Gender Gaps in the Labor Market and Social Security Finances

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Abstract

Does the incorporation of women into the labor market help mitigate the negative effects of an aging population on Pay-as-you-go Social Security finances? To address this question, I develop an overlapping generations model with heterogeneous married households. The model starts from a balanced growth path in 1975, with demographic changes triggering a transitional phase, ultimately leading to a new steady state. My model accurately generates the increase in employment of married women by educational attainment, hours worked, and key pension moments between 1975 and 2019 while also effectively capturing life-cycle savings profiles. I find that women alleviate the fiscal burden induced by the aging process, as they finance approximately 10% of male pensions until 2050. Despite this, the model converges to a steady state with persistent gender differences in employment, hours worked, average earnings, and pensions. To address these disparities, I evaluate the introduction of Gender-Based Taxation in the Spanish pension system, assuming women are taxed at a lower rate than men. This policy significantly reduces gender gaps and provides welfare gains for newborn cohorts. Overall, the study highlights the critical role of female labor market participation in alleviating Social Security financial strain and underscores the potential of gender-based tax policies to reduce gender gaps and promote economic well-being.

Keywords: Female Employment, Gender Gaps, Social Security, Gender-Based Taxation.

JEL Codes: J16, J21, H55, D15.

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1 Introduction

Pay-as-you-go pension systems have remained a key focus for policymakers for decades. Increasing longevity and decreasing fertility rates lead to demographic aging in societies, which have an impact on their financial viability. The old-age dependency ratio, the ratio of pensioners over contributors, is projected to increase from 30% in 2015 to 58% in 2075 for the EU28 (OECD, 2017). This will place additional burdens on the working-age population to finance pay-as-you-go pensions. As a result, researchers have studied the harmful implications of rapid population aging on pension finances and proposed pension reforms to alleviate the fiscal burden.[1]

Two other structural changes have also influenced the pension system concurrently with the aging process: the increase in the educational attainment of individuals and the rise in female employment rates. While some studies have explicitly analyzed the effect of education on the pension system (Conesa et al., 2020; Díaz-Saavedra, 2022), it has not yet been determined whether the increase in female employment rates helped to alleviate the financial burden generated by the aging population. This paper aims to answer the following question: Did women help alleviate the financial burden caused by the demographic transition? If so, by how much and for how long?

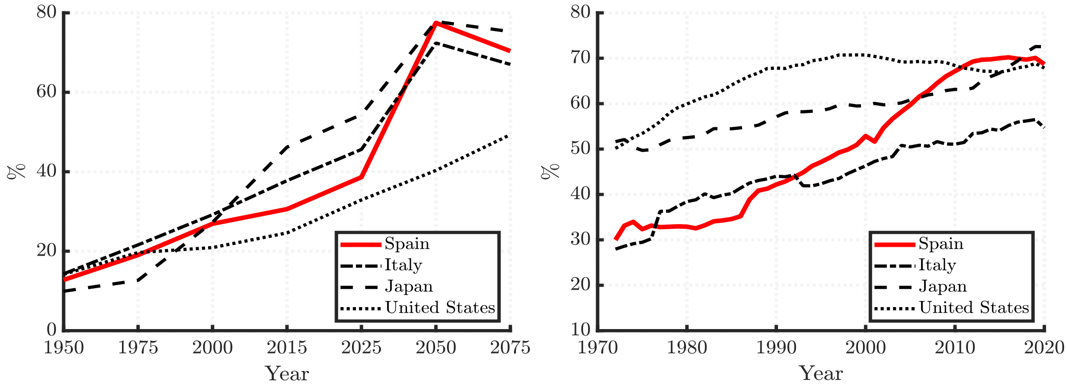
The Spanish economy is a suitable case study for three key reasons. First, Spain has emerged as one of the foremost advanced economies regarding the celerity and enormity of demographic aging.[2] The Old-age dependency ratio is projected to escalate from 30.6% in 2015 to 70.4% in 2075, see Figure 1a. Second, the expenditure on public pensions represents a big share of the Spanish government finances (10.9% in 2019), and its sustainability is in trouble. The debt of Social Security reached a historical maximum of 6% of the Gross Domestic Product (GDP, henceforth) in 2020, and the previous pension reforms (2011 and 2013) do not seem to solve this fiscal problem completely.[3] Third, there has been a notable and swift surge in the participation of women in the labor force. While the female labor force participation in Spain stood at a mere 30% in 1975, it had risen steeply to 70% in 2019, surpassing leading countries such as the United States, as illustrated in Figure 1b.

Building on the seminal work of Auerbach et al. (1987), I develop a deterministic, overlapping generations model populated by married households, a representative firm, and a

[1]For instance: De Nardi et al. (1999), Kotlikoff et al. (2001), Galasso and Profeta (2004), Attanasio et al. (2007), Kitao (2015) and Nishiyama (2015), among many others.

[2]A comparative analysis of Spain with other countries concerning the proportion of tertiary education, fertility rates, and life expectancy at age 65 by gender can be found in Figure A.1 included in the Appendix.

[3]See Díaz-Gimenez and Díaz-Saavedra (2017) and Conde-Ruiz and González (2015) for a discussion of these two reforms.



(a) Old-age dependency ratio **(b)** Female labor force participation

Figure 1. Old age dependency ratio and female labor force participation trends

Source: OECD statistics

government. Households are heterogeneous in several dimensions, such as the age, the education of each spouse, the number of children, their productivity, the labor market status of the wife, the private savings accumulation, and the pension rights. When the household is born, the wife draws participation cost to join the labor market and makes a career choice. This decision differentiates households into one and two-earner households, which I denote as "traditional" and "modern" couples. After that, both spouses solve a joint maximization problem where they decide how much to consume, save, and work. Furthermore, the model economy incorporates the main components of the Spanish Social Security regarding retirement and widow pensions. I assume that the government budget balances each period by adjusting the labor Social Security tax rate.

I calibrate this model to an initial steady state in 1975 to reproduce the Spanish economy's basic demographic and economic properties. After this year, I assume that the model is no longer in a steady state because several demographic trends hit the economy, such as the increase in life expectancy, drop in fertility rates, increase in the educational attainment of the population, and drop in the participation cost women face when they want to enter the labor market. The model replicates the increase in the female employment rate observed in the data from 1975 to 2019. After 2019, I simulate the economy by introducing the quantitative projections of these trends until it reaches a final steady state. Each period, I assume that Social Security's budget is balanced.

To understand the role women played in pension funding, I run two main exercises. First, I create a novel indicator called the Gender Imbalances Indicator that quantifies the share of male pensions financed by women once they have already financed female pensions. Second, I run a counterfactual analysis where I assume that women did not increase their employment rate as much as they did. In particular, I keep the policy functions for female employment equal to the initial steady state and do not decrease the participation cost. However, I still introduce the other components of the demographic transition: the fertility, education, and life expectancy channels. Therefore, women still increase their participation in the labor market, but not as much. Finally, I propose a policy experiment, Gender-Based Taxation, to reduce the persistent gender gaps this model projects in the final steady state.

The paper's main findings are that women play a crucial role in sustaining the Social Security System. Specifically, until 2050, women will redistribute resources to men. The Gender Imbalance Indicator shows that women finance around 10% of male pensions. If women did not change their policy functions regarding participation and hours worked, the Social Security tax rate would have increased between one and two percentage points in 2019. Despite demonstrating that women help alleviate the fiscal burden, they still face female-specific barriers that make it difficult to narrow the gaps in the labor market, such as participation, hours of work, earnings, and average pensions. I show that Gender-Based Taxation, if introduced after 2019, effectively decreases the gender gaps in the labor market and generates welfare gains for newborn cohorts.

The paper lies at the intersection of three lines of research. The first concerns a long tradition in macroeconomics research on sustaining Social Security systems. This literature uses life-cycle models pioneered by Auerbach and Kotlikoff (1987). In particular, I contribute to the literature that analyzes self-financed pension systems. İmrohoroglu et al. (1995) studied the optimal replacement rate in the United States. Fuster et al. (2007) evaluates the elimination of the Social Security System with altruistic individuals. In Spain, Díaz-Giménez and Díaz-Saavedra (2009) studied the effect of delaying the statutory legal retirement age. However, I depart from the existing literature by considering a two-earner household environment and modeling the female labor supply. To the best of my knowledge, Sánchez-Martín and Sánchez-Marcos (2010) are the first and only authors who introduced this new household's environment in the pension literature. However, modeling females' labor supply in the extensive and intensive margins is widespread in other set-ups. For instance, Guner et al. (2011) studies the effect of two proposed tax reforms in the U.S. in a life cycle model with married and single households. Kaygusuz (2015) and Nishiyama (2019) assess the implications of removing the Old Age and Survivor's program of the U.S. Social Security system on the labor market.

The second relevant strand of literature pertains to recent research concerning the growth in female labor force participation observed over previous decades. This branch of literature can be divided into two areas. The first area focuses on documenting this new labor market phenomenon for the US (Goldin (2006)) and Spain (Guner et al. (2014)). The second area proposes several explanations behind the changes in women's labor market outcomes. On the supply side, various studies suggest that technological advancements in households that reduce the cost of producing home goods (Greenwood et al. (2005)), the availability of contraceptive pills (Goldin and Katz (2002)), advancements in medical technologies related to motherhood such as infant formula (Albanesi and Olivetti (2016)), a reduction in the cost of childcare and the gender wage gap (Attanasio et al. (2008)), have contributed to this change. Other potential explanations include the importance of cultural beliefs (Fernandez and Fogli (2009)), a decrease in discrimination against women (Jones et al. (2015)), or an increase in aggregate productivity in professional occupations (Gayle and Golan (2012)). In light of this, the present paper extends the literature cited above to a new section that explores the consequences of this labor market trend on Social Security finances.

The third strand of the literature is the evaluation of tax reforms using heterogeneous dynamic models. Various studies, such as Ventura (1999), Díaz Giménez and Pijoan-Mas (2006), Conesa and Krueger (2006), Kaygusuz (2015), and Guner et al. (2012a), have explored this area. This study aligns with the work of Guner et al. (2012b), who analyzed the effects of Gender-Based Taxation on the U.S. tax system using a heterogeneous model. This paper introduces Gender-Based Taxation in Spain and contributes to the literature in two ways. First, it examines the impact of Gender-Based Taxation on the Social Security system, a topic that has not yet been analyzed. Second, it provides a quantitative perspective on the ongoing debate regarding whether more elastic labor suppliers should be taxed at a lower rate. This discussion has supporters, such as Alesina et al. (2011), and detractors, such as Saint-Paul (2008). The study also leverages the classical result of the second-best optimal taxation theory, which demonstrates the efficiency gains from differential taxation and advocates for taxes based on non-modifiable conditions, such as gender, as suggested by Akerlof (1978).

The remainder of the paper is organized as follows. Section 2 describes the institutional framework. Section 3 describes the socioeconomic trends in Spain. Section 4 describes my quantitative model. Section 5 specifies the calibration methodology in the initial steady state and presents the model results. Section 6 describes the transition, calibration and results. Section 7 computes the role of women in Social Security funding. Section 8 shows the results and the welfare analysis of introducing Gender Based Taxation. Finally, Section 9 concludes.

2 Institutional framework

The pension program for the elderly population in Spain is structured as a pay-as-you-go defined benefit system. The core components of the current pension system were established in 1967 and further refined throughout the 1970s. Over the past 50 years, the system has undergone six significant reforms in 1985, 1997, 2002, 2007, 2011, and 2013. The contributory pension scheme includes four categories: old age, disability, survivor, and orphanhood. Additionally, there are three primary pension regimes: the general regime, special schemes, and government employee schemes.

This paper focuses on the general regime (RGSS), which accounted for 71% of the retirement pensions in Spain in January 2019. Below, I outline the principal regulations for old-age pensions under the RGSS and their major changes over time. Table A.1 in the Appendix presents these changes in detail; for an in-depth description, see Garcia-Mandicó and Jiménez-Martín (2020).

The pension system is financed by contributions, which are fixed percentages of covered earnings (total earnings minus bonus payments) between a floor and a ceiling. In 2019, workers and employers were required to contribute 4.7% and 23.6% of taxable earnings, respectively, to finance pensions. To be eligible for a retirement pension, a worker must have contributed to Social Security for at least N_c years before retirement. Before 1985, N_c was 8 years, but since 1985, the minimum has been 15 years. The legal retirement age was 65 before the 2011 reform, which raised it to 67. Both early and late retirements are allowed, with specific conditions and penalties for early retirement and rewards for late retirement.[4][5]

If eligible, the pension is calculated by multiplying the replacement rate by the regulatory base. The regulatory base is a weighted average of monthly covered earnings over a reference period comprising the last N_b years before retirement. The reference period has changed over time: it was 2 years before 1985, increased to 8 years in 1985, 15 years in 1997, and 25 years in 2011. The replacement rate decreases if the worker retires before the legal retirement age and increases if the worker retires after the legal retirement age. Additionally, the replacement rate increases with the number of years the worker has contributed to Social Security. A worker must have worked N_f years to qualify for the full pension, which was 35 years until the 2011 pension reform increased it to 37 years. Since 2002, pensions have been subject to an annual legislated ceiling roughly equal to the covered earnings ceiling.

[4] Before 1985, early retirement was only available to workers who made their first contribution before 1967. In 2002, early retirement at age 61 was extended to the rest of the population. The 2011 reform further restricted early retirement.

[5] Except for workers in dangerous professions who find it challenging to maintain their working activities, early retirement is penalized.

The existing literature largely agrees that these pension reforms alone cannot effectively address Spain's Social Security financing issue.[6] The Social Security debt is likely to constitute a substantial portion of the Spanish GDP over time. In the subsequent section, I will delineate the key socioeconomic trends substantiating this claim.

3 Socioeconomic trends in Spain

This section provides an overview of the evolution of employment rates, demographic structure, fertility rates, and education transitions in Spain between 1975 and 2019. Further, it discusses the main projections in these areas and their implications for sustaining the Spanish pension system.

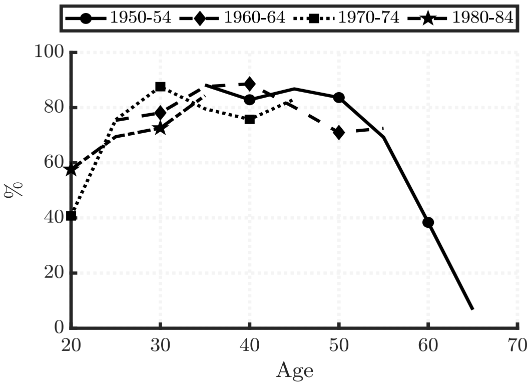
3.1 Labor market trends

During the authoritarian regime (1939-1975) in Spain, the Catholic Church endorsed the male-breadwinner model, which limited women's roles to childcare and household tasks. Married women required their husbands' permission for many legal and financial matters. However, the end of the dictatorship in 1975 marked a turning point for women's rights. The advent of democracy, entry into the European Union in 1986, and social and policy changes, including anti-discrimination laws and free public schooling for children aged three and above in the 1990s, helped transform the cultural norms surrounding women's roles.

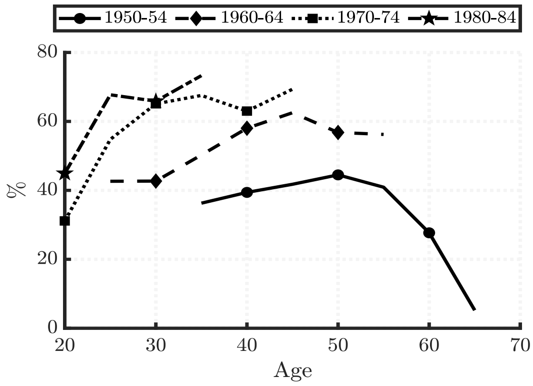
Since the 1970s, the male-breadwinner model has been gradually supplanted by the dual-breadwinner model, where women have paid jobs, contribute to the household income, and thereby alter the traditional gender roles within the household. Figure 2 illustrates the employment rates by gender for four cohorts: 1950-54, 1960-64, 1970-74, and 1980-84. The left panel of Figure 2a indicates that men's employment rates remained relatively constant across these cohorts. However, there was a significant increase in women's employment rates, as displayed in the right panel of Figure 2b, with a considerable rise across all age groups. For example, at age 35, 36% of women born in the 1950s were employed, compared to 73% for women born in the 1980s.

Figure 3 illustrates the evolution of the female employment rate over time compared to the rates observed for single and married women. The figure shows that the female employment rate increased from 30% in 1975 to 70% in 2019, mainly due to the higher employment rate among married women. Specifically, single women experienced a 9.5 percentage point

[6] See Appendix H for a literature review.



(a) Men



(b) Women

Figure 2. Employment rate by gender and cohort.

Source: Spanish Statistical Office (INE)

increase, while married women experienced a 45.8 percentage point increase. These trends suggest a significant shift in women's labor market behavior, which Guner et al. (2014) have analyzed in more detail.

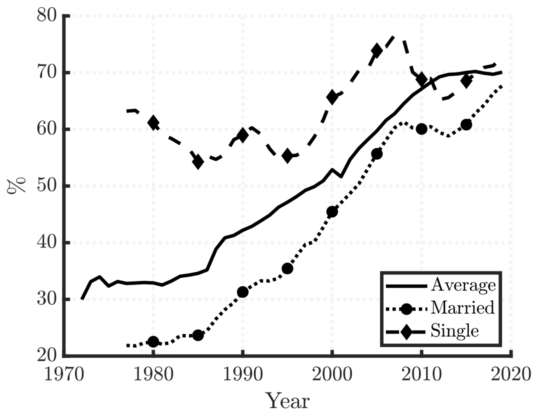


Figure 3. Female employment rate by marital status and the economy's average

Source: Spanish Statistical Office (INE).

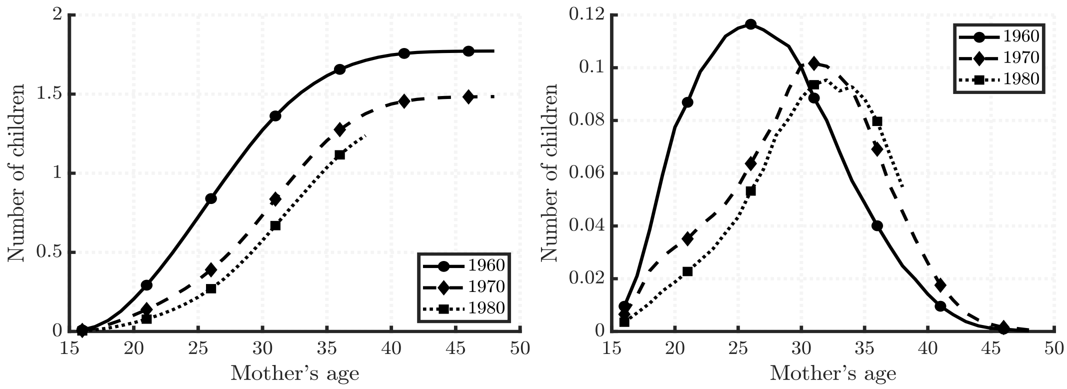
3.2 Demographic trends

During the last few decades, many developed countries have undergone a demographic transition characterized by declining fertility rates and increasing life expectancy. In this new phase, countries face challenges related to an aging population, where a smaller working-age population must support a larger elderly population. Spain is one of the leading countries experiencing this demographic shift, with a low fertility rate and a significant increase in life expectancy.

Life expectancy. In recent decades, men and women have experienced a rapid increase in life expectancy at 65. In the early 1970s, men and women had 14 and 17 years of life expectancy, respectively. Life expectancy has increased by five years for both genders and will continue increasing in the coming decades. According to the Spanish Statistical Office, by 2050, men and women are expected to have a life expectancy of 21.9 and 25.5 years, respectively. This demographic shift alone will lead to an extension of pension payments and a subsequent increase in pension expenditure.

Fertility rates. It is well known that fertility rates have plummeted, and women have been delaying fertility. To better give a magnitude of those trends, I make a cohort analysis of the fertility rates using the birth rates between 1975 and 2018 provided by the Spanish Statistical Office. I focus on three cohorts of women: born in the 1960s, 1970s, and 1980s. The 1960s and the 1980s are the oldest and the youngest generations, for which I observe their completed fertility rates.

Figure 4 presents the cumulative cohort fertility rate in Figure 4a and the age-specific fertility rates in Figure 4b. The results reveal that recent cohorts exhibit a declining trend in the number of children. Specifically, women in the 1960s cohort had an average of 1.8 children at the age of 48, whereas those born in 1980 had 1.24 children at the age of 38. Additionally, the postponement in the onset of childbearing is approximately five years.[7]



(a) Cumulative cohort fertility rate

(b) Age-specific fertility rate

Figure 4. Cohort fertility rate.

