On the Spanish Public Pension Reserve Fund*

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Abstract

One of the main rationales for establishing public pension reserve funds is to smooth tax rates over time by accumulating assets in advance to help finance the increase in pension expenditures associated with population ageing, thereby reducing the need for large tax increases as demographic pressures intensify. However, when a public pension reserve fund invests predominantly in government debt, as is the case in Spain, its ability to facilitate intertemporal tax smoothing is greatly diminished, since the fund's assets are simultaneously liabilities of the same public sector. In this paper, we use a large-scale overlapping-generations model calibrated to the Spanish economy to analyze the aggregate and welfare effects of redirecting the additional payroll tax contributions currently used to finance the Spanish reserve fund toward individual retirement accounts (IRAs). Under this reform, contributions are accumulated throughout workers' careers and converted into a constant annuity during retirement. Our findings show that such a policy generates substantial welfare gains relative to the current institutional arrangement, and even when compared with an alternative policy in which the reserve fund is allowed to invest in assets other than Spanish government debt. These gains are primarily driven by higher consumption in retirement and improved consumption smoothing over the life cycle. Moreover, in an open-economy setting, the present discounted value of the expected lifetime consumption gains accruing to the generations alive at the time of the reform could exceed 23% of current Spain's GDP. In a closed economy, however, the reform also triggers important general-equilibrium effects through its impact on capital accumulation, wages, and output. As a result, the overall social value of introducing IRAs is larger.

Keywords: OLG, social security reform, demographic trends, dynamic analysis

JEL classification: C63, H55, J11

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1 Introduction

The demographic transition experienced by most advanced and emerging economies has placed increasing pressure on pay-as-you-go (PAYG) pension systems. Declining fertility rates and, in particular, rising life expectancy have simultaneously reduced the contribution base while expanding the number of beneficiaries, generating persistent financial imbalances in public pension schemes. In response, policymakers have implemented a wide range of parametric and structural reforms, including increases in the statutory retirement age, the introduction of automatic adjustment mechanisms, and/or the adoption of multi-pillar pension systems aimed at diversifying the sources of income available during retirement.

Public Pension Reserve Funds have also become an increasingly important component of pension systems, particularly in countries operating PAYG schemes. A defining feature of these funds, which distinguishes them from private pension funds, is that their ultimate beneficiaries, namely current and future cohorts, do not hold legal or beneficial ownership of the underlying assets. Instead, ownership resides with the institution responsible for administering the public pension system. These funds typically serve three main purposes. First, they provide a financial buffer that can be drawn upon during periods of adverse macroeconomic shocks. Second, they contribute to the diversification of pension financing sources. Third, by accumulating assets in advance of rising pension expenditures, they facilitate intertemporal tax smoothing and help partially offset the fiscal costs associated with population ageing (Yermo, 2008; OECD, 2021).

Spain, whose pension system is organized on a pay-as-you-go (PAYG) basis, is among the countries that have established a public pension reserve fund in response to the fiscal challenges posed by population ageing. The fund was created following the recommendations of the Toledo Pact of 1995, with the first effective allocation of resources taking place in 2000.[1] Initially, the fund was financed through Social Security surpluses accumulated during periods of favorable economic conditions. Following the 2021 pension reform, however, its primary source of financing became the revenues generated by the Intergenerational Equity Mechanism (IEM), a payroll tax that is being gradually phased in until it reaches 1.2 percent of covered labor earnings in 2029. The fund was conceived as an intertemporal stabilization instrument designed to alleviate the fiscal pressures associated with demographic ageing. In this sense, its primary objective is to facilitate the smoothing of taxes and Social Security contributions over time.

Despite this objective, the fund has historically followed a highly conservative investment strategy, with its portfolio invested almost exclusively in Spanish government securities. While such an allocation ensures a high degree of safety and liquidity, it substantially limits the fund's effectiveness as a tax-smoothing device. Because the fund's assets are largely liabilities of the same public sector

[1] Section 2 provides a detailed description of the Spanish fund's origins, functions, sources of financing, investment policy, and asset accumulation over time.

that owns them, a balance-sheet consolidation problem arises: the accumulation of reserve assets does not generate net public wealth Consequently, the fund's ability to transfer resources across generations and smooth future tax distortions is severely constrained, if not entirely eliminated (Fernández Villaverde, 2025).

To enable the Spanish Public Pension Reserve Fund to function as an effective instrument of intertemporal tax smoothing, its investment strategy should be redirected away from Spanish government debt and toward a diversified portfolio of assets issued outside the Spanish public sector, including foreign government bonds and private-sector securities. Unlike domestic public debt, such assets constitute net financial claims on external entities and therefore contribute to the accumulation of public-sector net wealth. By building up these assets in advance of the fiscal pressures associated with population ageing, the Fund could provide an additional source of financing for future pension expenditures, thereby reducing the need for sharp increases in taxes or social security contributions as demographic imbalances intensify (Yermo, 2008). Achieving this objective also requires not only a more diversified asset allocation but also a governance framework and risk-management strategy consistent with the Fund's long-term mandate and financing objectives (Andonov et al., 2018).[2]

To address this issue, we analyze the aggregate and welfare consequences of a counterfactual policy that allows the Spanish Public Pension Reserve Fund to accumulate net financial wealth by investing in a diversified portfolio of foreign government bonds and private-sector securities rather than Spanish government debt. This exercise enables us to quantify the extent to which an alternative investment strategy could enhance the Fund's capacity to smooth taxes and pension financing over time.

Specifically, we analyze two model economies beginning in 2023. The first, referred to as the *Benchmark Model Economy*, replicates the current operation of the Spanish Public Pension Reserve Fund. Under this arrangement, the Fund is financed through the revenues generated by the IEM and invests these resources exclusively in Spanish government debt. Beginning in 2033, the Social Security system gradually liquidates the Fund's assets in accordance with the withdrawal schedule established under current legislation. The second economy, the *Reformed Model Economy 1*, retains the same financing mechanism and imposes the same restriction that asset decumulation cannot begin before 2033.[3] The key difference between the two economies lies in the Fund's investment

[2]Previous research has identified additional reasons why a Public Pension Reserve Fund should invest in assets other than domestic government debt. For instance, Bohn (1999) examines whether the U.S. Social Security Trust Fund should invest in equities rather than exclusively in safe government securities. Using a stochastic overlapping-generations model calibrated to U.S. data, he finds that equity investments can generate positive welfare effects by improving intergenerational risk sharing. The underlying mechanism is that stock returns are positively correlated with the wage-indexed benefit obligations of the Social Security system. This correlation helps align the Fund's investment returns with fluctuations in its pension liabilities, thereby improving risk sharing across generations and helping to stabilize the payroll tax rate. Thus, Bohn's analysis highlights intergenerational risk sharing as a key rationale for equity investment, while also identifying potential benefits in terms of payroll tax smoothing.

[3]The reform further assumes that the Fund is fully depleted by 2060. Consequently, asset sales are used to smooth

policy. Whereas the Benchmark Model Economy assumes that all contributions are invested in Spanish government debt, the Reformed Model Economy considers a counterfactual scenario in which the Fund allocates its resources to assets issued outside the Spanish public sector.[4]

To do so, we simulate an open-economy overlapping-generations model with labor-market search frictions, endogenous job creation and destruction, and three employment states: employment, unemployment, and inactivity. The economy is populated by heterogeneous households, a representative firm, and a government, and builds on the framework developed by Díaz-Saavedra et al. (2023). A key feature of the model is its detailed representation of the Spanish welfare state, including means-tested transfers, public unemployment insurance, and a pay-as-you-go pension system financed through payroll taxation. Households operate in a stochastic labor-market environment in which they face job-finding and job-separation shocks, as well as idiosyncratic productivity risk while employed. Upon reaching retirement age, individuals may choose to withdraw from the labor force and claim pension benefits. The interaction between these exogenous shocks and households' optimal labor-supply, job-search, and retirement decisions generates an endogenous distribution of individuals across employment, unemployment, inactivity, and retirement. In addition to payroll taxes, the model incorporates labor income, capital income, and consumption taxation. An aggregate production function and a government that must balance the budget close the model. The model is then used to simulate the Spanish economy over the coming decades, taking into account projected changes in both the age and educational composition of the population.

The model differs from that of Díaz-Saavedra et al. (2023) in several important respects. First, it incorporates a more recent estimate of the labor share obtained from the International Labour Organization (ILO) database, allowing the model to match key Spanish macroeconomic aggregates and ratios more closely. Second, it explicitly incorporates the Social Security contribution ceiling, a feature that is particularly relevant for accurately quantifying the revenues generated by the IEM. Third, we have also substituted the proportional tax on labor income of the previous version with a progressive household income tax. This allows us to exploit the heterogeneity in our model economy, and to avoid the ongoing discussion of whether model economies should be calibrated to replicate the marginal or the average tax rates of the progressive personal income taxes of real economies. And forth, the model includes labor-augmenting technological progress, which improves the projection of the long-run financial position of the Spanish Social Security system, given the important role of productivity growth in determining future pension expenditures (see, e.g., Díaz-Saavedra, 2016).

Our simulations yield five initial main findings. First, with the notable exception of aggregate

the tax burden during the period in which demographic projections from the Spanish National Statistics Institute (INE) indicate the most severe ageing-related fiscal pressures. Once the Fund is exhausted, however, revenues collected through the IEM are assumed to be allocated entirely to financing a portion of the pension system's deficit.

[4]Because aggregate uncertainty is absent from the model, foreign government bonds and private-sector securities are treated as perfect substitutes and are therefore assumed to yield the same risk-free rate of return.

consumption, the two model economies display remarkably similar macroeconomic outcomes. In particular, we find virtually no differences in the main aggregate variables. Since total hours worked remain largely unchanged across the two economies, and since the capital stock adjusts endogenously to maintain a capital-to-labor ratio consistent with the exogenous interest rate, output also exhibits only negligible variation.

Second, annual aggregate household consumption increases by more than 2% during the coming decades in the reformed economy, especially after the Public Pension Reserve Fund begins liquidating its assets. This result arises because the sale of assets issued outside the Spanish public sector generates net revenues for the consolidated government sector, allowing lower tax rates to be used to satisfy the government budget constraint. By contrast, such a tax-smoothing mechanism is unavailable in the benchmark economy, where revenues generated by the sale of Spanish government debt held by the Fund are exactly offset by higher liabilities within the consolidated public-sector balance sheet.

Third, the reform generates substantial welfare gains. Individuals alive at the time of the 2023 reform benefit the most, as they experience significantly lower tax rates during the period between the onset of asset decumulation and the eventual depletion of the Fund. As a result, their expected lifetime consumption increases considerably. Quantitatively, we find that the present discounted value of the remaining lifetime consumption gains accruing to currently living generations exceeds 16% of Spain's current GDP. Future generations also benefit from the reform, albeit to a lesser extent after the Fund has been fully depleted. The underlying reason is that the revenues generated by liquidating the Fund's assets are larger than those raised through the IEM alone. Consequently, the reform delivers its largest tax-smoothing effects while the Fund is being decumulated, although some benefits persist thereafter through the continued use of IEM revenues to finance part of the pension system's deficit.

Fourth, the ability of the Spanish Public Pension Reserve Fund to smooth taxes over time is constrained by the relatively small volume of assets it accumulates. At present, the Fund's assets amount to less than 1% of GDP, and although our simulations indicate that they could reach approximately 6% of GDP by 2033, the year in which withdrawals are first permitted, this stock remains too limited to absorb a substantial share of the future increase in pension expenditures. Consequently, the Fund can only partially mitigate the need for higher taxes as demographic pressures intensify.[5]

[5]International comparisons underscore the magnitude of this limitation. Norway's Government Pension Fund Global holds assets equivalent to roughly 300% of GDP, while public pension reserve funds in Japan and South Korea each hold assets of approximately 45% of GDP. Sweden's reserve fund represents around 30% of GDP, and the assets managed by the Canada Pension Plan Investment Board amount to nearly 25% of GDP. Spain, by contrast, lies at the lower end of the distribution. Its Social Security Reserve Fund peaked at approximately 6–7% of GDP before the global financial crisis, but was substantially depleted between 2012 and 2017 and currently holds assets equivalent to less than 1% of GDP. These figures highlight the limited ability of the Spanish reserve fund to provide meaningful intertemporal tax smoothing in the face of population ageing (OECD, 2024).

