverty.

Consequently, in this section we explore the consequences of exempting the minimum pension from the Pension Revaluation Index, and making its real value a constant share of per capita output instead[38]. Apart from the aggregate consequences and the fiscal costs involved by this exemption, we are interested in the disincentive effects that it could have on the economic behaviour of households, including labour supply and saving.

Relative to our baseline simulations, we find that this change essentially involves trading off a higher minimum pension against a lower PRI, which reduces further the real value of all other pensions, and against the higher consumption tax rate that is needed to finance it. These effects increase the compensation to those alive at the moment of the reform, the debt to GDP ratio, and the needed consumption tax rate to balance the government budget (see Table 7 and Figure 14). [39]

At the household level, this time the reform increases savings and work hours by less, in comparison to the baseline simulation, so that output is only 1.0 percent higher in 2070 in the reformed economy. [40] Finally, we also find that a higher minimum pension reduces the range of variability of pensions, thereby reducing pension inequality, so that the pension Gini index decreases by up to 8 percentage points, from 0.24 to 0.17 in 2070.

9.2 Labour Productivity

In many cases, labour productivity growth becomes an essential variable when studying the future sustainability of public pension systems. According to Díaz-Saavedra (2016), this is also the case for Spain. Specifically, an increase in labour productivity growth reduces the financial burden faced

[38] We therefore assume that the minimum pension remains constant at 27.6 percent of output per capita in both model economies

[39] Since a higher cost of public debt implies higher interest payments and a higher consumption tax rate, it could be expected that the related welfare gains for newborns brought about by the reform would be lower in comparison to our baseline simulations. However, we find that the long-term welfare gains of newborns hardly vary. That is, future cohorts do not dislike paying higher consumption taxes if these additional tax collections are used to increase those pensions aimed at protecting against poverty risk.

[40] A higher minimum pension encourages early retirement, especially for low-educated workers who reduce their average retirement age by one year in the reformed economy, in comparison to the reform in the baseline simulation.

Table 7: The Reformed Model Economies and the Minimum Pension ($\underline{p}$)

	2020	2030	2040	2050	2060	2070
Annual Real Revaluation of Pensions (%)						
Baseline	0.0	-0.5	-0.8	-0.3	0.4	0.2
Excluding $\underline{p}$	0.0	-1.1	-1.7	-1.3	-0.4	-0.5
Average Pension[a]						
Baseline	0.0	-4.8	-14.4	-23.8	-26.7	-25.4
Excluding $\underline{p}$	0.0	-6.3	-17.0	-25.9	-29.1	-28.7
Consumption Tax Rate (%)						
Baseline	16.2	13.2	12.4	12.2	12.2	12.2
Excluding $\underline{p}$	16.2	13.4	12.7	12.7	12.7	12.7
Output[a]						
Baseline	0.0	-0.5	1.9	1.8	1.8	1.8
Excluding $\underline{p}$	0.0	-1.4	0.6	1.7	1.3	1.0

[a] Difference in percentage with the Benchmark Economy.

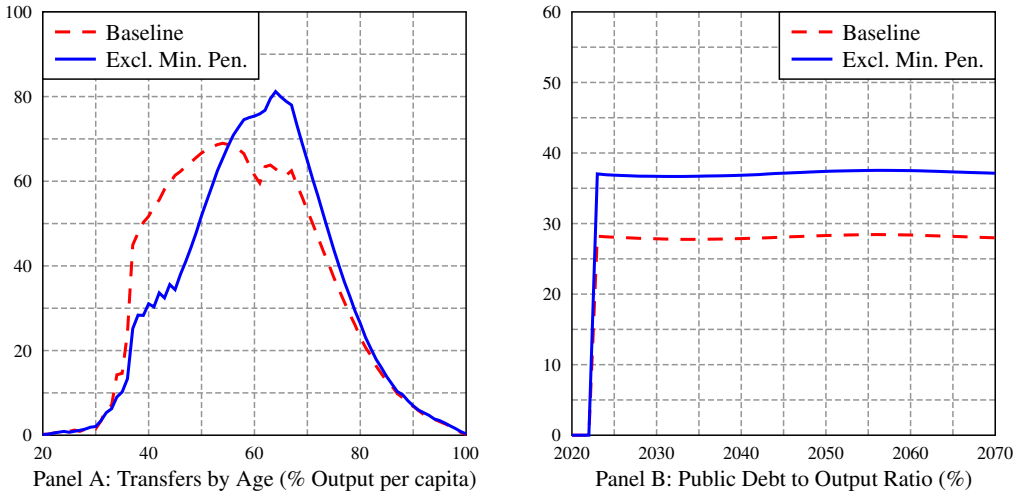
by the pension system in Spain, given that both the past earnings included in the Regulatory Base and the pensions in payments are not adjusted to the growth rate of wages, but to the Consumer Price Index. Consequently, this characteristic of the Spanish pension system means that earnings in productivity are transferred to pensions with a certain time lag, so the financial burden of the public pension system decreases (see Figure 15).