Note: The fertility rate is defined as the total births at period t by 1000 mothers in fertile ages (16-48).
Sources: Birth records 1975-2018 from INE.

I merged the aforementioned data with Eurostat's projections to calculate the cohort fertility rate projections. The evolution of these projections is presented in Figure 5. On average, the fertility rate declines from 1.8 children per household for women born in 1959 to 1.46 for those born in 2019. Although there is a slight increase in total fertility rates after

[7]Read Ahn and Sánchez-Marcos (2020) for a complete analysis of the fertility rates by cohorts in Spain.

the 1993 birth cohort, projections indicate that the levels will still be considerably below those of women in the 1960s cohort.

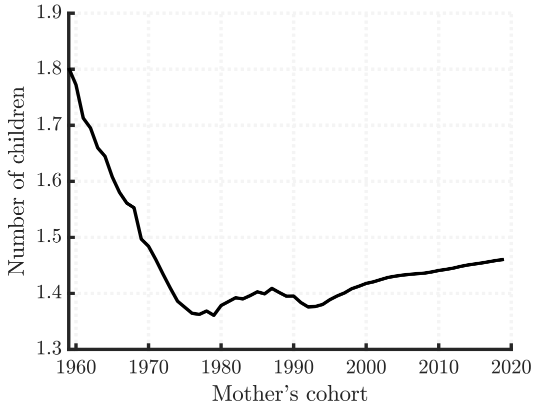


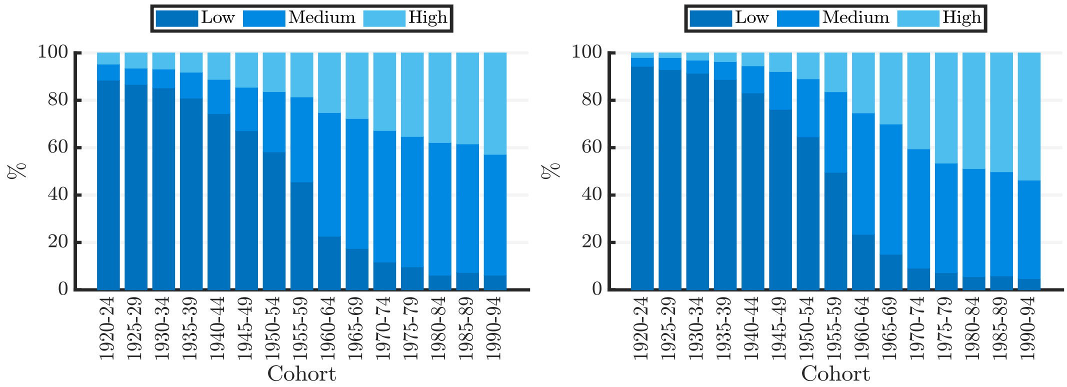
Figure 5. Cohort fertility rates

Note: The fertility rate is defined as the total births at period t by 1000 mothers in fertile ages (16-48). *Sources:* Birth records 1975-2018 from INE and projections 2019-2067 from Eurostat.

3.3 Educational trends

Spain has witnessed rapid and extensive growth in the educational qualifications of its population. Figure 6 shows the educational attainment levels of men and women across cohorts characterized as low, medium, and high education. The cohort-wise analysis of educational attainment indicates that until the '60s cohort, the typical characteristic of the Spanish population was a low level of education, with approximately 74% and 80% of men and women born between 1920-60 having low educational attainment. However, there has been a shift in this trend, with merely 6.2% and 4.7% of men and women born between 1990-94 falling into the low educational attainment category. Furthermore, women born in the first half of the 1990s reveal higher educational attainment than men, with 54% being highly educated as opposed to 44% of men.

Changes in the composition of women's education impact the labor market, fertility rates, and life expectancy. Figure 7 shows the evolution of the female employment rate over time, the total fertility rates by education and cohort, and the life expectancies over time and gender. Figure 7a shows that the female employment rate increases with the level of education. The rise in the proportion of women attaining tertiary education, in combination with this relationship, has a positive impact on the average female employment rate. Notably, the employment rate of low-educated women experienced the most substantial increase between 1977 and 2019, narrowing the employment gap by education. Figure 7b shows that the total fertility rate has declined across all educational attainments. Thus, differences in the fertility rate across education are persistent. Since education negatively



(a) Men **(b)** Women

Figure 6. Educational attainment by gender and cohort.

Notes: A low-education individual is someone with, at most, a primary education level, whereas a medium-educated individual has completed secondary education, including upper secondary education and vocational training. High-educated individuals have a tertiary education.
Source: INE.

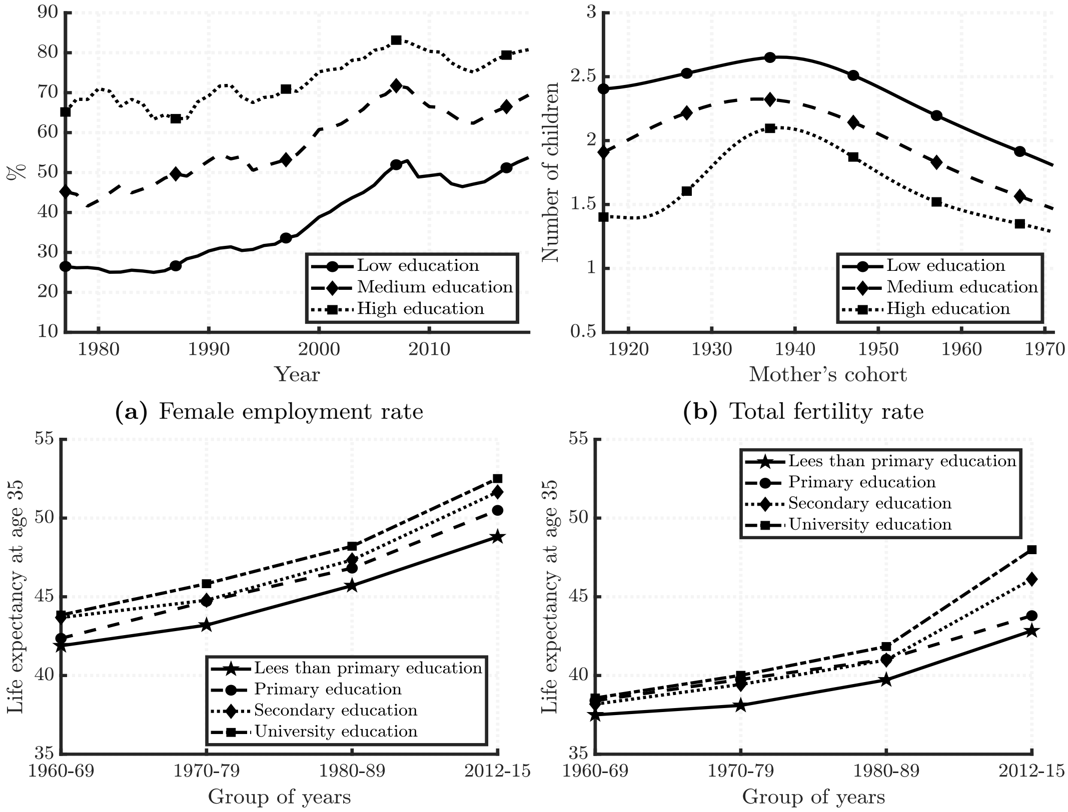
correlates with the number of children, increasing women's education also impacts the low fertility rates.

Regarding education, Permanyer et al. (2018) analyzed the relationship between educational attainment and life expectancy in Spain from 1960 to 2015. Figures 7c and 7d shows the estimated life expectancy for women and men by education, respectively. Individuals with higher levels of education generally experience longer life expectancies than those with lower levels of education. This gap has continued to widen over time, as evidenced by the fact that although life expectancy at age 35 has increased for all education groups, it has increased more rapidly for the highly educated. Specifically, life expectancy at age 35 increased by 6.9 years for women with low education and 8.7 years for those with high education. For men, the corresponding increases were 5.3 years and 9.4 years, respectively. Higher education correlates with longer life expectancy, so the compositional change favoring more educated individuals will also impact future life expectancy.

3.4 Implications of the socioeconomic trends in the Social Security finances

The demographic changes we have observed in Spain, namely the increase in life expectancy and the decline in fertility rates, indicate that the country is becoming an aging society. This shift in the population structure will have a detrimental impact on pension sustainability. The primary reason for this is the rise in the proportion of retired cohorts relative to working-age cohorts, as evidenced by the increase in the old-age dependency ratio.

In 1975, the proportion of individuals aged over 65 to 16-65 was 16.92%. However,



(a) Female employment rate

(b) Total fertility rate

(c) Life expectancy for women

(d) Life expectancy for men

Figure 7. Female employment, total fertility rates (TFR), and life expectancy at age 35 by education.

Sources: INE For the female employment rate, Zeman et al. (2014) for the total fertility rate and Permanyer et al. (2018) for the life expectancy.

according to the Spanish Statistical Office, this figure will increase to 57% by 2050. In other words, the old-age dependency ratio is expected to triple between 1975 and 2050. This demographic shift will further exacerbate the challenges of financing pensions, as the pool of contributors will become smaller, and the burden on those remaining will increase.

At the same time, the rise in the population's educational attainment also impacts Social Security funding, apart from its effects on employment, fertility, and life expectancies discussed in the previous section. Workers with a college degree usually have higher productivity compared to non-college-educated ones. This will positively increase Social Security's tax revenues but also increase Social Security expenditures because they will claim higher pensions compared to their non-college-educated counterparts.

Conesa et al. (2020) show for the US economy that a rise in the college attainment of individuals reduces the labor tax rate needed to balance the budget in a general equilibrium OLG model and thus helps to finance the Social Security System. More recently, Díaz-Saavedra (2022) highlights the importance of a parametric distinction in the pension formula about education since higher longevity for college-educated individuals substantially decreases the progressivity of the Spanish Social Security System. With a general equilibrium model for Spain, he shows that to fully restore the system's long-term progressivity in pensions, a policy combining an increase in the minimum pension and increasing the number of periods of labor income used to compute the pension is needed.

4 The model economy

I study an overlapping generations model economy with a continuum of heterogeneous households, a representative firm, and a government. The unit of analysis is the household, which consists of a husband and wife of the same age who never divorce. I assume Spain is a small open economy, and the model is deterministic. Time is discrete and runs forever. In every period t, a new household generation, s, is born. Throughout this section, I present the model economy in a steady state, where variables do not depend on the period.

4.1 The households

Households are heterogeneous concerning age j, the educational attainment of the husband and the wife z, x, the number of children $\phi(x)$, the initial labor market productivity of each spouse ϵ^i; the household type m; the labor market status of each spouse s; the private assets accumulation b and pension rights of each spouse e. I denote $i \in \{w, h\}$ to refer to the wife and the husband, respectively.

Age. Individuals enter the economy at age 20 ($j = 1$) as workers and retire at the exogenous age of 65 ($j = J_R$). Life is deterministic, and it lasts J_h periods for the husband and J_w periods for the wife, where $J_h < J_w$. Women in the model live longer than men, so I only model widow pensions.

Education. At the beginning of life, each spouse is endowed with an exogenous type that refers to educational attainment and remains constant over the life cycle. For husbands, the type is z, where $z \in Z$ and $Z \subset R_{++}$ is a finite set. For wives, the education type is given by x, where $x \in X$ and $X \subset R_{++}$ is a finite set. I consider three levels of education for both genders: low, medium, and high. I denote the distribution of education type of couples by $M(z, x)$, where $\sum_{z \in Z} \sum_{x \in X} M(z, x) = 1$.

Children. Each household has an exogenous number of children determined by the wife's educational attainment, $\phi(x)$. I assume that all the children arrive deterministically to the household. Children aged 0-2 (babies) impose both time (ψ) and monetary costs (q). While the time cost is levied on all mothers in the economy, the monetary cost only applies to working mothers and is proportional to their labor supply. I denote by $\bar{\phi}_j(x)$ the number of babies in the household at age j.

Labor market productivity. The labor market productivity of each age-j spouse-i by education type has two components. First, when individuals enter the economy, they draw an initial productivity level from a log-normal distribution denoted by ϵ^i, which depends on the individual's educational attainment. It satisfies the following conditions: $\epsilon^i \in E$, where $E \subset R_{++}$ is a finite set. I denote the time-invariant distribution of the initial productivity of the spouses by $S\left(\epsilon^h(z), \epsilon^w(x)\right)$. Second, education and gender determine the individual's earnings profile over the life cycle. $\varpi_j^h(z)$ and $\varpi_j^w(x)$ denote the wage at age j of a husband with education z and wife with education x, respectively.

The gross labor income of a worker i at age j supplying l_j^i units of labor and, given the economy wage rate ω, is given by:

$$
\begin{aligned}
y_j^h &= \varpi_j^h(z)\epsilon^h(z)\omega l_j^h \\
y_j^w &= \varpi_j^w(x)\epsilon^w(x)\omega l_j^w.
\end{aligned}
\tag{1}
$$

Household type. At the beginning of life, women decide whether to stay home and constitute a traditional couple or to join the labor market and form a modern couple, $m \in \{0, 1\}$. To make this decision, in line with Guner et al. (2012a), I assume that in the first period, wives draw a participation cost, κ, from a cumulative distribution function that depends on the wife's education type $\Omega(\kappa|x)$. This cost aims to account for the additional constraints women face when deciding to enter the labor market, and I assume that it is constant over the life cycle. $\Omega(\kappa|x)$ denotes the probability of the utility cost being κ and $\sum_{\kappa \in K} \Omega(\kappa|x) = 1$. Women are less likely to work when these costs are sufficiently high, while women are more likely to work when these costs are low.

Labor market status. In this economy, there are three labor market statuses: employed, non-active, and retired, $s\{e, n, r\}$. Employed individuals are in the labor market and receive a salary that depends on the efficiency units and hours worked. In this model, I assume all husbands are employed during the working state, $j \in [1, J_R]$, while only women in modern households are employed. Non-active individuals refer to women without a job and who are not looking for a job, i.e., only women in traditional households are in this status. All individuals, after $j = J_R + 1$, become retirees. This decision is exogenous in the model.

Whether they are entitled to a retirement pension or a widow pension depends on the pension rights described below and the husband's age.

Private assets. All households enter the economy with no assets and die without assets. However, during the life cycle, there is heterogeneity in the asset holdings, $b \in B$. Households save on risk-free assets with return r and are constrained to non-negative.

Pension rights. Individuals differ in their pension rights. For retirement pensions, the Spanish pension system determines that eligibility depends on the amount of contributed years to the labor market, N_c. Moreover, for widow pensions, the law states that all wives who become widows receive a widow pension which is independent of their retirement pension rights. I assume that agents are myopic about pension rights and the pension formula.

Preferences. Following Erosa et al. (2022), preferences are represented by a per-period utility function that depends on the husband and wife's consumption and leisure. Notice that I assume the same Pareto weight of husbands and wives in the household utility. The per period utility function of a household at age j, time t is:

$$\begin{aligned} U(c_j, l_j^h, l_j^w) =& 2\ln(c_j) + \nu\frac{(1-l_j^h)^{1-\gamma}}{1-\gamma} + \nu\frac{(1-l_j^w-\bar{\phi}_j\psi)^{1-\gamma}}{1-\gamma} \\ &- \kappa\Lambda\{l_j^w\}, \end{aligned} \tag{2}$$

where c_j is the public good household's consumption and l_j^i is the labor supply of each spouse i. In modern households, $\Lambda\{.\} = 1$ and females incur a utility cost κ. If a female has a baby, she also incurs a time cost proportional to the number of babies in the household $\bar{\phi}_j\psi$. Note that $\frac{1}{\gamma}$ is the intertemporal elasticity of leisure, and ν is the weight on work's disutility, common across genders.

4.2 The firm.

In this model economy, I assume that there is a representative firm. It produces output with standard constant returns to scale labor-augmenting production function:

$$Y = K^{\theta}(AL)^{1-\theta} \tag{3}$$

where (A, K, L) represents the productivity, the aggregate capital, and aggregate labor, respectively. Capital depreciates at a constant rate, δ. The firm rents capital in the international capital market at an exogenous rate r and hires domestic labor supply at a wage per efficiency unit of ω. The law of motion of the labor augmenting productivity factor A_t is $A_{t+1} = (1+\widetilde{g})A_t$, where the technological process is exogenous.

4.3 The government.

The government in this economy runs a pay-as-you-go pension system. It taxes labor earnings with a payroll tax from the working-age cohorts.[8] It uses these revenues to provide pensions to the retired cohorts. The social security budget constraint is:

$$P = T, \tag{4}$$

where P denotes aggregate pensions and T, is the aggregate revenues collected by the payroll tax. I assume the government uses the payroll tax, τ, to balance the Social Security budget for all periods.[9] In Appendix C, I carefully describe how I aggregate pensions and contributions.

4.3.1 The pension system

In the model, I choose the pension system rules to replicate the 2010 Spanish pension system, focusing on the general regime with regular retirement and widow's pensions.

Retirement pensions. To qualify for a retirement pension in Spain, an individual must have contributed to the Social Security system for at least N_c years. When a retiree has the right to receive a pension, the amount depends primarily on the regulatory base and the replacement rate.

The regulatory base refers to an individual's average earnings over the past N_b periods before retirement. The regulatory base is multiplied by the replacement rate, which increases with the working years. Additionally, retirement pensions are bounded below and above to capture the minimum and maximum pensions. Worker i's retirement pension is calculated according to the following formula:

$$p^i = \alpha^i \quad \frac{\sum\limits_{j=J_R-N_b}^{J_R-1} y_j^i l_j^i}{N_b}, \tag{5}$$

where N_b is the number of years considered for computing the regulatory base (average

[8] I assume that the payroll tax is not capped.

[9] I do not model the reserve fund introduced in Spain in 2000.

lifetime earnings) and α^i is the replacement rate. The pension system replacement rate is a step function that increases with the total individual's number of worked years at the retirement age, x^i. In particular, I use the following formula:

$$\alpha^i = \begin{cases} 0 & \text{if } x^i < a_1 \\ \alpha_0^p + \triangle\alpha_1^p(x^i - a_1) & \text{if } x^i \in [a_1, a_2] \\ \alpha_2^p + \triangle\alpha_3^p(x^i - a_2) & \text{if } x^i \in [a_2, a_3] \\ 100\% & \text{if } x^i > a_3. \end{cases} \tag{6}$$

Widow pensions. Following the death of her husband, the wife receives a widow pension proportional to his retirement pension. Any retired female with a retirement pension lower than the maximum pension is eligible for this widow pension. The widow's pension is determined by a fixed proportion χ of her husband's pension:

$$pd = \chi p^h. \tag{7}$$

There are specific bounds for both retirement and widow pensions in the model. For example, $\bar{P}$ and $\bar{Pd}$ represent the maximum quantities for retirement and widow pensions, while $\underline{P}$ and $\underline{Pd}$ represent their minimum quantities.

4.4 The household's problem

In this section, I describe the household problems of a modern household in a recursive form. The same problems for traditional households can be found in Appendix B. I will omit the dependence of variables on the husband and wife's education and age.

4.4.1 Workers

When the household is in the working stage, it makes decisions on consumption (c), savings (b), the labor supply of the husband (l^h), and those of the wife (l^w). The vector of state variables is given by: the age, the education of each spouse, the labor market productivity of each spouse, the private assets accumulation, and the pension rights $\mathbf{s} = \{j, z, x, \epsilon^h, \epsilon^w, b, e\}$.

The optimization problem of modern households in the working stage is given by:

$$
\begin{aligned}
W^M(\mathbf{s}) = \max_{\{c,l^h,l^w,b'\}} & \left\{U(c, l^h, l^w) + \beta W^M(\mathbf{s}')\right\} \\
& \text{subject to} \\
& c + b' = (1-\tau)l^h y^h + (1-\tau)l^w y^w + (1+r)b - q\bar{\psi} l^w \\
& c \geq 0 \\
& l^h \in [0, 1] \\
& l^w \in [0, 1] \\
& b \geq 0,
\end{aligned} \tag{8}
$$

where y^i is the gross labor income of individual i, determined in Equation 1.

4.4.2 Retirees

After $j = J_R$ the household retires. In this stage, the household no longer works but chooses consumption (c) and savings (b). The vector of state variables is given by: the age, the education of each spouse, the labor market productivity of each spouse, the private assets accumulation, the pension rights, the pension, and the widow pension $\mathbf{s} = \{j, z, x, \epsilon^h, \epsilon^w, b, e, p, pd\}$. The optimization problem of modern households in the retirement stage is given by:

$$
\begin{aligned}
R^M(\mathbf{s}) = \max_{\{c,b'\}} & \left\{U(c) + \beta R^M(\mathbf{s}')\right\} \\
& \text{subject to} \\
& c + b' = p^h + p^w + pd + (1+r)b \\
& c \geq 0 \\
& b \geq 0,
\end{aligned} \tag{9}
$$

where the retirement pensions are computed according to Equations 5 and 6. Moreover, the widow's pension, pd, follows Equation 7 and is only received when the husband dies.