Fifth, and closely related to the previous result, the reform has little effect on the projected path of Social Security deficits. Consequently, even under an investment strategy that permits some degree of intertemporal tax smoothing, substantial tax increases remain necessary to finance future pension expenditures. For example, when the consumption tax is used to balance the consolidated government budget, the tax rate must rise from 15% to approximately 26% over the coming decades in the reformed economy.[6] The underlying reason is the projected deterioration in the financial position of the pension system, whose deficit reaches around 7% of GDP in our simulations.[7]

The results described above suggest that the sustainability challenges facing the Spanish public pension system are structural in nature rather than cyclical. In Díaz-Gim'enez and Díaz-Saavedra (2026), we show that an important source of these challenges is the reversal of key pension reforms implemented at the beginning of the previous decade. In particular, the reforms enacted in 2021–2023 largely dismantled the sustainability-oriented framework introduced by the 2011 and 2013 reforms. The earlier reforms sought to strengthen the long-run financial viability of the system by increasing the statutory retirement age, extending the earnings reference period used to calculate pension benefits, and introducing automatic adjustment mechanisms linking pension expenditures to demographic and financial developments. By contrast, the recent reforms abolished these automatic stabilizers, most notably the Pension Revaluation Index and the Sustainability Factor, restoring full indexation of pensions to inflation and replacing the previous sustainability framework with alternative financing measures. Although these changes improved benefit adequacy and protected retirees' purchasing power, they also shifted a substantial share of the adjustment burden onto future taxpayers, thereby intensifying concerns about the long-term financial sustainability of the pension system.

Against this backdrop, the projected fiscal pressures associated with population ageing have motivated a wide range of proposals for structural reform of the Spanish pension system (e.g., Argandoña et al., 2011; Cebrián and Fernández, 2015; Díaz-Gim'enez and Díaz-Saavedra, 2017; Sánchez-Martín et al., 2026). Despite some differences in design, these proposals share a common feature: the introduction of a multi-pillar pension system combining a public pay-as-you-go pillar with a funded component designed to complement public retirement income. Under most proposals, the first pillar would consist of a public pension linked to individuals' lifetime contributions through a notional defined-contribution (NDC) scheme. In such a system, notional account balances would be adjusted using indexation mechanisms reflecting demographic and macroeconomic developments, thereby aligning pension entitlements more closely with the system's long-run financial capacity. The second pillar would consist of funded individual retirement accounts (IRAs) that accumulate

[6] In the benchmark economy, the required increase is even larger, with the consumption tax rate rising from 15% to 29%. These results further illustrate the limited scope for tax smoothing given the modest stock of assets accumulated in the Public Pension Reserve Fund.

[7] Comparable estimates can be found in Sánchez-Martín et al. (2026), and Díaz Giménez and Díaz Saavedra (2026).

financial assets during individuals' working lives and are converted into annuity payments upon retirement. Participation in this funded pillar would ideally be mandatory in order to ensure broad coverage, adequate retirement savings, and a more balanced distribution of retirement income across sources.

However, a large body of research has emphasized that structural pension reforms of this magnitude can impose substantial welfare losses on some transition generations (see, for example, Kotlikoff et al., 2001; Conesa and Garriga, 2003). These adverse distributional effects may, in turn, undermine political support for the reform and increase the likelihood of future policy reversals. At the same time, Díaz-Gim'enez and Díaz-Saavedra (2025) show that a carefully designed transition strategy, including compensatory transfers to adversely affected individuals, may be essential both to protect those who lose from the reform and to mitigate political resistance, thereby increasing its likelihood of implementation and long-run survival. A major obstacle to such a strategy, however, is the limited fiscal space available in many advanced economies. In particular, countries such as Spain already face high levels of public indebtedness, which constrain their ability to finance the transitional costs of pension reform through additional borrowing (Ghosh et al., 2013).

Given the economic and political challenges associated with implementing a comprehensive structural reform of the pension system, a more gradual approach may be preferable. One possibility is to build on existing institutions and progressively introduce some of the key elements of a multi-pillar pension system. For example, and in the case of Spain, these revenues generated by the IEM could be redirected toward funded IRAs rather than being used to accumulate assets in the Public Pension Reserve Fund. This is precisely the policy experiment considered in our final simulation exercise. Specifically, we analyze a third model economy, which we refer to as the Reformed Economy 2, in which revenues generated by the IEM are allocated to IRAs that accumulate financial assets throughout individuals' working lives and are converted upon retirement into a constant annuity paid until death, in a manner broadly similar to the systems operating in, for example, Sweden and Denmark. Furthermore, following the Exempt-Exempt-Taxed (EET) principle, both contributions and investment returns are assumed to be exempt from taxation during the accumulation phase, with taxation deferred until benefits are withdrawn during retirement (Armstrong et al., 2015).

The results indicate that this reform dominates the alternative policy arrangements considered in the paper. Unlike the two economies based on the Public Pension Reserve Fund, IRAs generate a direct increase in retirement income through the annuitization of accumulated savings, allowing households to achieve substantially better consumption smoothing over the life cycle. As a consequence, both consumption and welfare remain persistently higher, particularly among low-income households. Quantitatively, the present discounted value of the expected lifetime consumption gains accruing to the generations alive at the time of the reform amounts to more than 20% of Spain's current GDP. Not surprisingly, the welfare gains experienced by both newborn generations and the

majority of individuals alive at the time of the reform exceed those obtained under the alternative policy in which the Public Pension Reserve Fund is permitted to invest outside the Spanish public sector.[8] Finally, despite the sizeable welfare improvements generated by the reform, we continue to find only negligible differences in aggregate labor supply, capital accumulation, and output.

Finally, all the previous model economies under the assumption of a closed economy, implying the absence of international trade in goods and services as well as cross-border capital flows. In this environment, wages and interest rates are determined endogenously through the clearing conditions of the domestic labor and capital markets. Consequently, any policy change that affects household saving or labor-supply decisions has direct implications for factor supplies and, therefore, for equilibrium factor prices.

An important difference emerge when the model economies are analyzed in a closed-economy setting. In both reformed model economies, the revenues collected by the IEM are invested in domestic physical capital. As a result, the reforms increase aggregate capital accumulation and, consequently, raises output. Because aggregate effective labor supply remains virtually unchanged, the expansion of the capital stock increases the capital-to-effective-labor ratio, reducing the equilibrium interest rates while increasing wages. Furthermore, for the reasons outlined above, aggregate consumption rises, whereas the consumption tax rate necessary to satisfy the government budget constraint falls. Quantitatively, however, these effects are stronger in the closed economy, as the endogenous adjustment of wages and interest rates amplifies the impact of the reform on household behaviour and aggregate economic outcomes. Finally, we continue to find that the *Refomed Economy 2* is the winner of the race among both reformed economies.

Our paper relates to three distinct strands of the literature. The first examines the sustainability of Social Security systems in the context of population ageing. Given the size of this literature, we do not attempt a comprehensive review here. Representative contributions include Huggett and Ventura (1999), Conesa and Garriga (2008), İmrohoroğlu and Kitao (2012), and Díaz-Giménez and Díaz-Saavedra (2017). Using overlapping-generations frameworks, these studies quantitatively evaluate the aggregate and welfare effects of parametric pension reforms designed to address the fiscal challenges arising from demographic change.

The second strand focuses on the role of public pension reserve funds and encompasses several interrelated areas concerning their design, operation, and management. A first line of research examines their contribution to actuarial and fiscal sustainability, analyzing how the accumulation of reserve assets can mitigate demographic pressures and smooth contribution rates over time (Costrell and McGee, 2025; OECD, 2021). A second branch emphasizes governance arrangements

[8] Although older workers and retirees tend to prefer the policy that uses IEM revenues to accumulate external assets in the Public Pension Reserve Fund, reflecting the value they place on tax smoothing, the age distribution of the current Spanish population implies that nearly 60 percent of the population would support the introduction of IRAs.

and political risks, highlighting the importance of institutional independence, transparency, and accountability in protecting reserve funds from short-term political interference. For example, Yermo (2008) finds that stronger governance frameworks are associated with greater credibility and improved performance. Third, a substantial body of work investigates investment strategies and asset allocation, showing that globally diversified portfolios can improve risk-adjusted returns and enhance the long-run sustainability of pension systems (Dreassi et al., 2017, and Bohn, 1990). Finally, the political-economy literature underscores the risks of opportunistic government behavior, including the use of reserve funds for fiscal or electoral purposes, which may undermine their intended role as intertemporal stabilization mechanisms (Wang and Bohn, 2019).

The third strand studies the pre-funding of pay-as-you-go (PAYG) pension systems, whereby part of current contributions is invested in financial assets to help finance future pension liabilities. This approach has been extensively analyzed in both overlapping-generations and quantitative life-cycle models. For instance, Kotlikoff, Smetters, and Walliser (2001) show that the introduction of funded IRAs can generate substantial long-run welfare gains through higher saving and capital accumulation, although the transition may impose significant costs on some cohorts. Similarly, Kitao (2015) finds, in the context of Japan, that a move toward partial funding through individual accounts improves welfare and alleviates part of the fiscal burden associated with rapid population ageing, albeit at the cost of greater inequality across generations. More generally, OECD (2021) emphasizes that pre-funding can strengthen the sustainability of pension systems by facilitating intertemporal tax smoothing and reducing the distortions associated with pension financing. To the best of our knowledge, however, no previous study has examined the aggregate and welfare implications of replacing a public pension reserve fund with a system of IRAs. This paper seeks to fill that gap.[9]

The paper is organized as follows: section 2 describes the main features related to the Spanish Public Pension Reserve Fund; section 3 presents the model economy; section 4 describes the calibration procedure and its results; section 5 describes the simulations; section 6 describes the baseline scenario used in our simulations; section 7 presents the results; section 8 presents the sensibility analysis; section 9 discusses policy implications derived from our quantitative exercises; and, lastly, section 10 concludes.

2 The Spanish Public Pension Reserve Fund

The Spanish Social Security Reserve Fund, commonly referred to as the Public Pension Reserve Fund (Fondo de Reserva de la Seguridad Social, FRSS), is the principal instrument for accumu-

[9]In a recent working paper, Calvo López S., and D. Fernández Méndez (2026) advocate redirecting IEM revenues toward IRAs. While their proposal shares important similarities with the reform analyzed in this paper, they do not provide a quantitative evaluation of its macroeconomic or welfare consequences. Consequently, the potential benefits and costs of such a policy remain largely unknown.

lating financial reserves within Spain's public pension system. Its original purpose was to build up resources during periods of financial surplus to help finance contributory pension expenditure when ordinary Social Security revenues become insufficient. The creation of the fund was rooted in the recommendations of the Toledo Pact, which, in 1995, advocated the establishment of financial stabilization mechanisms to mitigate the effects of demographic ageing and economic fluctuations on the long-term sustainability of the pension system. These recommendations were subsequently incorporated into the legal framework through Law 24/1997, while the first effective allocation of resources to the fund took place in 2000 (Gallego Losada, 2014).

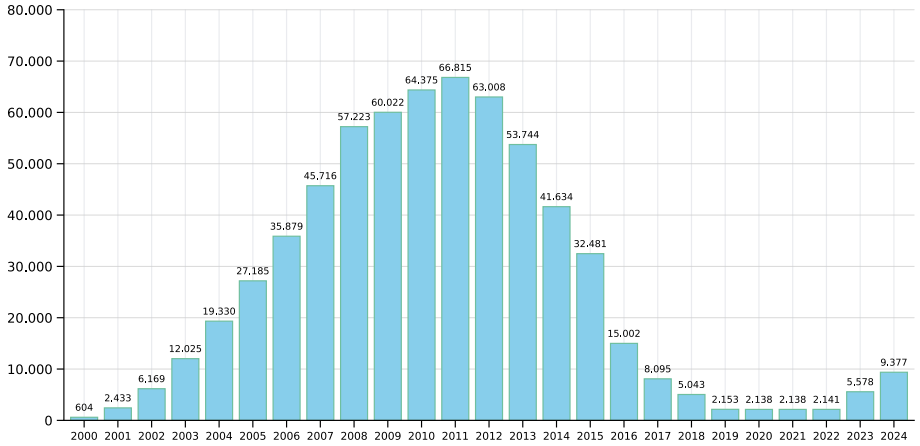
During the first decade of the twenty-first century, the FRSS accumulated assets rapidly, supported by strong economic growth, sustained employment expansion, and recurrent Social Security surpluses. Surplus resources generated by social security contributions were transferred to the fund, whose assets reached a historical peak of €66.815 billion in 2011, equivalent to more than 6% of Spanish GDP. By then, the FRSS had become one of Europe's largest public pension reserve funds relative to the size of its national economy, reflecting both favourable macroeconomic conditions and the strong revenue performance of the Social Security system (Gallego Losada, 2014).