The baseline simulations assumed that the annual labour productivity growth rate was 0.9 percent, so that this section presents the results that we obtain when we assume that this annual rate is 2 percent in both the Benchmark and the Reformed Model Economies. As expected, the pension deficit, when simulating the Benchmark Model Economy, is lower in comparison to the baseline experiments (see Panel A of Figure 15), and consequently the reductions in pensions needed by the reform to equilibrate the pension budget are also lower. Thus, the total amount of transfers to those households alive at the moment of the reform reaches 9.5 percent of output. Finally, the welfare gains for future newborns brought about by the reform are 3.5 percent.

9.3 Closed Economy

The baseline experiments consider open economies. Even though the Spanish economy is part of the European Union, the European Financial Union is not so developed as to consider Spain a fully open economy. For this reason, we also analyze it as a closed economy. Therefore, as a final robust analysis, we simulate all the previous model economies under the assumption that Spain is a closed

Figure 14: The Transfers and the Public Debt



economy.[41]

Given the closed economy assumption, the wage rate and interest rate are determined by market clearing conditions of domestic labour and capital markets, so that any policy change that affects household savings and/or work hours has a direct effect on the supply of capital and labour in the economy and the factor prices. Also in contrast to our baseline simulations, the wealth transfer at the beginning of the pension reform are invested in productive capital in a closed economy, increasing the aggregate capital stock in the economy (see Figure 16). The larger capital stock decreases the interest rate, and since the capital to labour ratio increases, the wage rate is higher.

When we compare the results of this reform of the pension system under the assumptions of open or closed economies, we find that the aggregate consequences of the reform do not depend significantly on whether the economy is open to international capital flows or not. For instance, the fiscal cost of the transfer program aimed at compensating alive households in 2023, is just 2 percentage points of output higher compared to the cost obtained under the assumption of an open economy.

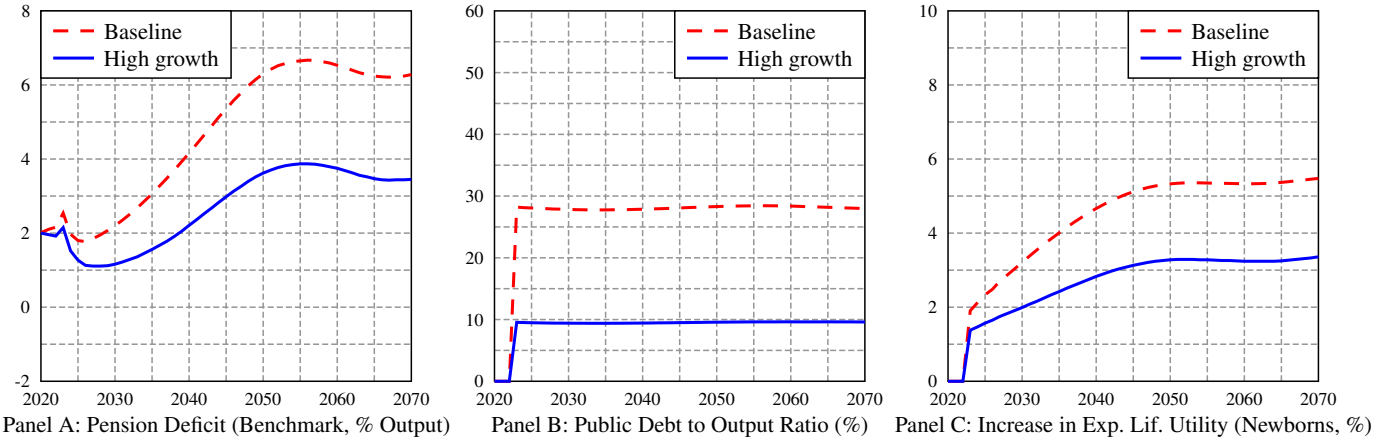
9.4 Early Announcement[42]

Our simulations assume that the reform of Spanish Public Pension is announced and implemented at the beginning of 2023, and that such changes are totally unexpected by the households that populate the model economy.

[41] For this last exercise, we continue to use the same values in the parameters as those used in the baseline simulations.

