A Parametric Reform of the Spanish Public Pension System*

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October 7, 2005

Abstract

I show that a theory based on households that differ in their education, receive an uninsurable, idiosyncratic endowment of efficiency labor units, understand the link between the payroll taxes they pay and the public pensions that they receive, and decide when to retire from the labor force, successfully replicates the retirement behavior of Spanish households. I calibrate this theory to the Spanish economy so that it replicates its demographic features, its macroeconomic aggregates and ratios, the Lorenz curves of its income and earnings distributions, and many of its institutional features. I then use the model economy to study the aggregate, distributional, retirement and welfare consequences of increasing the number of years of contributions that are used to compute the pensions, and I evaluate this policy reform in the context of both the Spanish demographic and educational transitions. I find that the reform increases the stock of capital by 3.5 percent, output by 1.1 percent and consumption per capita by 1.4 percent. The average pension decreases by more than 15 percent, and the average retirement age increases from 62.6 to 62.8 years. The reform also reduces the Social Security deficit from 11.9 to 6.6 percent of GDP in the year 2050. Finally, I find that the welfare of the retirees at the moment of the policy change increases by 1.8 percent of lifetime consumption, and that the welfare consequences of the reform are mixed for the workers.

JEL CLASS.: D58, H55, J1, J26
KEYWORDS: Applied General Equilibrium, Retirement, Social Security Reform

*This paper has benefit greatly from the insights and advice of Javier Díaz-Giménez.

†I gratefully acknowledge the financial support of the Spanish Ministerio de Ciencia y Tecnología (Grant SEC2002-004318). I also thanks Alfonso Sánchez Martín and Juan Carlos Conesa for many useful comments and suggestions.

Contents

1 Introduction

The Project — The future financial viability of pay-as-you-go pension systems is in doubt for two main reasons: the aging of the populations and the trend of workers to retire at younger ages. Consequently, in the next few decades, the retiree to worker ratios of developed economies will increase significantly and the current unfunded pension systems will no longer be financially viable. There is another trend which should affect the financial situation of unfunded pensions systems. Specifically, workers become more educated. This *educational transition* is also important because more educated workers both pay higher payroll taxes and collect higher pensions.

This article has two purposes. First, I design a model economy that replicates the basic facts of the retirement behavior of Spanish households, and many of the aggregate, distributional and institutional features of the Spanish economy. Second, I use the model economy to study the aggregate, distributional, retirement and welfare consequences of extending the number of years of contributions used to compute the pension benefits from the current fifteen years to the entire working life of the households, in the context of both a demographic and an educational transition.

Facts — Between 1957 and 1977, the average number of children per Spanish fertile women was 2.8.[1] Since 1980, this number has decreased continuously, and in 1998 it was only 1.16. This change in fertility will change the retiree-to-worker ratio of the Spanish economy very significantly. In 1997 in the Spanish economy there were 23 retirees for every hundred workers and, according to the projections of the Spanish *Instituto Nacional de Estadística*, by the year 2050 there will be no less than 60. Since the Spanish Public Pension System is unfunded, this ageing process of the Spanish population will have significant effects on its future financial viability.

The financial strain on Spanish public pensions has been compounded by another trend: as in most of developed countries, Spanish workers are retiring earlier. If in 1980 the participation rate of male Spanish workers between ages 55 and 64 was 77 percent, in 1995 this number was only 55 percent. One explanation of this change is that social security benefits themselves provide large incentives to leave the labor force early. For instance, Sánchez Martín (1999) finds that the minimum retirement pension benefit provided by the Spanish *Régimen General de la Seguridad Social*, created a strong incentive for workers to retire as early as possible.[2].

Another important fact concerning the Spanish population is that in the last thirty years, Spanish households became significantly more educated. Specifically, in 1977 around 9 percent of Spanish working age people had high school studies and 3 percent had college studies. Twenty years later, in 1997, these shares were 24 percent and 13 percent. In 2050, according to Meseguer (2001), they are projected to be 41 percent and 24 percent. This educational transition is also important for the financial viability of the pension system, because more educated workers both pay higher payroll taxes and collect higher pensions.

A modelling question — In this paper, I ask if I can provide a theory that accounts for the retirement behavior of Spanish households. The theory I am looking for should be based on

[1]This statistic is computed dividing the total number of children born in any given year by the total number of women between ages 15 and 50.

[2]The *Régimen General de la Seguridad Social*, is the most important public pension system in Spain. For instance, in 2001, 73.9 percent of all workers belonged to this regime.

the optimal choices of households who are heterogeneous in their education levels, who face an uninsured idiosyncratic process in their endowments of efficiency labor units, and who decide when to retire optimally.

I find that I can provide such a theory. Specifically, I show that a model economy that replicates the main Spanish macroeconomic aggregates, the Lorenz curves of the Spanish distributions of income and earnings, and the main institutional features of the Spanish economy also accounts in great detail for the retirement behavior of Spanish households.

A policy question — I also ask what will be the aggregate, distributional, retirement and welfare consequences, of increasing the number of years of contributions that are used to compute the Spanish pensions from the last 15 years of the current system to the entire working lifetimes of the households in the reformed economy. In the model economy, this reform is announced and implemented in 2005, and the new rules only apply to current workers.

I find that, in the year 2050 in the reformed economy the average pension of the retirees decreases by 15 percent. This is because in the reformed economy the early years of the working lives of households, which is when they are least productive, are used to compute the pensions. I also find that the average retirement age increases from 62.6 to 62.8 years. This is because the opportunity cost of continued working, namely the pension, decreases. As a consequence, the Social Security deficit decreases from 11.9 percent of the model economy output under the current system to 6.6 percent under the reformed system. This improvement in the financial condition of the pension system implies that a smaller consumption tax rate is needed to balance the government budget. Specifically, the consumption tax rate decreases from 34.1 percent before the reform to 24.4 percent after the reform. The reduction in the pensions results in a capital stock that is 3.5 percent higher. This is because public pensions are an imperfect substitute of private savings. Finally, I find that the reform brings about an increase of 1.1 percent in output and an increase of 1.4 percent in consumption. Consumption increases in part because the reduction in the consumption tax rate more than compensates the reduction in pensions.

The reform changes the average value of pensions, but it does not change the retirement behavior of households. This is because minimum pensions play a very significant role in determining retirement behavior under the current system, and the reform that we study leaves minimum pensions unaltered. Specifically, under the current system every worker is entitled to receive the minimum pension regardless of the number of years during which he has contributed to the system. Moreover, since minimum pensions are exempt from early retirement penalties, the strong incentives to work associated with these penalties disappear. Consequently, every worker who is only entitled to a minimum pension chooses to retire at age 60 (the earliest possible retirement age) both in the benchmark and in the reformed economies.

The reform brings about a welfare gain of 1.8 percent of lifetime consumption to the households that are retired when the policy change is enacted. This is because they receive the same pension and they pay lower consumption taxes. However, I find that the results are mixed for workers. Specifically, most of the non-high school workers are better off for three reasons: because their life-time earnings profile is essentially flat and, consequently, the number of years used to compute the pension makes little difference to them; because most of these of households of this type receive the minimum pension, and this pension is not affected by the reform; and because after the reform they pay lower consumption taxes. Most of the high school and college workers are worse off after the reform because the lower consumption taxes are not enough to compensate them for the reduction in their pensions. Finally, I find that the proposed reform has no significant effects on earnings and income inequality.

Policy reform: previous answers —The ability of parametric reforms to reduce the burden of demographic changes has been subject of a large body of previous research. For instance, De Nardi, Imrohoroglu, and Sargent (1999) study the consequences for the U.S. economy of increasing the compulsory retirement age in four years. This analysis is implemented in a large scale overlapping generations model where households face idiosyncratic lifetime and labor productivity uncertainties. Their findings are that the reform reduces the size of the fiscal burden and, therefore, the consumption tax required to finance it from 36.9 to 31.2 percent. For the Spanish economy, Arjona (2000) finds that at the end of the demographic transition, the pension benefit must be reduced by 33 percent of its 1995 value in order to keep the payroll tax rate and the pension system deficit constant. Finally, and also for the Spanish case, Sánchez Martín (2003) explores various parametric reforms that increase both the number of years of contributions used to compute the pension and the compulsory retirement age. He finds that the best of these parametric reforms reduces the deficit of the pension system from 9 to 5 percent of the model economy output.

The model economy — This paper combines various features of model economies described elsewhere in the literature. I consider an overlapping generation model where households differ in their education as in Kotlikoff *et al.* (2001), face stochastic lifetimes as in Hubbard and Judd (1987), and face an uninsurable idiosyncratic shock to their endowments of efficiency labor units as in Conesa and Krueger (1999). Moreover, the households understand the link between payroll taxes and pensions as in Hugget and Ventura (1999), and make endogenous retirement decisions as in Sánchez Martín (2002).