This accumulation phase came to an abrupt end with the global financial crisis and the subsequent sovereign debt crisis. From 2012 onwards, deteriorating labour market conditions, weaker contribution revenues, and persistently rising pension expenditure led to substantial withdrawals from the fund to finance contributory pension benefits. Between 2012 and 2017, these withdrawals reduced its assets from more than €66 billion to approximately €8.1 billion. The decline continued in subsequent years, with the fund's balance falling to €2.138 billion by 2020. This depletion reflected the increasing gap between pension expenditure and current contribution revenues during this period.

The fund's financial position began to recover following the pension reforms introduced between 2021 and 2023. In particular, the replacement of the Sustainability Factor with the Intergenerational Equity Mechanism (Mecanismo de Equidad Intergeneracional, MEI) established a dedicated revenue source intended to rebuild the reserve fund. Additional contributions under the MEI began flowing into the FRSS in January 2023, contributing to a substantial recovery in its asset holdings. By the end of 2025, the fund's assets had reached €14.069 billion, equivalent to 0.83% of Spanish GDP (Social Security, Informe a las Cortes Generales 2025).

The financing structure of the FRSS has therefore changed substantially over time. Initially, the fund was financed primarily through Social Security budget surpluses. Its current financing framework, by contrast, relies mainly on revenues from the MEI, supplemented by part of the surpluses generated by collaborating mutual insurance entities and by returns on the fund's investment portfolio. Subsequent legislative changes, including those adopted in 2023 and 2025, have reinforced this framework with the aim of rebuilding the reserve progressively and strengthening the pension

Figure 1: Accumulated Assets in the Spanish Public Pension Reserve Fund (Billions of Euros)*



* Source: González (2025).

system's capacity to cope with the demographic pressures expected over the coming decades.

Despite these changes in its financing arrangements, the FRSS has historically pursued a highly conservative investment policy. Its management has prioritized capital preservation, security, and liquidity over the pursuit of higher returns. Since the mid-2000s, the portfolio has consisted predominantly of debt securities issued by the Spanish Government, with only limited holdings of sovereign bonds issued by other highly rated euro-area countries at certain times. According to official management reports, the portfolio's exposure to Spanish public debt increased progressively until such securities accounted for virtually all its assets.[10]

This investment policy has important implications for the fund's capacity to smooth the fiscal adjustment associated with population ageing. Although accumulating reserves can provide the Social Security system with a financial buffer, investing those reserves primarily in Spanish government debt does not generate an equivalent accumulation of net financial assets for the consolidated public sector, since the fund's holdings are liabilities of the Spanish Government. Consequently, the extent to which the FRSS can facilitate intertemporal tax smoothing depends not only on the size of its assets but also on the nature of the instruments in which those assets are invested.

3 The Model Economy

We analyse an overlapping-generations open-economy model with heterogeneous households, a representative firm, and a government sector. The framework extends the model developed in

[10] see *Fondo de Reserva: Informe a las Cortes Generales 2025.*

detail in Díaz-Saavedra et al. (2023). The primary enhancements consist of the introduction of an income tax system and a social security function. Accordingly, these components are described in detail, while the remaining elements of the model are presented more briefly for the sake of exposition.[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 labour market status, $s \in \mathcal{S}$; and in their private assets, $a \in A$. Sets J, H, $\mathcal{Z}$, $\mathcal{S}$, and A, are all finite sets and we use $\mu_{j,h,z,s,a}$ to denote the measure of households of type (j, h, z, s, 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.

Labour 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). Workers decide when to retire, leaving the labour 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 labour 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 labour services and receives a salary that depends on his endowment of efficiency labour 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.

[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, where this dependence comes from the ageing transition that is modelled as a change, over time, of the age-specific survival probabilities and the share of age groups and education levels as new cohorts enter the economy, as well as from any changes to policy variables. In this section we omit this dependence.

The stochastic component is independently and identically distributed across the households, and we calibrate it to match moments of the Spanish earnings and wealth distribution, following Castañeda et al. (2003). This component does not depend on the age or the education of the households, and we assume that it follows a first order, finite state, Markov chain. We assume that this stochastic component can take three values, and we make this assumption because it turns out that three states are sufficient to account for the Lorenz curves of the Spanish distributions of income and labour 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 labour 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 labour market flows between unemployment and employment. The job offer involves employment at a wage rate that corresponds to a productivity level that is drawn from the unconditional distribution of productivity. 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 labelled 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 labour 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 labour productivity. If they decide to retire, they loose the endowment of labour efficiency units for ever and exit the labour market. Unemployed and inactive households who are R_0 years or older are forced to retire.

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

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

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 labour and the search effort. Labour 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 labour market permanently.

Insurance Markets. An important feature of the model is that there are no insurance markets for the stochastic component of the endowment shock, for unemployment risk, or survival risk. We model different public insurance systems that help agents in the economy smooth consumption in the face of these shocks.

3.2 The Firm

In our model economy there is a representative firm. Aggregate output depends on aggregate capital, K, and on the aggregate labour input, L, through a constant returns to scale, Cobb-Douglas, aggregate production function:

$$Y = K^{\theta}(B\ L)^{1-\theta} \tag{1}$$

where B is the labour augmenting growth factor, whose law of motion is $B^{'} = (1+g)B$, and where g is the labour augmenting growth rate.

Factor and product markets are perfectly competitive and the capital stock depreciates geometrically at a constant rate, δ. The firm rents capital in the international capital market at an exogenous interest rate r, and hires workers in the domestic market at a wage rate ω per efficiency unit of labour. Under these assumptions, the international interest rate r pins down the wage rate ω. Finally, the profit maximizing behaviour of firms implies that their demand of both capital and labour are equal to their marginal productivities.

[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 The Government

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

3.3.1 The Pension System

Differently from Díaz-Saavedra et al. (2023), this version of the model economy introduces an additional institutional feature of the current Spanish public pension system: the payroll tax rate is capped. Specifically, the payroll tax function is given by:

$$t_p(y^l) = \begin{cases} \tau_p y^l & \text{if } y^l < \overline{y}^l \\ \tau_p \overline{y}^l & \text{otherwise} \end{cases} \tag{2}$$

where parameter τ_p is the payroll tax rate, y^l is the gross labour 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.

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 part of 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:

$$\tau_y(y_t^b) = a_0 \left\{ y_t^b - \left[a_1 + (y_t^b)^{-a_2} \right]^{-1/a_2} \right\} \tag{3}$$

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.[14]

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

3.3.3 The Consolidated Government Budget

The consolidated government and pension system budget constraint is

$$G + Z + P + U = T_k + T_y + T_c + T_p + E \tag{4}$$

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 the part of unintentional bequests collected by the government, and we assume that the portion of accidental bequests that is not taxed by the government is wasted.

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.[15]

4 Calibration

Differently from Díaz Saavedra et al. (2023), we choose 2022 as our calibration year. Also, this version of our model economy introduces an income tax function composed of three parameters, as proposed by Gouveia and Strauss (1994). Moreover, and because we introduce a cap for the social security tax function that adds an additional parameter, we should finally determine the value for four new parameters. However, and since we updated the calibration target year, the final number of parameters to be calibrated are 44, and we show some of these values in Appendix 1.[16]

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

[15] De Mooij and Keen (2012) and Alesina et al.(2015) show that consumption taxes are among the most widely used instruments for raising government revenue.

[16] This implies that to fully characterize this version of our model economy, we must choose the values of a total of 44 parameters. Of these 44 parameters, 5 describe the household preferences, 21 the process on the endowment of efficiency labour units, 4 the production technology, 5 the pension system rules, and 9 the remaining components of the government policy. To choose the values of these 44 parameters, we need 44 equations which formalize our calibration targets. In Brogueira de Sousa et al. (2022), Díaz Saavedra et al. (2023), and in the Appendix 1 of this paper, we describe in detail the calibration procedure.

procedure. To differentiate targeted from untargeted moments, we present the first group of Spanish statistics in bold face.

Macroeconomic Aggregates and Ratios. Table 1 reports the main macroeconomic aggregates and ratios for Spain and the benchmark model economy in 2022. Overall, the benchmark economy replicates the key features of the Spanish economy remarkably well, matching most of the principal macroeconomic aggregates and ratios. The main discrepancies arise in the investment-to-GDP and public-consumption-to-GDP ratios. However, this last difference is expected, as public consumption is determined residually in the model to ensure that the government budget constraint is satisfied in the calibration target year.

Table 1: Macroeconomic Aggregates and Ratios in 2022 (%)*

	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^b/Y
Spain	**2.94**	53.24	25.89	20.36	**12.91**	**1.54**	**0.83**	**9.15**	**12.16**	**2.71**	**6.99**	**0.20**
Model	2.94	53.45	28.96	12.82	12.68	1.58	0.81	9.14	12.16	2.71	7.00	0.20

*In this table, variable Y is GDP at market prices.

[a]Variables C, I, and X denote private consumption, investment, and net exports.

[b]Some Spanish regions feature a proportional tax on bequests. We use the aggregate revenue of this tax in 2018 as the data point for E (0.20% of output). But in our model economy, aggregate accidental bequests as a fraction of output are significantly higher in the initial steady state. Consequently, we assume that the portion of accidental bequests that is not taxed by the government is wasted.

The main calibration differences relative to the earlier version of the model developed in Díaz-Saavedra et al. (2023) are reflected in the capital-to-GDP, consumption-to-GDP, and investment-to-GDP ratios. In particular, the previous version was unable to match these ratios closely in its 2018 calibration year. By contrast, the revised model delivers a substantially better fit, as the discrepancies between the simulated and observed values for the Spanish economy in 2022 are considerably smaller.

The labour market. Table 2 shows the profiles of the employed, and unemployed households by age and education. 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 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 2 shows the profiles of employee, unemployed, inactive and retired households by age.

Again, the model economy does a good job in replicating the shares and age-profiles of labour status, although we also find that it predicts a higher (lower) unemployment (employment) rate in comparison to Spain.

Table 2: Labour Market Shares in 2022 (% of population).

	W	U	I	R
Spain	**61.09**	8.83	**5.57**	24.50
Model	57.27	12.43	5.30	25.00

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

5 The Simulations

The Benchmark Model Economy. Our benchmark economy is the economy that we modelled and calibrated to approximate the Spanish economy in 2022. Specifically, this economy features the Spanish public pension rules just after the pension policy reversal, when the Sustainability Factor and the Pension Revaluation Index were eliminated, as described in Díaz-Giménez and Díaz-Saavedra (2025). In addition, we assume that this economy introduces the IEM, which increases the payroll tax rate. This increase goes from 0.6 percentage points in 2023, to 1.2 percentage points in 2029, the year from which it will remain constant at that level, and these additional revenues are accumulated in a Reserve Fund. Since 2033, the Spanish Government can make withdrawals from this fund in order to partially reduce the imbalance between payroll tax revenues and pension expenditures (see Figure 3)[17].