[42] We would like to thank an anonymous referee who suggested this analysis to us.

Figure 15: The Pension Deficit, the the Debt to Output Ratio, and the Welfare Gains



There is also the alternative case that there are also announcement delays. However, announcing the pension reform in advance could entail some moral hazard issues, especially those related to the compensation system analyzed here: agents might behave strategically if they knew in advance that they could be compensated with public transfers following a pension system reform. Specifically, households could dissave their assets in advance so that their net wealth would be sufficiently reduced at the time of implementing the transfer scheme, thus obtaining greater compensation from the government. For this reason, we assumed that not only the reform of the pension system but also the implementation of the transfer scheme are announced and implemented immediately, and without prior knowledge by households.

In this section, however, we assume that the government announces in 2019 the pension reform that would take place in 2023, but implements the transfer scheme at the same time as the announcement, precisely to avoid strategic behaviour by agents in relation to the stock of their accumulated assets. This assumption opens up an interesting margin. Specifically, the households now have more time to adapt their optimal decisions of consumption, saving and labour before the pension reform comes into force. This is especially important for those more elderly households nearing retirement, who would otherwise have no opportunity to adapt themselves to new pension rules.

The implication is straightforward. The public transfers needed to compensate those households hurt by the pension reform are lower in comparison to an unexpected reform, especially for more elderly households (see Panel A of Figure 17). As a result, the fiscal cost of the public transfer program is also reduced, now representing 21.2 percent of output. For comparison, in our baseline simulations, this figure was 28.2 percent of output (see Panel B of Figure 17). Finally, we find not