5 Calibration details and results for the initial steady state

This section describes the initial steady-state calibration. The model economy's functional forms and parameters are intended to reproduce the Spanish economy in 1975 and the Spanish pension system. The calibration consists of a two-step estimation strategy. In the first step, I assign values to parameters that can be identified outside the model. Then, in the second step, I calibrate the remaining parameters in the second step to target some moments of the Spanish economy. In the Appendix, Table D.1 summarizes the central parameter values for the initial steady state.

5.1 Parameter values set exogenously

Timing. The length of the model period corresponds to one calendar year. The agent's endowment of discretionary time is 5200 hours per year.[10] Individuals' disposable time is split into labor, leisure, and raising babies for mothers.

Demographics. Lifetime is certain and common to all generations alive in the initial steady state. Individuals enter the economy at age 20 and die deterministically. The lifetime of individuals in the initial steady state is taken from the life expectancy at age 65 in 1975 provided by the Spanish Statistical Office (INE, the acronym in Spanish). In the initial steady state, women live until age 82, $J_w = 63$, and men until age 79, $J_h = 60$. Retirement is deterministic and happens at age 65, $J_R = 46$.

The initial share of age groups in the population, $N_{t,j}$, corresponds with the Spanish population pyramid by age from INE in 1975. This implies an old-age dependency ratio of 17.2% while the data counterpart is 16.82%.[11]

Education. Individuals' education levels are classified as low, medium, and high. In the initial steady state, each cohort has a specific educational attainment. To compute the initial distribution of households by the educational attainment of the spouses, I follow the methodology in Esteve and Cortina (2006) using the Spanish Census of 2001 and 2011. I carefully explain the methodology in Appendix E, and in Table E.2, I show the calibration results. In the initial steady state, 59% of households are composed of two spouses with low education, 19% of medium education, and 4% of high education.

Initial productivity. At the beginning of the life cycle, individuals draw an initial productivity from a log-normal distribution that is gender and education-specific. I estimate the mean and the variance of the distributions using the "Muestra Continua de Vidas Laborales" (MCVL) and the Industry and Services Wage Survey. Since in the 70s, there was a lot of selection of women for those in the labor market, I assume that the variable of female distri-

[10] I consider 16 hours per day, 6 days per week, and 52 weeks per year of discretionary time.

[11] The model and the data are not perfectly matched because people enter the economy at the age of 20, whereas the data include individuals from the age of 16, and some people's lifetimes are longer in reality than those in the model.

bution is the same as men's, and for the mean, I calibrate it to match the exogenous gender wage gap specified below. Table 1 shows the mean and variance of the log-normal distribution by education. See Appendix D.2 for a complete description of the sample restrictions and the specific methodology.

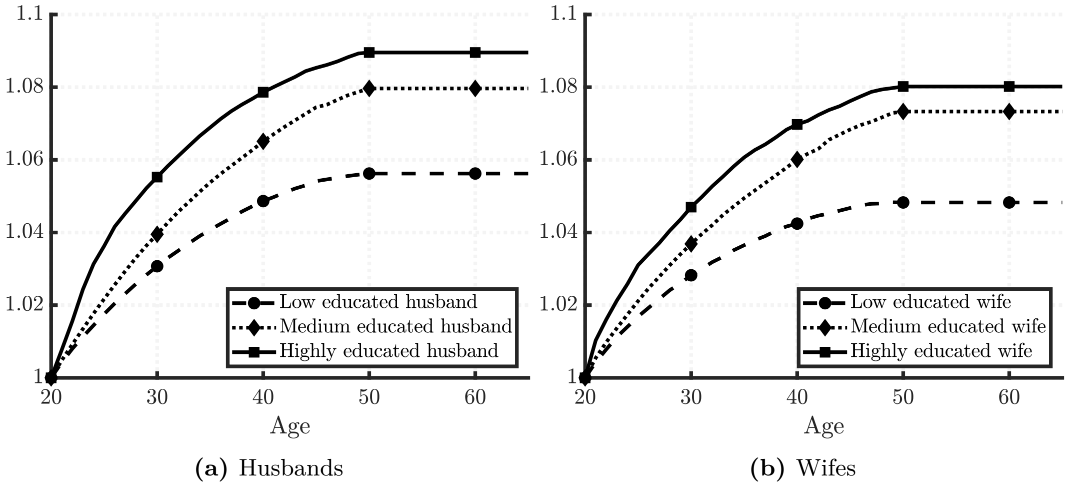
Table 1. Mean and variance of the log-normal distribution by education.

	Mean, μ^h	**Variance, σ**
Led	9.42	0.327
Med	9.56	0.396
Hed	9.76	0.450

Slope of earnings. I estimate the earnings profile over the life cycle by gender and educational attainment using the MCVL. In particular, the slope of the earnings profile comes from the predicted values of the following estimated model:

$$Y_i = \beta_0 + \beta_1 X_i + \epsilon_i, \tag{10}$$

where Y_i are the log yearly earnings of an individual i. X_i is a control vector that includes: age, age squared, a dummy variable for low and medium education, an interaction term between education and age, and a dummy variable for gender and occupation. The slope of life-cycle earnings is normalized to one for all individual types. See Figure 8 for a gender and education comparison.



(a) Husbands **(b)** Wifes

Figure 8. Predicted profile of earnings by education and gender in the initial steady state
Source: MCVL, using the 1980-2001 sample.

Return of assets. I use the real one-year Treasury Bill rate between 1960 and 1975 for the asset's return. In particular, $r = 0.036$, which is in line with the computations of Licandro et al. (1996) for Spain (3.75%) and Erosa et al. (2016) for U.S. (4%).[12]

The productivity growth. I set the labor augmenting productivity growth equal to the average growth rate of real Gross Domestic Product per capita between 1913 and 1975 estimated by De la Escosura (2017). This implies a productivity growth of $g = 1.77\%$.

Number of children. The number of children the household has is mother's education-specific. To compute these fertility rates, I use the cumulative fertility rates of the cohorts 1910-1955 by education of the mother from the Zeman et al. (2014) database. The number of children attached to low, medium, and highly educated women in the initial steady state are 2.5, 2.2, and 1.8, respectively. See Appendix D.3 for a complete explanation of the computation of these.

Arrival of children to the household. I compute the average age at first birth and the average spacing between children using the INE. In 1975, women had, on average, their first children at the age of 25, $J_c = 6$. Moreover, the second and the third arrive with a three and two years gap, i.e., $j = 9$ and $j = 11$, respectively.

The time cost of babies. Babies, aged 0-2, impose a time cost on mothers, independent of their labor market status. I estimate this cost using the INE's Spanish Time Use Survey (2001-2002). I set the time cost equal to the gap in the time spent with children between married mothers and fathers. This gap is 46 minutes per day, which in model terms implies that $\psi = 0.046$.

The monetary cost of babies. When the mother works, the household incurs in a monetary cost that accounts for the childcare cost. This cost is proportional to the mother's labor supply. To estimate the out-of-pocket childcare cost, I combined three different data sources: Immervoll and Barber (2006) analysis for 2002 with the OECD database, the Household Budget Survey provided by INE in 2006, and the survey of Household's Expenditure in Education provided by the INE in the course 2011-2012. These estimations were 6%, 7.4%, and 7.12% of full-time workers' average earnings, respectively. As there is no richer database, I set the per-child care cost faced by full-time working women, q is the 7% of average earnings in the economy.

[12] There is no consensus in the literature about which is the best proxy for the world interest rate. "The 3-month U.S. T-Bill rate, the rate of return on the S&P 500, the LIBOR rate, and a weighted average of several countries' T-Bill rates, have been employed as nominal interest rates" Blankenau et al. (2001).

The pension formula. Using the General Regime System of 2002, I determine that the retirement age equals 65 years old, $J_R = 46$. To qualify for a retirement pension, a worker must have worked full-time for at least 15 years, $N_c = 15$. For a complete distinction between full-time and part-time employees, see Appendix D.5. Regulatory bases consider gross labor earnings over the preceding 15 years to retirement, $N_b = 15$, while widows receive 52% of their husband's pension. In addition, I use the replacement rate parameters presented in Equation 6.

Retirement and widow's pensions are limited to guarantee a minimum income level at retirement and prevent getting too high pensions. These bounds are calculated as percentages of average earnings. I use the Social Security annexes from 1980-2014 and the average yearly earnings provided by De la Fuente (2017) to compute the average of these bounds. The Appendix in Table D.1 summarizes all pension formula parameters.

Household preferences. The intertemporal elasticity of leisure γ is set exogenously. I take the calibration in Erosa et al. (2022), so $\gamma = 4$.

5.2 Parameter values set by solving the model

Six parameters remain undefined: the initial distribution of female wages, the taste of leisure, the three participation costs, and the discount factor. The remaining six parameters are chosen to minimize a loss function determined by deviations between the model implied and data moments. In what follows, I specify how I pin down each of the parameters, even though equilibrium outcomes determine them all. Table 2 shows the second-stage parameters and data moments.

Table 2. Second-Stage Parameters and Data Moments

	Parameter	Value	Targeted data moments
Mean female initial earnings	μ^w	$\mu^h - 0.27$	Gender wage gap full-time workers
Taste of leisure	ν	0.58	Average male working hours in 1987
Participation cost, led	$\varphi(1)$	9.9	Female employment rate led (25-45)
Participation cost, med	$\varphi(2)$	7.9	Female employment rate med (25-45)
Participation cost, hed	$\varphi(3)$	5	Female employment rate hed (25-45)
Discount factor	β	0.992	Wealth over income ratio

Note: led, med, and hed refer to low, medium, and highly educated women.

Initial productivity for females. For females, I assume the moments of the log-normal distribution of the initial productivity are the same as for males, but with a lower mean, μ^w.

I calibrate this drop in the mean to match the gender wage gap for full time-workers to 17%, which is the estimation with the MCVL in 2001.[13]

Taste of leisure. I calibrate the taste of leisure, ν, to match the average hours worked by men during the working ages. The first available estimation from the INE is from 1987 and equals 39.1 hours per week. Since the total discretionary time in a year is 5200 hours (100 hours per week), the average fraction of time worked is 0.391. Thus, the Frisch elasticity of labor supply is $\frac{1}{\gamma}\frac{(1-n)}{n}$ where n is the average time worked. This calibration implies that the labor supply elasticity is 0.39 for males in the initial steady state.

Participation cost. The calibration strategy of $\kappa(x)$ follows Kaygusuz (2010), Kaygusuz (2015) and Guner et al. (2012a). When the household enters the model economy, the wife draws a utility cost of participating in the labor market, $\kappa(x)$, from a gamma distribution that depends on her educational attainment. Once this cost is set, it is constant over the life cycle. The scale parameter η is 5 for all education groups. The shape parameter $\varphi(x)$ is calibrated to match the women's employment rate by educational attainment in the initial steady state. As estimated by Sánchez-Marcos (2003), the female employment rate for married women aged 25-45 in 1980 for low, medium, and highly educated women was 20.7%, 37.3%, and 66.5%.

The discount factor. Following Kaplan and Violante (2010), the discount factor is calibrated to match the median household wealth over income ratio in 2002. I take the definition and data from the Encuesta Financiera de las Familias (EFF) reported by the Bank of Spain in 2002. Net wealth is defined as the total value of assets (both real and financial) minus the number of debts. Income is defined as the sum of the property income from the households' asset holdings and the gross labor and non-labor earnings received by all household members. The Spanish median wealth over income ratio was 4.32 in 2002. This estimation is much higher than the one reported in Kaplan and Violante (2010) for the U.S. economy. The explanation relies on the high wealth of Spain compared to the U.S., driven mainly by housing. As there is no available data for the previous years, I assume that the evolution of the wealth-to-income ratio behaves as the evolution of personal wealth over national income in Blanco et al. (2021). In particular, from 1975 and 2002 it grows from 400% to 500%. Therefore, the implied wealth-to-income ratio is 3.46 for the year 1975.

[13] This estimation is in line with Guner et al. (2014) of 17.1% in 1994.

5.3 Calibration results for the initial steady state

In this section, I show how well the model matches the target moments explained before. I also study the model's ability to reproduce some untargeted moments.

5.3.1 Targeted moments

As shown in Table 3 the model perfectly matches the moments targeted by the initial steady-state calibration in 1975. At the aggregate level, the model fits the wealth-to-income ratio, the average hours worked by males, and the gender wage gap in the Spanish economy in 1975 satisfactorily. The model also almost perfectly matches the employment rates of married women by education, which are targeted by modifying the shape of the gamma distributions for the participation costs women face if they want to join the labor force.

Table 3. Model fit, targeted moments in the initial steady state

		Model year	**Model**	**Data**
Married female employment rate (25-45)	Led	1975	20.6%	20.7%
	Med	1975	37.4%	37.3%
	Hed	1975	66.9%	66.5%
Male average weekly working hours		1975	39.1	39.5
Wealth over income ratio		1975	3.3	3.5
Gender wage GAP of full time workers		1975	17.6%	17.0%

Note: led, med, and hed refer to low, medium, and highly educated women.

5.3.2 Implications for untargeted statistics

In the initial steady state, the model generates a plausible hump shape profile of assets over the life cycle. Figure 9 shows the evolution of assets over the life cycle for three households composed of a wife and a husband with the same education. Savings are a tool for smoothing consumption since the model has no aggregate uncertainty. In traditional households, women are not entitled to a retirement pension, so this mechanism is essential.

In the calibration, I target the employment rate of married women, but I do not target the number of hours worked. Table 4 shows that the model reasonably replicates the share of married women working more than 35 hours per week for medium and highly-educated women in 1980. However, the model implies that 23.09% of low-educated women work more than 35 hours per week, while 14% do in the data. The lack of career interruptions, apart from childcare, might explain why their hours worked are higher among low-educated women than in the data.

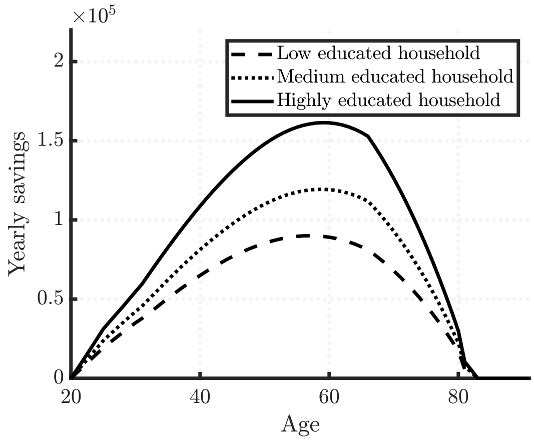


Figure 9. Life-cycle profile of assets in the initial steady state

Table 4. Share of women working more than 35 hours per week in the initial steady state

	Year	**Model**	**Data**
Low educated	1980	23.09%	14%
Medium educated	1980	25.46%	23.10%
Highly educated	1980	31.30%	32.30%

Source: Sánchez-Marcos (2003)

6 Aging transition with a PAYG pension system

This section shows the model's transition between steady states under a PAYG pension system which assumes a budget balance each period. In Section 6.1, I describe the demographic, educational, and participation costs of women and the fiscal scenarios I use in my simulation. Section 6.2 discusses the calibration results for the targeted and untargeted moments. Section 6.3 provides an overview of the evolution of the Social Security contributions rate, household composition, and gender gaps in employment, hours worked, earnings, and pensions between steady states.

6.1 Methodology: projections and calibration

The benchmark and the counterfactual economies have the same initial conditions described in Section 5. Below I describe my assumptions during the transition.

Age distribution. I use the age distribution of households and its projections from the INE between 1976 and 2069. After 2069, I assume that it is constant. The age distribution implies that the old-age dependency ratio changes over time and grows from 17.78% in 1975 to 50% in 2069 (see Figure 10a).

Life expectancy. I assume that cohorts alive in the initial steady state make their decisions assuming that the life expectancy for men and women is 79 and 82 years, respectively. However, in 1976, I assume that the cohorts who are still in the working-age stage, receive a shock about their real life expectancy and reoptimize their decisions accordingly. Figure 10b shows the life expectancy I assume for cohorts alive in the initial steady state by their age at that time.[14] Newborn generations also face a cohort-specific life expectancy by gender, shown in Figure 10c. I assume that after 2014, it is constant. This implies that the life expectancy of men and women entering the economy after 2014 is 88 and 91, respectively. I select these life expectancies in Figures 10b and 10c to match the average life expectancy at age 65 for each period between 1976 and 2069. Since life is deterministic in the model, these parameters can be cleanly identified outside the model. See Figure F.1 for the model fit.

Number of children and their arrival. Consistent with the data, I assume that the fertility rates by educational attainment of the mother drop for newborn cohorts. For cohorts born until the model period 1991 (the 1971's generation), I follow the same methodology as in the calibration of the initial steady state. For younger cohorts, I build the cohort fertility rate in the same fashion as Ahn and Sánchez-Marcos (2020), given the Birth Records for the 1972-2027 generations by the INE. Since this database does not provide fertility rates by education, I assume that the differences in the cohort fertility rates across educations are constant and equal to the 1971 cohort.[15] The number of children attached to low, medium, and highly educated women drop from 2.5,2.2 and 1.8 in 1975 to 1.8,1.5, and 1.3 in 2050, respectively. See Figure 10d for an evolution of the fertility rates by cohort. Also, the mother's age when giving birth to her first child increases consistently with the INE, assuming it remains constant after 2015. It increases from 25 in 1975 to 31 for cohorts arriving in the economy after 2015. See Figure 10e for the evolution of the mother's age at first birth.

Education. For cohorts born in the model years 1976-1998, I follow the same methodology and data source as in the initial steady-state calibration. For cohorts born between 1999-2015, I combine the data from the INE on the educational attainment of men and women with the Spanish Census. With the Spanish Census data, I construct a likelihood modifier that is informative about the assortative mating of couples. See Section E in the Appendix for a detailed description of the methodology and Table E.1 for the evolution of the educational

[14]For example, take the case of a man of age 20 in 1975. In 1975, he makes decisions according to the life expectancy of 79, and in 1976, he receives a shock stating that his new life expectancy is 85.

[15]Assuming the same differences in the fertility rates by education levels is not a stringent assumption. These differences are constant for the last ten available cohorts in the Zeman et al. (2014) database.

attainment by cohort. For cohorts born after 2015, I assume their educational composition is the same as in 2015.[16] The shares of couples with two spouses being drop-outs, high school graduates, and college graduates change from 59%,19%, and 4% in 1975 to 2%, 40%, and 29% in 2050.[17] Figure 11 shows the implied evolution of educational attainment by gender.

Participation cost of women. I change the gamma distribution shape associated with the female participation cost between 1975 and 2019 to match the female employment rate by educational attainment of married women aged 25-54 in 2019. From 1976 to 2019, I assume the participation cost by education decreases linearly. Figure 10f shows the evolution of the gamma distribution of the participation cost by education.

Fiscal policy. I assume that the Social Security budget is balanced each year. This is achieved by updating the payroll tax. Individuals have perfect foresight about the path of taxes in the Benchmark economy and make their decisions accordingly.