Three important features distinguish my paper from those in the literature. (*i*) my benchmark model economy replicate the stylized facts of retirement behavior of Spanish households. This is important for two reasons: as we will see in the next section, formal previous attempts to account for the facts that characterize early retirement behavior had little success. And second, we can analyze the consequences of any social security reform on the households' retirement behavior. (*ii*) I calibrate my model economy to the Lorenz curves of Spanish income and earnings as reported by Budría and Díaz-Giménez (2004). This has also two implications: this allow me to obtain a process on earnings that is consistent with both the aggregate and the distributional data on income and earnings. But more important, it also enables me to analyze the distributional consequences of any social security reform, an issue from which the literature on social security has generally abstracted [3] (*iii*) And finally, together with a demographic transition, I introduce an educational transition to the model economy. Specifically, workers become more educated. This is also important because more educated workers both pay higher payroll taxes and collect higher pensions. We measure quantitatively the effect on this educational transition on the social security deficit.

2 The facts and the literature

2.1 Early retirement

In most developed countries workers are retiring earlier. In the past thirty years, this phenomenon has been stronger in Finland, France, Germany, and Netherlands, where the participation

[3] Fonseca and Sopraseuth (2004) is an exception.

rate for those male workers aged between 55 and 64 has decreased to less then 60%, as shown in Table 1. Early retirement has thus complemented the aging process in increasing the ratio of retirees per worker.

Table 1: Participation rates of 55-64 male workers (%)

	1970	1980	1990	2000
Canada	84.2	76.2	64.3	61.0
Finland	71.1	57.3	47.1	48.1
France	75.4	68.5	45.8	41.1
Germany	82.2	65.5	60.5	55.2
Netherlands	80.8	63.6	45.7	51.4
Spain	84.2	75.7	62.4	60.3
UK	91.3	81.8	68.1	63.3
USA	80.7	71.2	67.8	67.3

Source: Conde-Ruiz and Galasso (2003).

According to Gruber and Wise (1999), the generous early retirement provisions are responsible for this drop in participation rates. Specifically, they argue that individuals are often induced to retire early because of the large implicit tax imposed on continuing to work after early retirement age. An agent's early retirement decision thus represents the optimal response to the economic incentives provided by the social security system.

Blondal and Scarpetta (1998) find that the proportion of early retirees in most OECD countries is higher in low and intermediate educational groups. Table 2, shows the participation rates by educational level in Spain, of those workers aged 60-64.

Table 2: Participation Rates of Spanish Workers Aged 60 to 64 in 1997

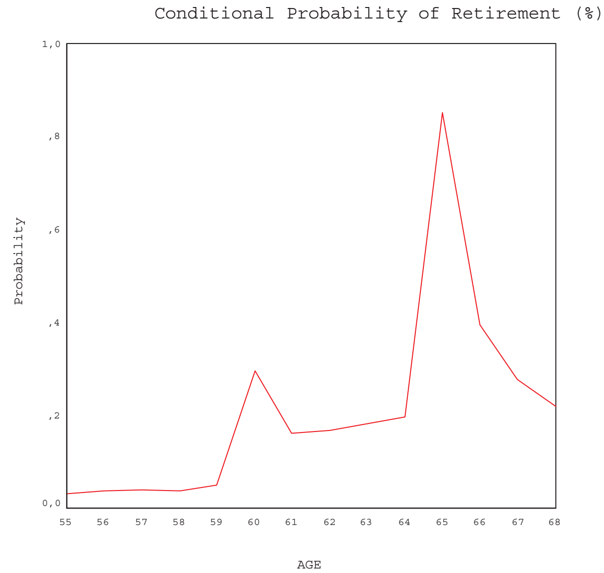
Education	(%)
Non-High School	25.9
High School	41.2
College	61.2

Source: Spanish *Instituto Nacional de Estadística*

However, several studies find that early retirement incentives are related to labor income *level* and not to the individuals' educational achievement. For example, Boldrin, Jiménez, and Peracchi (1999) find that in Spain, the implicit tax on continuing to work at the age of 60, is near 86% for a worker in the 10th percentile earnings, and −15% for a worker in the 90th percentile earnings[4]. Also for the case of Spain, Jiménez and Sánchez Martín (1999) find that, while the probability of leaving the labor force is not affected by the labor income level at the age of 65–the normal retirement age–, there is a clear inverse relationship at the age of 60–the early retirement age–, and this relationship is independent of individuals' education. The next figure shows the conditional probability of retirement for Spanish workers in 1997 [5].

[4]The implicit tax is computed as minus the ratio between the change in the worker's social security wealth with respect to one year earlier and projected earnings.

[5]These probabilities are defined as the probability of retiring from the labor force in any period.



Source: Sánchez Martín (2003)

The data show two peaks: at ages 60 and 65. At the age of 60, the minimum retirement pension provided by the Spanish public pension system plays a significant role. Specifically, every worker with at least 15 years of contributions is entitled to receive the minimum retirement pension. Moreover, since minimum pensions are exempt from early retirement penalties, the strong incentives to work associated with these penalties disappear. Consequently, every worker who is only entitled to a minimum pension, most of them low income workers, chooses to retire at age 60 and avoid the high implicit tax rate on continuing to work[6]. For instance, Sánchez Martín (2003) finds that 67.7% of Spanish workers retiring at age 60 in 1995 collected the minimum pension benefit. The peak at age 60 is related to: (*i*) the lack of actuarial adjustment of pensions after the retirement age of 65, and (*ii*) the foregone pension reaches its maximum at 65. [7]

In conclusion, we have seen that (*i*) Early retirement has thus complemented the aging process in increasing the ratio of retirees per worker, (*ii*) The early retirement provisions are responsible for the drop in participation rates, and (*iii*) Incentives of early retirement depend on the level of labor income.

In spite of the importance of early retirement, formal attempts to account for the facts that characterize early retirement behavior had little success. Specifically, researchers have failed to come up with a quantitative theory that accounts for both the observed participation rates by educational level, and the age-dependent conditional probabilities of retirement.

In this section we summarize the findings of Sánchez Martín (2003), and Fonseca and Sopraseuth (2004). These articles share the following features: (*i*) their model economies introduce the households' retirement decision, (*ii*) their model economies are populated by heterogeneous agents, and (*iii*) they study the aggregate and welfare effects of social security reforms.

[6]Another way to exit from the labor market in Spain before the normal retirement age is achieved by drawing on disability pensions. See Boldrin, Jiménez, and Peracchi (1999).

[7]This conclusion is supported by the results of a number of different studies, such as Diamond and Gruber (1999), and Boldrín, Jiménez, and Peracchi (1999).

Sánchez Martín (2003) studies a life cycle model where households are heterogeneous in their education and make endogenous retirement decisions between ages 60 and 64, with age 65 being the mandatory retirement age. However, households are homogeneous within each educational type in his model economy because their endowments of efficiency labor units are deterministic. He calibrates his model economy to the Spanish economy. With the exception of the retirement behavior of low income workers, his model economy fails to account for the facts that characterize the retirement behavior of Spanish households. Specifically, in his model economy every worker who chooses to retire at age 60 collects the minimum pension. This is because non-high school workers are the only ones who choose to retire at this age and they all collect minimum pensions. This is not the case for high school and college workers for two reasons: because the labor income foregone is higher for more productive types, and because their average labor earnings are greater than the minimum pension. Consequently, these workers have an additional incentive to continue working in order to avoid the early retirement penalty, and they choose to do so until age 65 (the mandatory retirement age). This has two implications: First, in Sánchez Martín's model economy the participation rates of non-high school, high school and college workers aged 60 to 64 are zero percent, 100 percent, and 100 percent respectively. And second, the conditional probabilities of retirement between ages 61 and 64 are zero.

Fonseca and Sopraseuth (2004) study a life cycle model where households are altruistic and differ in their skills (unskilled to skilled workers). High skilled workers enter to their economy at age 23, and low and medium skilled workers at age 20. Households are also heterogeneous in their labor status. Specifically, they can be employed, unemployed, or retired. However, and as in Sánchez Martín (2003), households are homogeneous in labor income within skill and labor status groups. Fonseca and Sopraseuth calibrate their model economy to both the French and the Italian economies in the year 2000. Their benchmark model economies fail to account for the retirement behavior of both the French and the Italian households[8]. In their model economy calibrated to the Italian economy, every worker chooses to retire at the first retirement age of 60. In their model economy calibrated to the French economy, low and medium skilled workers also choose to retire at the first retirement age of 60, and the high skilled workers wait until the age of 63. This is for two reasons: First, every worker can claim his o her pension without penalization for early retirement once he or she has contributed for at least 40 years, in the case of France, and 35 years in the case of Italy. And second, even the high skilled workers have labor income *levels* that are not high enough to give them an incentive to delay retirement.

This brief literature review shows that those model economies which abstract from heterogeneity in labor income within educational/skill groups fail to account for the retirement behavior of older workers. Specifically, probabilities of early retirement depend on the relationship between pension systems' rules and labor income, and they are independent of the individuals' education.

2.2 Trends in education

The labor force became more educated in most developed countries. For instance, the average years of schooling in the population aged 25-64 has grown 0.8% per year over the past 40 years in the European Union. This number is 0.8% per year for U.S.. Table 3 shows the projections

[8]See Gruber and Wise (1999) for a description of the retirement behavior of both the French and Italian households.

of this variable for some European countries.