Figure 16: Aggregate and Welfare Consequences in the case of the Closed Economy

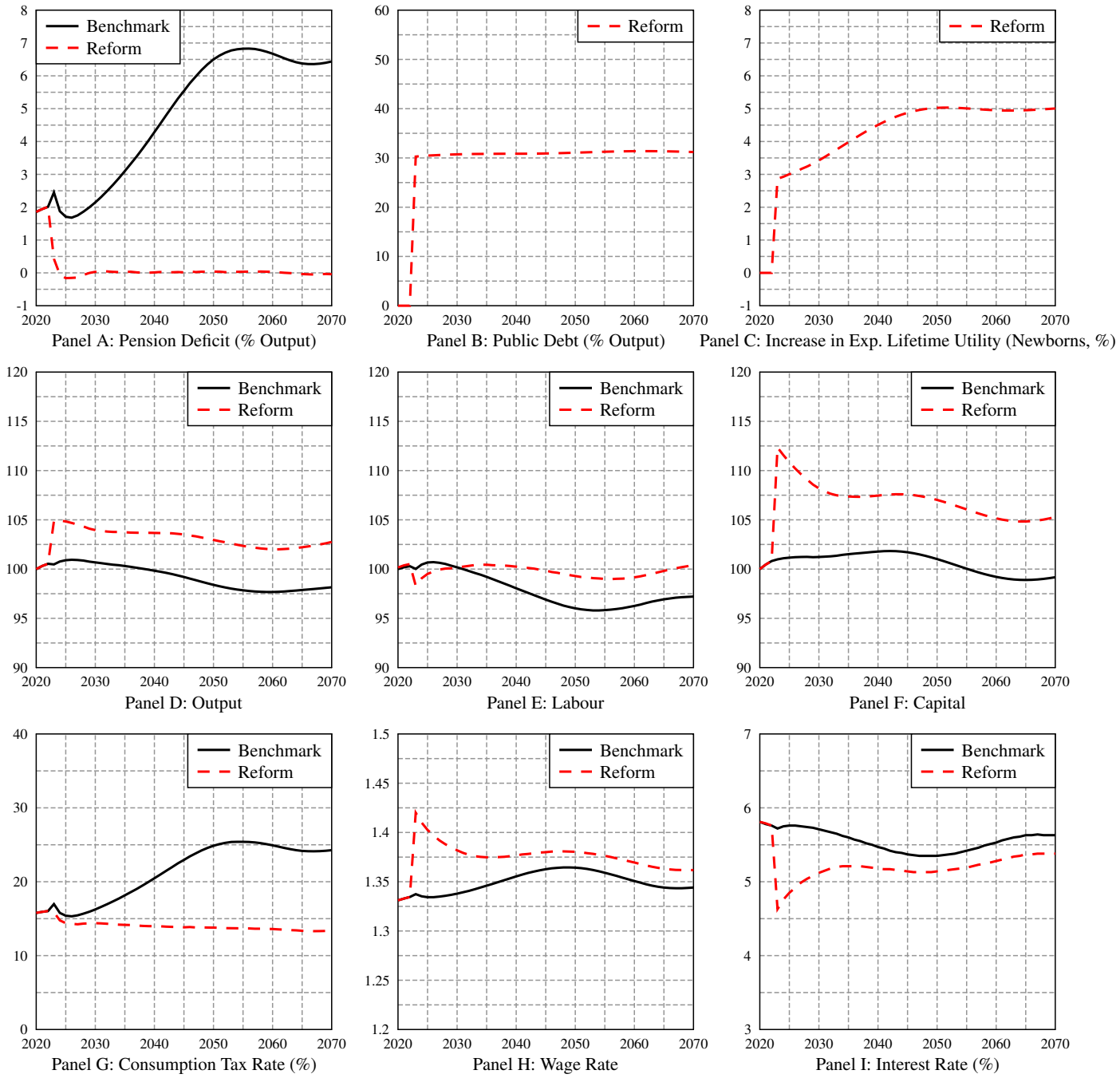
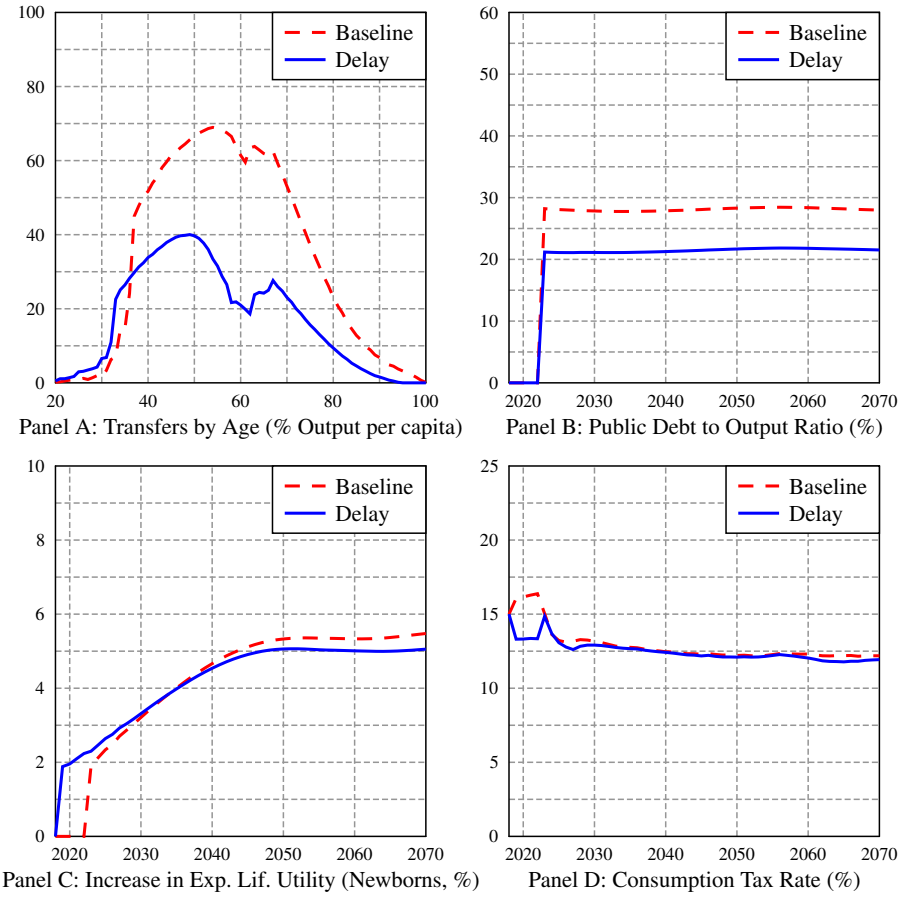


Figure 17: Aggregate and Welfare Consequences in the case of the Early Announcement Economy



Panel A: Transfers by Age (% Output per capita)

Panel B: Public Debt to Output Ratio (%)

Panel C: Increase in Exp. Lif. Utility (Newborns, %)

Panel D: Consumption Tax Rate (%)

significant differences in the in the rest of the aggregate and welfare consequences (see Panels C and D of Figure 17). [43]

In conclusion, if the pension reform is announced in advance the result is lower public transfers needed to compensate households that are negatively affected by the policy change. This gives households, especially those nearing retirement, additional time to adjust their optimal decisions before the reform takes effect.