6.2 Calibration results

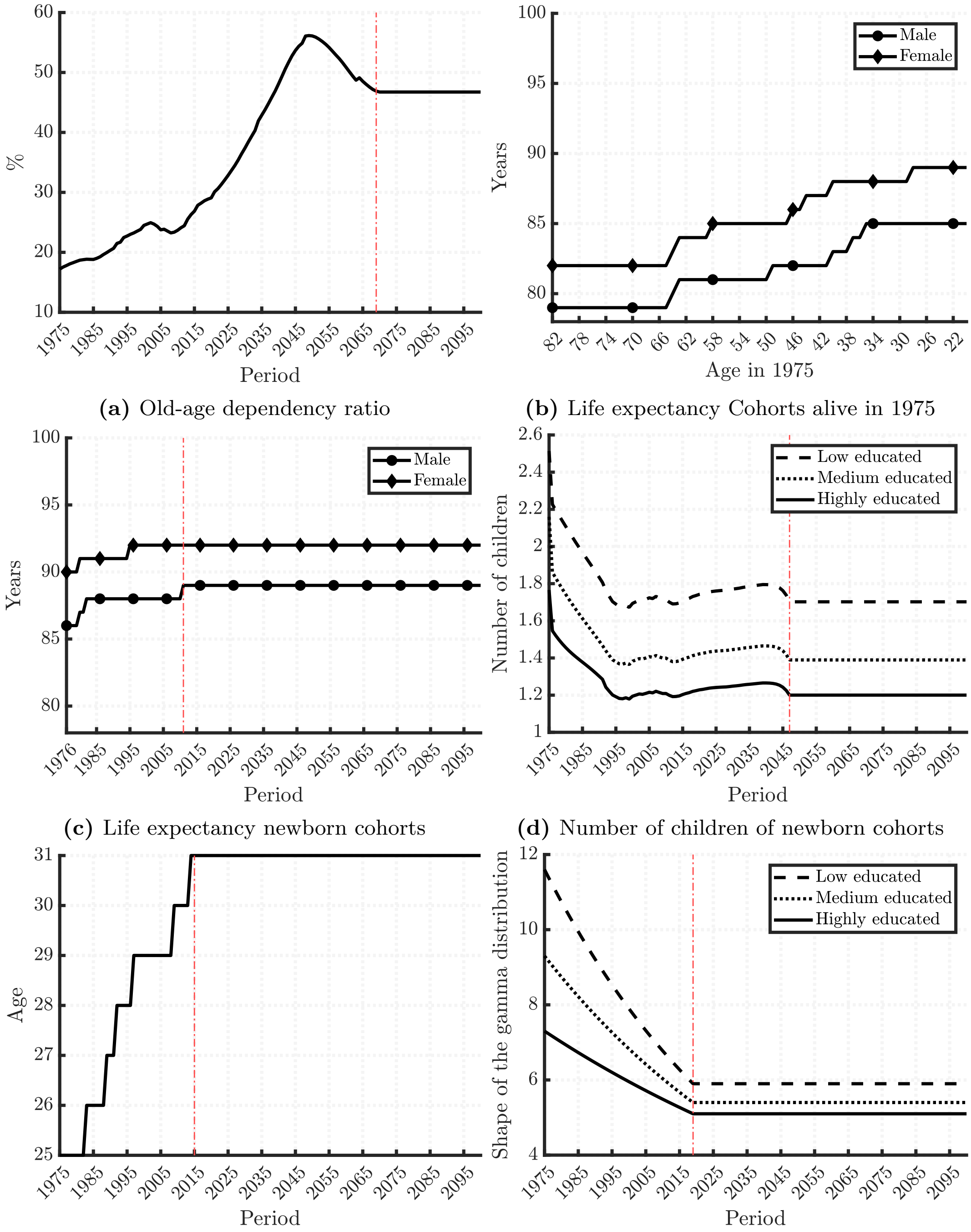
Targeted moments. Figure 12 shows the model fit of the employment rate by education of married women in 2019. This Figure shows that I match well the employment rates in 2019. Despite these being the only targeted moments, the linearly decreasing cost from the initial steady state to 2019 allows me to capture an evolution that is close to the data.

Implications for untargeted moments. Table 5 shows that the model successfully replicates selected labor supply and pensions statistics for 2019. It captures the effective hours worked by gender, the share of female pensioners, and the gender wage gap for full-time workers. The model does not replicate the correct size of the gender gap in retirement pensions and Social Security contributions. One should be cautious when comparing these gaps. The data moments represent the gender gap in contributions and pensions across all individuals, including singles, while the model only considers married individuals.

The gender gap in retirement pensions in the model is 6.2 percentage points lower than in the data. One possible explanation might be that career interruptions are absent, except for children's arrival. Prolonged absences from the labor market affect women's pensions. As a result, the model may generate a higher replacement rate than the data. The minimum

[16] Table E.2 in the Appendix summarizes the implied share of household types through time.

[17] For educational attainment, my scenario aligns with those in the literature. For example, De Sousa et al. (2022) assumes that men drop-outs, high school graduates, and college graduates in 2050 will be 8.9%, 65.1%, and 26.0%, while I use 7%, 62%, and 32%, respectively.



(a) Old-age dependency ratio

(b) Life expectancy Cohorts alive in 1975

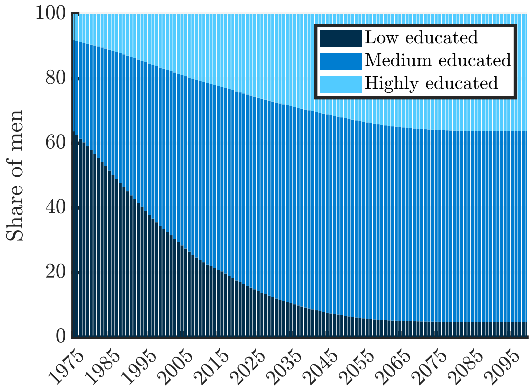
(c) Life expectancy newborn cohorts

(d) Number of children of newborn cohorts

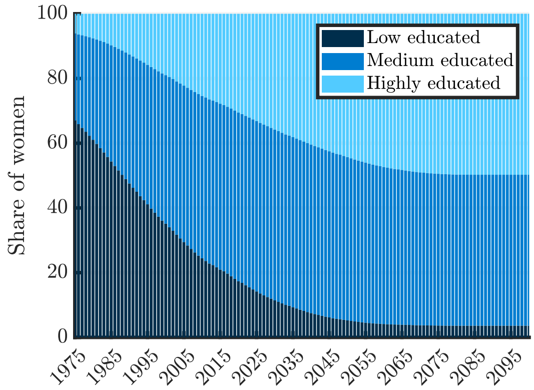
(e) Mother's age at birth child birth

(f) Shape of the gamma distribution

Figure 10. Scenarios along the transition
Note: The vertical line indicates the cohort from which the specific scenario is constant.



(a) Share of men by education



(b) Share of women by education

Figure 11. Evolution of educational attainment by gender along the transition

Table 5. Labor market and pension outcomes in 2019

	Year	**Model**	**Data**
Female weekly hours worked	2019	31.45	30.4[a]
Male weekly hours worked	2019	36.89	36.2
Share of female pensioners over all pensioners	2019	36.71%	35.38%[b]
Gender gap in average retirement pension	2019	23.31%	29.52%[b]
Gender gap in average contributions to Social Security	2019	29.67%	16.2%[c]
Gender wage gap	2019 (2014)	12.87%	12.74%[d]

Notes: [a] From the INE and excludes commuting time. [b] From the National Institute of Social Security (NISS), only considers retirement pensions to the General Regime (RGSS). [c] From the NISS and considers the difference between the average contribution base to the RGSS. [d] From Anghel et al. (2019).

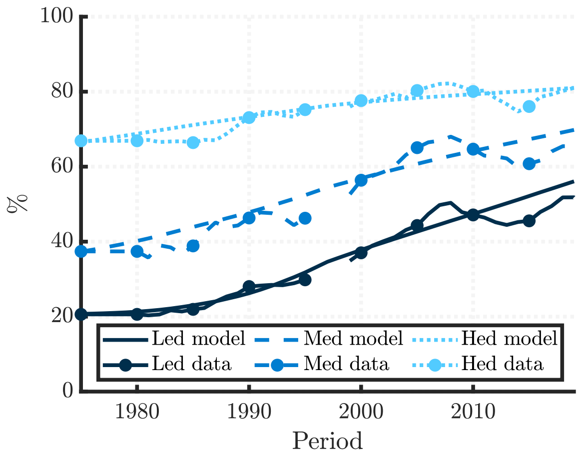


Figure 12. Model fit female employment rate by education

pension may also be overestimated. This would imply that the model raises the pensions of low-income pensioners, who are most likely women.

The model predicts that women contribute far less to Social Security than men. It overestimates this gap by 13.5 percentage points. The lack of single women may be the most plausible explanation. Women in this group work more and contribute more than married women. In 2019, their employment rate is about 70%. The lack of a minimum taxable income could also cause this mismatch. The only salaries contributing to Social Security are those above the minimum taxable income bracket. The model, however, taxes all income. Due to the positive exogenous gender wage gap, women are more likely to contribute to Social Security in the model while they would not be eligible taxpayers.

6.3 Description of the transition

The economy is at an initial steady state in 1975. At this time, most households are traditional. In particular, 62% of them feature a husband who works and a wife who stays at home. The remaining 38% of households are modern, meaning women participate in the labor market. In the initial steady state, conditional on working, men work, on average, 29 hours more than women. This is due to several factors. First, women face a participation cost that prevents some women from participating in the labor market. Second, earnings are exogenous and are lower for women than for men. Third, having a child raises women's opportunity cost of working. Finally, if women work, they have to incur childcare costs.

Starting in 1976, the economy undergoes a transition that concludes in a new steady state in 2100. During the transition, several exogenous changes occur, reflecting what we observe in the data for the period between 1976 to 2019 and the projections I described in Section 6.1. First, both spouses' education levels increase. Second, fertility rates decrease for all women, regardless of their education. Third, women delay fertility. Fourth, men and women live longer. Finally, the age distribution shifts to older ages, resulting in an increase in the old-age dependency ratio.

Between 1976 and 2100, two endogenous changes accompany the exogenous changes above. First, the Social Security tax rate changes to balance the Social Security budget each period. Second, women's participation cost decreases linearly to match the female employment rate by education in 2019 and remains constant after that.

Figure 13 shows the transition path of the Social Security contributions and the old-age dependency ratio. The old-age dependency ratio rises steadily between 1976 to 2050, going from 17.8% to 59%. It then declines and stabilizes at 50% after 2069. As a result, the Social Security contribution rate increases between 1976 and 2050, going from 9.6% to 30.8%, and then lowers to 25.9% in 2100.[18]

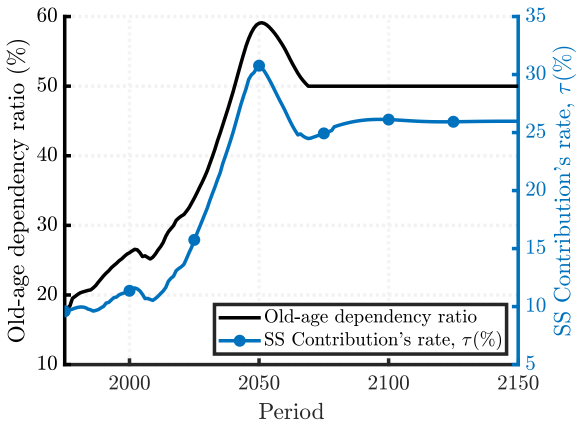
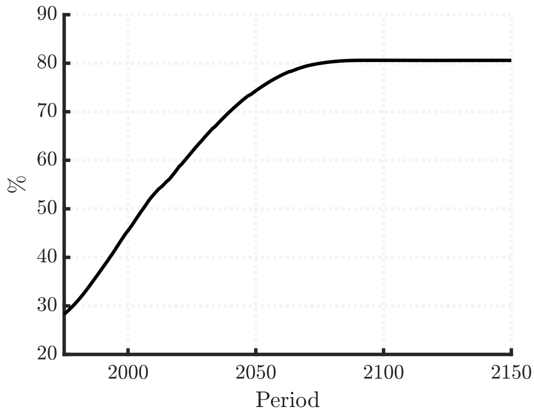


Figure 13. Social Security contribution tax rate and the old-age dependency ratio in the Benchmark economy

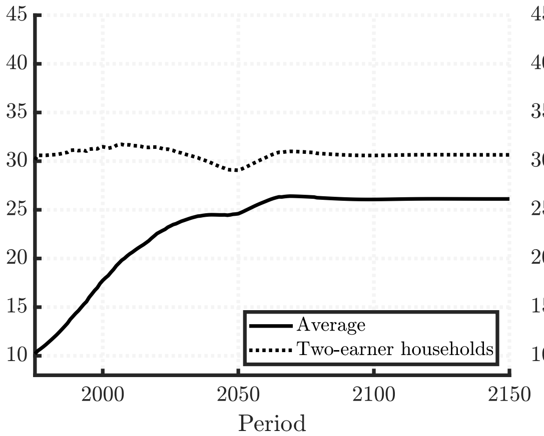
Figure 14 displays the transition paths of the share of modern households and hours worked by gender. Panel (a) shows that the share of modern households increases rapidly and reaches 80.6% in 2100. This increase is driven by several factors. First, the increase in the average level of education generates an incentive for women to participate in the labor market and form modern households. Second, the decrease in fertility rates implies lowers childcare costs and thus reduces the opportunity cost of creating a modern household. Third, the reduction in women's participation reduces the barriers women face when forming a modern household. Then, Panel (b) shows that, on average, women work 15.9 more hours in

[18]My results align with the pension literature. For example, De Sousa et al. (2022) finds that the payroll tax rate would reach 51.1% in 2068 to fund the pension payments in Spain under a small open economy assumption. Díaz-Gimenez and Díaz-Saavedra (2017) showed that under the pension system rules governing in 2013, the pension reserve fund would have accumulated a debt of 9% of GDP in 2050. Moreover, the consumption tax necessary to balance the budget would have been 22.6%. Sánchez Martín and SánchezMarcos (2010) computed a tax increase need of 5.7 percentage points between 2020 and 2050 to finance the Spanish pension system.

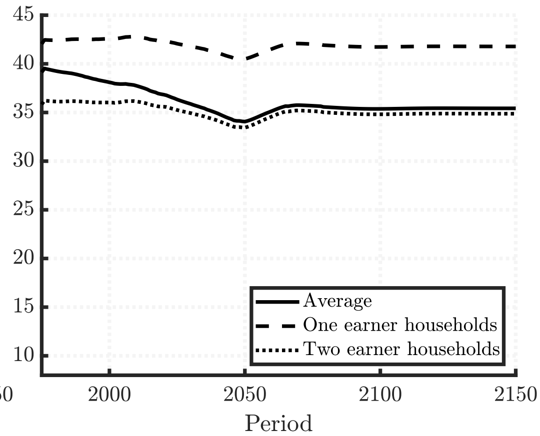
2100 than in 1976. This is because women have fewer children, regardless of their education level. Furthermore, the composition of the female workforce changes towards highly educated women, who have a steeper life-cycle profile of earnings and higher productivity compared to their less educated counterparts. Finally, Panel (c) indicates that, on average, men reduce their weekly hours worked by 5 hours between steady states.[19] This reduction is driven by the increase in the Social Security contribution rate and the rise of modern households. In particular, compared to those in traditional households, husbands in modern ones work fewer hours. Additionally, during the transition, women in modern households work more, allowing husbands to work fewer hours.



(a) Share of modern households



(b) Female weekly hours worked



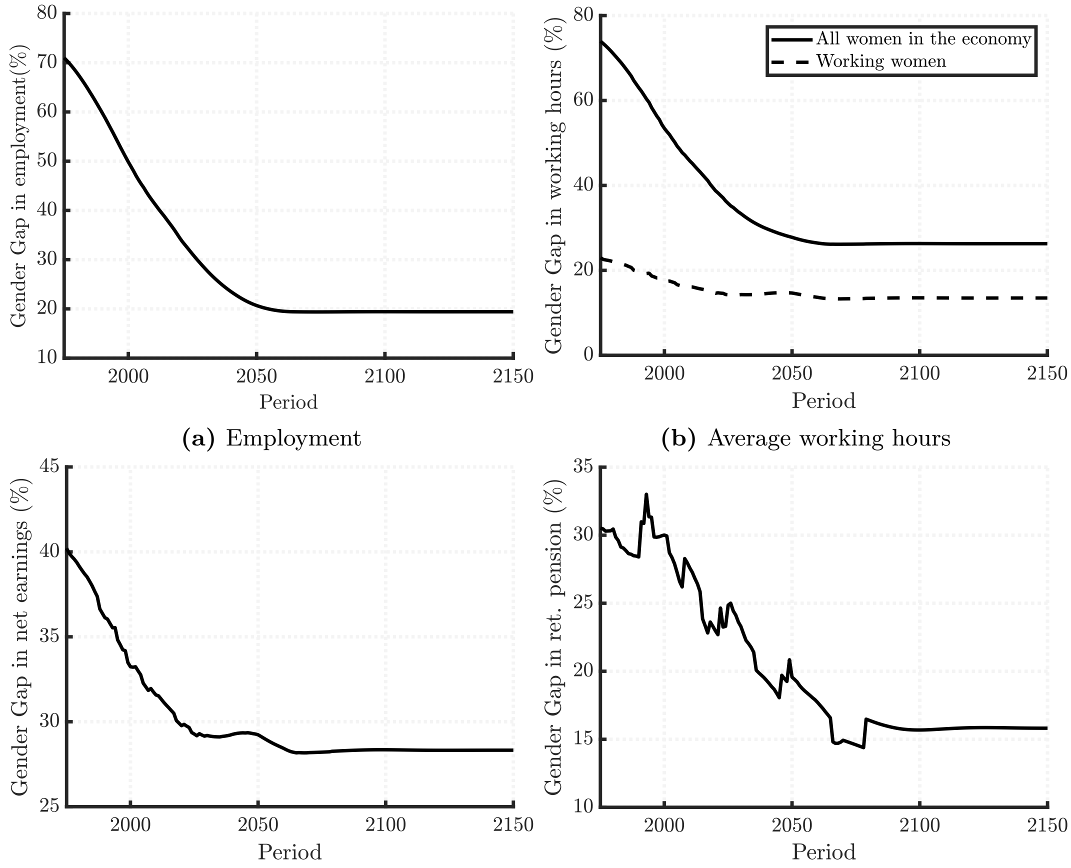
(c) Male weekly hours worked

Figure 14. Labor market outcomes in the Benchmark economy

Figure 15 displays the evolution of gender gaps during the transition. Panels (a)-(c) show that the gaps in employment rates, average working hours, and net earnings decrease steadily between 1976 and 2100. In particular, they reach minimum levels of 19.4%, 26.3%, and 28.3%, respectively, in the new steady state. Panel (d) presents the gap in average retirement pensions. This gap decreases between the two steady states because women work

[19]This finding aligns with McGrattan and Rogerson (2008), who observed a similar decrease in male average weekly working hours in the U.S. following women's incorporation into the labor market.

and contribute more to Social Security and thus have a higher replacement rate. In the new steady state, the gap in the average retirement pension is 15.8%.



(a) Employment **(b)** Average working hours

(c) Net earnings **(d)** Retirement pension

Figure 15. Gender gaps in the Benchmark economy
Note: All the gender gaps in this Figure compare working women, women in modern households, to all men in the economy except Figure 15b where I compare women in modern households to all women in the economy.
Gender gaps are calculated by subtracting the mean of the variable of interest for men from the mean variable of interest for women. Divide the result by the mean variable of interest for men and multiply by 100.

Despite the general reductions in the gender gaps, the new steady state in 2100 still exhibits severe gender disparities. In Section 8, I explore potential tax reforms aimed at mitigating these gender gaps.

7 The contribution of women to financing pensions during the demographic transition

I perform two exercises to quantify women's role in the Social Security system. In the first exercise, I construct a novel measure of the share of men's pensions financed by women and vice versa. When this indicator is positive for women, it implies that women's contributions to Social Security are critical to sustaining it. Section 7.1 discusses the main drivers behind the evolution of this indicator over time. The second exercise simulates the model economy, assuming that women have the same employment and hours worked policy functions as in the initial steady state. This exercise aims to determine what would have happened if women had not changed their labor supply decisions. Section 7.2 illustrates the main simulation results.

7.1 The Gender Imbalance Indicator

According to the Gender Imbalance Indicator (GII, from now on), women's contributions to Social Security will alleviate the financial burden caused by the aging of the Spanish population until 2050. They will finance, on average, 10% of male's pensions. In the long run, however, men will also finance a similar share of female pensions. Women's longer life expectancy and eligibility for both retirement and widow pensions explain this.

Because most households in the initial steady state were traditional, women contributed 5.6 percentage points less to Social Security than men. However, men's pension expenditure was 5.4 percentage points higher than women's since only 22% of them had a pension entitlement. See Figure 16 for the evolution of contributions and pensions by gender. Despite the lower pension expenditure for women, women's contributions weren't enough to cover their costs due to factors like the redistributive pension formula and widow pensions. Therefore in 1975, men financed 5.4% of female pensions. See Figure 17 for the evolution of the GII for females in the left panel and males in the right panel.

As the transition unfolds, both genders show increased contributions and pensions as a share of gross income, see Figure 16. Social Security contributions increased due to three main factors: a higher female labor supply, a higher Social Security tax rate, and higher educational attainment.[20] In terms of pension expenditures, spending grew due to the aging population and the greater number of women entitled to pensions. As a result, the percentage of female pensioners increased from 36.7% in 2019 to 44.6% in the final steady state.

Aside from the general trend toward higher contributions and pensions, Figure 16 shows a discernible pattern of redistribution of resources between genders. From 1980 to 2050, women's Social Security contributions exceeded their pension expenditures. This results in a net transfer of resources from women to men. Indeed, between 1993 and 2026, women financed around 10% of men's pensions (Figure 17a). In 2050, each gender will pay for its pensions; after that, men will redistribute resources to women. The model predicts that men

[20]For males, a higher marginal tax rate and higher educational attainment compensate for a lower labor supply.

will cover about 10% of women's pension expenditures at the end of the simulation (Figure 17b). While both genders experience a rise in their contributions and pensions over time, this redistribution of resources reflects an essential aspect of gender inequality in the Social Security System.