TABLE 3: PROJECTED YEARS OF SCHOOLING IN THE 25-64 POPULATION

	2002	2012	2052
Belgium	11.2	11.7	12.3
Finland	12.0	12.8	13.7
France	10.9	11.4	12.1
Greece	10.6	11.3	12.1
Ireland	11.0	11.8	12.8
Italy	9.7	10.4	11.1
Netherlands	11.8	12.1	12.4
Spain	9.6	10.6	11.9
UK	12.1	12.4	12.9

Source: Montanino, Przywara, and Young (2004).

As we see in Table 3, Spanish households also became significantly more educated. According to Meseguer (2001) in 1977 around 9 percent of Spanish working age people had high school studies and 3 percent had college studies. Twenty years later, in 1997, these shares were 24 percent and 13 percent. In 2050, according to Meseguer's projections, they will be 41 percent and 24 percent.

The literature analyzing social security reforms has abstracted from these facts. Specifically, those model economies populated by heterogeneous agents in their education or skill, which analyze social security reforms, assume that the percentage of low, medium, and high educated individuals within the labor force are the same every period. This is a shortcoming, since this *educational transition* is also important for the financial viability of the pension system, because more educated workers both pay higher payroll taxes and collect higher pensions.

3 The model economy

The model is a production economy in discrete time $t = 1, 2...$, where a period t corresponds to one year. There are three types of agents: Government, Households, and Firms.

3.1 Government

The government in this model economy plays three roles: it runs a pension system, it spends and taxes, and it distributes unintentional bequests.

The pension system redistributes resources intergenerationally through a pay-as-you-go system, financed with workers' contributions on gross labor earnings up to a maximum. These contributions are described by the social security tax function, $\tau_s(y_t)$, where y_t denotes gross labor earnings. Every household must retire at age 65. However, households may retire after they reach age 60. If they choose to do so, their pensions are penalized by an age-dependent factor λ_j.

A retiree of age j receives a pension $b_{min} \leq b(j) \leq b_{max}$, where b_{min} is the minimum retirement pension received by all retirees, and b_{max} is the maximum retirement pension. The pension, $b(j)$ is computed according to:

$$b(j) = (1 - \lambda_j)[\frac{1}{N_b}\{\sum_{i=j-N_b}^{j-1} y_i\}] \tag{1}$$

which combines an average of gross labor earnings during the last N_b years previous to the retirement from the labor force, and the coefficient of penalization for early retirement. The age-dependent penalization takes the value

$$\lambda_j = \begin{cases} > 0 & \text{if } 60 \leq j < 65 \\ = 0 & \text{if } j = 65 \end{cases} \tag{2}$$

Table 4 summarizes the social security rules of the model economy.

Table 4: The Public Pension Systems

		Spain	**Benchmark**
Payroll Tax		Proportional on gross labor earnings between a minimum and a maximum	Proportional on gross labor earnings up to a maximum
		compulsory until retirement	compulsory until retirement
Pension	Regulatory Base	mean of the gross labor earnings during the last 15 years prior to the retirement	mean of the gross labor earnings during the last N_b years prior to the retirement
	Replacement Rate	it depends of the number of years of contributions	independent of the number of years of contributions
	Penalizations for early retirement	8% per year between 60 and 64 years old	x% per year between 60 and 64 years old
	Floor and ceilings	Maximum and minimum benefits	Maximum and minimum benefits

Note. The rules describing the Spanish Public Pension System are those of the *Régimen General de la Seguridad Social.*

The government collects taxes, T_t, through a proportional consumption tax, τ_{ct}, a proportional labor income (the net of social security contributions) tax, τ_{lt}, and a proportional capital income tax, τ_{kt}. Government also consumes, G_t, an exogenous and constant proportion of output, Y_t, each period. In addition, there exists public debt, B_t, which also represents an exogenous and constant proportion of output each period.

Each period, τ_{ct} adjust in order to have equilibrium in the government budget constraint:

$$G_t + P_t + (1 + r_t)B_t = T_t + T_{st} + B_{t+1} \tag{3}$$

where T_{st} and P_t are the total contributions and benefits from the pension system.

The final role is to distribute equally among the living the accidental bequests E_t

$$Z_t = E_t \tag{4}$$

where Z_t stands for the total transfers to households.

3.2 Households

3.2.1 Demographics

I assume that my model economy is inhabited by a continuum of heterogeneous households, which differ in their education. Households enter the economy at age 20, and for reasons that will become clear later on, they can live up to a maximum of 100 years. They face a death hazard every period with conditional probability of survival from age j to $j+1$ at period t given by ψ_{jt}. Households also have children at the age-specific fertility rate f_{jt}. Let μ_{hjt} be the measure of households with education h, age j, at any period t. Hence, period t gross population growth rate, $(1+n_t)$, is given by:

$$(1+n_t) = \sum_{j=20}^{100} f_{jt} \sum_{h} \mu_{hjt} + \sum_{j=20}^{100} \psi_{jt} \sum_{h} \mu_{hjt} \tag{5}$$

and the measure μ_{hjt} evolves along time according to:

$$\mu_{hj+1t+1} = \frac{\psi_{jt}}{(1+n_t)} \mu_{hjt} \tag{6}$$

$$\mu_{h20t+1} = \frac{1}{(1+n_t)} \sum_{j=20}^{100} f_{jt} \mu_{hjt} \tag{7}$$

Given that in my model economy, households go through the life cycle stages of working and retirement, their labor status is denoted with the variable e. That is, workers are referenced with $e=1$, while retirees are left with $e=2$.

3.2.2 Education

I abstract from the education decision, so education is determined at fertility. In addition, I impose that newborns may be endowed with any of three different stocks of human capital. The first possibility is that households have non-high school studies, so $h=1$.[9] For those households who have completed high school studies, I assign them $h=2$. Finally, households that have completed college studies are referenced with $h=3$.

3.2.3 Endowments of efficiency labor units

At any period t, workers' labor productivity has two components: a deterministic labor productivity index ϵ_{hj}, and an uninsured idiosyncratic stochastic shock s. The stochastic process for labor productivity is independent and identically distributed across households and follows a finite state Markov chain. The conditional transition probability matrix is $\Gamma_{ss'} = \Gamma(s'|s) = Pr\{s_{t+1} = s'|s_t = s\}$, where s and $s' \in S = \{1, 2..., m_s\}$.

3.2.4 Preferences

I assume that households value both their consumption and leisure. Consequently, the households' preferences can be described by the following standard expected utility function:

[9] I include within this group illiterate households to those who have compulsory studies. Due to the changes in the Spanish educational laws, I assume that compulsory studies is equivalent to *Estudios Secundarios Obligatorios (ESO)*, *Graduado Escolar*, *Certificado Escolar*, and *Bachiller Elemental.*

$$E[\sum_{j=20}^{100} \beta^{j-1} u(c_j, (1-l_j)] \quad (8)$$

where the function u is continuous and strictly concave in both arguments, β is the time discount factor, c_j is consumption, and $0 \leq l_j \leq 1$ is labor. Consequently, $(1-l_j)$ is the amount of time that the households allocate to non-market activities.

3.2.5 The households' decision problem

In order to state the households' maximization problem, I split it according to three different stages of their life cycles.
A. *From age 20 to age 59* (Households are not allowed to retire during this period)

$$\begin{gathered} V(h,j,s,e,a,b) = \max_{c,l,a'} \{u(c,(1-l)) + \beta\psi_j \sum_{s' \in S} \Gamma_{ss'} V(h, j+1, s', e', a', b') \\ (1+\tau_c)c + a' = (1-\tau_l)[y - \tau_s(y)] + (1 + r(1-\tau_k))a + z \\ b' = \begin{cases} 0 & \text{if } j < 60 - N_b \\ (b+y)/[j - (60 - N_b - 1)] & \text{if } 60 - N_b \leq j < 60 \end{cases} \quad ; \quad e = e' = 1 \quad ; \quad a' \geq 0 \end{gathered} \quad (9)$$

where r denotes the net capital rental rate, w denotes the wage rate, $y = ws\epsilon l$ denotes the gross labor earning, and z denotes government transfers. Prime variables denote their end of period values. Within this stage of their life cycles, households make optimal decisions for consumption, savings, and hours worked.

The law of motion of b captures the main features of the Spanish social security benefits. That is, the retirement pension is the average of gross labor earnings during the last N_b years prior to retirement. Given that the first possible retirement age from the labor force is set at the age of 60, I start to compute the pension claims when households are aged $(60 - N_b)$ years old.