In our model economy, we assume that the Pension Reserve Fund evolves between 2023 and 2032 according to

$$F^{'} = (1+r)F + \Delta T_p \tag{5}$$

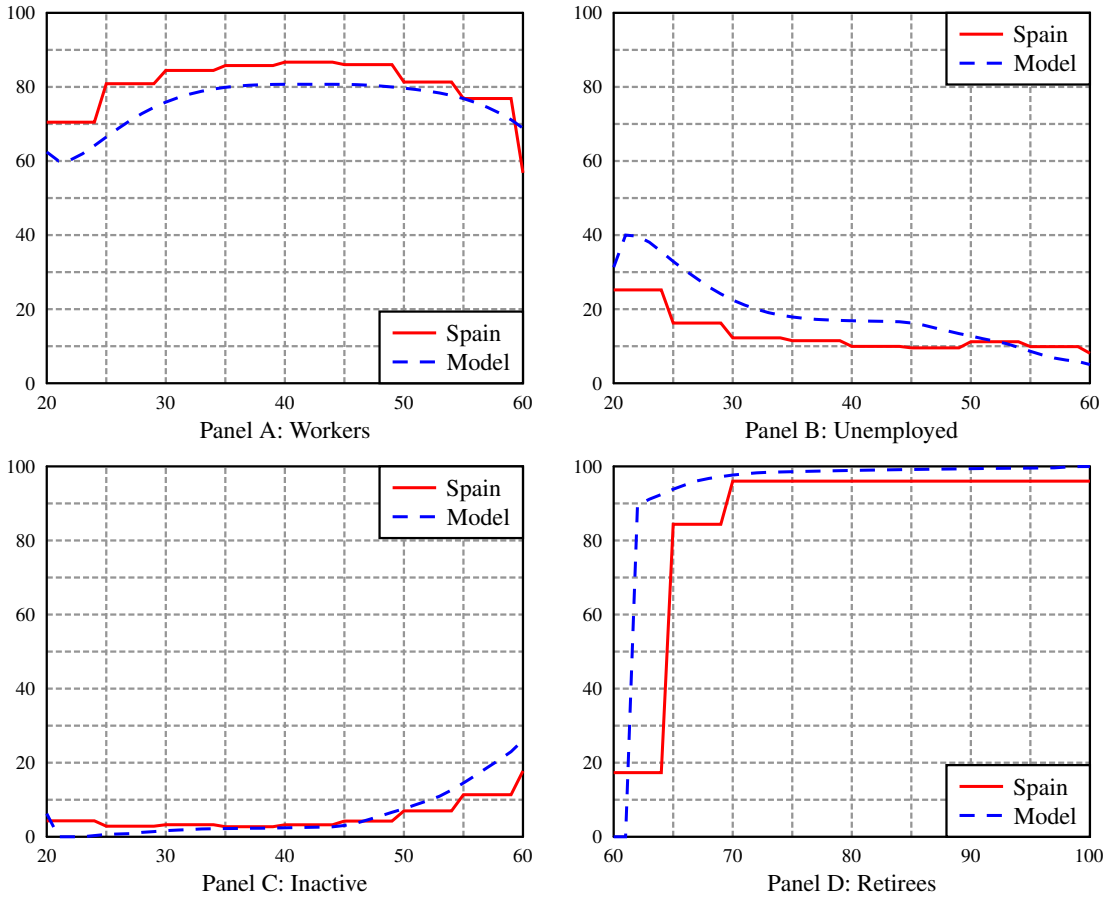
where $F^{'}$ is the value of the Pension Reserve Fund at the beginning of the next period, r is the exogenous interest rate, and ΔT_p are the additional payroll tax revenues collected by the IEM. After 2032, the law of motion of this fund is given by

$$F^{'} = \begin{cases} (1+r)F + \Delta T_p - x\ Y, & \text{if } T_p - P < 0. \\ (1+r)F + \Delta T_p, & \text{otherwise.} \end{cases} \tag{6}$$

where x is the maximum disbursements from the Pension Reserve Fund per year as a share of the Gross Domestic Product (see Panel A of Figure 3). We assume that the reserve fund is invested in domestic public debt, and that x_t is given by the values approved by the Spanish Government in 2023. Finally, we require the pension reserve fund to be non-negative, so that when the pension fund assets ran out, the government removes this fund.

[17]The values of these maximum annual disbursements from the Pension Reserve Fund have been approved through the Spanish Royal Decree-Law 2/2023, of March 16, 2023, and published in the Spanish Official State Gazette, BOE-A-2023-6968, page 21. We assume that after 2052, the maximum annual disbursements from the Pension Reserve Fund continues to be 0.51 percent of output while this fund still has assets.

Figure 2: Labour Market Shares by Age in Spain and the Model Economy in 2022 (%)*



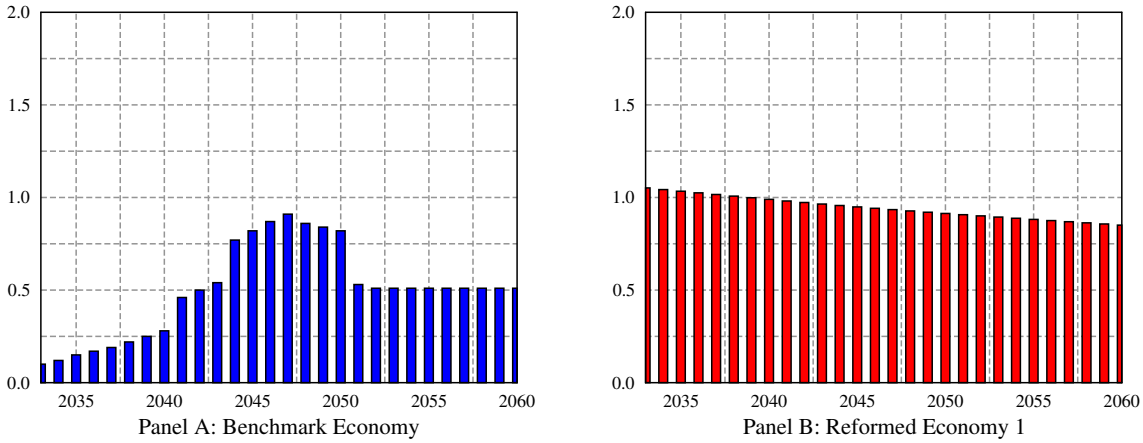
*The shares of workers are the shares of workers in the sum of workers and unemployed. We compute this share for Spain from the *Encuesta de Población Activa (2022)*, reported by the INE.

Apart from the IEM, our model economy does not introduce the remaining parametric changes approved by the 2021 and 2022 pension reforms. Among these, the most prominent are the introduction of a solidarity contribution, the gradual increase in both the maximum contribution base and the maximum retirement pension, and the enhancement of pension reward for workers who delay retirement beyond the statutory retirement age. This is because, while some of these measures strengthen the revenue side of the pension system, others generate offsetting increases in pension expenditures. As a result, their combined effect on the overall financial balance of the system is relatively limited.[18]

Note that public debt does not appear on the government's consolidated balance sheet for two reasons. First, we abstract from the stock of public debt outstanding at the time the IEM was

[18]See Díaz-Giménez and Díaz-Saavedra (2026) for a detailed description of these parametric reforms and a quantitative evaluation of their effects.

Figure 3: Withdrawals from the Public Pension Reserve Fund (% of GDP)



introduced, namely at the end of 2021.[19] Second, given the investment policy of the Reserve Fund, a balance-sheet consolidation issue arises from that date onward: the Fund's assets are liabilities of the same public sector that owns them. As a result, the accumulation of assets in the Reserve Fund does not generate net public wealth. Put differently, the additional revenues raised through the IEM are exactly offset by the increase in public debt issuance required to finance the corresponding accumulation of Fund assets.

The Reformed Model Economy 1. Our second policy experiment assumes that the Spanish government continues to operate the Public Pension Reserve Fund, but under an alternative investment strategy, and a different disbursement policy. Specifically, we assume that the revenues generated by the IEM are invested in a diversified portfolio of foreign government bonds and private-sector securities rather than in Spanish government debt.[20] And also unlike the Benchmark Model Economy, this reform assumes that the Fund is fully depleted by 2060. Consequently, asset sales are used to smooth the tax burden during the period in which demographic projections from the Spanish National Statistics Institute (INE) predict the most intense ageing-related fiscal pressures. Once the Fund has been exhausted, all revenues generated by the IEM are assumed to be directed toward financing a portion of the pension system's deficit.

On the other hand, the Fund continues to be financed through its existing mechanism, while asset withdrawals remain subject to the current institutional constraint that decumulation cannot commence before 2033. Accordingly, the law of motion governing the Fund in this reformed economy is given by:

[19] According to World Bank data, Spain's public debt amounted to 118.7% of GDP at the end of 2021.

[20] Because aggregate uncertainty is absent from the model, foreign government bonds and private-sector securities are treated as perfect substitutes and are therefore assumed to yield the same exogenous risk-free rate of return.

$$F' = \begin{cases} (1+r)F + \Delta T_p - z\,Y, & \text{if } T_p - P < 0. \\ (1+r)F + \Delta T_p, & \text{otherwise.} \end{cases} \tag{7}$$

where z represents annual disbursements from the Pension Reserve Fund as a percentage of GDP (see Panel B of Figure 3). It should be noted that, under the Fund's new investment policy, the government's consolidated budget constraint changes once the accumulated assets can begin to be decumulated. Specifically, starting in 2033, when the Fund is first permitted to liquidate a portion of its assets, the consolidated budget constraint takes the following form:

$$G + Z + P + U = T_k + T_y + T_c + T_p + E + z\,Y \tag{8}$$

The Reformed Model Economy 2. In this third model economy, revenues generated by the IEM are redirected to IRAs owned by working-age individuals. These accounts accumulate financial assets throughout the working life and are invested in a diversified portfolio of foreign government bonds and private-sector securities, yielding the exogenous real rate of return available in international capital markets. Upon retirement, the accumulated assets are annuitized and transformed into a constant stream of payments that individuals receive for the remainder of their lives.

Specifically, the law of motion of these IRAs is given by

$$b' = (1+r)b + \tau_{iem} y^l \tag{9}$$

where b' is the end of period stock of assets accumulated in the IRAs, r is the exogenous interest rate, τ_{iem} is the payroll tax associated to the IEM, and y^l is the gross labour income.[21] Upon retirement, assets accumulated in the IRAs are used to buy a lifetime annuity, and following Brogueira de Sousa et al. (2022), this annuity can be written as:

$$p(b) = \left[1 + \sum_{t=1}^{T-R} \frac{\prod_{i=0}^{t} \psi_{R+i}}{(1+r)^t} \right]^{-1} b \tag{10}$$

where $p(b)$ denotes the annuity payment received by the retiree, and is treated as part of the taxable base within the personal income tax code. Note that we adopt the standard modelling assumption whereby contributions, interest earnings, and capital gains are exempt from taxation during the accumulation phase, with taxation deferred until benefits are withdrawn in retirement. This assumption is motivated by the prevailing practice in most OECD countries, commonly referred to as the Exempt–Exempt–Taxed (EET) regime (see Armstrong et al., 2015).

[21] Note that for unemployed and inactive households, $y^l = 0$.

6 The Scenario

In the following section, we analyse the aggregate and welfare effects of two reformed model economies. To ensure comparability, all model economies are initialized under identical conditions and are simulated on a common baseline scenario. The main characteristics of this scenario are outlined below.

Demography. The demographic evolution replicates the demographic projections for Spain for the period 2022–2072 estimated by the *Instituto Nacional de Estadística* (INE) in 2022.[22]

Education. The initial educational distribution of our model economies replicates the educational distribution of the Spanish population in 2022, as reported by the INE.[23] After 2022, we assume that the educational shares for the 20-year old entrants are 7.33 percent, 62.62, and 30.05 percent forever for drop-outs, high school graduates, and college graduates. Those shares are the educational shares of the most educated cohort ever in Spain, which corresponds to the 1980 to 1984 cohort.

Growth. We assume that the labour productivity growth rate is 1.1 percent after 2022. The rationale for this choice is because the Spanish average annual labour productivity growth rate between 1995 and 2012 was precisely 0.9 percent, according to the OECD.

Fiscal Policy. 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 2022 values. The part of unintentional bequest taxed by the government is identical across the economies. The consumption tax rates differ across the economies because we adjust them to close the consolidated government budget after 2022. All remaining variables in the consolidated government budget constraint and the law of motion of the Pension Reserve Fund are endogenous and therefore differ both over time and across model economies.[24]

Reform Announcement. We assume that both reforms of Spanish Public Pension Reserve Fund are announced and implemented at the beginning of 2023, and we also assume that these reforms are unexpected by households.

[22] These projections can be found at $https://ine.es/dyngs/INEbase/es/operacion.htm?c = Estadistica_C cid = 1254736176953 menu = resultadosidp = 1254735572981$. This ratio increases from 33.1 in 2022 to 52.8 in 2070. We assume that the age distribution remains constant after 2072.