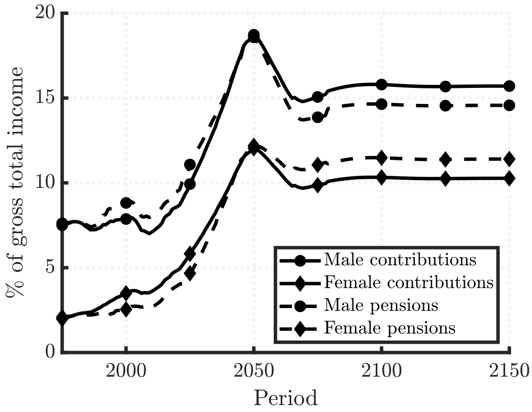


Figure 16. Social Security contributions and pensions in the Benchmark economy
Note: This graph shows the evolution of contributions and pensions by gender as a percentage of total gross income, including male and female labor earnings.

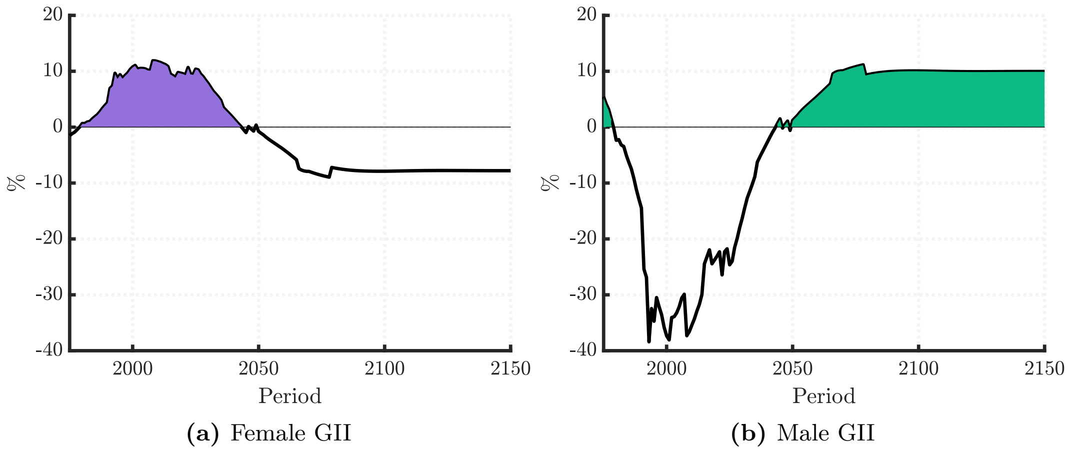


Figure 17. Gender Imbalance Indicator in the Benchmark economy
Note: The Female Gender Imbalance Indicator is the ratio of female contributions minus female pensions to male pensions. Therefore, it represents the share of male pensions funded by females after financing their retirement and widow pensions. Similarly, the Male Gender Imbalance Indicator is calculated as the male surplus over female pensions, indicating the share of female pensions financed by men.

Several factors might explain the redistribution of resources from men to women in the long run. These factors include the minimum and maximum pension levels, the increasing life expectancy of women, and the provision of widow pensions in addition to retirement pensions. To explore the relative importance of these factors, I conducted a decomposition exercise in the final steady state, as shown in Figure 18. The first scenario involves the elimination of minimum and maximum pensions. In this scenario, men would fund 2.95 percentage points less of women's pensions. According to this study, pension entitlement limits are not the primary cause of resource redistribution between genders. The second exercise assumes equal life expectancies for both genders, effectively removing widow pensions. Under this hypothetical scenario, men would fund only 0.33% of women's pensions. Therefore, this simple accounting exercise highlights that women's longer life expectancy and the provision of widow pensions primarily explain the long-term redistribution of resources from men to women.

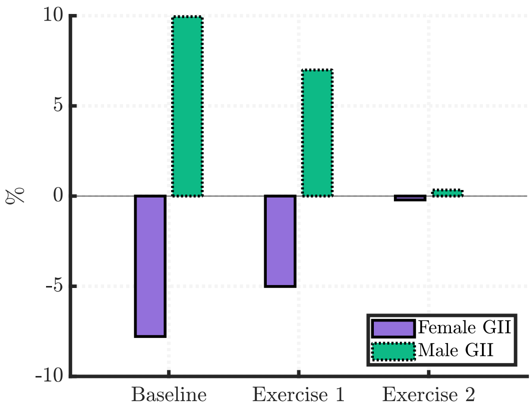


Figure 18. Gender Imbalance Indicator under two hypothetical scenarios
Note: The Female GII is the ratio of female contributions minus female pensions to male pensions. The Male GII is calculated as the male surplus over female pensions. Baseline refers to the Benchmark economy. Exercise 1 denotes an economy where I eliminate the bounds in the pension formula. Exercise 2 denotes an economy where I assume equal life expectancy for men and women.

7.2 Disentangling the role of women and education on the Gender Imbalance Indicator

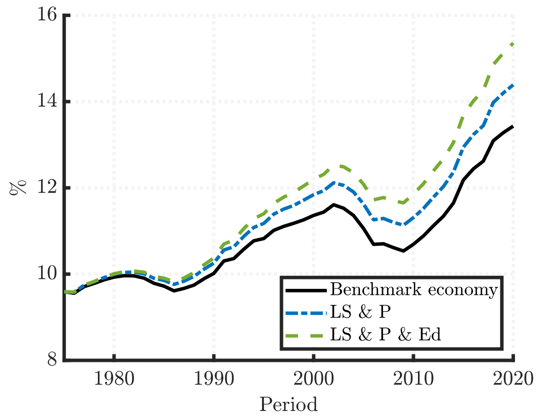
I use my model to simulate two economies that differ in their policy functions of female labor supply and the educational transition only. In the first model economy, which I label *LS&P*, I assume that the policy functions regarding employment and hours worked by women are constant and equal to those of the initial steady state. I also remove the educational transition in the second model economy, which I label *LS&P&Ed*. To better understand the role of education and women's employment separately, I simultaneously study both exercises in this section.

The consequences for labor supply. Even though the policies are those of the initial steady state, the share of modern couples along the transition increases due to two main factors. First, during the transition, women experience reduced time and monetary costs due to fewer children than in the initial steady state. This decreases the opportunity cost of working. Secondly, higher educational attainment correlates with a higher employment rate and more hours worked in the household. In the *LS&P&Ed* exercise, I eliminated this second channel.

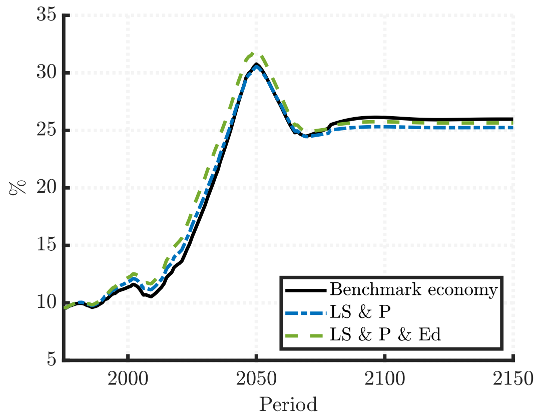
While the Benchmark economy converges to a final steady state where 80.6% of women are employed, and the average labor supply of women is 26.1 hours per week, these numbers would be 50.7% (39.5%) and 17.3 (13.6) for the *LS&P* (*LS&P&Ed*) economies.[21] The decrease in female labor supply impacts female Social Security contributions, resulting in an 18 (28)% decrease in 2019.

The labor market, however, also exhibits a substitution effect, in which men work harder to offset the reduced female labor supply. This substitution effect accentuates by omitting the educational transition.[22] This results in a 0.99 (1.5) percentage point increase in men's average weekly hours worked in 2019. Consequently, males' Social Security contributions rise by 10 (15)%. This growth in male contributions mitigates the decline in female contributions in the short run.

The Social Security contributions rate. Pension expenditure differed slightly from that of the Benchmark economy until 2019 since the cohort of women who increased their participation in the Benchmark economy retired after 2019. Figure 19a compares the evolution of the Social Security contribution rate required to balance the budget in the Benchmark economy with the other two hypothetical economies. In 2019, the tax rate rose from 13.3% in the Benchmark economy to 14.2 (15.1)% in the *LS&P* (*LS&P&Ed*) economies. The increase in the tax rate suggests that until 2019, the Social Security System benefited from increased women's employment rates and educational attainment.



(a) Until 2019



(b) All the transition

Figure 19. Social Security contributions rate in the *LS&P* and *LS&P&Ed* economies

Since the number of women eligible for retirement pensions and the average pension decrease after 2019, pension expenditures for females decline compared to the Benchmark economy. Female pension expenditures, however, fall less than female Social Security con-

[21]Figure A.4 and Figure A.5 displays the evolution of the female employment rate and the female labor supply over time for these three economies.

[22]In the Appendix, Figure A.5 shows males' weekly hours worked.

tributions. Therefore, the final steady state reflects differences of 26.7 (42.5%) and 28.5 (45.4%) in pensions and Social Security contributions, respectively.[23] This is partly due to women living longer than men and receiving minimum and widow pensions. Hence, the model predicts that the pension system would benefit more from having fewer women in the labor market in the long run. This drop in pension expenditure would eventually reduce the tax rate in the final steady state. This would be 0.73 (0.41) percentage points lower than in the Benchmark economy, as illustrated in Figure 19b.

The consequences for the Gender Imbalance Indicator. Figure 20 compares the evolution and projections of the Gender Imbalance Indicator for women (left panel) and men (right panel). By 2019, the drop in female labor force participation and hours worked compared to the Benchmark economy explains 100% of the redistribution of resources from women to men. Moreover, the Gender Imbalance Indicator would have fallen to -4% if the educational transition had not been included, indicating that 9.5% of women's pensions were financed by men in 2019. The role of women in pension funding is negligible in these two scenarios. In the final steady state, men would have financed a larger share of women's pensions, especially in the most restrictive economy without an educational transition. In other words, the educational transition amplifies the effects of a higher female labor force participation rate. Overall, the Social Security System benefited from a higher female employment

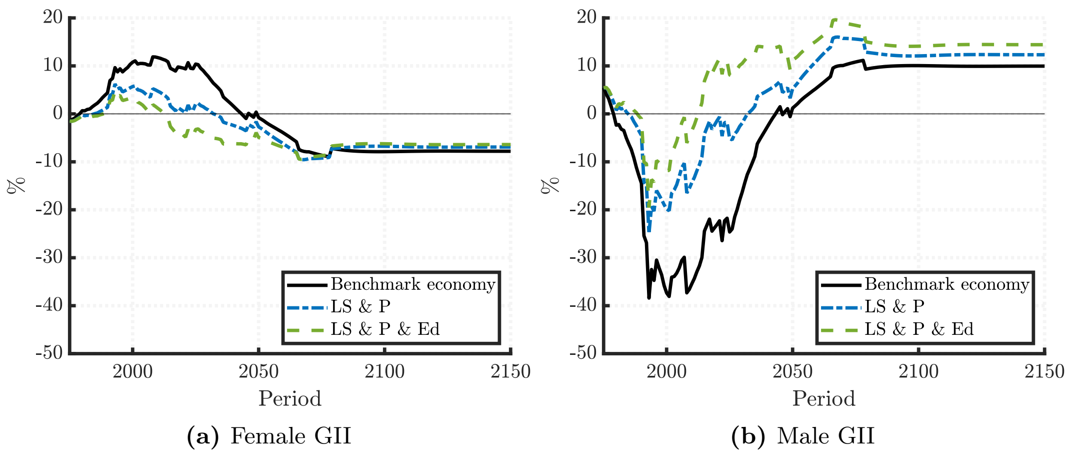


Figure 20. Gender Imbalance Indicator in the *LS&P* and *LS&P&Ed* economies
Note: The Female GII is the ratio of female contributions minus female pensions to male pensions. The Male GII is calculated as the male surplus over female pensions.

rate and educational attainment until 2019, preventing the payroll tax from increasing by 1-2 percentage points. However, this is no longer the case in the long run since a lower tax rate would have been possible if female employment and educational attainment had stayed

[23]Figure A.6 in the Appendix shows the percentage change in Social Security contributions and pensions by gender relative to the Benchmark economy.

the same. The main reason is the drop in pension entitlements and average pensions compared to the Benchmark economy. In addition, there would have been an earlier and more substantial redistribution of resources from men to women in these hypothetical scenarios.

8 Policy experiment: Gender-Based Taxation in the Social Security

The redistribution of resources from women to men in the following decades will be another glass wall preventing women from breaking the gender gap in employment and labor supply. Thus, this redistribution might be a factor behind the significant and persistent gender gaps shown for the Benchmark economy in Section 6.3. Since separate Social Security budgets are only a temporary solution to narrow gender gaps in the labor market, here I propose the introduction of Gender-Based Taxation in Social Security as a promising policy that generates a considerable narrowing in the gender gaps, such as in earnings, participation, and hours worked, and creates welfare gains for newborn cohorts.[24] Section 8.1 discusses its theoretical framework. Section 8.2 explains the methodology I use and the main assumptions I make. Lastly, Section 8.3 and 8.4 show the simulation results and the welfare analysis, respectively.

8.1 Theoretical framework

The tax experiment proposed here relies on a solid theoretical framework that shows and proves that women should be taxed at a lower rate than men because their work elasticity is lower. Rosen (1977) and Boskin and Sheshinski (1983) pioneer this literature by indicating the efficiency gains from taxing women and men at different rates. More recently, Alesina et al. (2011) showed that Gender-Based Taxation (GBT, from now on) with lower taxes for women is superior to the ungendered tax rate. The idea behind this result is that taxing women at a lower rate increases female labor participation and the discrimination cost for employers. At the same time, men's labor supply is more rigid, and they do not reduce their labor supply by much when their marginal tax increases. This tax reform encourages women to increase their labor participation, an explicit goal of the European Union's Lisbon agenda. Despite this, implementing such a policy in a country where gender equalizing policies are one of Spain's main targets would be, at least, controversial.

In addition to the progressive tax system, fiscal policy can close gender gaps in employment, pay, and pensions. Higher tax burdens for second earners impact female labor

[24] Section G in the Appendix shows the simulation results for separate Social Security budgets since 1975.

force participation. Kaygusuz (2010) shows that the reduction in the income tax rate in the 1980s in the U.S. explained 20-24% of the rise in married female employment. Guner et al. (2012a) evaluated the introduction of a proportional income tax and separate filing in the U.S. implies higher female labor force participation for married women by 4.6% and 10.4%, respectively. Guner et al. (2012b) showed that introducing proportional income tax and Gender-Based Taxation in the U.S. would induce women to work more and display welfare gains.

This paper contributes to the literature by examining how gender-based taxation affects the closeness of gender gaps in the labor market through the Social Security contributions tax rate. Future research will need to determine the optimal Social Security tax reform with a gender-based scope.

8.2 Methodology

The policy experiment I present here works as follows: in 2019, the government announced that women will always have a lower tax rate than men. In particular, the percentage difference in the tax rate between genders is calculated so that gender imbalances are zero at the introduction of the policy in the year 2019. As a result, the tax on women is 20% lower than the tax path derived from the Benchmark economy, and agents have perfect foresight. Men's Social Security tax rate is adjusted yearly to ensure a balanced budget.

8.3 Findings

The consequences for the Social Security contributions rate. Figure 21 shows the evolution of taxes for males and females, respectively. Compared to the Benchmark economy, the tax on males was 1.5 percentage points higher in 2019, while the tax on women was 2.6 percentage points lower. The tax differential between males and females reaches its maximum level in 2050 when the tax on males is 4.1 percentage points higher, and the one on females is 6.1 percentage points lower than the Benchmark economy. These differences in the final steady state are 3.9 and 5.2, respectively. [25]

The consequences for labor supply. Changes in the tax rate levied on women and men significantly impact the labor market. Since women's taxes are lower than those in the Benchmark economy, they are encouraged to increase their extensive and intensive margins of labor supply. In the extensive margin, Figure 22a shows the employment rate over time in

[25] See Figure A.7 for an overview of the percentage point tax differences between the Benchmark economy and the GBT policy experiment.

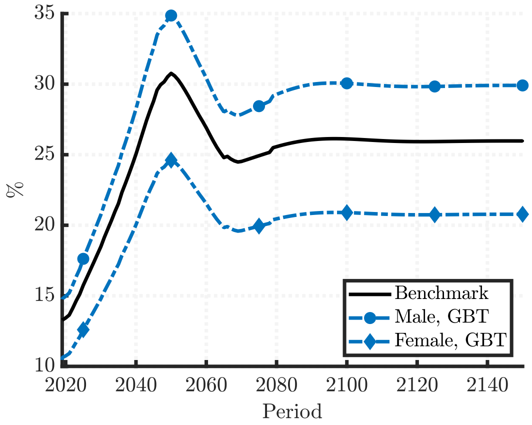
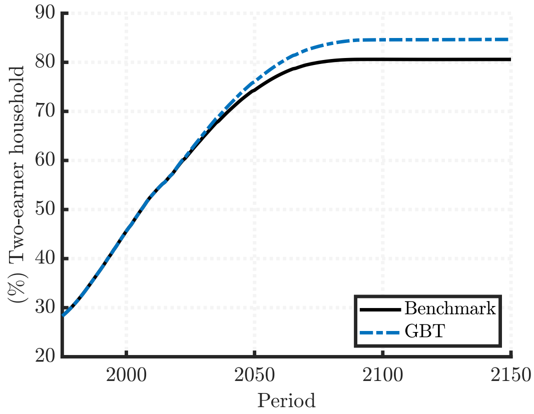


Figure 21. Social Security contributions rate in the GBT policy experiment
Note: previous to 2019, the tax rate for women and men is the same and equal to the Benchmark economy.

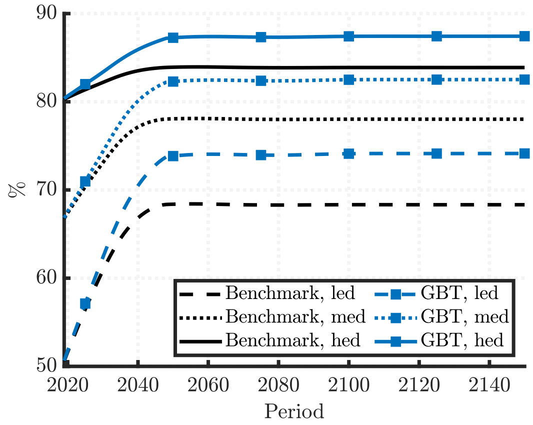
these two scenarios. It shows that the female employment rate increases by four percentage points compared to the Benchmark economy. Women with low and medium education mainly drive this change; see Figure 22b for participation rates by education. Tax changes primarily affect women at the margins of forming a modern or traditional household, and women with low and medium education are more likely to be in the margin. Thus, they increase their employment rate the most. On the intensive margin, there are also substantial effects. Figure 22c plots the path of average working hours in the Benchmark and GBT economies. The average woman works one hour more per week than the average woman in the Benchmark economy.

Rather than motivating men to work, this policy disincentives them since their new tax path is higher than the Benchmark. Regarding hours spent in the labor market, Figure 22d plots the path of male labor supply in the benchmark economy and GBT economies. Due to a greater share of modern couples- for whom men supply fewer hours of weekly work- and a higher tax rate levied on men, the average labor supply falls by one hour per week. According to Figure A.8 in the Appendix, the shift is attributed to a decrease in average hours worked by modern couples, i.e., there is a substitution effect between genders in those couples where both members have a paid job.