B. *From age 60 to age 64* (If households choose to retire, they must pay a penalty that reduces their pensions)

$$\begin{gathered} V(h,j,s,e,a,b) = \max_{c,l,a'} \{u(c,(1-l)) + \beta\psi_j \sum_{s' \in S} \Gamma_{ss'} V(h, j+1, s', e', a', b') \\ (1+\tau_c)c + a' = (1-\tau_l)[y - \tau_s(y)] + (1 + r(1-\tau_k))a + z + b(j)I_{l=0} \\ b' = \begin{cases} (N_b b + y)/N_b & \text{if } l > 0 \\ b(j) & \text{if } l = 0 \end{cases} \quad ; \quad a' \geq 0 \\ e = 1 \quad e' = \begin{cases} 1 & \text{if } l > 0 \\ 2 & \text{if } l = 0 \end{cases} \end{gathered} \quad (10)$$

or

$$e = e' = 2 \quad \text{for} \quad 60 < j \leq 64$$

where $I_{l=0}$ is an indicator function with value 1 if hours worked are zero, and 0 otherwise.

To understand the impact of pension rules in retirement behavior, let us see the marginal cost and benefits that any worker who continues working faces. The costs are basically two: the reduction in leisure, and the foregone pension. The benefits are also two: the collected earnings and the reduction in the early retirement penalization. There is also another effect which, as we will see later on, is a cost. This is the change in the pension claim. This change is a cost because, given the concavity of the life cycle profile of gross earnings, the movement of current gross labor earnings into the averaging period reduces this average, since it substitutes for the value observed N_b years before.

However, the minimum pension eliminates one of the benefits of continuing to work. Specifically, the minimum pension eliminates the incentive to reduce the early retirement penalization, since no retiree can receive less than this minimum amount.

C. *From age 65 to age* 100 (Every household that reaches age 65 is forced to retire)
In this last stage, households make optimal decisions for consumption and saving

$$\begin{aligned} V(h,j,e,a,b) &= \max_{c,a'}\{u(c) + \beta\psi_j V(h,j+1,e',a',b') \\ (1+\tau_c)c + a' &= (1+r(1-\tau_k))a + z + b(j) \end{aligned} \tag{11}$$

$$\text{If } \ j = 65 \quad e = \begin{cases} 1 \\ 2 \end{cases} \quad e' = 2 \ ; \quad \text{If } \ j > 65 \ \ e = e' = 2 \ ; \quad b = b' = b(j) \ ; \quad a' \geq 0$$

3.3 Technology

We assume that aggregate output, Y_t, depends on aggregate capital, K_t, and the aggregate labor input, L_t, through a constant return to scale production function, $Y_t = f(K_t, L_t)$. Firms are competitive in the product and factor markets and the profit maximizing behavior gives rise to the following first order conditions:

$$r_t = F_K(K_t, L_t) - \delta_t \tag{12}$$

$$w_t = F_L(K_t, L_t) \tag{13}$$

where δ stands for the capital's depreciation rate.

3.4 Definition of equilibrium

Let $h \in H = \{1, 2, 3\}$, $j \in \mathcal{J} = \{20, 21, ..., 100\}$, $s \in S = \{1, 2, ..., m_s\}$, $e \in E = \{1, 2\}$, $a \in R_+$, and $b \in \mathcal{B} = [b_{min}, b_{max}]$. Also, let χ be the probability measure of $\Re = H \times \mathcal{J} \times S \times E \times R_+ \times \mathcal{B}$.

Given initial conditions K_1, B_1, and χ_1, a competitive equilibrium for this economy is a sequence of household value functions $\{v_t(h, j, s, e, a, b)\}_{t=1}^{\infty}$; sequences of household policies, $\{c_t(h, j, s, e, a, b), l_t(h, j, s, e, a, b), a'_t(h, j, s, e, a, b)\}_{t=1}^{\infty}$, sequences of government policy, $\{b_{min}, b_{max}, N_b, \tau_{st}(y_t), \lambda_{jt}, Z_t, \tau_{ct}, \tau_{lt}, \tau_{kt}, G_t, B_t\}_{t=1}^{\infty}$, measures of households, $\{\chi_t\}_{t=1}^{\infty}$, vector of factor prices, $\{r_t, w_t\}_{t=1}^{\infty}$, and vector of macroeconomic aggregates, $\{K_t, L_t, T_t, T_{st}, E_t, Z_t, P_t\}_{t=1}^{\infty}$, such that the following conditions hold:

(i) Factor inputs, tax revenues, accidental bequests, transfers, and pension payments are obtained aggregating over households:

$$K_{t+1} = \int k'_t d\chi_t \tag{14}$$

$$L_t = \int s\epsilon l_t d\chi_t \tag{15}$$

$$T_t = \int \tau_{ct} c_t d\chi_t + \int \tau_{kt} r_t a_t d\chi_t + \int \tau_{lt}[y_t - \tau_{st}(y_t)] d\chi_t \tag{16}$$

$$T_{st} = \int \tau_{st}(y_t) d\chi_t \tag{17}$$

$$E_{t+1} = \int (1 - \psi_{jt})(1 + r_t) a'_t d\chi_t \tag{18}$$

$$Z_t = \int z_t d\chi_t \tag{19}$$

$$P_t = \int b_t d\chi_t \tag{20}$$

where all the integrals are defined over the state space $\Re$.

(ii) Given, χ_t, K_t, L_t, r_t, and w_t, the household policy solves the households' decision problem described in (9), (10), and (11) , and factor prices are the factor marginal productivities.

(iii) The goods market clears:

$$\int c_t d\chi_t + K_{t+1} + G_t = F(K_t, L_t) + (1 - \delta) K_t \tag{21}$$

(iv) The government budget constraint is satisfied:

$$G_t + P_t + (1 + r_t)B_t = T_t + T_{st} + B_{t+1} \tag{22}$$

$$Z_t = E_t \tag{23}$$

(v) The law of motion for χ_t is:

$$\chi_{t+1} = \int_{\Re} Q(h, j, s, e, a, b; \aleph) d\chi_t \tag{24}$$

where Q is the transition function, and $\aleph \subset \Re$

4 Calibration

To solve this model economy I must choose specific forms for various functions and choose values for their parameters.

4.1 Functional forms and parameters

Government
To characterize the Fiscal Policy, I must choose the values for the consumption tax rate, τ_c, the labor income tax rate, τ_l, the capital income tax rate, τ_k, the government consumption, G, and the government debt, B.

On the other hand, to characterize the Social Security Policy, I must choose the maximum and minimum benefits, b_{max} and b_{min}, the age-specific penalization for early retirement, λ_j, the number of years of contributions used to compute the pension, N_b, and the functional form for the social security tax function.

My choice for the age-specific penalization for early retirement is

$$\lambda(j) = \begin{cases} \lambda_1 + \lambda_2(j - 60) & \text{if } j < 65 \\ 0 & \text{if } j = 65 \end{cases} \tag{25}$$

The rationale for this choice is because, according to *Régimen General de la Seguridad Social*, penalizations for early retirement are a linear function of the retirement age.

Finally, I must choose a model economy's social security tax function. Remember that workers' contributions to the Spanish pension system are a fixed proportion of labor earnings up to a maximum. Hence, my choice is:

$$\tau_s(y_t) = a_0 - [a_0(1 + a_1 y_t)^{-(a_2 + y_t)}] \tag{26}$$

The rationale for this functional form is because this function reaches a maximum a_0 in the R_+, with the parameter a_1 controlling for the slope of the function. Hence, the government characterization leaves me with 13 parameters.

Demographics
I have to set the conditional survival probabilities, ψ_j, and the population growth rate, n_t. From the INE's mortality tables, I obtain the conditional survival probabilities in 1998[10]. Consequently, to characterize the demographics of the model economy, I must choose the values of one parameter: n_t.

Education
In the last thirty years, the Spanish households became significantly more educated. Specifically, in 1977 around 3 percent of Spanish working age people had college studies and 9 percent had high school studies. In 1997, these shares were 13.4 percent and 24.0 percent. The projections for 2050 are 24.0 percent and 41.0 percent, according to Meseguer (2001).

The educational shares also change in my model economy. I assume that, given initial conditions, the shares i_{ht} evolve according to the following equation:

$$i_{ht} = i_{ht-1} + \eta_h \tag{27}$$

The rationale for this choice is that the series of above shares appear to be roughly linear into Meseguer's projections. Therefore, I impose linearity for simplicity. This gives me 6 additional parameters: three initial conditions i_{h1} and three for η_h,

Endowments of efficiency labor units
I assume that the deterministic profile is given by the following equation:

$$\epsilon_{hj} = \alpha_{h0} + \alpha_{h1} j + \alpha_{h2} j^2 \tag{28}$$

The rationale for this choice is that this functional form captures the concavity of the profiles of workers' productivity over their life cycle.

I also assume that stochastic efficiency labor units (s) can take three values. The reasons for this choice are two: first, I want to keep the process on s as parsimonious as possible; and second, I find that with three states, the Gini indexes of income and earnings distributions of my model economy account for the Spanish indexes almost exactly. This gives me 21 additional parameters: nine for α_{h0}, α_{h1}, and α_{h2}, three for s, and 9 for the transition probability matrix Γ_{ss}.

Preferences
My choice for the households' common utility function is:

$$u(c_j, (1-l_j)) = [(c_j)^{\gamma}(1-l_j)^{(1-\gamma)}]^{1-\sigma}/(1-\sigma) \tag{29}$$

where $\gamma \in (0,1)$ is the consumption share and σ is the coefficient of relative risk aversion. Hence, these two parameters and the discount factor β characterize households' preferences.