10 Conclusions

This study highlights the critical need for pension system reforms to address the financial and political sustainability challenges posed by demographic changes, such as increased life expectancy and declining fertility rates. Using the Spanish public pension system as a case study, the findings emphasize that without reform, Spain's pay-as-you-go pension system is projected to face unsustainable deficits, potentially exceeding 6 percent of GDP by 2050.

Introducing a comprehensive reform package—including a sustainability factor, new revaluation rules, extended calculation periods for pension benefits, and eliminating payroll tax caps—can significantly mitigate these challenges by reducing pension expenditures and increasing system revenues. However, while the proposed reforms improve long-term financial sustainability and intergenerational equity, they impose short-term welfare losses, particularly on older and highly educated workers. A transition strategy, involving compensatory transfers, is essential to prevent political reversals and ensure public acceptance.

These findings may be extrapolated to other European countries facing similar demographic and financial pressures. A balanced reform approach, combining sustainability measures with social equity considerations, is crucial for the success of pension system overhauls.

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Appendix A

This Appendix describes how we calibrate the new parameters that appear in this version of our model economy.

The fiscal policy. This version of our model economy assumes the income tax function proposed by Gouveia and Strauss (1994). To identify this function, we must choose the values of parameters a_0, a_1, and a_2. Following Díaz Saavedra (2020), we set $a_0 = 0.45$, $a_1 = 1.071$. To determine a_2, we impose that the model economy ratio income tax revenues to output at market prices, should replicate its Spanish counterpart in 2018. According to the Spanish National Institute of Statistics, INE, this ratio was 7.05 percent in that same year. Consequently, we set $a_2 = 0.2570$.

The pension system. In 2018 in Spain, the payroll tax rate paid by households was 28.3 percent and it was levied only on the first 45,014 euros of annual gross labor income, which corresponds to 141.06 percent of per GDP per person aged 20+.[44] Consequently, we set the both the maximum tax cap and the maximum covered earnings as 1.4106 of model economy per capita output. To determine the payroll tax rate, we impose that the model economy ratio payroll tax collections to output at market prices be 10.20 percent, which is the value observed in the Spanish economy in 2018. This implies that the payroll tax rate of our model economy is $\tau_{ss} = 0.231$.

Our choice for the number of years used to compute the retirement pensions in our benchmark model economy is $N_b = 21$. This is because in 2018 the Spanish *Régimen General de la Seguridad Social* took into account the last 21 years of contributions prior to retirement to compute the pension. Our choice for the first and normal retirement ages are $R_0 = 62$ and $R_1 = 66$, so that to identify the early retirement penalty function, we choose $\rho_0 = 0.28$, and $\rho_1 = 0.07$. This is because we have chosen $R_0 = 62$.

We assume that the minimum and the maximum pension, are also directly proportional to per capita income. Specifically, we assume that the minimum pension, $\underline{p}$, is 23.62 percent of model

[44] In Spain in 2018, the GDP per person who was 20 or older was 31,910.46 euros.

economy output per capita. For the maximum pension, $\overline{p}$, we assume that this number is 113.9 percent. These numbers correspond to their values in 2018, since in that year, the minimum yearly retirement pension in Spain was 7,537.1 euros, and the maximum yearly pension was 36,121.8 euros. Finally, we assume that the fictitious quote is 24 percent of per capita output, so that we set $y^{fq} = 0.24y$.

Changes with respect to the previous version. Since this version introduces many of the institutional features of the current Spanish public pension system in great detail, we have had to change the value of some of the parameters with respect to their assigned values in Díaz Saavedra et al. (2023) during the calibration process . Table 8 shows the previous and the current values for these parameters. The rest of parameters of the model economy continue to have the same values as in that paper.

Table 8: Parameters: Actual and Past Values

	Parameter	This Version	Díaz Saavedra et al. (2023)
Preferences			
Time preference	β	0.9835	0.9965
Leisure weight	γ	1.6812	1.7281
Disutility of labor	α	78.0001	28×10^4
Int. elast. of subst.	φ	0.5000	0.1000
Productivity			
Productivity shock	$z(2)$	2.4301	2.3490
Productivity shock	$z(3)$	7.9001	5.9042
Probability	z_{21}	0.0330	0.0291
Probability	z_{22}	0.9670	0.9708
Technology			
Productivity growth rate	g	0.0090	0.0000
Depreciation rate	δ	0.1185	0.1138
Public Pension System			
Replacement rate	p_r	0.9724	0.7650
Payroll tax rate	τ_p	0.2310	0.2599
Fiscal Policy			
Unemployment replacement rate	b_0	0.3582	0.3751
Consumption tax rate	τ_c	0.1500	0.2599
Capital income tax rate	τ_k	0.2416	0.2500