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

[24] We assume that during the transitional dynamics, public consumption is a constant proportion of output at market prices. Alternatively, one might assume that public consumption remains constant at the Benchmark economy level throughout the transition path of the Reformed Economy. This approach is convenient if one would assume that public consumption also generates some utility benefits for households, so that they can be neglected in the welfare calculation. In contrast, our modelling choice assumes that public consumption remains constant as a fixed proportion of GDP in all transitional dynamics (the Benchmark and the Reformed economies), so that the public consumption per capita differs throughout all economies.

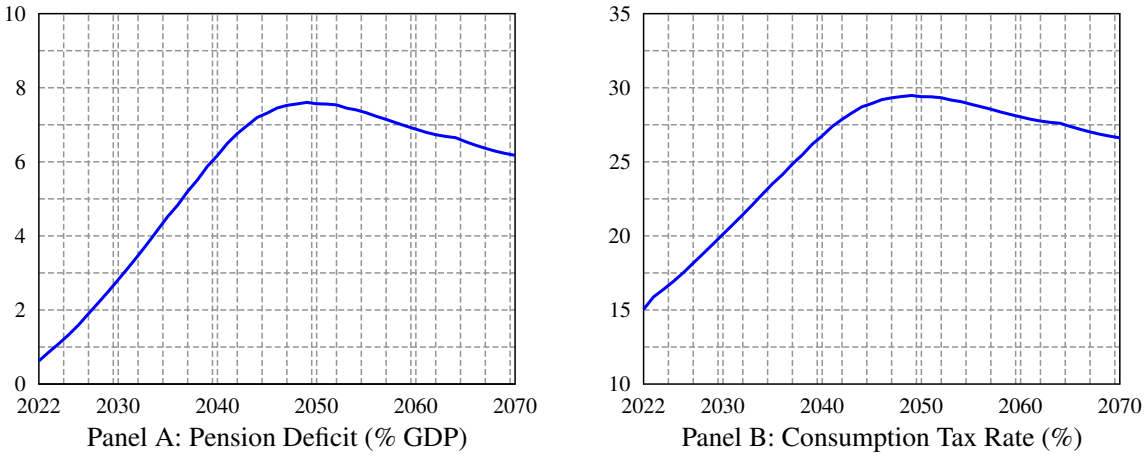
7 Results

We analyse the aggregate and welfare consequences of the aforementioned policy reforms. The analysis is conducted in two steps. First, we analyse the aggregate and welfare consequences associated with these policy changes in a hypothetical long run final steady state. Finally, we compare the transitional dynamics of all model economies, tracing the adjustment path from the initial equilibrium to the final steady state. As a first step, however, we analyze the projected evolution of the public pension system's budget over the coming decades and its implications for the consumption tax rate.

7.1 The Benchmark Model Economy

Recall that, in the *Benchmark Model Economy*, we assume that the Spanish Public Pension Reserve Fund invests the additional revenues generated by the IEM in domestic government debt. Our simulations indicate that Spain's current pay-as-you-go, defined-benefit pension system is financially unsustainable. Specifically, the pension system deficit is projected to reach 7.5 percent of GDP by 2050 (Panel A of Figure 4). Financing this deficit through consumption taxation would require raising the consumption tax rate to 29.4 percent in the same year, 14.3 percentage points above its 2022 level (Panel B of Figure 4).

Figure 4: The Public Pension Deficit and the Consumption Tax Rate



*: % of Output per Capita 20+.

Consistent with the existing literature on Spanish pension reform, we find that these sustainability challenges are fundamentally structural in nature. Specifically, while pension system revenues remain broadly stable over time, pension expenditures increase substantially. Revenues amount to 12.1% of GDP in 2022 and 11.2% in 2070, whereas expenditures rise from 12.7% of GDP in

2022 to 17.4% in 2070. This increase in spending is driven primarily by two factors: improvements in longevity and population aging. According to the INE's 2022 demographic projections, life expectancy at age 65 is expected to increase from 21.1 years in 2022 to 24.6 years in 2070. Over the same period, the share of the population aged 65 and over is projected to rise from 33.1% to 53.5%.

7.2 Alternative Investment Strategies Beyond Spanish Public Debt

In the second alternative economy, the Public Pension Reserve Fund is not allowed to invest in Spanish government debt. The purpose of this experiment is to evaluate whether the Fund's accumulated assets can provide a meaningful source of financing for the sustained rise in pension expenditures anticipated over the coming decades. Instead, all Fund resources are invested in risk-free domestic or foreign assets yielding returns given by the exogenous international interest rate.

7.2.1 The Long Run

In the long run, the Public Pension Reserve Fund is eventually depleted, and the revenues generated by the IEM are used directly to finance a portion of the pension system's deficit. As a result, the consumption tax rate falls by 1.8 percentage points, from 26.6% to 24.8%, relative to the Benchmark Economy. This reduction in distortionary taxation increases aggregate household consumption by 1.4%.

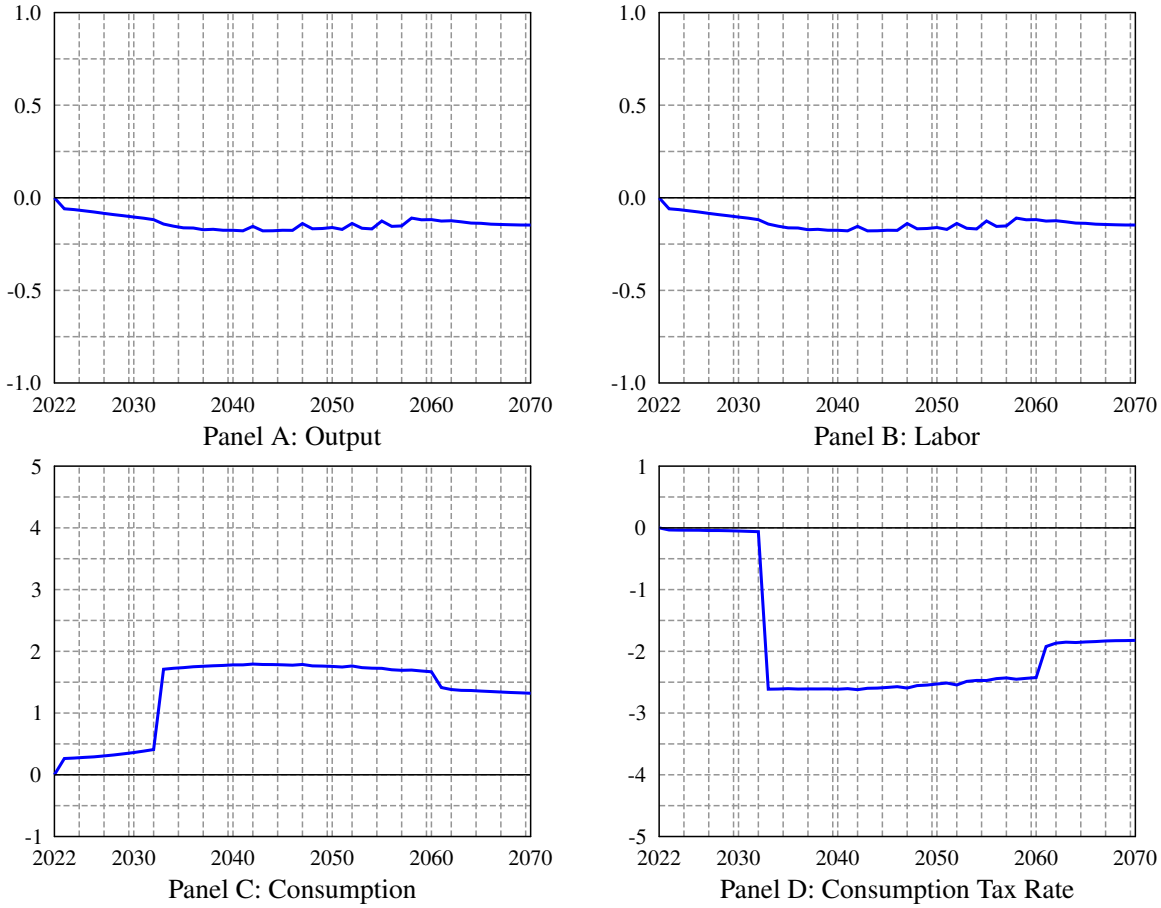
Beyond its effects on consumption and the consumption tax rate, however, the reform has virtually no impact on the main macroeconomic aggregates. In particular, total hours worked, and hence aggregate output, remain largely unchanged relative to the Benchmark Economy. Because the rental rate of capital is fixed exogenously, the capital stock adjusts endogenously to maintain a capital-to-labor ratio consistent with that rate, resulting in only negligible changes in aggregate capital. Finally, the increase in expected lifetime consumption translates into a 1.1% rise in expected lifetime utility at birth.

7.2.2 Transitional dynamics

Recall that the new investment policy of the Spanish Public Pension Reserve Fund is announced and implemented at the beginning of 2023 and is assumed to be unanticipated by households. Consequently, the paths of economic variables diverge across the two economies from that point forward. The remainder of this section describes the evolution of the main aggregate variables. We also assume that the Fund starts liquidating its asset holdings in 2033 and is fully depleted by 2060. The revenues generated through asset sales are used to partially finance pension expenditures, allowing the government to smooth taxes over time during the period of greatest demographic

pressure. Thereafter, revenues generated by the IEM are allocated directly to cover the pension system's deficit. Consequently, the Public Pension Reserve Fund disappears as a separate institution once its assets have been fully exhausted.[25]

Figure 5: Differences in Key Variables Relative to the Benchmark Model Economy*(%)



*: The differences in the consumption tax rate are reported in percentage points.

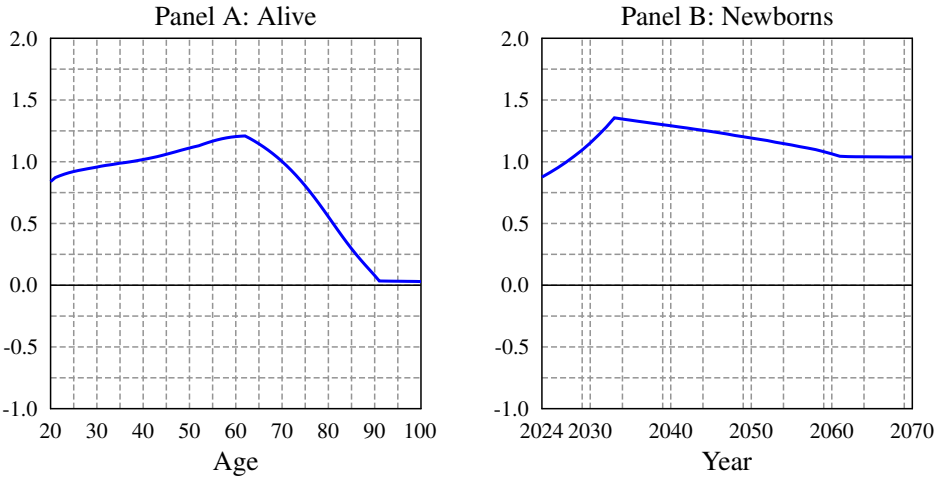
Panel A of Figure 5 shows that this investment policy for the Public Pension Reserve Fund has virtually no effect on the evolution of aggregate output. This result reflects the absence of significant changes in total hours worked and the endogenous adjustment of the capital stock, which maintains a capital-to-labour ratio consistent with the constant, exogenous interest rate.

In contrast, the policy has important implications for the path of the consumption tax and,

[25]The 2021 reform of the Spanish pension system imposes withdrawal limits that cap total asset sales at 0.91 percent of GDP by 2047 (see Panel A of Figure 3). As shown by Díaz-Giménez and Díaz Saavedra (2026), this rule is sufficiently conservative to prevent the Fund from ever being fully depleted. In contrast, we assume that the Fund is exhausted by 2060, enabling it to serve as an effective tax-smoothing device during the demographic transition. Accordingly, the withdrawal policy considered in our analysis differs from that prescribed by the 2021 reform.

consequently, for aggregate household consumption. As shown in Panel D of Figure 5, once the Public Pension Reserve Fund begins to liquidate a portion of its assets in 2033, these asset sales reduce the increase in consumption taxation required to finance pension expenditures.[26] As a result, the consumption tax follows a flatter trajectory, remaining roughly 2.5 percentage points below its level in the Benchmark Model Economy throughout this period. The resulting reduction in the tax burden boosts aggregate household consumption (Panel C of Figure 5), which in turn broadens the tax base. Once the Fund is fully depleted, revenues generated by the IEM are used directly to finance part of the pension deficit, allowing the consumption tax rate to remain below that prevailing in the Benchmark Model Economy.