[10]The data is available at www.ine.es/inebase/cgi/um?M=%Ft20%2Fp319&0=inebase&N=&L=.

Technology
I choose a standard Cobb-Douglas aggregate production function. Consequently, technology gives me two additional parameters: the capital share of income, θ, and the depreciation rate, δ.

Adding up
My modeling choices and my calibration strategy imply that I must choose the values of a total of 46 parameters to compute the equilibrium of my model economy. Of these 46 parameters, 13 describe the government policy, one describes the demographics, 6 describe the educational shares, 21 describe the endowment of efficiency units, 3 describe household preferences, and the remaining two describe the aggregate technology, .

4.2 Targets

To choose values for the model parameters, I use 1997 as my calibration target year since I have data from two of our calibration targets, namely the Spanish Lorenz curves of income and earnings distributions, from this year.

Government
In Table 5 we report the revenues and expenditures from the combined Spanish Central, Autonomic, and Local Governments for the year 1997.

TABLE 5: TAX REVENUES AND PUBLIC EXPENDITURES IN 1997

Revenues	%GDP	Expenditures	%GDP
Social Security Contributions	13.10	Public Consumption	17.53
Individual Income Taxes	7.34	Public Gross Investment	3.07
Production Taxes	5.42	Pensions	12.05
Sales and Gross Receipts Taxes	5.03	Other Transfers	5.89
Corporate Profit Taxes	2.75	Other Expenditures	3.17
Estate Taxes	0.36		
Other Taxes	0.40		
Other Revenues	4.21		
Total Revenues	38.61	Total Expenditures	41.71
		Deficit	3.10

Source: National Accounting reports, INE.

I assume that the capital income taxes collected by Individual Income and Corporate Profit Taxes in the Spanish economy are collected in my model economy by the capital income tax, τ_k. I also assume that the labor income taxes collected by the Individual Income Taxes, are collected in my model economy by the labor earnings tax, τ_l. Social security taxes are collected in my model economy by the social security tax function, $\tau_s(y_t)$. I define in my model economy as Public Expenditures the sum of public consumption, retirement pensions, and interest payments from public debt. I assume the government budget constraint to be balanced. Consequently, given the tax revenues and the public expenditure in my model economy, I also assume that the consumption tax rate adjusts in order to balance the government budget.

I target the effective taxation of capital income and of labor earnings (the net of social security contributions) of the Spanish economy. According to Boscá *et al.* (1999) these numbers were 18.7% and 18.0% respectively. I also target a public consumption to output ratio, G/Y, of 17.5%, and a public debt to output ratio, B/Y, of 66.7%. The rationale for these ratios is as follows: According to *National Accounting reports* (INE), the value for the government consumption in 1997 was 86.639 million euros and the value of GDP was 494.140 million euros. This way I obtain the figure of 17.5%. On the other hand, *Instituto de Estudios Fiscales* (2004) reports that the Public Debt to output ratio in 1997 was 66.7%. The final target comes from assuming equilibrium in the government budget constraint. This assumption determines the value of the consumption tax rate.

I target the minimum and maximum pension benefits at 1997. From the Spanish Social Security records, the minimum pension was 87% of *salario mínimo interprofesional* (SMI); maximum pension benefit was 4.3 times SMI. On the other hand, the minimum pension was 79% of the average retirement pension $\overline{b}$. Consequently, I set the minimum pension $b_{min} = 0.79 \times \overline{b}$, and the maximum pension $b_{max} = 4.9 \times 0.79 \times \overline{b}$.

I also target the number of years of contributions used to compute the pension, N_b, the age-dependent penalization for early retirement, and the maximum penalization. According to *Régimen General de la Seguridad Social*, the years of contributions used to compute the pension are 15, the penalization for early retirement is 8 percent per year prior to age 65, and the maximum penalization is 40% which applies to those retiring at the first early retirement age 60. Note that these two targets determine the values for λ_1 and λ_2. Specifically, λ_j is set according to:

$$\lambda_j = \begin{cases} 0.4 - 0.08(j-60) & \text{if } 60 \leq j < 65 \\ 0 & \text{if } j = 65 \end{cases} \tag{30}$$

I want my model economy social security tax function to mimic the workers' contributions to the Spanish pension system up to maximum. Hence, I target the payroll tax rate and the maximum taxable earnings. According to the *Régimen General de la Seguridad Social*, the payroll tax is 28.3%. Note that this target determines the value of a_1 in the social security tax function. From the Spanish Social Security, the maximum taxable earnings at 1997 was 6 times the SMI. This target determines the value for a_0, that is, $a_0 = 0.283 \times 6.9 \times \overline{b}$. My final target comes from imposing that the shape of the model economy social security tax function coincides with the workers' contributions to the Spanish pension system, in spite of the change in units. I find that this final target implies the value for $a_2 = 0.7701$. Hence, government gives me 13 targets.

Demographics

According to the INE's mortality tables, the expected lifetime of Spanish households in 1998 was 79.4 years (conditional on being alive at the age of 20). I set the maximum length of life at 100 in order to replicate this expected lifetime. I target the dependency rate of the Spanish population at 1997 to be 26.5%. The rationale for this number is as follows: According to *Encuesta Población Activa* (EPA), in Spain there were 6,382,809 people aged 65 or over in 1997. For the same year, there were 24,069,372 people aged between 20 and 64. This way I obtain the figure of 26.5%. Note that, given survival probabilities and the maximum length of life, my target for the dependency rate allows me to determine the value for n_t. Thus, I have one additional target.

Education
I target the shares of high school and college working age Spanish people in 1997 and their projections for the year 2050. According to Meseguer (2001), 24.0% of workers had high school studies, and 13.4% of workers had college studies. His projection for the year 2050 is 41%, and 24% respectively[11]. Hence, I have four additional targets.

Endowments of efficiency labor units
I want the deterministic profiles of labor efficiency units in my model economy to approximate the empirical profiles by educational type of Spanish workers in 1997. Hence, I estimate these empirical profiles with quadratic functions. Note that each of these three targets determine the three parameters c_{h0}, c_{h1}, and c_{h2}.

Preferences
I target the share of disposable time allocated to working in the market to be 27.2%. The rationale for this choice is as follows: According to *Encuesta sobre el tiempo de trabajo (INE)*, the average number of hours worked per active people in 1996 was 1290. If I consider discretionary time to be 13 hours a day, this implies that total discretionary time is 4745 hours. This way I obtain the number 27.2%. Next, I choose a value of $\sigma = 2$, as it is standard assumption in the literature. This gives me two additional targets.

Technology
I impose the capital income share in Spain in 1997 to be 0.375. The rationale of this choice comes from the findings of Zabalza (1996). Hence, technology gives me one additional target.

Aggregates
I want my model economy's macroeconomic aggregates to replicate the macroeconomic aggregates of the Spanish economy. Hence, I target a capital-output ratio, K/Y, of 2.50, and an investment-output ratio, I/Y, of 22.13%. The rationale for these choices is as follows: 2.50 is the average between Licandro *et al.* (1997), who report a value of 2.35, and King and Levine (1994) who find a value of 2.65. The investment-output ratio was obtained from the INE's National Accounting reports. Specifically, gross investment was 109.357 million euros, and the Spanish gross domestic product was 494.140 million euros. This way I obtain the 22.13% number. Hence, this leaves me with two targets.

Spanish Income and Earnings distribution
I target the two Gini indexes and six selected points of Spanish income and earnings distributions at 1997, as reported by Budría and Díaz-Giménez (2004), in Tables 6 and 7.

[11] The projection extends until 2050.

Table 6: Spanish Income Distribution in 1997 (%)

	Lowest Groups (%)			Quintiles					Top Groups (%)		
Gini	1	1–5	5–10	1st	2nd	3rd	4th	5th	10–5	5–1	1
0.39	.0	0.6	1.4	5.4	10.7	15.9	23.3	44.6	10.7	11.1	6.4

Table 7 Spanish Earnings Distribution in 1997 (%)

	Lowest Groups (%)			Quintiles					Top Groups (%)		
Gini	1	1–5	5–10	1st	2nd	3rd	4th	5th	10–5	5–1	1
0.57	.0	.0	.0	0.0	2.5	15.6	27.3	54.8	13.0	14.7	6.6

Normalizations
I normalize s(1)=1. Moreover, and since the transition probability matrix is a Markov matrix, its rows must add up to one. This property imposes three additional normalizations. I normalize the shares of educational types $\sum_{h=1}^{3} i_{ht} = 1$. Note that this normalization imposes that $\sum_{h=1}^{3} \eta_h = 1$. It implies that I have 6 additional targets.