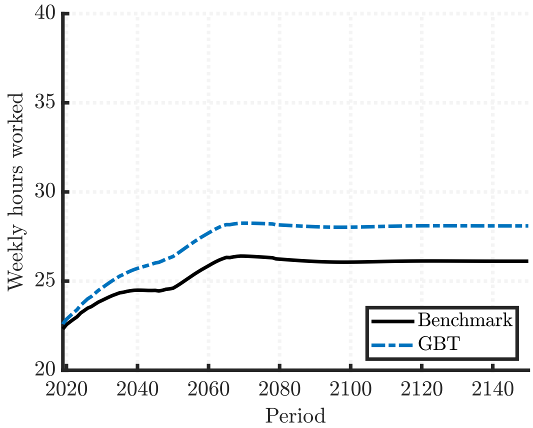
The consequences for the GII and the gender gaps in the labor market. Under GBT, men play a crucial role in pension funding. According to the Gender Imbalances indicator, after 2019, men finance women's pensions. Figure 23 shows the Gender Imbalance indicator in the Benchmark and GBT economies. In the final steady state, men finance 9.9% of female pensions in the Benchmark economy and 23.55% in the GBT Experiment. The higher female employment rate and hours worked are offset by a lower tax path and a wage



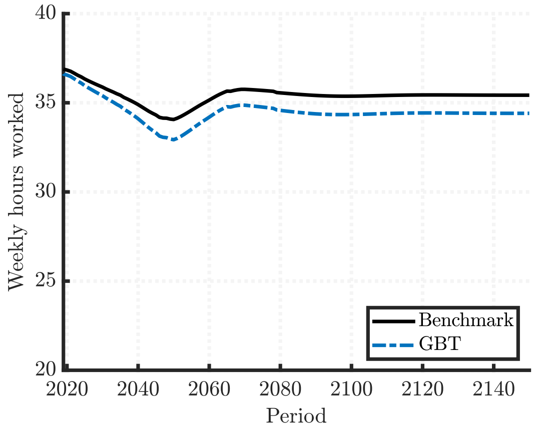
(a) Female employment rate



(b) Female employment rate by education



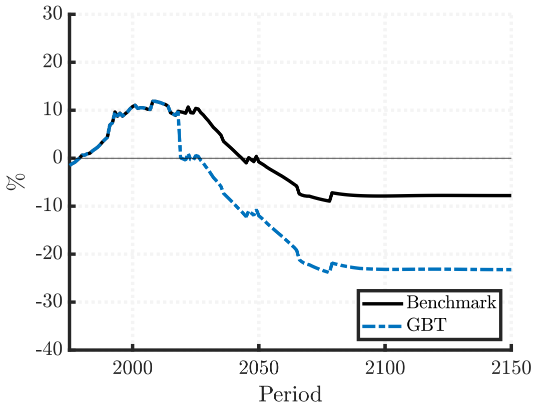
(c) Female labor supply



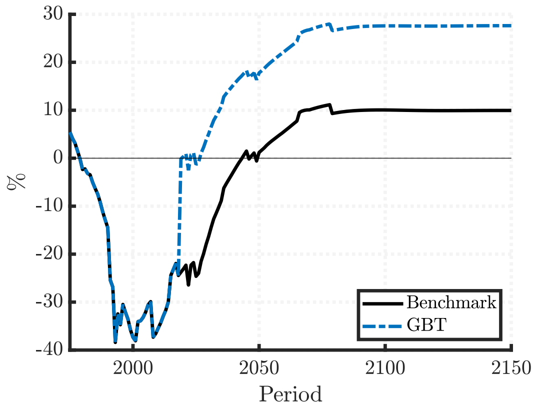
(d) Male labor supply

Figure 22. Labor market reactions by gender in the GBT policy experiment
Note: In Figure 22b, led, med, and hed represent women with low, medium, and high education.

gap for women, which explains this result. Consequently, compared to the Benchmark economy, female contributions fall by 11.6% in the final steady state, while pension expenditures on female pensions rise by 4.2%. Tax rates for men are higher, so their contributions increase by 9.3%, while their pension expenditure decreases by 1.4%. Although this experiment does



(a) Women's surplus/ men's pensions



(b) Men's surplus/ women's pensions

Figure 23. Gender Imbalance Indicator in the GBT policy experiment
Note: The Female GII is the ratio of female contributions minus female pensions to male pensions. The Male GII is calculated as the male surplus over female pensions.

not achieve full gender parity, it provides a relevant source to lessen gender pay and working gaps. Figure 24 shows the gender gap comparison between the Benchmark and the GBT economies. In this regard, the most outstanding achievement is narrowing the gaps in hours worked and net earnings; see Figures 24a and 24b. These narrow by 10.7 percent and 5.9 percent, respectively. The drop in the gender gap in hours worked is not merely a consequence of women providing more work per week but also because men in modern couples are reducing their labor supply. As a result of a higher tax on men than on women, the convergence in hours worked results in a 14.1% earnings gap in the final steady state (vs. 28.3% in the Benchmark economy).

There is also convergence on the extensive margin of labor supply. In particular, gender gaps in employment narrow by 4.07 percentage points; see Figure 24c. Although this drop might seem small compared to the number of hours worked, it increases the employment rate of women with low and medium levels of education. This previous convergence directly impacts the average pension gap between women. Among women, a higher share will be eligible for a retirement pension due to their long working hours and greater net earnings, which translates to a 4.1 percentage points reduction in average pensions compared to the Benchmark economy, see Figure 24d.

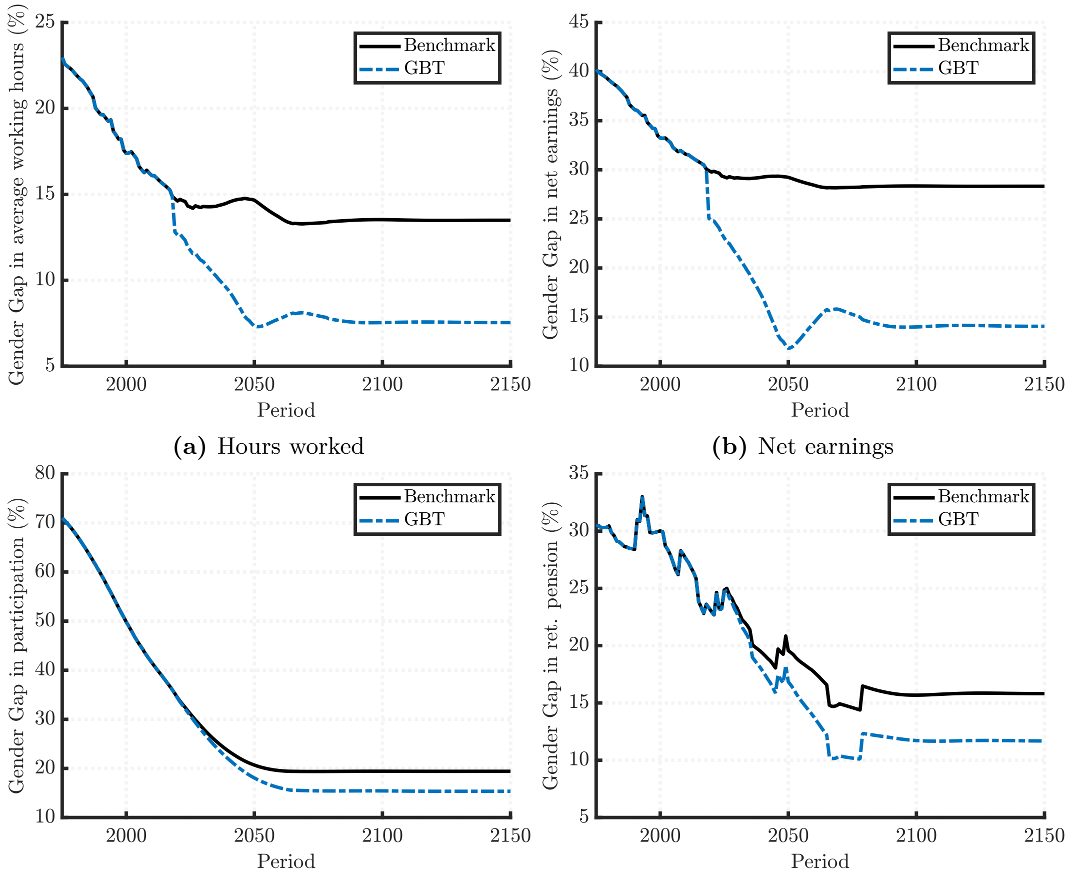
8.4 Welfare analysis

Methodology. The welfare measure consists of computing the per-period consumption compensation under the Benchmark economy, which guarantees equal discounted welfare under the current tax system in 2019 and the one implied by the tax reform (GBT). Then, the welfare gains or losses of cohort s are calculated as the constant percentage change, λ_s, in the baseline consumption path, such that these households are indifferent between the current tax system and the tax reform. Thus λ_s is given by

$$\lambda_s = \left(e^{\mathbb{E}V\left(\ddot{\boldsymbol{\Psi}}_{\mathbf{s}}, \ddot{\boldsymbol{\Upsilon}}_{\mathbf{t}}; \ddot{\boldsymbol{\Omega}}_{\mathbf{t}}\right) - \mathbb{E}V\left(\boldsymbol{\Psi}_{\mathbf{s}}, \boldsymbol{\Upsilon}_{\mathbf{t}}; \boldsymbol{\Omega}_{\mathbf{t}}\right)} - 1\right) \times 100, \tag{11}$$

where $\boldsymbol{\Psi}_{\mathbf{s}}$ denotes the state variables of the household, $\boldsymbol{\Upsilon}_{\mathbf{t}}$ the aggregate state variables of the economy at time t and $\boldsymbol{\Omega}_{\mathbf{t}}$ is the government policy schedule regarding the Social Security tax rate at time t. All the variables with the accent, $\ddot{x}$, refer to the states and tax policy under the GBT tax reform.

The interpretation of this welfare measure is simple: λ_s denotes the percentage of consumption cohort s needs to receive to be indifferent between the Benchmark economy and the GBT economy. When $\lambda_s > 0$, it implies that household aged j at time t would be



(a) Hours worked (b) Net earnings (c) Employment (d) Retirement pension

Figure 24. Gender gaps in the Benchmark economy and the GBT policy experiment

better under the reform scenario. In contrast, this household would like to remain under the Benchmark economy scenario if $\lambda_s < 0$.

First, I will analyze the welfare effects of the tax reform on households that were already born at the time of its implementation and then on those that were born afterward.

Main assumptions. Before analyzing the welfare gains or losses of individuals alive in 2019, it is worth mentioning the main underlying assumptions I make with these cohorts. First, these households decided to form a traditional or a modern household at the beginning of their life cycle. To make this decision, they drew the participation cost for women, and they had perfect foresight about the path of taxes, i.e., the one of the Benchmark economy. If the discounted expected value of forming a modern household (net of participation costs) outweighed the discounted expected value of forming a traditional couple, this household would choose to form a modern couple. Otherwise, it would form a traditional couple. Second, the tax reform, GBT, is taken here as an unanticipated shock. All cohorts remained traditional or modern in 2019 based on their decision when they were born. Essentially, I keep couples from reoptimizing their household type decision. It is possible, however, for them to adjust their labor supply, consumption, and savings in this new economy.[26]

Cohorts alive in 2019. Table 6 summarizes the average consumption compensation for different household types in 2019. While, on average, households prefer to remain in the Benchmark economy (-0.1% of lifetime consumption), there are substantial heterogeneous effects among households. Specifically, traditional couples suffer welfare losses of 1.49% of their lifetime consumption compared with modern couples, with welfare gains of 0.25%.

The traditional couple will suffer welfare losses because they cannot change their household composition, and men's taxes are higher than in the Benchmark economy. It is less straightforward for modern couples to gain welfare, however. This is because the Gender-Based Taxation economy increases the husband's tax rate while decreasing the wife's. This analysis shows that the latter outweighs the former, and therefore, modern couples are better off under the new tax system.

Table 6. Welfare effects of the GBT policy experiment for cohorts alive in 2019

Type	% Consumption Compensation
All households	-0,10
Traditional households	-1,49
Modern households	0,25
Low educated female	-0,44
Medium educated female	-0,19
Highly educated female	0,12

From an educational perspective, welfare increases with the wife's education. Women with low education experience a welfare loss of -0.44% lifetime consumption compensation, whereas women with college degrees experience a welfare gain of 0.12%. The effect is purely compositional: women with low education work less and form traditional marriages. Table 7 adds to the previous analysis by assessing welfare implications by spouse education level. It shows that welfare losses are significantly higher among households with low- and medium-educated men but decrease with women's education. One interesting result is that households with a highly educated wife and a low or medium-educated husband receive welfare gains since women are the primary income providers in their households.

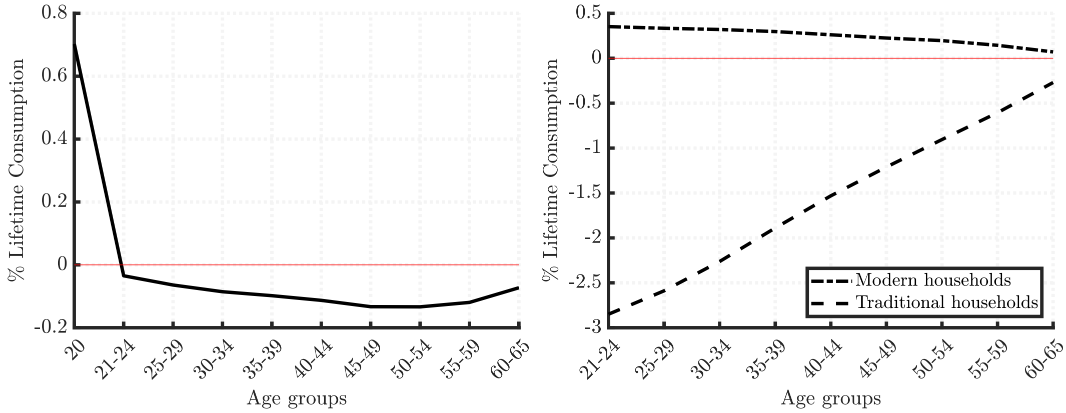
Finally, 25 shows a decomposition exercise of lifetime consumption compensation by age group (25a) and age group and household type (25b). The first result in 25a is that although only newborn cohorts are better off under this tax reform scenario, the losses of cohorts alive in 2019 vary with age. This chart displays a U shape, indicating that the

[26]This assumption is consistent with the baseline model, in which individuals only choose their household type at the beginning of their lives and cannot reoptimize it.

Table 7. Welfare effects of the GBT policy experiment by spouses' education alive in 2019

		Female		
		Low educated	Medium educated	Highly educated
Male	Low educated	-0,36	-0,01	0,39
	Medium educated	-0,52	-0,18	0,23
	Highly educated	-0,71	-0,38	0,03

eldest and youngest cohorts have lower welfare losses than the middle cohorts. Between 21 and 54, welfare drops because the older the cohort, the greater the share of traditional households. Welfare increases in cohorts older than 54 because the policy change affects only a few working years, so losses are minimal. The second result is in line with this last finding. Figure 25b shows that welfare losses and gains by household type decrease with age. This is explained by older cohorts living under the new policy regime for fewer years than younger cohorts for whom the changes persist for longer.

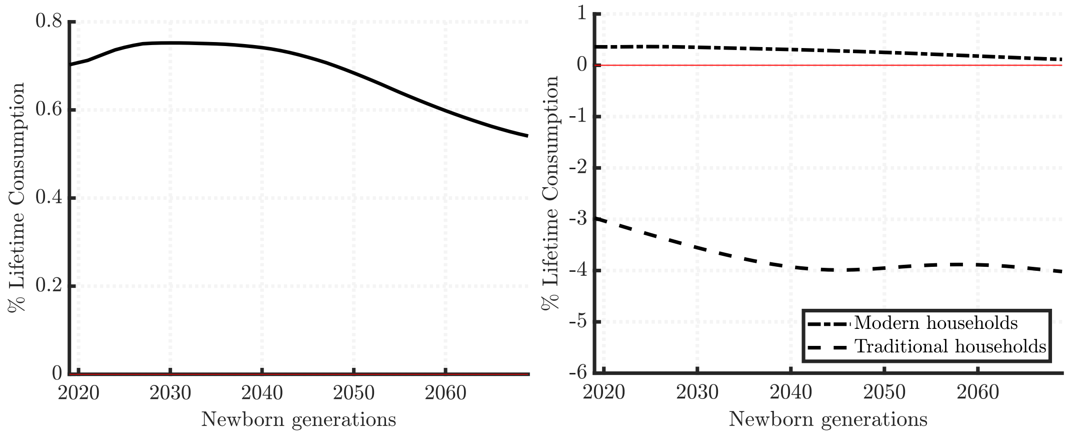


(a) All households

(b) By household type

Figure 25. Welfare implications by age groups and household type of the GBT policy experiment
Note: traditional households refer to one-earner households where only the husband works, while in modern households, both partners are in the labor market.

Newborn cohorts. Figure 26 presents the percentage of lifetime consumption for newborn cohorts on average (26a) and by household type (26b). The first panel shows that newborn cohorts are, on average, better off. Despite this, welfare ranges from a maximum of 0.75% in 2027 to 0.55% in the younger cohorts. The second panel shows that modern households have welfare gains and traditional households have welfare losses, but it varies by cohort. In particular, modern couples' welfare gains decrease for younger cohorts while traditional couples' welfare losses increase for younger cohorts. Tax differentials between men and women in this policy experiment and the Benchmark economy explain these differences by cohort. Figure A.7 shows that these differences increase yearly, achieving a maximum in 2050 and dropping after that.



(a) All households **(b)** By household type

Figure 26. Welfare implications, newborn cohorts of the GBT policy experiment
Note: traditional households refer to one-earner households where only the husband works, while in modern households, both partners are in the labor market.

Finally, regarding the education of newborn cohorts, two observations are relevant. First, in modern households, welfare gains and losses are also heterogeneous across households with different levels of education between the wife and husband. On the one hand, those whose wives are more qualified than their husbands benefit more from the tax change. For instance, in 2019, modern households consisting of a highly educated woman married to a low-educated man would have to receive 0.9% in consumption to compensate for being in the Benchmark economy instead of the GBT Experiment. On the other hand, those households where the husband's education is greater than the wife's face the highest welfare losses as men are the primary income providers. For example, in 2019, modern households composed of highly-educated husbands and low-educated wives should receive -0.32% in consumption compensation for the GBT Experiment. Second, for traditional households, welfare is homogeneous by education because the hours worked do not change dramatically by the husband's education.[27]

Overall, the Gender-Based Taxation Experiment narrows gender gaps in the labor market, and new generations benefit from it in terms of welfare. Therefore, GBT is an excellent policy that reduces gender differences in the labor market, benefiting newborn cohorts.

9 Conclusion

The purpose of the current study is to determine the consequences of the greater female labour force participation on the Social Security finances in Spain. Despite the vast literature

[27]Tables A.2 and A.3 in the Appendix display the winners and the losses of newborn generations by education for modern and traditional households, respectively.

related to changes in the employment rate of women, consequences for government finances have been neglected. In this paper, I show that women have been crucial to sustaining the Social Security system and the model's projections display that they will continue to be until 2050. Specifically, I construct a measure called the Gender Imbalance Indicator that quantifies the share of males' pensions financed by females. This indicator shows that by 2019, women finance around 10% of men's pensions. While a high proportion of women contribute to the Social Security System, few older women receive a retirement pension. If they do, the gender gap in the pension is high. The model's projections show that this pattern still holds until 2050 when men start to finance a positive share of females' retirement pensions. Despite the higher contributions females make, they can not finance their pensions in the long run.

Four aspects make women different from men. First, women's life expectancy is higher than males'; thus, even if the pension entitlement is the same, the pension expenditure is higher for women because this expenditure holds for more periods. Second, I model only widow pensions, which complement retirement pensions. Thus, the pension expenditure rises for the additional periods women live because they become widows and receive a widow pension. Third, women earn less than men due to persistent gender differences in the labor market. Then, the existence of minimum pensions makes some women receive a higher pension than the one they would be entitled to in the absence of these boundaries. Fourth and finally, the maximum pension caps above the expenditure of males' pensions.

This study has identified an additional barrier that women face when entering the labor market. Given this extra burden, I use this model economy as a laboratory to answer the following questions: What are the roles of higher education and female labor force participation in the gender imbalance indicator? To what extent does the redistribution of resources from women to men in the short run set up an extra barrier preventing more women from entering the labor market or working more?

Results show that by 2019, the increase in female labor force participation explains 100% of the gender imbalances. Moreover, if one kept fixing the educational transition, the gender imbalance indicator would have been -4%, implying that men would have financed 9.5% of women's pensions. Notably, the redistribution of resources from women to men prevents women from narrowing gender differences in the household. If they had a Social Security budget different from the one of males, and even with women facing a childcare cost in out-of-pocket money and time together with a flatter age profile of earnings and a wage gap compared to men, the drop in the tax rate in the short run incentives them to work more hours.

Combined with the additional pressures of childcare and wage discrimination, this wealth redistribution has halted progress toward gender parity, especially in the labor market. Therefore, gender-sensitive strategies are critical to prevent long-term scarring in the labor market. To this end, I propose a policy experiment embedding gender parity: Gender-Based Taxation (GBT, foresight). It eliminates the gender imbalances in 2019 and seeks to reduce gender differences such as labor supply, participation, and pension entitlements. Although this experiment does not achieve full gender parity, the introduction of Gender-Based Taxation (GBT) leads to shorter gender differences in participation, earnings, and retirement pensions. At the same time, it displays generalized welfare gains of 0.7-0.55% in consumption compensation.