Figure 6: Differences in Expected Lifetime Utility (%)



The increase in expected lifetime consumption improves the welfare not only of future generations but also of those alive at the time the reform is implemented. Specifically, we find that all cohorts alive in 2023 would prefer the alternative investment policy for the Public Pension Reserve Fund, with workers approaching retirement experiencing the largest welfare gains in terms of expected lifetime utility (Panel A of Figure 6). For the remaining cohorts alive at the time of the reform, the gains are more moderate. Among younger workers, this outcome reflects the fact that, despite the smoother path of consumption taxation, they continue to face increases in the consumption tax rate until 2060. For retired households, welfare gains are smaller because they benefit from lower consumption tax rates relative to the Benchmark Model Economy for only a limited portion of their remaining lifetimes.

The policy is also welfare-improving for all cohorts born after 2023, primarily because the decumulation of the Fund's assets reduces the need for higher consumption tax rates to finance rising pension expenditures. However, these welfare gains decline monotonically across successive cohorts

[26] According to our model, the Fund's asset holdings peak at approximately 6% of GDP in 2033.

and gradually converge to their long-run level as the year of birth approaches 2060. In the long run, expected lifetime utility increases by approximately 1%. The intuition is straightforward. Once the Fund's assets have been fully depleted, revenues generated by the IEM are used exclusively to finance a portion of the pension deficit. Although this arrangement continues to moderate the increase in consumption tax rates relative to the Benchmark Model Economy, the resulting welfare gains are smaller, as households no longer benefit from the additional tax relief provided by asset decumulation (see Panel B of Figure 6).

7.3 Individual Retirement Accounts

Recall that in the third model economy, revenues generated by the IEM are redirected to IRAs owned by working-age individuals. These accounts accumulate financial assets throughout the working life and are invested in a diversified portfolio of foreign government bonds and private-sector securities, yielding the exogenous real rate of return available in international capital markets. Upon retirement, the accumulated assets are annuitized and transformed into a constant stream of payments that individuals receive for the remainder of their lives.

7.3.1 The Long Run

From a life-cycle perspective, the defining feature of IRAs is that contributions are deferred consumption. Put differently, unlike distortionary taxes that permanently reduce disposable resources, mandatory contributions to retirement accounts increase future income streams. Retirees therefore enter old age with higher financial wealth, which directly translates into higher consumption during retirement (see third column of Table 3).

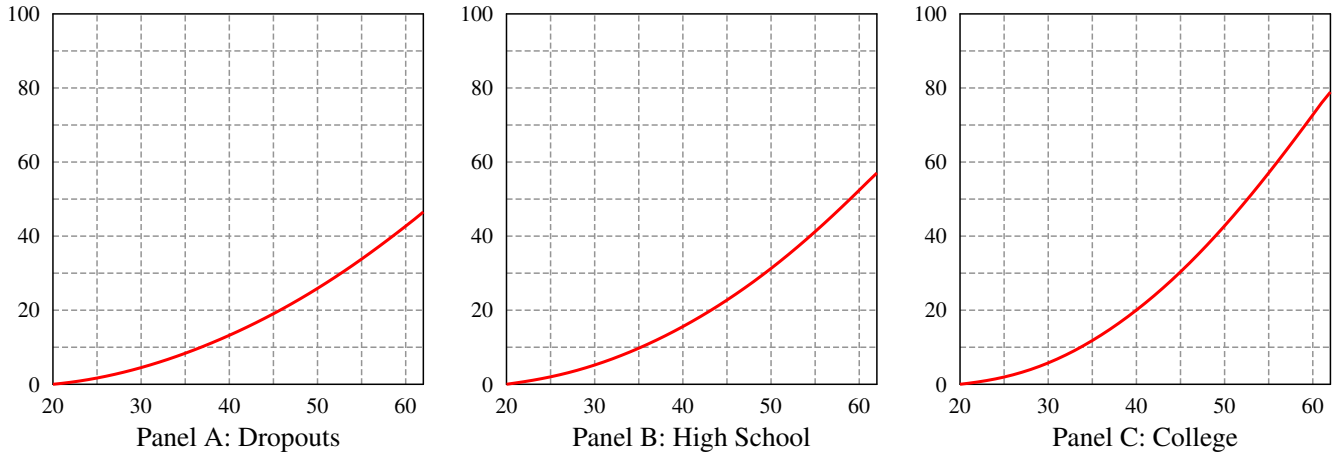
Specifically, and at the first retirement age 62, the accumulated stock of assets held in IRAs represents 46.5%, 57.7%, and 79.8% of GDP per capita 20+ for high school dropouts, high school, and college-workers, respectively (see Figure 7). Consequently, the annualized value of these retirement assets also varies markedly by educational attainment, corresponding to 2.7%, 3.3%, and 4.6% of GDP per capita 20+ for that same groups.[27] Moreover, these annuities are financed through a contribution rate of only 1.2%, substantially lower than the contribution rates prevailing in many countries where IRAs represent an additional source of retirement income.[28]

Related to this, the increase of consumption in the retirement phase reduces the need for precautionary savings during working years (see column 2 of Table 3). That is, workers internalize

[27] When expressed in constant Euros, these figures translate into annual payments of €1,088 (€90.7 monthly), €1,330 (€110.8 monthly), and €1.854 (€154.5 monthly), respectively, measured in 2024 Euros.

[28] For example, the contribution rate into mandatory private pension accounts was 4.75 percent in Germany in 2024. Consequently, even moderate policy adjustments in contribution rates have the potential to generate economically meaningful improvements in retirement income adequacy.

Figure 7: The Accumulated Stock of Assets in the Individual Retirement Account*



*: % of Output per Capita 20+.

the fact that part of their future consumption is already financed through mandatory retirement accounts, and thus choose to allocate a larger fraction of their current income to consumption (see column 3 of Table 3). Moreover, the increase in consumption has further fiscal implications, since higher consumption during both working life and retirement increases the consumption tax base. Consequently, given that consumption taxes are among the most widely used instruments for raising government revenue (De Mooij and Keen, 2012; Alesina et al., 2015), a larger consumption tax base allows the government to generate a given amount of revenue with a lower tax rate. This, in turn, further increases household consumption. For instance, the consumption tax rate needed to close the government budget decreases from 26.7 percent in the Benchmark economy to 24.5 percent in the Reformed economy.

At the aggregate level, the reform results in a significant increase in household consumption, with aggregate consumption exceeding that of the benchmark economy by 5 percent. However, we continue to find no significant variation on total worked hours, and consequently, output. However, and looking at the fine print, we find a small reallocation of labour supply over the life cycle. Specifically, younger workers optimally choose to supply fewer hours of labour, anticipating extended participation in the labour market later in life, thereby allowing them to accumulate greater assets in their IRAs (see column 4 of Table 3). This result is related with the findings of McGrattan and Rogerson (1998), who reported that US workers in the last century both shortened their working period and shifted work hours from older to younger ages as social security coverage increased. Another finding is that, although households in the reformed economy hold lower levels of liquid assets (see column 2 of Table 3), their overall wealth, including assets accumulated in IRAs, is approximately 14 percent higher than that of households in the benchmark economy. In

particular, assets held in these IRAs amount to 37.5 percent of total output.

Finally, the reform generates unambiguously positive welfare effects. Compared with the benchmark economy without IRAs, households benefit from a 1.93 percent increase in expected lifetime utility at birth. This welfare gain is mainly driven by two complementary mechanisms: improved consumption smoothing and higher lifetime consumption. Moreover, the welfare gains exhibit a negative relationship with respect to educational attainment: the increase in expected lifetime utility is largest for dropouts (2.03 percent), followed by high school graduates (1.94 percent) and college-educated households (1.83 percent). This result stems from the fact that dropouts experience the most pronounced decline in liquid asset savings during their working years and the greatest percentage increase in consumption in old age in comparison to its educational counterparts.

Table 3: Differences in Labour Hours, Liquid Assets, and Consumption by Age Groups (%)*

	Assets	Consumption	Work hours
20-34	–0.38	1.61	–0.08
35-49	–1.19	1.83	–0.17
50-64	–4.97	3.29	–0.47
65+	–34.93	8.58	1.64

* Differences between the Reformed and the Benchmark economies.

7.3.2 Transitional Dynamics

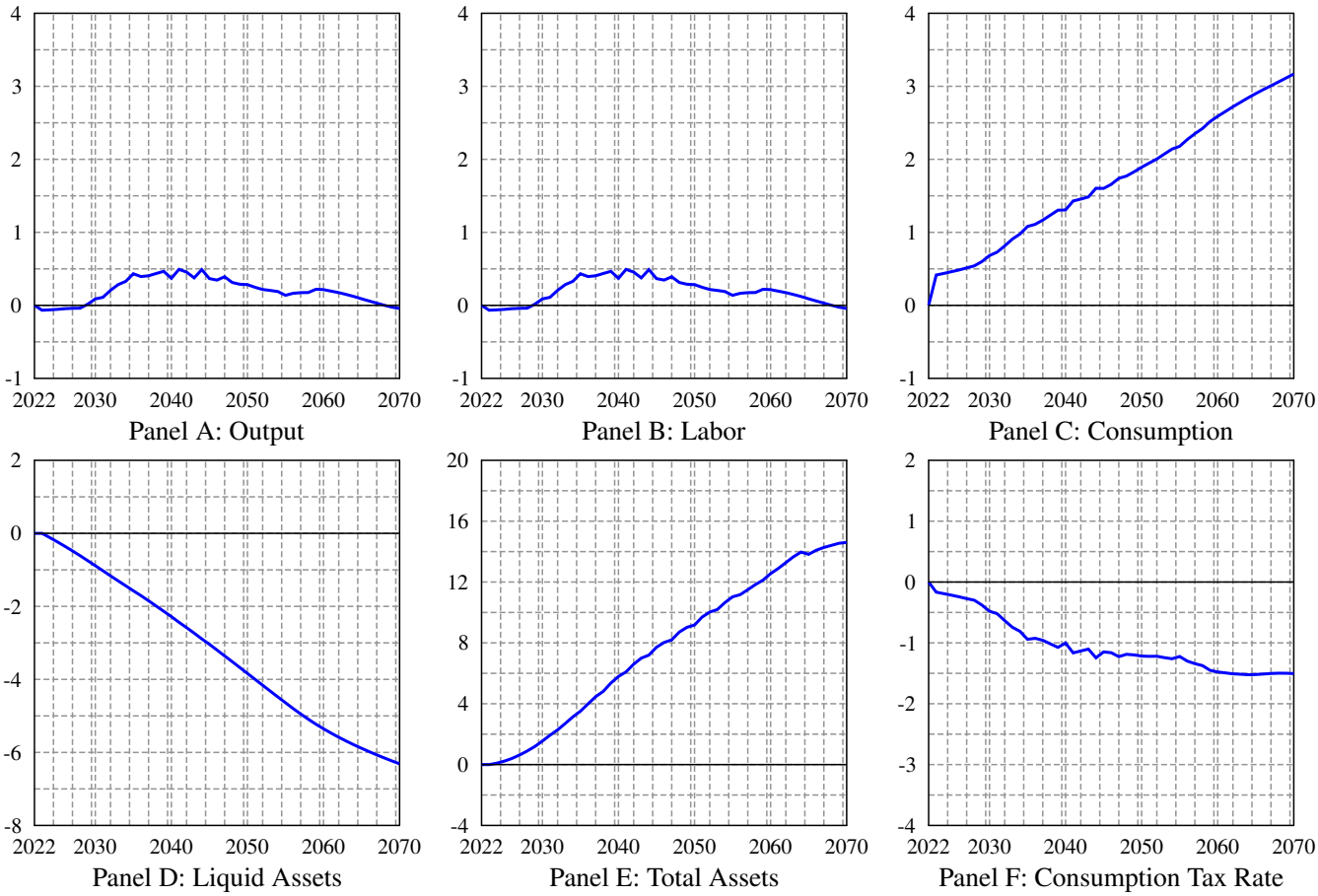
As in the previous reform scenario, we continue to assume that the government announces and implements a policy change at the beginning of 2023. Unlike the current institutional arrangement, under which IEM revenues are used to accumulate assets in the Public Pension Reserve Fund, the reform redirects these revenues to workers' IRAs.