4.3 Choices

The values of some of the model parameters are obtained directly because they are uniquely determined by one of my targets. In this fashion, I make $\sigma = 2$ and $\theta = 0.375$. Similarly, the values of the conditional survival probabilities ψ_j were obtained from the INE's mortality tables. Given these survival probabilities together with the maximum length of life, my target for the dependency rate of the Spanish economy in 1997, determines the population growth rate in my model economy, $n_t = 0.0100$. The values for the shares of educational types, i_{h1} and η_h, were set from Meseguer (2001) and (27). With the quadratic approximation to the empirical profiles of labor efficiency units of Spanish workers, I get the values for c_{h1}, c_{h2}, and c_{h3} for the three educational types. From the *Régimen General de la Seguridad Social*, I obtain the values for the coefficients λ_1 and λ_2 in the penalization function, and the value N_b. I also find that $a_2 = 0.7701$ allows the shape of the model economy social security tax function to coincide with the workers' contributions to the Spanish pension system, in spite of the change in units. I take from Boscá *et al.* (1999) the values for the capital income tax rate $\tau_k = 18.7\%$, and also for the labor earnings tax rate $\tau_l = 18.0\%$. Finally, the normalization of the endowment of efficiency labor units implies that $s(1) = 1.0$.

Table 8: Parameter Values for the Benchmark Model Economy

	Parameter	Value
Preferences		
Time Discount Factor	β	0.9939
Consumption Share	γ	0.3481
Relative Risk Aversion	σ	2.0000
Technology		
Labor Share	θ	0.3750
Capital Depreciation Rate	δ	0.0800
Fiscal Policy		
Government Consumption	G/Y	0.1766
Government Debt	B/Y	0.6670
Labor Tax Rate	τ_l	0.1800
Capital Earnings Tax Rate	τ_k	0.1870
Public Pension System		
Maximum Contribution	a_0	2.9400
Slope Tax Function	a_1	0.0309

Following Castañeda *et al.* (2004), the values of the remaining 21 parameters are determined solving the system of nonlinear equations obtained from imposing that the relevant statistics of the model economy should be equal to the corresponding targets. Given that solutions for these systems are not guaranteed not only to exist but also to be unique, I tried many different initial parameter values and sets of weights to find the best calibration[12].

Table 9: Stochastic Endowments And Stationary Distribution If Workers

	$s=1$	$s=2$	$s=3$
s	1.0000	2.9845	4.6291
$\pi(s)\%$	38.03	40.03	21.94

Table 10: Transition Probabilities

	To s'		
From s	$s'=1$	$s'=2$	$s'=3$
$s=1$	0.8376	0.0028	0.1594
$s=2$	0.0000	0.9776	0.0223
$s=3$	0.2812	0.0357	0.6829

[12] Actually we solved a smaller system of 12 equations because our guesses for the values of aggregate physical capital and aggregate labor uniquely determines the values for a_0, b_{min}, b_{max}, G, B, because the value of τ_c is determined residually from the government budget constraint, and because the normalization of the matrix Γ_{ss} allows me to determine the values of three of the transition probabilities directly.

5 Simulation strategy

5.1 Government financing

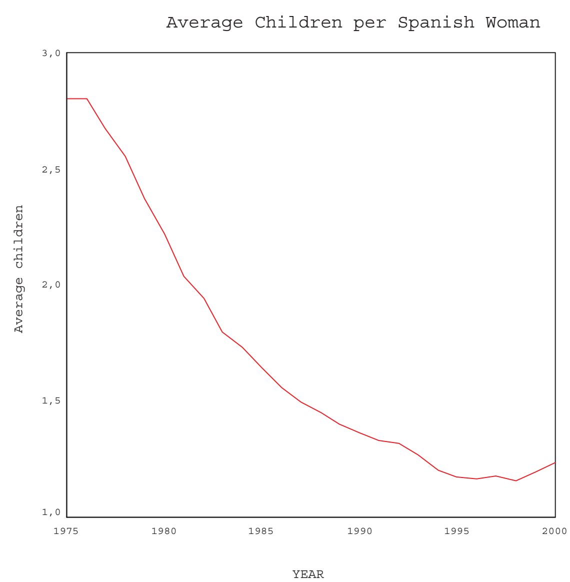
In this paper I make two different assumptions concerning the financing of the public pension deficit, and I show the dynamic results under these two assumptions.

In the first assumption, I assume as before that the consumption tax rate adjusts in order to balance the government budget, and government debt is an exogenous and constant proportion of output each period. I call this as *Benchmark 0*.

In the second assumption, I assume that the social security deficit is financed with public debt. However, this public debt is not part of the households' portfolio, so it is external debt to the economy. I also assume that this public debt pays 4% per year, and that the consumption tax rate adjust in order to balance government consumption with the other tax revenues, namely, the capital income tax, the labor income (net of social security contributions) tax, and the consumption tax revenues. Factor prices are the factor marginal productivities. I call this model economy *Benchmark 1*.

5.2 Transitions

In the last thirty years Spanish demography has changed significantly. According to the INE, between 1957 and 1977, the average number of children born to Spanish women was 2.8. However, since 1978 this rate has shown a decreasing trend, as is shown in the next figure, reaching the minimum value 1.16 in 1998. One of the consequences of this change in fertility rate is that the ratio of people older than 64 to people aged between 20 and 64, which was 26.5 percent in 1997, is projected to lie between 55-60 percent in 2050.



As I said in the introduction, in the last thirty years, the Spanish households have become significantly more educated. Specifically, in 1977 around 3 percent of Spanish working age people had college studies and 9 percent had high school studies. In 1997, these shares were

13.4 percent and 24.0 percent. The projections for 2050 are 24.0 percent and 41.0 percent, according to Meseguer (2001).

In this article I simulate both the demographic and the educational transitions as follows:

A. *Demographic Transition*
I assume that in my model economy demographic patterns are non-stationary from 1998. This is due to two reasons: First because Spanish demographic transition began in 1978, and second, because households enter into my model economy at age 20. These patterns are characterized as follows:

1. 1998-2025: Recovery of fertility rates f_{jt}. The average number of children per woman increases from 1.16 in 1998, and grows at a yearly rate of 3% until 2012, when this rate starts to decline, reaching a level of 1.92 children per woman in year 2025. This number is constant from year 2026 onwards[13].

2. 1998-2050: Increase of life expectancy. I make every cohort have a higher conditional survival probability ψ_{jt}. This increase is parameterized in such a way that life expectancy goes up from the value observed in 1998 (79.4 years) to 81 in 2050.

3. 2051-2132: Convergence of population dynamics. When life expectancy stabilizes in 2051, the demographic structure of the population will still adjust for 81 more years, through changes in the population growth rate.

B. *Educational Transition*
Since in 1997, the population structure in Spain was neither stationary in age nor in education dimensions, I start at 1950 and assume that the population structure was stationary. Educational transition starts in 1951. I assume that in my model economy the labor force composition by educational types becomes stationary at 2050, since this is the last year for Meseguer's projections. Note that this assumption has two implications: First, the measure of households by educational type entering the economy becomes stationary in 2005 because the maximum working period extends for 45 years. And second, the educational transition ends in 2086, because educational shares for the retirees are still changing after 2050.

6 Calibration results

In this section I report the behavior of my benchmark model economies, which I have calibrated to the targets described in the last section.

6.1 Macroeconomic aggregates

I report the values of some of my aggregate targets for Spain and for the benchmark models economies in Table 11. [14]

[13] The initial values for the age-specific fertility rates were taken from INE.

[14] The numerator of column 7 are the taxes raised over the income of production factors. For the Spanish economy, this is the sum of the revenues raised by *Impuesto sobre la Renta de las Personas Físicas* and the *Impuesto sobre sociedades* as reported by INE.

Table 11: Ratios in 1997

	K/Y (1)	I/Y (2)	G/Y (3)	B/Y (4)	T_s/Y (5)	P/Y (6)	$(T_k+T_l)/Y$ (7)
Spain	2.50	22.1%	17.5%	66.7%	11.7%	9.0%	10.0%
Benchmark 0	2.49	21.1%	17.5%	66.7%	17.0%	15.3%	12.6%
Benchmark 1	2.61	24.4%	17.5%	66.7%	17.0%	15.5%	12.3%

We see that both model economies overstate the magnitude of the revenues and expenditures of the Spanish pension system. This is for several reasons[15]. First, in the Spanish economy there is a significant number of retirement pensions computed according to the rules of other schemes, apart from the *Régimen General de la Seguridad Social*, as for example self employed. These schemes have lower contribution rates and pensions. And second, within the *Régimen General de la Seguridad Social*, some rules exists from which I have abstracted, as for example the penalty for insufficient years of contributions, or the case of workers who do not qualify to receive a *contributive* pension because they have less than 15 years of contributions.

The remaining statistics are very similar in all economies. Finally, remember that G/Y are exogenously fixed.

6.2 Inequality

I report the Gini indexes and selected points of the Lorenz curves of income in Spain and in the benchmark model economies in Table 12.

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Table 12: Households Income Distribution in 1997 (%)

		Lowest Groups (%)			Quintiles					Top Groups (%)		
	Gini	1	1–5	5–10	1st	2nd	3rd	4th	5th	10–5	5–1	1
Spain	0.39	.0	0.6	1.4	5.4	10.7	15.9	23.3	44.6	10.7	11.1	6.4
Benchmark 0	0.40	.0	0.5	0.9	4.1	10.9	17.4	23.0	44.8	10.1	12.9	5.8
Benchmark 1	0.39	.1	0.6	1.0	4.5	11.0	17.4	22.5	44.6	10.1	12.9	5.9

I find that my benchmark model economies account for the Spanish distribution of income almost exactly. If we look at the fine print, we find that *Benchmark 0* generates a small higher inequality in the income distribution as indicated by its Gini index.