The findings from this study make several contributions to the current literature. First, and to the best of my knowledge, the present study is the only investigation into the impact of women on pension funding. Second, the results of this research support the idea that taxing women at a permanently lower rate is a promising policy with significant implications for policies that target to narrow gender differences. It confirms the findings of Guner et al. (2012b) who found that the society gain from introducing Gender-Based Taxation in the United States. Third, it validates the importance of modeling women in a Social Security paper. If we were to eliminate women from the analysis, the Social Security tax rate would have been underestimated and overestimated in the short and the long run, respectively.

A number of caveats need to be noted regarding the present study. First, labor force participation for females is a one-time decision at the beginning of their lives. This assumption prevents women from reacting to the policy changes if they are already in the economy. Second, it might overestimate women's retirement pension due to the lack of contributions gaps due to childbirth or unemployment. Third, it does not capture general equilibrium effects.

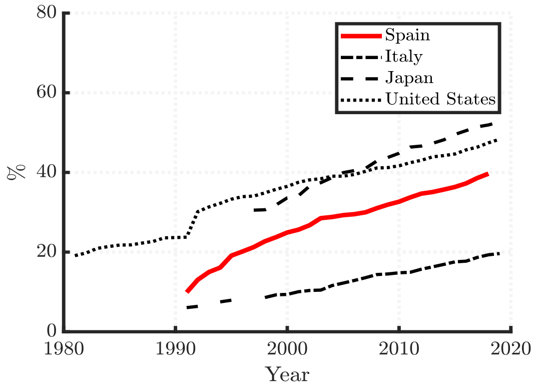
Although the findings should be interpreted with caution, this study has several strengths: it provides a quantitative answer to a question that has not been previously addressed with a model that replicates key features of the Spanish economy, both in 1975 and 2019. It carefully models the Social Security System and captures the central transitional dynamics in Spain during the last forty-five years. Finally, it provides a great instrument that could answer different policies, such as eliminating widow pensions or taxing consumption to finance the extra cost of Social Security without increasing its rate or analyzing previous Social Security reforms implemented in Spain.

Further research might include a general equilibrium analysis with an endogenous fertility decision to check how households react to different tax incentives regarding the number of children. Additionally, several possible studies for other countries using the same model set up are apparent. Thus, further research in cross-country comparison is needed to fully understand the implications of the increase in women's employment rate on pension funding.

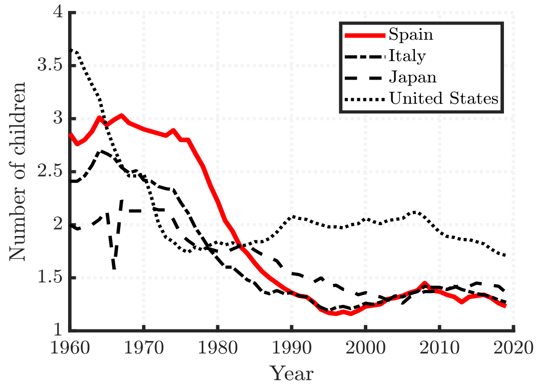
Appendices

A Figures and Tables

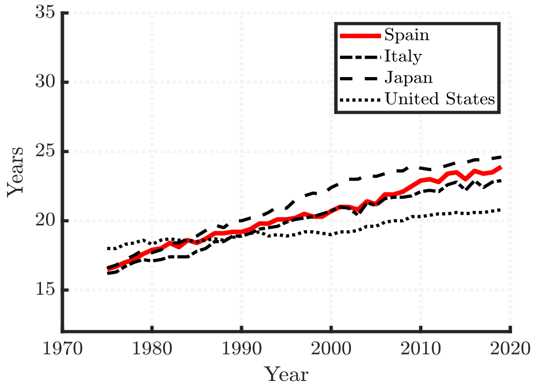
A.1 Introduction



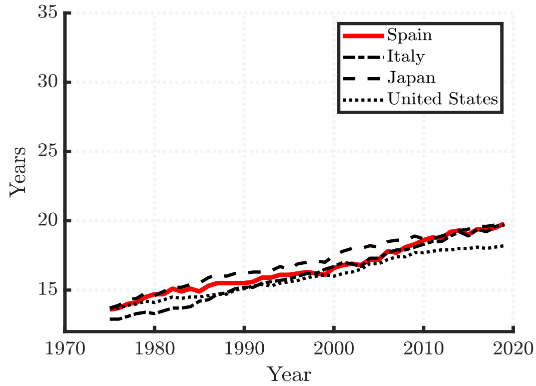
(a) Share of population with a tertiary education



(b) Total fertility rate



(c) Female life expectancy at 65



(d) Male life expectancy at 65

Figure A.1. Demographic trends

Source: OECD statistics

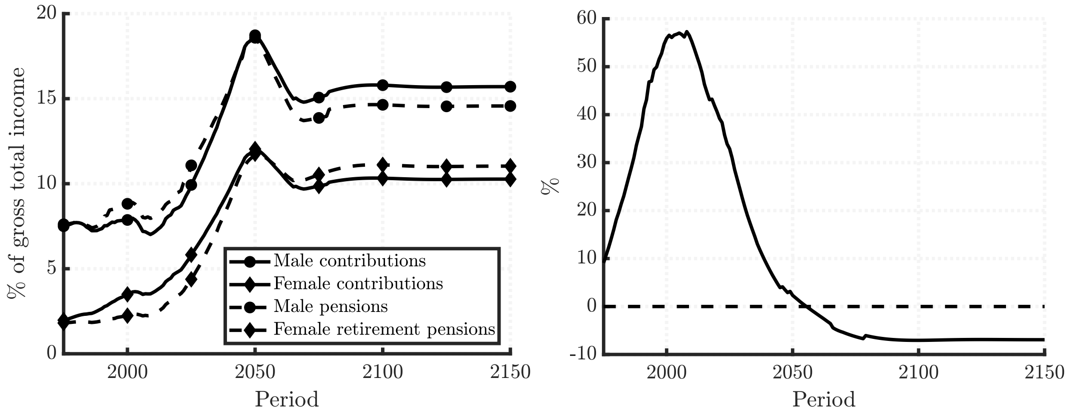
A.2 Institutional Framework

Table A.1. Key parameters of old-age pensions from 1980 onwards

Reform	Legal retirement age	N_c	N_f	N_b
Prior 1985	65	8	35	2
1985	65	15	35	8
1997	65	15	35	15
2002	65	15	35	15
2007	65	15	35	15
2011	67*	15	37	15**
2013	67*	15	37	16**

Notes: * or 65 if 38.5 years of contributions. ** 25 years from 2022 onwards.
N_c, N_f, and N_b represent the years of contributions for pension eligibility, for a full pension, and for the pension calculation, respectively.

A.3 Benchmark economy



(a) Evolution **(b)** % Difference for female

Figure A.2. Social Security contributions and retirement pensions

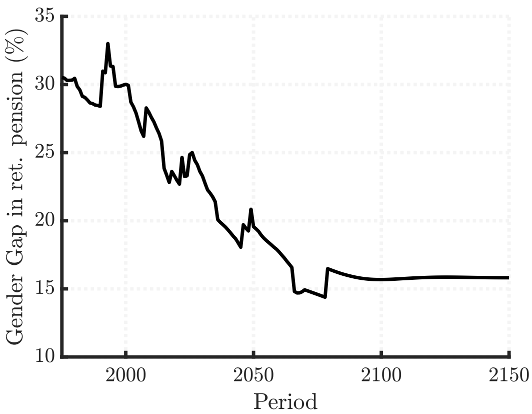


Figure A.3. Gender gap in average retirement pension

A.4 Counterfactual exercises *LS&P* and *LS&P&Ed*

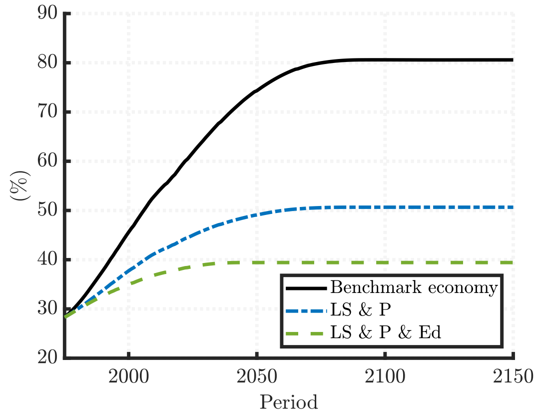


Figure A.4. Female employment rate

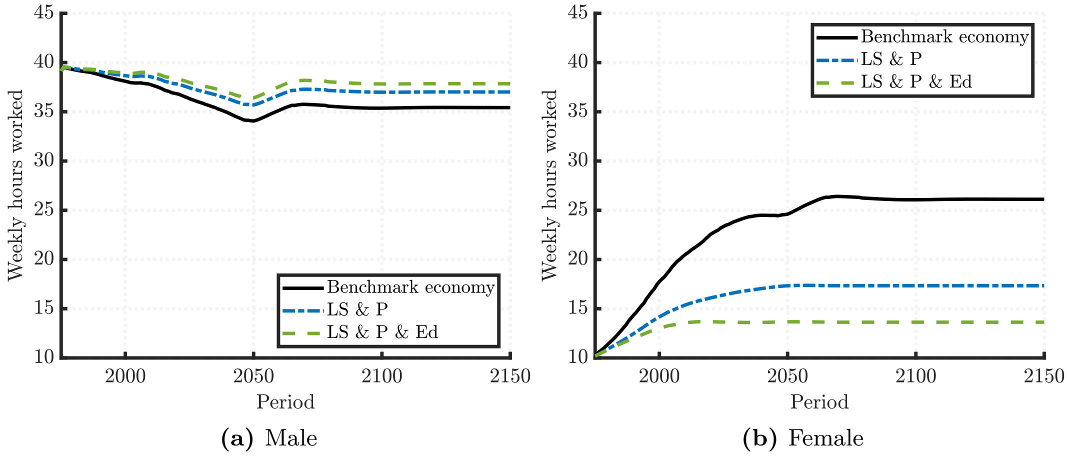


Figure A.5. Average weekly hours worked

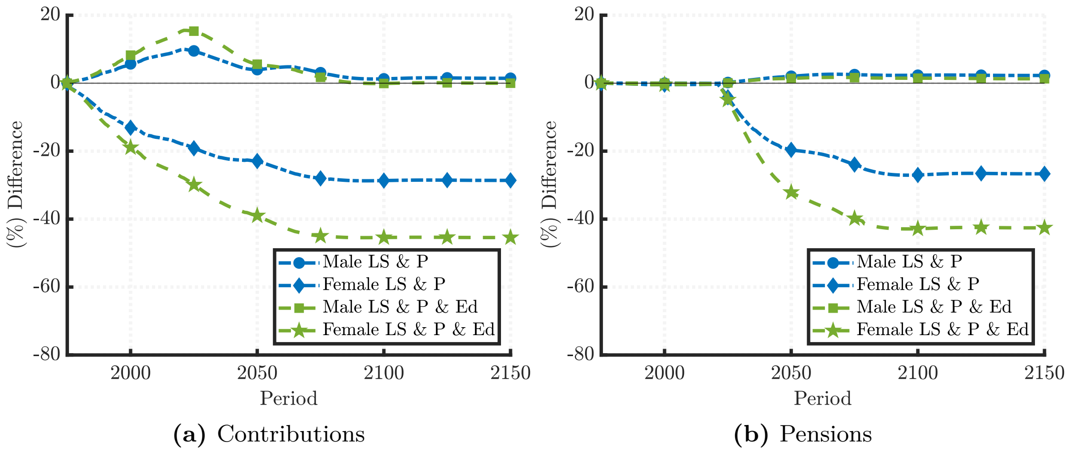


Figure A.6. % change of contributions (A) and pensions (B) relative to the Benchmark economy

A.5 GBT experiment

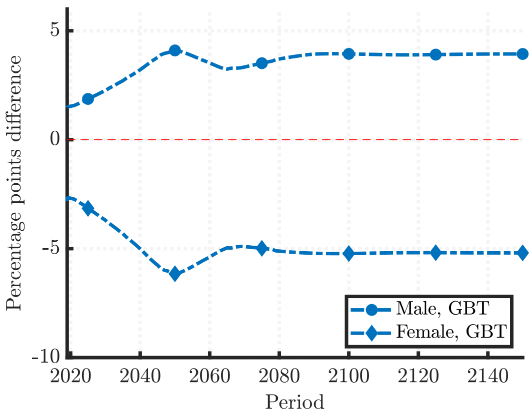


Figure A.7. Difference in the Social Security contributions rate between the Benchmark economy and the GBT tax rates

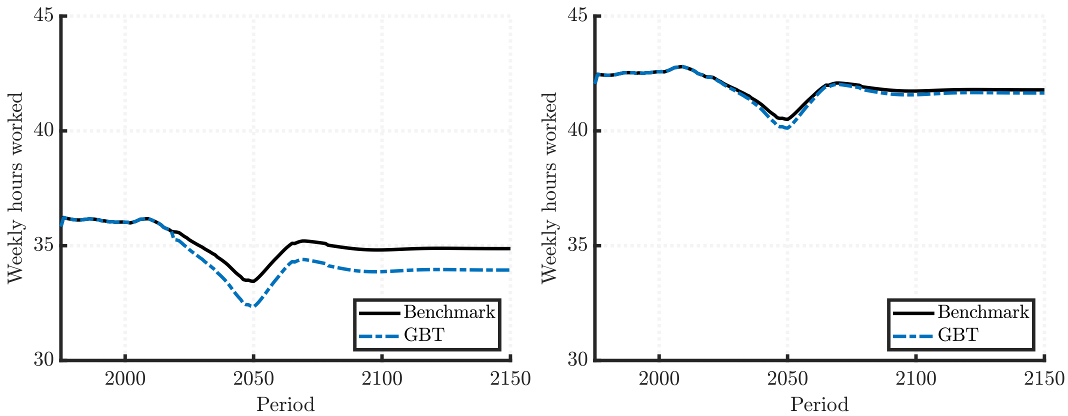


Figure A.8. Male average worked household by household type

A.6 Welfare analysis

Table A.2. % Consumption compensation newborn cohorts in modern households

		Female		
		Low educated	Medium educated	Highly educated
Year 2019				
Male	Low educated	0,20	0,54	0,90
	Medium educated	-0,07	0,28	0,63
	Highly educated	-0,32	0,01	0,36
Year 2039				
Male	Low educated	0,12	0,47	0,85
	Medium educated	-0,13	0,21	0,58
	Highly educated	-0,41	-0,08	0,30
Year 2069				
Male	Low educated	-0,04	0,32	0,71
	Medium educated	-0,30	0,05	0,43
	Highly educated	-0,59	-0,24	0,14

Table A.3. % Consumption compensation newborn cohorts in traditional households

	Male		
Year	Low educated	Medium educated	Highly educated
2019	-2,54	-2,56	-2,58
2039	-2,78	-2,80	-2,84
2069	-3,03	-3,05	-3,09

B The household's problem for traditional couples

$$\begin{aligned} W^T(\mathbf{s}) = \max_{\{c,l^h,b'\}} & \left\{ U(c,l^h) + \beta W^T(\mathbf{s}') \right\} \\ & \text{subject to} \\ & c + b' = (1-\tau) l^h y^h + (1+r)b \\ & c \geq 0 \\ & l^h \in [0,1] \\ & b \geq 0 \end{aligned} \tag{12}$$

$$\begin{aligned} R^T(\mathbf{s}) = \max_{\{c,b'\}} & \left\{ U(c) + \beta R^T(\mathbf{s}') \right\} \\ & \text{subject to} \\ & c + b' = p^h + pd + (1+r)b \\ & c \geq 0 \\ & b \geq 0 \end{aligned} \tag{13}$$

C Aggregating pensions and contributions

I assume the Social Security budget is balanced at all periods t. Therefore, the Social Security contributions rates, τ_t, satisfy the following condition:

$$\tau_t = \frac{P_t}{T_t}, \tag{14}$$

where P_t represents the aggregate expenditure on retirement and widow pensions at time t, and T_t are the Social Security contributions collected at time t. I describe below how these two aggregate variables are composed.

$$P_t = \sum_{i=\{w,h\}} \sum_{j=J_R}^{J} \sum_{z=1}^{Z} \sum_{x=1}^{X} \sum_{\epsilon^h(z)}^{E(z)} \sum_{\epsilon^w(x)}^{E(x)} \sum_{m=0}^{1} (p^i_{t,j,z,x,\epsilon^h,\epsilon^w,m} + pd_{t,j,z,x,\epsilon^h,\epsilon^w,m}) \\ M_t(z,x) S\left(\epsilon^h, \epsilon^w\right) F_{t,j}(z,x,\epsilon^h,\epsilon^w) N_{t,j}, \tag{15}$$

$$T_t = \sum_{i=\{w,h\}} \sum_{j=1}^{J_R-1} \sum_{z=1}^{Z} \sum_{x=1}^{X} \sum_{\epsilon^h(z)}^{E(z)} \sum_{\epsilon^w(x)}^{E(x)} \sum_{m=0}^{1} l^i_{t,j,z,x,\epsilon^h,\epsilon^w,m} y^i_{t,j,z,x,\epsilon^h,\epsilon^w,m} \\ M_t(z,x) S\left(\epsilon^h, \epsilon^w\right) F_{t,j}(z,x,\epsilon^h,\epsilon^w) N_{t,j}, \tag{16}$$

where $N_{t,j}$ is the share of individuals of age j at time t and $F_{t,j}(z,x,\epsilon^h,\epsilon^w)$ denotes the distribution of households depending on whether they are traditional or modern.

D Calibration: initial steady state

D.1 Main Table

Table D.1. Calibration initial steady state

	Parameter	Value
Demographics		
Husband's life expectancy (periods)	J_h	60
Wife's life expectancy (periods)	J_w	63
Women's mean age of first child	J_c	6
Fixed time cost of babies	h	0,046
Fertility rates	$\phi(1,\bar{s})$	2,5
	$\phi(2,\bar{s})$	2,2
	$\phi(3,\bar{s})$	1,8
Household preferences		
Intertemporal elasticity of leisure	γ	4
Discount factor of households	β	0,992
Taste of leisure	θ	0,58
Distribution participation cost		
Shape low educated	$\varphi(1,\bar{s})$	9,9
Shape medium educated	$\varphi(2,\bar{s})$	7,9
Shape high educated	$\varphi(3,\bar{s})$	5
Pension		
Retirement age	J_R	46
Eligibility (years of experience)	N_c	15
Contributed years	N_b	15
Survivor pension: share of husband's pension	χ	52%
Minimum retirement pension with dependent	$\underline{P}$	29%
Minimum retirement pension without dependent		24%
Minimum disability pension	$\underline{Pd}$	23
Maximum pension (both types)	$\bar{P}_t$ and $\bar{Pd}_t$	125%
Penalties pension formula		
Penalties	α_0^p	0,5
	$\triangle\alpha_1^p$	0,03
	α_2^p	0,8
	$\triangle\alpha_3^p$	0,02
	a_1	15
	a_2	25
	a_3	35
Annual interest rate	r	0,036
Annual productivity growth	g	0,0177

D.2 Earnings

The central database I use to calibrate the earnings is the Continuous Sample of Working Histories *(Muestra Continua de Vidas Laborales, MCVL)*. With the editions 2006-2017, I construct a yearly panel. I restrict my sample to full-time workers. These workers belong to the general regime. I exclude part-time workers and individuals with non-positive wages to work with a stable earnings measure over time.

Distribution of the initial productivity. The first available year in the MCVL is 1980; however, this year's number of observations for highly educated men and women is low. To overcome this issue, I computed the initial productivity by education using the sample from 2001.

Once I estimate those moments of the log-normal distribution for 2001, I make two assumptions to get the distribution in 1975. First, I assume the variance is the same as the one estimated in 2001. Second, I subtracted from the mean of the log-normal distribution the annual growth of earnings between 1980-2001. I computed the average earnings per hour growth between 1980 and 2001 with the Industry and Services Wage Survey.[28] The calculations show that the annual growth was $7,4\%$. Table D.2 summarizes the male's initial earnings distribution parameters. I discretized the initial steady state distribution by considering seven initial productivity and forty-nine possible combinations for each household's educational type.

Table D.2. Moments of the log-normal distribution.

	μ^h_{01}	μ^h_{75}	$\sigma_{01} = \sigma_{75}$	# obs
Led	9.62	9.42	0.327	23453
Med	9.76	9.56	0.396	12971
Hed	9.96	9.76	0.450	7897

Notes: 01 accounts for 2001 while 75 does for 1975.