The transitional dynamics are characterized by the convergence toward the long-run equilibrium. Throughout the transition, household consumption rises markedly, accompanied by a decline in the consumption tax rate resulting from the broadening of the tax base. Moreover, and although households hold lower levels of liquid assets, their total wealth increases due to the accumulation of assets in IRAs.

As in the previous reformed economy, the aggregate effects of the reform on output are quantitatively modest, remaining below 0.5% (see Panel A of Figure 8). This result reflects the limited response of aggregate labor supply, which remains largely unchanged under the reform. Specifically, a modest reallocation of labor effort over the life cycle is largely offset by a slight postponement of labor force exit at older ages. Moreover, because the economy is assumed to be open, the stock of physical capital adjusts endogenously to maintain constant factor prices.[29]

[29]The reform also has no significant implications for the long-run sustainability of the Spanish pension system. In

Figure 8: Differences in Key Variables Relative to the Benchmark Model Economy*(%)



*: The differences in the consumption tax rate are reported in percentage points.

The reform generates welfare gains for both current and future generations by increasing consumption during retirement and improving intertemporal consumption smoothing. As shown in Panel B of Figure 9, these gains slightly exceed 1% for the cohort born in the year of the reform and increase gradually thereafter, converging smoothly to their long-run level as the economy transitions toward its new final steady-state equilibrium.

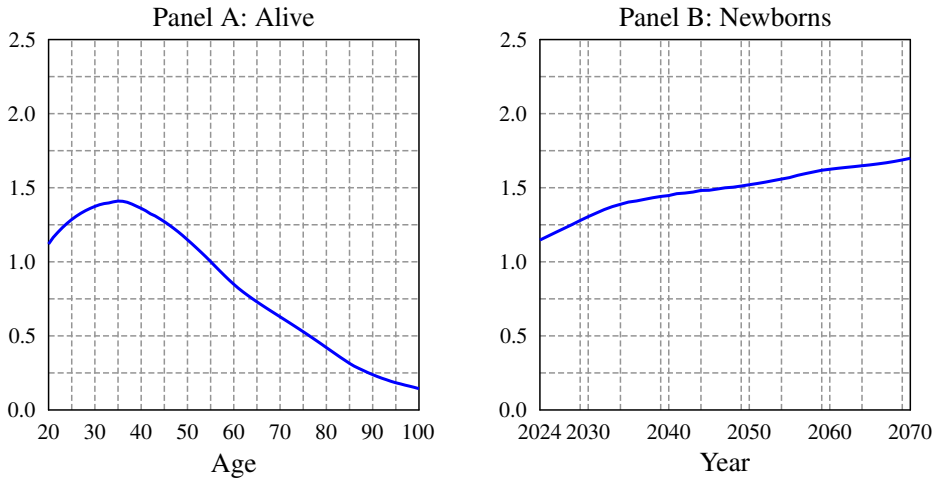
The reform also generates substantial heterogeneity across the generations alive at the time of its implementation. Although all cohorts experience increases in expected lifetime consumption, the magnitude of these gains is inversely related to age, with younger individuals benefiting the most (see Panel A of Figure 9). Two factors explain this result. First, older individuals have a shorter

both the benchmark and reformed economies, sizeable pension deficits emerge over the coming decades, requiring substantial increases in consumption tax rates to ensure a consolidated fiscal balance.

remaining contribution period and therefore accumulate fewer assets in their IRAs, resulting in lower annuity payments during retirement. Second, they benefit from the reform-induced reduction in the consumption tax rate for a shorter period of time (see Panel B of Figure 8). Consequently, while the reform increases expected lifetime consumption for all generations alive at the time of its implementation, the size of these gains declines steadily with age.

Overall, the increase in expected lifetime consumption among the generations alive at the time of the reform is quantitatively substantial. For example, the present discounted value of the cumulative increase in expected lifetime consumption across all affected cohorts amounts to almost 24% of GDP in the year of the reform (2023), equivalent to more than €358.6 billion.[30]

Figure 9: Differences in Expected Lifetime Utility (%)



7.4 Overall assessment

The introduction of IRAs generates substantial welfare gains, particularly for future generations and younger cohorts alive at the time of the reform. These gains are primarily driven by higher lifetime consumption, especially during retirement, reflecting the additional resources accumulated through the new retirement saving scheme. An important question, however, is whether these effects are amplified under autarky, that is, in a closed-economy environment where factor prices adjust endogenously to changes in the capital-to-effective-labor ratio. We examine this issue in the following section.

[30]This estimate is obtained by discounting future consumption gains using the model-implied annual real interest rate of 3.04%.

7.5 Choosing among the two alternatives

We simulate two alternatives to the benchmark economy. In the first, the Public Pension Reserve Fund is prohibited from investing in Spanish government debt, implying that its resources are instead allocated to risk-free domestic or foreign assets that earn returns determined by international interest rates. In the second, the revenues generated by the IEM are redirected to IRAs rather than being transferred to the Public Pension Reserve Fund.

Both alternatives yield higher welfare results than the current institutional arrangement, under which IEM revenues are used to purchase Spanish government debt. The relevant question, therefore, is which of these two alternatives would be preferred not only by future generations but also by individuals alive at the time of the reform. From a long-run perspective, the preferred option is to allocate the additional payroll tax revenues raised through the IEM to IRAs (see Panel B of Figure 10).

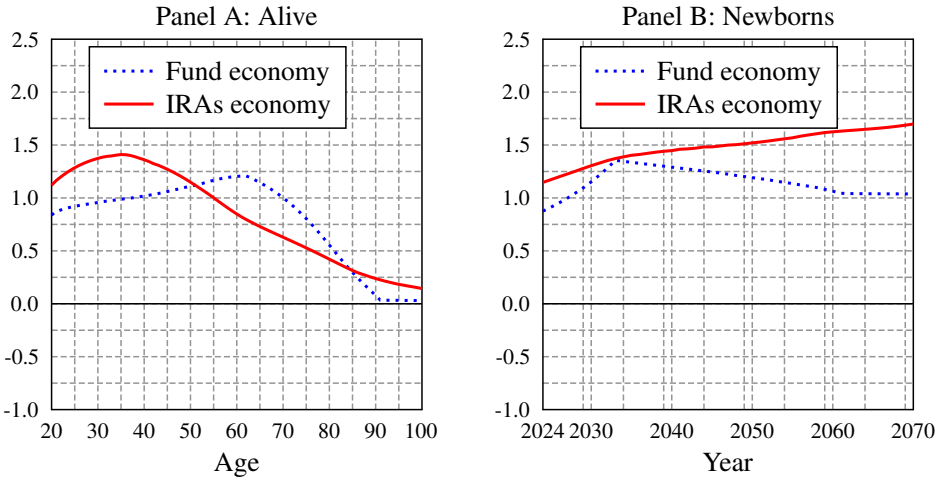
The ranking of the two alternatives differs with household's age, however, when considering cohorts alive in 2023. We find that individuals between the ages of 52 and 84 would prefer maintaining a public pension reserve fund rather than redirecting IEM revenues to IRAs (see Panel A of Figure 10). For older workers, this preference is largely explained by the tax-smoothing benefits associated with the reserve fund. Given their relatively short remaining working lives, these individuals have limited scope to accumulate significant balances in their retirement accounts, reducing the gains from individual capitalization. For retirees, the case is even clearer: because they would no longer contribute to IRAs, they would not benefit from the higher retirement income generated by such accounts. Consequently, the lower consumption tax burden achieved through tax smoothing cannot be offset by additional retirement resources.

In contrast, younger and middle-aged individuals show a clear preference for allocating IEM revenues to IRAs. Furthermore, once the age distribution of the Spanish population at the time of the reform is incorporated into the analysis, support for the introduction of IRAs rises to nearly 58% of the population.[31] More broadly, both policy alternatives generate sizeable increases in lifetime consumption for the generations alive at the time of the reform. In particular, under the IRA policy, the present discounted value of the expected cumulative increase in lifetime consumption across all affected cohorts reaches almost 24% of GDP in 2023, the year of the reform, equivalent to more than 358.6 billion euros. The corresponding figure is 16.7% of GDP when IEM revenues are instead used to accumulate assets away to domestic public debt.[32] The substantially larger consumption gains associated with the IRA policy provide a compelling explanation for its stronger political support among individuals alive at the time of the reform.

[31] The age distribution is obtained from the Spanish National Statistics Institute (INE).

[32] These estimates are computed by discounting future consumption flows using the model-implied annual interest rate of 3.04 percent.

Figure 10: Differences in Expected Lifetime Utility (%)



8 Sensitivity Analysis

The analysis presented thus far assumes an open economy. While Spain is a member of the European Union and its financial markets are deeply integrated with those of other European economies, the degree of financial integration is not sufficiently complete to justify treating Spain as a fully open economy. To assess the robustness of our results, we therefore also simulate all previous model economies under the assumption of a closed economy, where international trade and cross-border capital movements are absent and domestic investment must be financed entirely by domestic saving.[33]

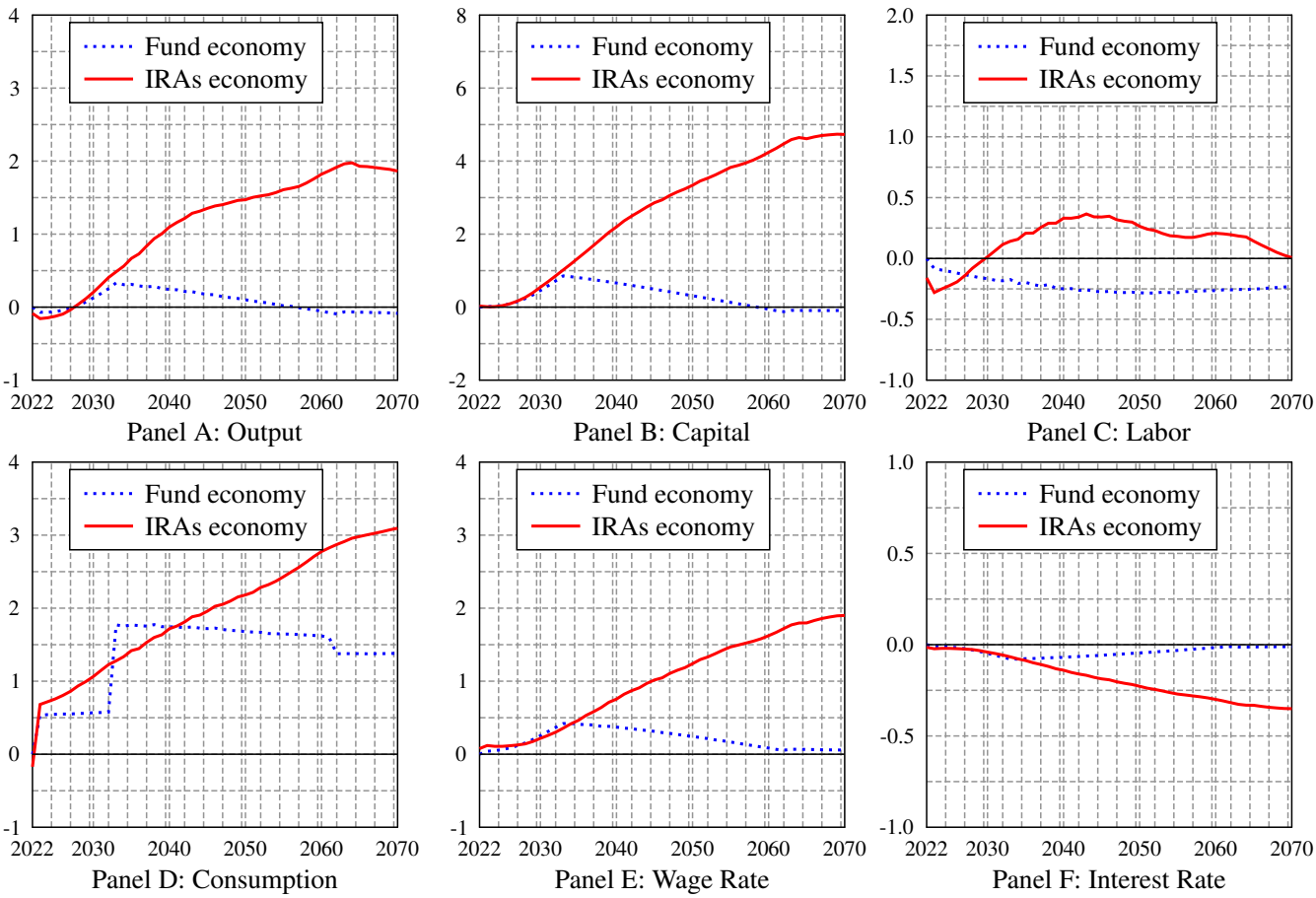
Given the closed economy assumption, the wage rate and interest rate are determined by market clearing conditions of domestic labour and capital markets, so that any policy change that affects household savings and/or work hours has a direct effect on the supply of capital and labour in the economy and the factor prices.