I report the Gini indexes and selected points of the Lorenz curves of earnings in Spain and in the benchmark model economies in Table 13.

Table 13: Households Earnings Distribution in 1997 (%)

		Lowest Groups (%)			Quintiles					Top Groups (%)		
	Gini	1	1–5	5–10	1st	2nd	3rd	4th	5th	10–5	5–1	1
Spain	0.57	.0	.0	.0	0.0	2.5	15.6	27.3	54.8	13.0	14.7	6.6
Benchmark 0	0.55	.0	.0	.0	0.5	5.6	15.0	23.8	55.0	12.3	16.7	7.4
Benchmark 1	0.54	.0	.0	.0	0.5	5.7	14.9	23.7	55.2	12.2	16.8	7.4

[15]The contributions-output ratio (col.5) was obtained from the Spanish *Ministerio de Economía y Hacienda.* Contributions correspond to those collected by the Spanish *Seguridad Social.* The pension expenditures-output ratio (col.6) was obtained from the *Boletín de Estadísticas Laborales* of the Spanish *Ministerio de Trabajo y Asuntos Sociales.* This expenditure corresponds to the expenditures of all retirement pensions.

We see that all distributions are very similar. We find that the main differences are that the shares of earnings earned by the second and fifth quintiles are higher in the models than in the data, and that it is compensated by the shares earned by the third and fourth quintiles.

During my research, I tried many parameterizations of *Benchmark 0* increasing the accuracy of these statistics at the expense of the accuracy of other calibration targets, and these changes made little difference to my overall findings.

I also report the Gini index and selected points of the Lorenz curve of wealth in the benchmark model economies in Table 14.

Table 14: Households Wealth Distribution in 1997 (%)

		Lowest Groups (%)			Quintiles					Top Groups (%)		
	Gini	1	1–5	5–10	1st	2nd	3rd	4th	5th	10–5	5–1	1
Benchmark 0	0.54	.0	.0	.0	0.2	5.2	14.3	26.2	54.2	12.6	15.0	7.3
Benchmark 1	0.56	.0	.0	.0	0.1	4.7	13.7	25.3	56.2	12.9	16.1	8.0

I do not have data from Spain in order to compare with the Lorenz curve of wealth of my models economies. However, we see that both model economies cannot generate a high concentration of wealth in the top 5 and 1 percent, which is reflected in their low Gini indexes. Note that this is a common characteristic of OLG model economies where households are not altruistic. According to Díaz-Giménez *et al.* (1997), the Gini index of the U.S. distribution of wealth is 0.79, and the top one percent holds 29.6% of total U.S. wealth.

6.3 Retirement behavior

In this subsection, I report the statistics describing the retirement behavior of Spanish households and the households in both of my model economies. For comparisons, I also include the results obtained by Sánchez Martín (2003), since it is the only paper for the case of Spain, of those papers that introduce the early retirement decision.

In Table 15 I report the average retirement age[16], the employment rate, and the percentage of people who retire at age 60 collecting the minimum pension[17], for both Spain and my models economies.

Table 15: Retirement in 1997

	Spain	Benchmark 0	Benchmark 1
Average Retirement Age	61.4	61.6	61.6
Employment Rate (60-64 years) (%)	26.0	28.7	29.6
Early Retirees (60) holding b_{min} (%)	67.7	62.0	63.1

Note that my model economies account almost exactly for the average retirement age and the employment rate of those Spanish households aged 60 to 64. In Sánchez Martín, the numbers for these statistics are 63.6 years of age, and 73.8% respectively.

My benchmark model economies also do a better job of accounting for the observed percentage of Spanish workers who retire at the age of 60 having the minimum pension. For example, in Sánchez Martín (2003) this number is 100 percent. This is for two reasons: All

[16]The average retirement age for Spain is for male workers in 1995 (Scarpetta and Blondal, 1997).

[17]The percentage of early retirees holding minimum pension in Spain is the number that Sánchez Martín (2003) reports, and corresponds to the year 1995.

non-high school workers collect the minimum pension upon retirement. Specifically, his model economy is inhabited by heterogeneous households which differ in their education, but are homogeneous within each educational type because their endowment of efficiency labor units is deterministic. Thus, every household with a given education has the same pension upon retirement because they also had the same life cycle labor earning profiles. The average gross labor earnings in the last 15 years prior to age 60 of the non-high school workers is not higher than the minimum pension because they have a flat life cycle profile of labor earnings. Hence, they choose to retire because the minimum pension eliminates the incentive of reducing the early retirement penalization.

And second, high school and college workers keep working until age 65 because: (*i*) The foregone labor income is higher for more productive types, and (*ii*) Their average gross labor earnings is greater than the minimum pension, so these workers have an additional incentive to keep working because if they do so, they reduce the early retirement penalty.

This is not the case in my model economies. For instance, I find in *Benchmark 0* that 88.2% of workers who choose to retire at age 60 are non-high school, and 68.4% of all the non-high school who retire at 60 collect the minimum pension. In addition, 16.1% of the high school workers, and 11.0% of college workers retiring at age 60 collect the minimum pension.

I also find that most of the workers who choose to retire at age 60 and do not collect minimum pensions are low income workers. Specifically, these workers have the incentive to retire because: (*i*) a lower labor earning decreases the cost of leisure, and (*ii*) if they decide to work, labor earnings are low and hence their pensions would decrease, as current gross labor earnings move into the averaging period and substitute for the value observed 15 years before. It means that their social security wealth would be reduced, so they face high implicit taxes on continuing to work. And finally, some high labor income workers continue to work since high income means a subsidy to continue working.

In order to provide the reader with a clearer idea of how the incentive to continue to work changes with the level of labor income, I compute the implicit tax/subsidy of continuing to work for those workers aged 60 to 64 who are not subject to the minimum pension claim [18].

I do this for both low labor income and high labor income workers who are at each age j, in the median of the pension claim distribution at the beginning of the aforementioned ages. I choose the median of the distribution for two reasons. First, I want to eliminate the effect of the minimum pension on retirement behavior, so choosing the median of the distribution guarantees that even a worker who chooses to retire at age 60, collects a pension after the early retirement penalization higher than the minimum pension. And second, because I want to show how the incentives to retire at any age j can be very different depending on different labor incomes at that age, even for workers with similar previous labor income profiles. The methodology is the following:

A — I denote as *high income workers*, those workers facing the highest labor productivity shock. Then, I compute the implicit tax/subsidy of these workers for every educational type. The final implicit tax/subsidy comes from averaging the implicit tax/subsidy of each educational group by their employment rates at each age between 60 and 64.

B — I denote as *low income workers*, those workers facing the lowest labor productivity shock at every age between 60 and 64. Then, I proceed in the same way as for high income

[18] The implicit tax/subsidy of continuing to work at any age j is computed as minus the ratio between the change in the worker's social security wealth with respect to one year earlier and the projected earnings in age j. Social security wealth is the expected present value of the sum of all pensions received until the maximum age 100.

workers, but assuming that the time allocated to labor market activities is 25% of the total endowment. I make this assumption for two reasons. First, because most of these workers choose to retire so their labor supply is zero. And second, because the empirical profile of hours worked by Spanish workers shows that their labor supply at ages 60 to 64 is lower than at age 50. Hence, I choose 25% since this number is around 80% of hours worked by households aged 50 in my model economy.

Table 16 shows the age dependent implicit tax/subsidy.

Table 16: Implicit tax/subsidy on continuing to work (%)

Age	Low income	High income
60	16.7	–30.9
61	45.7	–26.2
62	71.1	–22.4
63	93.0	–18.9
64	112.0	–16.5

We see that high income workers face a subsidy at every age. This is because two reasons. First, by working one more year, these workers increase their pension claim by 8%, since they reduce the early retirement penalization. And second, the high labor income allows them to increase the pension claim since current gross labor earnings move into the averaging period and substitute for the value observed 15 years before. Finally, note that there is an inverse relationship between subsidy and age. This is due to the concavity in the labor income profile.

For low income workers, there is an increasing age dependent tax on continuing to work. The tax arises because the reduction in the penalization for early retirement is not enough to increase the social security wealth, as low labor income decreases the pension claim. Note that the tax increases with age due to the concavity in the labor income profile. hus, we see that any low income worker who is not entitled to receive the minimum pension, also has the incentive to retire in order to skip the implicit tax to continue to work.

In Table 17 I report participation rates by educational types. Notice that they are participation rates and not employment rates. However, it makes little difference, because the percentage of the unemployed people aged 60 to 64 is just 2.08% of the total population within this age range.