D.3 Number of children

To compute the average number of children by educational attainment, I use Zeman et al. (2014) database. The authors of this database extracted micro-data from the Spanish Population Census of 1991 and 2011 provided by the INE. I considered the first census for cohorts born before 1931 and the second for the others. Then, I smoothed the series with the Hodrick-Prescott filter. Figure D.1 shows the cumulative fertility rates by mother's cohort and educational attainment implied by the data and the trend. For the initial steady state, I take the average of the trend. Therefore the three parameters regarding the number of children are $\phi(1) = 2.5$, $\phi(2) = 2.2$, and $\phi(3) = 1.8$ where 1, 2, and 3 denote the mother's

[28] INE carried out this survey until 2000, when the quarterly labor cost survey replaced it. I computed this earnings growth per hour as an average of all sectors. I restricted my attention to workers and job categories.

education level. These refer to low, medium, and high education, respectively.

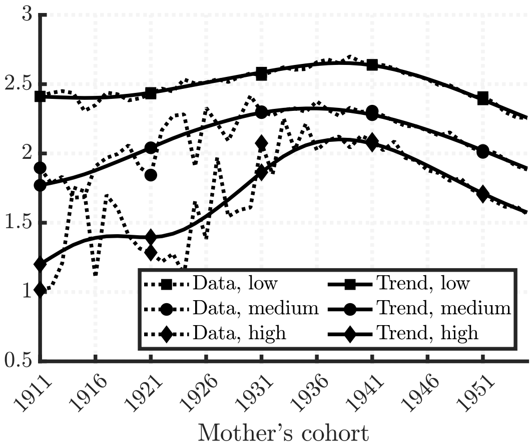


Figure D.1. Cumulative Fertility rate

D.4 Childcare cost

Regarding childcare costs, children are only costly when they are babies. I include childcare costs for the first three years of a child's life (0-2). The main reasons for this assumption are two. On the one hand, childcare expenditures for children over three years old might not be a key determinant for women's work. By the school year 2000-01, 89.7% of children aged three were enrolled in schools, and 68.4% of them were in free-of-charge public institutions. On the other hand, the cost is relevant for children younger than three, as few children have access to public kindergartens, which are cheaper but not free-of-charge administrations.

D.5 Full-time and part-time workers

Workers in the model are classified into full-time and part-time workers. The Spanish Statistical National Institute (*INE*) defines a full-time worker as an individual who works at least 30 hours per week and a part-time worker if he/she works less than 35 hours per week. Since between 30 hours and 35 hours, a worker can be considered a full-time worker or a part-time worker; I take the midpoint. If the individual works more than 32.5 hours per week, he is considered a full-time worker. Otherwise, it is considered a part-time worker. In the model, a full-time worker is an individual with no less than 0.325 units of labor supply. Additionally, an individual is classified as a participant in the labor market if her labor supply is at least one hour per week, i.e.: $l_t \geq 0.01$.

E Distribution of households by education of each spouse

Individuals' education levels are classified as low, medium, and high. Individuals with a low level of education have not completed secondary school; individuals with a medium level of education have not completed a university degree; and individuals with a high level of education have at least completed tertiary education.

E.1 In the initial steady state

To compute the initial distribution of households by the educational attainment of each spouse $M_{t=1}(z,x)$ I follow Esteve and Cortina (2006). In particular, I consider the educational attainment of couples and spouses who are residents in principal houses in the Spanish Census of 2001 and 2011. With this information, I computed the share of households for each combination of spouse's education for the 1910-1955 women's cohorts. Table **??** represents the data I extracted for cohort groups of 10 years. Nevertheless, I linearly approximate it to get it by cohort. Then, the newborn generation in the initial steady state, $j = 1$, corresponds with the data counterpart for the 1955 cohort. The generation of age $j = 2$ is assigned to the data counterpart in 1954, etcetera.

E.2 During the transition

The distribution of households for newborn cohorts follows the same methodology and data as the initial steady state until the cohort of 1979 (corresponding to newborns in the model year 1999). There is no available data for younger cohorts on the educational attainment of couples who are residents in principal households in the Spanish Census of 2001 and 2011. To overcome this challenge, I proceed as follows: 1) I construct a likelihood modifier using the Spanish Census data on education levels of married individuals of generation 1970-79. This is the ratio of the proportion of households of a given type to the proportion implied by random matching between education types. 2) Using the INE data of education of men and women for cohorts 1979-1995 (newborns in years 1999-2015 in the model), I compute a matrix of education levels of couples that would be implied by random matching (that is, just the product of the fraction of individuals of a given gender that have an education level). Then, I multiply this matrix of couples' education levels randomly matched by the likelihood modifier factor to estimate married individuals' educational attainment. See Table **??** for the distribution of couples by education and cohort.

Table E.1. Distribution of pairings (%) by partners' level of educational attainment and female birth cohort

			Wife's education		
	1910-1919		**Low**	**Medium**	**High**
		Low	80.60%	1.33%	0.34%
		Medium	5.58%	7.14%	0.48%
		High	1.79%	1.72%	1.02%
	1920-1929				
		Low	77.98%	1.63%	0.27%
		Medium	6.14%	9.04%	0.48%
		High	1.42%	2.01%	1.02%
	1930-1939				
		Low	70.25%	2.35%	0.30%
Husband's education		**Medium**	7.77%	12.70%	0.73%
		High	1.45%	2.78%	1.67%
	1940-1949				
		Low	47.73%	4.56%	0.37%
		Medium	10.89%	24.08%	1.60%
		High	1.43%	5.15%	4.20%
	1950-1959				
		Low	17.49%	8.19%	0.52%
		Medium	9.69%	41.72%	4.87%
		High	0.85%	7.28%	9.40%
	1960-1969				
		Low	8.06%	7.52%	0.49%
		Medium	6.04%	49.00%	9.21%
		High	0.32%	6.88%	12.48%
	1970-1979				
		Low	4.29%	5.56%	0.71%
		Medium	3.59%	46.80%	14.80%
		High	0.30%	6.40%	17.55%
	1980-1984				
		Low	1.7%	3.0%	0.5%
		Medium	2.5%	44.8%	16.8%
		High	0.2%	6.7%	23.8%
	1985-1989				
		Low	1.5%	3.5%	0.6%
		Medium	2.5%	41.9%	16.8%
		High	0.2%	6.6%	26.5%
	1990-1995				
		Low	1.4%	2.8%	0.5%
		Medium	1.9%	37.2%	16.8%
		High	0.2%	6.9%	32.2%

Table E.2. Evolution of household's composition

Male & Female	1975	2019	2050	2150
1 & 1	59%	12%	2%	1%
1 & 2	4%	5%	4%	3%
1 & 3	1%	1%	1%	1%
2 & 1	7%	5%	3%	2%
2 & 2	19%	40%	40%	37%
2 & 3	2%	13%	19%	20%
3 & 1	1%	0%	0%	0%
3 & 2	4%	6%	7%	7%
3 & 3	4%	17%	25%	29%

Notes: 1 refers to low education, 2 to medium education, and 3 to high education.

F The model fit regarding the average lifetime by year

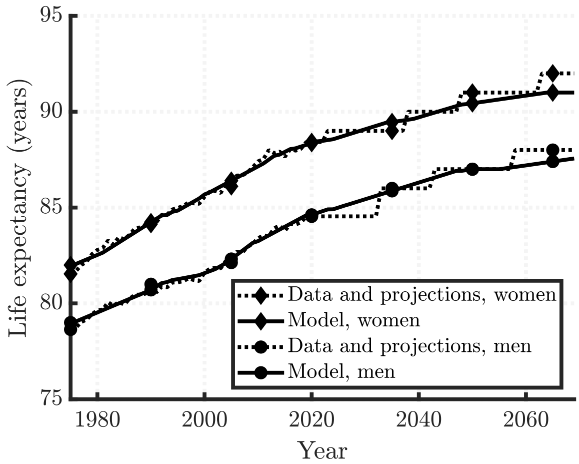


Figure F.1. Model fit average lifetime of by year

G Counterfactual exercise: Gender Imbalances Eradication

The Benchmark economy predicts that women will help finance male pensions until 2050 since the Social Security system rules imply distributing resources between genders. Furthermore, the model predicts substantial gender gaps in employment hours, earnings, and pensions, highlighting their persistence even in the final steady state.

Generally, when analyzing the barriers women face to labor market participation, the gender pay gap, occupational segregation, and caregiving responsibilities are the main reasons for discouraging women from working or working fewer hours than men. However, this counterfactual analysis aims to shed light on an emerging barrier to women's labor market participation: the redistribution of resources from women to men until 2050. In particular, women's contributions to Social Security will ease the financial burden created by men's aging.

Hence, I ran a counterfactual analysis introducing separate Social Security budgets by gender to improve the system's adequacy, equity, and fairness. Specifically, this exercise introduces separate Social Security budgets since 1976. At each period, I compute the necessary tax for males ($\tau_{t,h}$) and females ($\tau_{t,w}$) that ensures the budget assumption, i.e.:

$$\tau_{t,w} = \frac{\sum j = JR^{J} \sum_{i} \quad (P_{w,t,j,i} + Pd_{w,t,j,i}) \quad M_t(z,x) S\left(\epsilon_z, \epsilon_x\right) F_{t,j}(z,x,\epsilon_z,\epsilon_x) N_{t,j}}{\sum j = 1^{JR-1} \sum_{i} \quad l_{w,t,j,i} W_{w,t,j,i} \quad M_t(z,x) S\left(\epsilon_z, \epsilon_x\right) F_{t,j}(z,x,\epsilon_z,\epsilon_x) N_{t,j}}, \tag{17}$$

$$\tau_{t,h} = \frac{\sum j = JR^{J} \sum_{i} \quad P_{h,t,j,i} \quad M_t(z,x) S\left(\epsilon_z, \epsilon_x\right) F_{t,j}(z,x,\epsilon_z,\epsilon_x) N_{t,j}}{\sum j = 1^{JR-1} \sum_{i} \quad l_{h,t,j,i} W_{h,t,j,i} \quad M_t(z,x) S\left(\epsilon_z, \epsilon_x\right) F_{t,j}(z,x,\epsilon_z,\epsilon_x) N_{t,j}}. \tag{18}$$

I refer to this exercise as Gender Imbalance Eradication (GIE). It aims to answer the following questions. First, to what extent does this redistribution of resources from women to men in the short run set up an extra barrier preventing more women from entering the labor market or working more? Second, could eliminating these imbalances between genders narrow gender differences in the labor market?

Eliminating gender imbalances by taxing women and men at different rates would generate two trends in the Social Security contributions rate by gender; see Figure G.1. Until 2040, the government would run a budget surplus for women, decreasing women's taxes compared to the Benchmark economy. In contrast, the government would run a deficit for men, so men's taxes would be higher than in the Benchmark economy. The tax rate for women and men in 2019 would be 10.5% and 14.8%, respectively, while it is 13.3% in the Benchmark economy. After 2040, the trend would reverse. Women's tax rates would be higher than the Benchmark economy's, while men's would be lower. In the final steady state, women's tax rates would be 4.9 percentage points higher than men's.

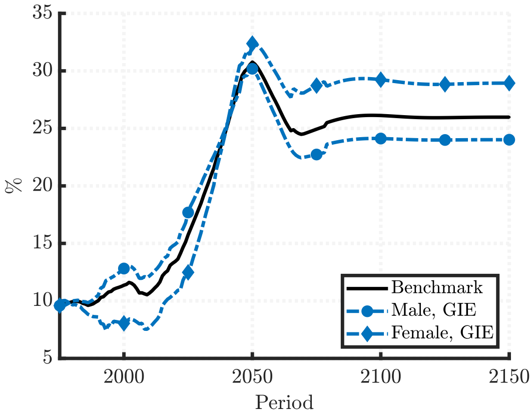
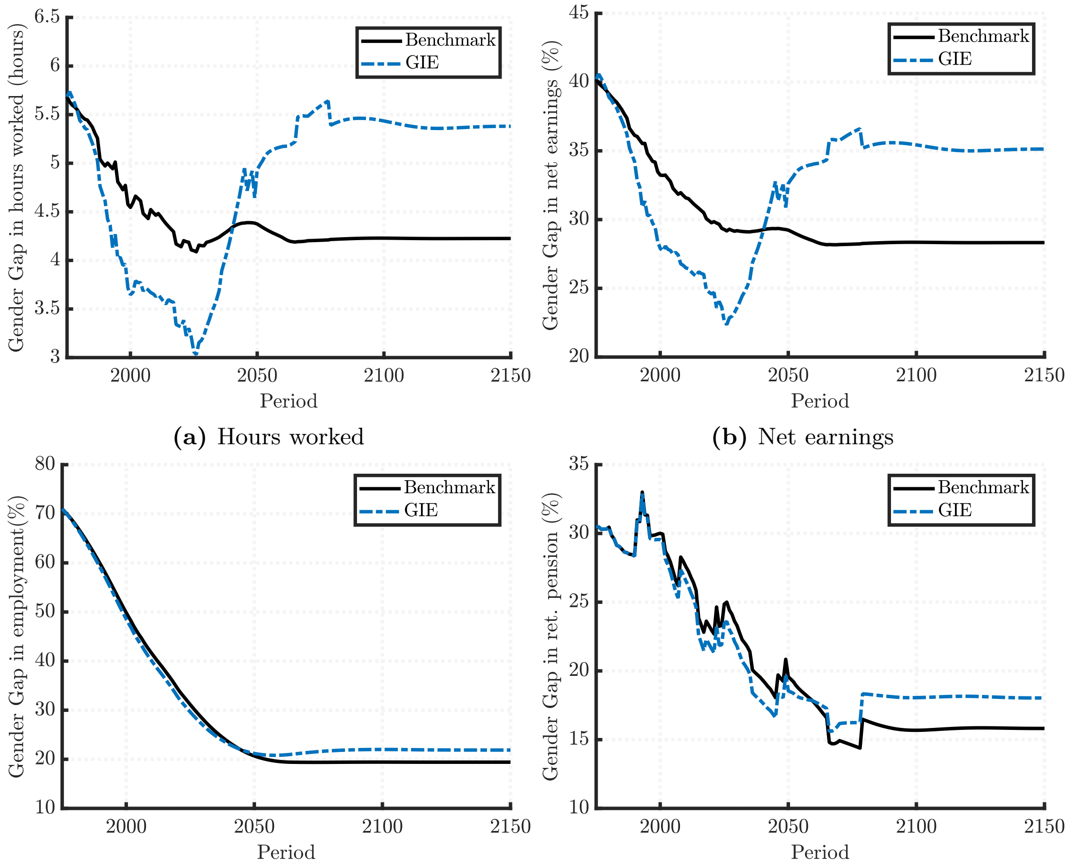


Figure G.1. Social Security contribution tax rate

The redistribution of resources from women to men does not prevent more women from entering the workforce. The main reason for this lies in the primary underlying assumption of this counterfactual analysis: both men and women have perfect foresight about tax paths. Based on this assumption, women (and men) anticipate both good and bad times regarding the tax difference between this hypothetical economy and the benchmark economy. Women decide at the beginning of their life cycle whether to form a traditional or modern couple, and they consider all the tax differences involved. As a result, between these two scenarios, the female average participation rate would increase only marginally in the short run. It would drop in the long run as the tax path is worse in this new economy; see Figure G.2c for a comparison of the gender gap in employment between the Benchmark and the GIE economies.



(a) Hours worked

(b) Net earnings

(c) Employment

(d) Retirement pension

Figure G.2. Gender gaps

While there is no significant difference in the intensive margin of labor supply between men and women, there is in the intensive margin. In particular, Figure G.3 shows the evolution of weekly hours worked by each spouse in modern households. It shows that removing the redistribution of resources between genders would have narrowed the difference in hours worked between spouses in the short run. Even though women face childcare costs, childbearing time costs, a flatter age profile of earnings, and a wage gap, the drop in the tax rate would incentivize them to work more. As a result, in 2019, modern couples would reduce the gap in hours worked by 4.2 to 3.3 hours per week; see Figure G.2a. This gap would narrow more for couples with low and medium-educated spouses.[29] Nevertheless, in the long run, as the female tax rate increases, the gap between hours worked by spouses in modern couples would widen by 1 hour per week.

[29]See Figure G.4 in the Appendix for a comparison between the gap in hours worked in the Benchmark economy minus the gender gap in hours worked in the GIE Experiment.

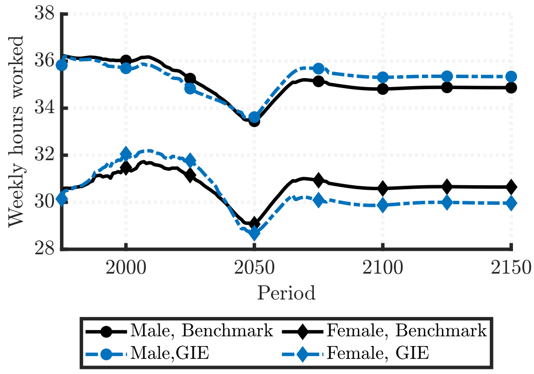


Figure G.3. Weekly hours worked by each spouse in modern households

The change in the hours worked also impacts the gender gap in after-tax earnings; see Figure G.2b for a comparison of the gender net wage gap between the Benchmark and the GIE economies. While in the short run, it would drop, in the long run, it would increase from 28.33% in the Benchmark economy to 35.11% in this proposed scenario. Lastly, since pensioners' share of retirement benefits is similar to that of the benchmark economy, the gender gap in retirement pensions would barely decrease. Its minor drop is due to a slight increase in the number of hours women work in this economy, which increases their average pensions. In this new economy, after 2043, women would work less, and fewer would enter the workforce, increasing the gender gap in retirement pensions by 3.25 percentage points.

In a nutshell, removing the redistribution of resources between genders would decrease gender gaps in hours worked and earnings. An increase follows this in those in the long run. Moreover, it would disproportionally affect the intensive margin of labor supply more than the extensive margin.

This counterfactual analysis brings to light another barrier women face when entering the labor market: the redistribution of resources to men. Eliminating this redistribution would imply a lower Social Security tax rate for females, which would induce a higher labor supply in the short run. Despite this, this exercise also shows that the tax rate would increase if women need to finance their pensions in the long run. As a result, in the long run, this would widen gender gaps in the labor market.

G.1 Extra Figures

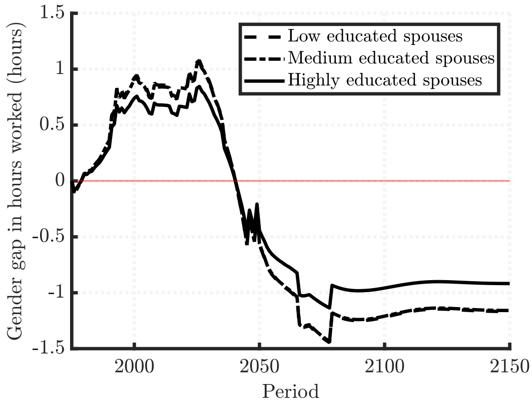


Figure G.4. Difference in the gender gap in hours worked in the Benchmark economy and the GIE Experiment

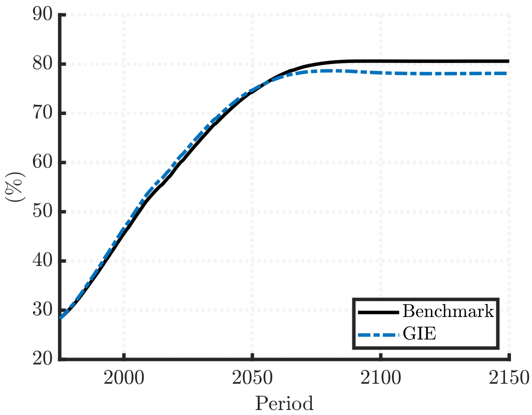


Figure G.5. Female employment rate

H Brief literature review on Spanish pension reforms

The impact of pension reforms in Spain has been extensively studied in the economic literature through the lens of overlapping generations models and accounting frameworks. Bonin et al. (2001) used a Generational Accounting framework and found that the new legal setting introduced in 1997 could result in future generations facing liabilities as high as 176% of 1996 GDP. Martín (2010) used a heterogeneous-agent dynamic general equilibrium model to examine the pension reforms in 1997 and 2001 and found that they increased the pension system's liabilities. Sánchez Martín and SánchezMarcos (2010) used a general equilibrium model where households consist of two potential earners to study the 1997 and 2002 pension reforms and obtained similar results. De la Fuente and Doménech (2013) estimated the effects of the 2011 pension reform with Aggregate Accounting and found that these measures would reduce expenditure by approximately 1.4 percentage points of the GDP. Finally, Díaz-Gimenez and Díaz-Saavedra (2017) used an overlapping generations model with endogenous retirement to analyze the 2001-2013 pension reform and found that while it improved the pension system's sustainability, it came at the expense of a reduction in the real value of the average pension.

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