Another important difference emerges when the model economies are analyzed in a closed-economy setting. In both reformed economies, the revenues generated by the IEM are ultimately invested in domestic physical capital. As a result, the reforms lead to an expansion of the aggregate capital stock and, consequently, to higher output. Because aggregate effective labor supply exhibits only negligible changes, the increase in capital accumulation raises the capital-to-effective-labor ratio, placing downward pressure on the equilibrium interest rate while increasing wages.

However, the effects described above for *Reformed Economy 1* (see Figure 11) are not only

[33]To this end, we increase the discount rate, β, from 0.9803 to 1.0105 in order to match the initial steady-state interest rate of 3.04 percent, which corresponds to its constant value in the open economy scenario.

Figure 11: Differences in Key Variables Relative to the Benchmark Model Economy* (Closed Economy %)

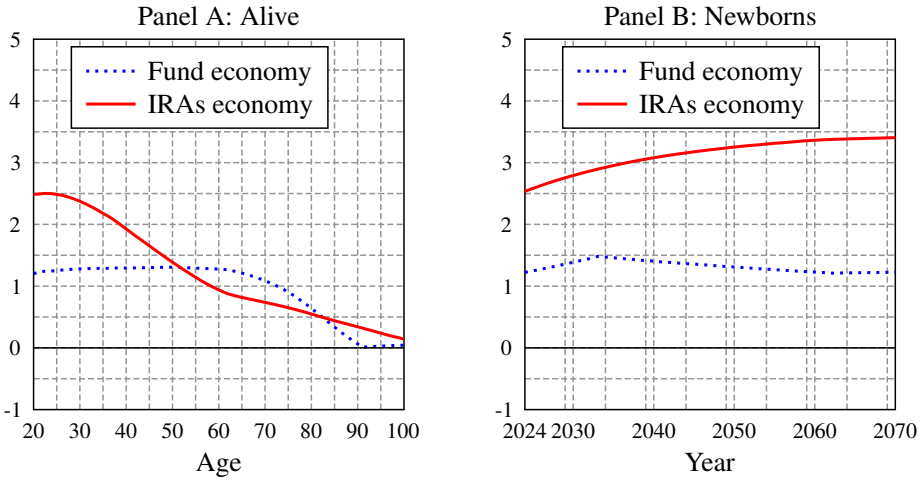


*: The differences in the interest rate are reported in percentage points.

modest in magnitude but also transitory. Specifically, because the Public Pension Reserve Fund is fully depleted by 2060, its alternative investment policy, which reallocates resources toward domestic assets other than government debt, increases the domestic capital stock and, consequently, aggregate output only until that date. Once the Fund is exhausted, these effects gradually vanish, leaving only a modest increase in aggregate household consumption (see Panel D of Figure 11). By contrast, the introduction of IRAs generates aggregate effects that are both larger and permanent. In this case, the continuous accumulation of assets in individual accounts sustains a higher capital stock over time, while the endogenous adjustment of wages and interest rates further amplifies the impact of the reform on household behavior and aggregate economic outcomes.

Finally, and consistent with the aggregate results discussed above, the welfare analysis reveals

Figure 12: Differences in Expected Lifetime Utility (Closed Economy, %)



that the reforms generate larger gains for both current and future generations than those obtained under the open-economy specification. Furthermore, the results again indicate that directing IEM revenues toward IRAs is the preferred policy option for the majority of individuals alive at the time of the reform (59%) and for all generations born thereafter (see Panels A and B of Figure 12).[34]

9 Policy Implications

Our findings suggest that allocating additional pension contributions to IRAs, rather than to public pension reserve funds whose portfolios are largely invested in domestic government debt, can generate substantial welfare gains for both current and future generations. These gains arise primarily from higher retirement consumption and improved consumption smoothing over the life cycle. Although our analysis focuses on Spain, similar conclusions may apply to other countries that operate public pension reserve funds subject to comparable investment restrictions. Furthermore, we find that general-equilibrium effects substantially reinforce the welfare gains associated with the reform. Consequently, the benefits of introducing IRAs increase as the economy becomes less financially integrated with international capital markets, allowing changes in domestic saving to exert a stronger influence on capital accumulation and factor prices.

It is well known that countries whose public pension systems face significant long-run sustainability challenges will eventually be required to reduce benefits, increase revenues, or adopt a

[34]Both policy alternatives generate bigger increases in lifetime consumption for the generations alive at the time of the reform. In particular, under the IRA policy, the present discounted value of the expected cumulative increase in lifetime consumption across all affected cohorts reaches almost 27% of GDP in 2023, the year of the reform, equivalent to more than 401.7 billion euros. The corresponding figure is 17.6% of GDP when IEM revenues are instead used to accumulate assets away to domestic public debt.

combination of both measures (see Díaz-Giménez and Díaz-Saavedra, 2025). As a result, both the generosity and adequacy of future public pensions are likely to decline, increasing the need for complementary sources of retirement income. In this context, IRAs constitute a natural complement to the existing public pension systems. More specifically, the gradual introduction of mandatory retirement saving through individual accounts, including both employee- and employer-based contributions financed through existing labor taxation, emerges as an attractive alternative to the continued accumulation of assets in public pension reserve funds, when such funds are required to invest predominantly in domestic government debt. This policy implication constitutes the central contribution of our paper.

The magnitude of our results depends critically on the investment restrictions imposed on public pension reserve funds. In particular, the welfare and macroeconomic gains associated with channeling additional retirement savings into IRAs, rather than into public reserve funds, would be considerably smaller in countries where reserve fund assets are allocated to diversified investment portfolios with a strong focus on long-term returns, such as Canada and New Zealand. By contrast, these gains are amplified when public pension reserve funds are used primarily to finance government borrowing through investments in domestic public debt.[35]

On the other hand, our analysis abstracts from several factors that may be relevant for the outcomes of our simulations. In particular, the model does not account for the possibility that individuals may liquidate assets held in IRAs during their working lives when facing liquidity constraints, such as those arising from job loss. In practice, and for example in countries such as Canada or Chile, although retirement savings are primarily intended for old age, partial early withdrawals are permitted under exceptional circumstances, including long-term unemployment, severe illness, or dependency. This flexibility further enhances consumption smoothing over the life cycle and, consequently, has important implications for household welfare (see Díaz-Saavedra et al., 2023).

10 Conclusions

This paper examines the macroeconomic and welfare consequences of alternative uses of the resources collected by the Spanish *Intergenerational Equity Mechanism (IEM)*. Specifically, and as part of the 2021 pension reform, Spain introduced the IEM, which imposes additional payroll contributions on both employers and employees. The resulting revenues are earmarked for the accumulation of assets in the Spanish Public Pension Reserve Fund.

Our quantitative analysis compares three model economies. The first captures the current

[35] This conclusion is reinforced by supplementary simulations showing that the estimated welfare gains decline when the Spanish government is allowed to invest *only* 50 percent of public pension reserve fund assets in risk-free foreign securities.

institutional arrangement, under which the assets of the Public Pension Reserve Fund are invested in Spanish government debt. This investment strategy severely limits the fund's capacity to smooth taxes over time, since its assets constitute liabilities of the same consolidated public sector. The second model economy assumes instead that the revenues collected by the IEM are used to buy risk free assets other than the Spanish government debt. And the third economy represents another counterfactual scenario in which the revenues allocated to the reserve fund are instead invested in IRAs.

Taking the open-economy specification as our baseline, we find that the introduction of IRAs is the winner of the race among the alternative policy scenarios considered. In particular, it generates a substantial increase in aggregate consumption and delivers sizeable welfare gains for both future generations and the majority of individuals alive at the time the reform is implemented. For the latter group, these gains are economically significant: the present discounted value of the increase in expected lifetime consumption amounts to nearly 24% of Spain's GDP in 2023. The main mechanism behind this result is the increase in consumption during retirement, as the annuitization of accumulated retirement savings allows households to achieve smoother consumption profiles over their lifetimes. Finally, we find that the reform has only negligible effects on aggregate labor supply and, consequently, on aggregate output.

Although Spain is a member of the European Union, the degree of financial integration within Europe may not be sufficient to justify treating the Spanish economy as fully open. We therefore also consider a closed-economy specification. In this setting, both reformed model economies generate significant general-equilibrium effects: higher domestic saving translates into greater capital accumulation, leading to higher wages and lower equilibrium interest rates. These adjustments amplify both the aggregate and welfare gains relative to those obtained under the open-economy specification. Nevertheless, our results continue to identify the introduction of IRAs as the welfare-dominant reform among the policy alternatives considered.

Clearly, redirecting IEM revenues toward IRAs would not address the underlying sustainability challenges of the Spanish public pension system, since the projected deficits of the pay-as-you-go pillar would remain largely unaffected. As a result, restoring the system's long-run financial balance would still require some combination of higher taxes, lower pension benefits, and other fiscal adjustment measures.

Nevertheless, this reform could serve as a stepping stone toward a broader restructuring of the Spanish pension system, facilitating a gradual transition from a purely pay-as-you-go scheme to a two-pillar system combining public and funded retirement provision. The first pillar would consist of a public pension based on individuals' lifetime contributions, with benefits determined through a notional defined-contribution (NDC) system. Under this approach, notional accounts would be adjusted using indexation mechanisms that reflect macroeconomic and demographic conditions,

thereby helping align pension entitlements with the system's long-term financial constraints. The second pillar would consist of the annuity income generated by funded IRAs upon retirement. Participation in this second pillar should ideally be mandatory to ensure broad coverage and adequate retirement savings. Moreover, the contribution rate would need to be substantially higher than the 1.2 percent of gross earnings currently levied to finance the Spanish Public Pension Reserve Fund if these accounts are to provide a meaningful complement to public pensions.

Disclosure statement

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix

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 this version of the model is an enhancement of that model economy, we describe below how we calibrate the new parameters that appear in this model economy.

New calibrated parameters

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-Giménez and Díaz Saavedra (2026), 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 2022. According to the Spanish National Institute of Statistics, INE, this ratio was 9.15 percent in that same year. Consequently, we set $a_2 = 0.4094$.

The pension system. In 2022 in Spain, the payroll tax rate paid by households was 28.3 percent and it was levied only on the first 49,672 Euros of annual gross labour income, which corresponds to 141.75 percent of per GDP per person aged 20+.[36] Consequently, we set the both the maximum tax cap and the maximum covered earnings as 1.4175 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 11.06 percent, which is the value observed in the Spanish economy in 2022. This implies that the payroll tax rate of our model economy is $\tau_p = 0.2301$.[37]

10.1 Changes with respect to the previous version.

Recall that this version of the model chooses 2022 as a calibration target year. In addition, this version introduces many of the institutional features of the current Spanish public pension system in great detail. Consequently, 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 4 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.

[36] In Spain in 2022, the GDP per person who was 20 or older was 35,040.3 Euros.

[37] However, the total pension system revenues that we target include the government's transfers to the pension system, which account for 1.1 percentage points of GDP. This is because this was the amount of fiscal resources that the Spanish government transferred to Social Security in 2022, to pay non-contributory pensions and those of public employees.

Table 4: Parameters: actual and past values

	Parameter	This version	Díaz Saavedra et al. (2023)
Preferences			
Time preference	β	0.9803	0.9965
Technology			
Productivity growth rate	g	0.0110	0.0000
Depreciation rate	δ	0.0985	0.1138
Public Pension System			
Replacement rate	p_r	0.6580	0.7650
Payroll tax rate	τ_p	0.2301	0.2599
Fiscal Policy			
Unemployment replacement rate	b_0	0.3695	0.3751
Consumption tax rate	τ_c	0.1504	0.2599
Capital income tax rate	τ_k	0.3024	0.2500