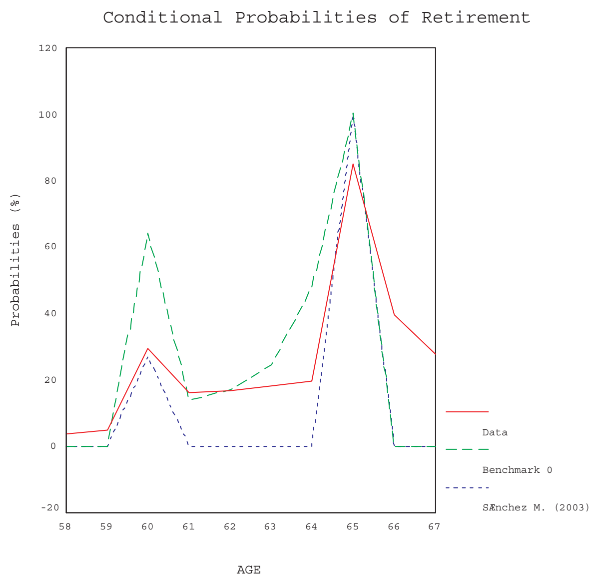
Table 17: Participation Rate among Individuals Aged 60 to 64 by Educational Level in 1997 (%)

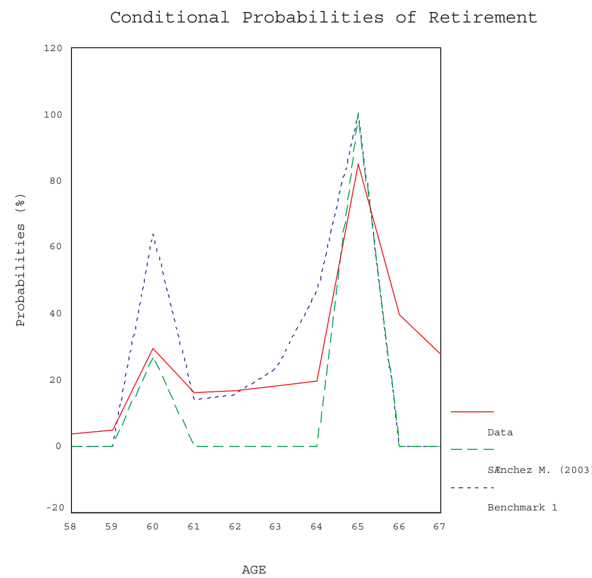
	Spain	Benchmark 0	Benchmark 1
Non-High School	25.9	15.3	15.2
High School	41.2	56.3	57.9
College	61.2	63.9	66.8

Benchmark 0 accounts almost exactly for the participation rate of college workers. Moreover, in spite of the differences between the results of my model economies and the data, my model economies do a better job than others in the literature. For example, in Sánchez Martín (2003) these numbers are 0% for non-high school workers, and 100% for both high school and college workers. As I said before, in his model economy high school and college workers find convenient to keep working until the compulsory retirement age of 65.

My benchmark model economies account for the relationship between participation and education. That is, the higher the education, the higher the participation rate. This is for two reasons. First most non-high school workers receive minimum pensions so they choose to retire earlier. And second, while leisure is equally valued across educational types, the foregone labor income is lower for less productive types, who therefore find more convenient to retire early.

In the next figure, I compare the conditional probabilities of retirement[19]. These are defined as the probability that a worker chooses to retire from the labor force. For comparison, I also include the conditional probabilities of retirement computed by Sánchez Martín (2003)





We can see that empirical data shows two main peaks: at ages 60 and 65. The pick at 60 is mainly because the minimum pension eliminates the incentive to work associated with the early retirement penalization, and also increases the opportunity cost of the foregone pension. In addition, people who expect a low labor earning at age 60, may find it optimal to retire in order to skip the implicit tax for continuing to work.

The peak at age 65 is the optimal response to the lack of actuarial adjustment of pension after the retirement age of 65, and the foregone pension reaching its maximum at 65.

There are some main differences between the profiles of probabilities of retirement of my model economies and those observed in Sánchez Martín (2003). The empirical probability at age 60 is 29.5 percent. In Sánchez Martín's model economy the probability of retirement at age 60 is 26.2 percent for two reasons. First, the non-high school workers are the only workers who choose to retire at this age. And second, because the share of non-high school workers within those households aged 60 in his model economy is precisely 26.2 percent. In my model economy, the share of non-high school workers aged 60 is 66.7%, and 82.7% of them choose to retire at this age. This is the main reason why the conditional probability at age 60 in my model economy is 64.2%. [20]

[19]The empirical data were obtained from Sánchez Martín (2003), and corresponds to the year 1994.

[20]One of the main reasons to observe a 29.5% value in empirical data, is that Spanish Social Security provides other pensions before age 60, such as disability pensions. Specifically, Spanish workers have alternative paths for retiring before age 60. See Boldrin, Jiméz and Peracchi (1999).

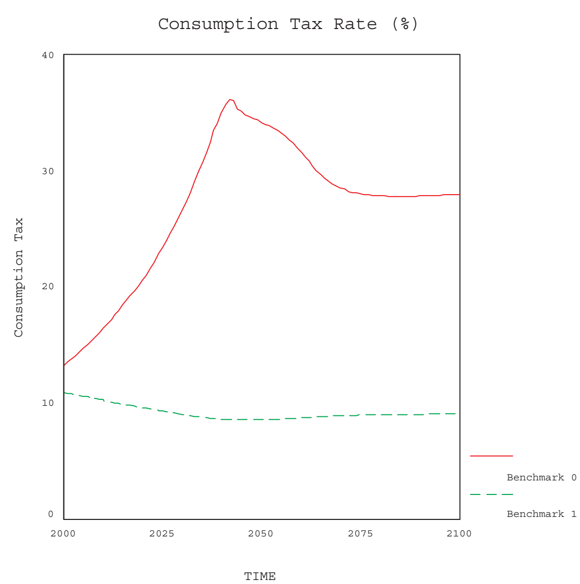
Also, after age 60 my model economy does a better job of accounting for the empirical probabilities. This is because in Sánchez Martín (2003) both the high school and college workers find it optimal to wait until the maximum retirement age, as they eliminate the early retirement punishment. On the contrary, in my model economy low income workers who do not receive the minium pension, still decide to retire before 65. This is because these workers skip the tax on continuing to work if they decide to retire.

Note that at age 65, the probabilities are identical in both model economies. This is because households are not allowed to keep working after age 65 in both models, which is not the case in the Spanish economy, so empirical probabilities are positive.

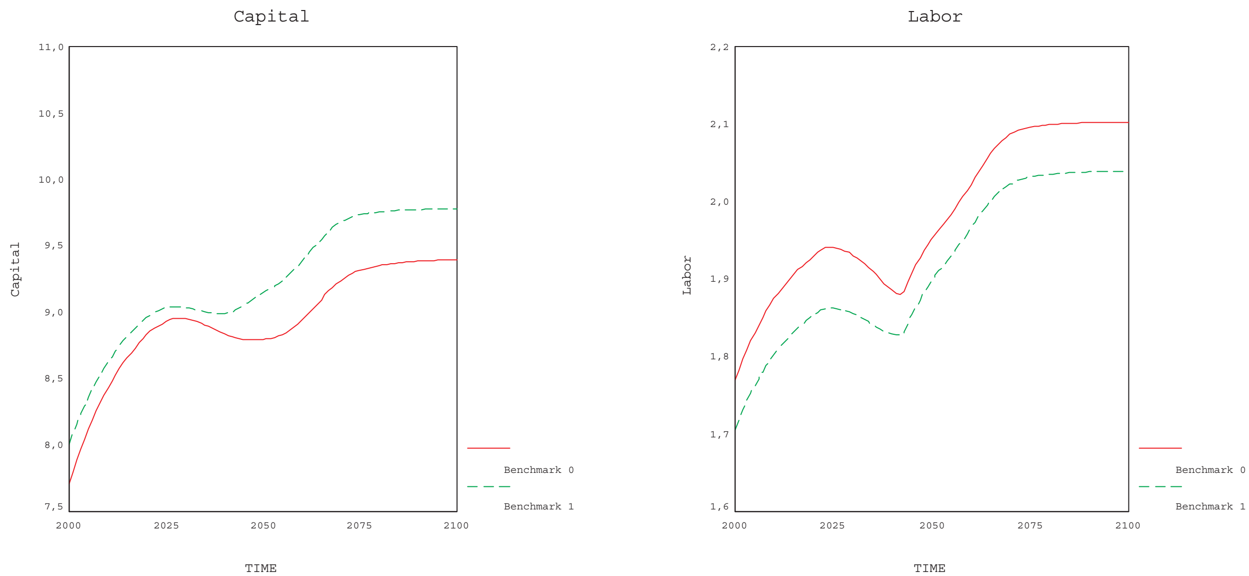
In conclusion, what we learn from the above results is that two main effects drive the early retirement behavior of households. First, the minimum pension which gives strong incentives to leave the labor force at the first retirement age, since this pension eliminates the incentives to keep working in order to reduce the punishment for early retirement. And second, a low level of labor income because it implies a implicit tax on continuing to work. Specifically, the reduction in the penalization for early retirement is not enough for increasing the social security wealth, as the low labor income decreases the pension claim.

6.4 Financing the government deficit

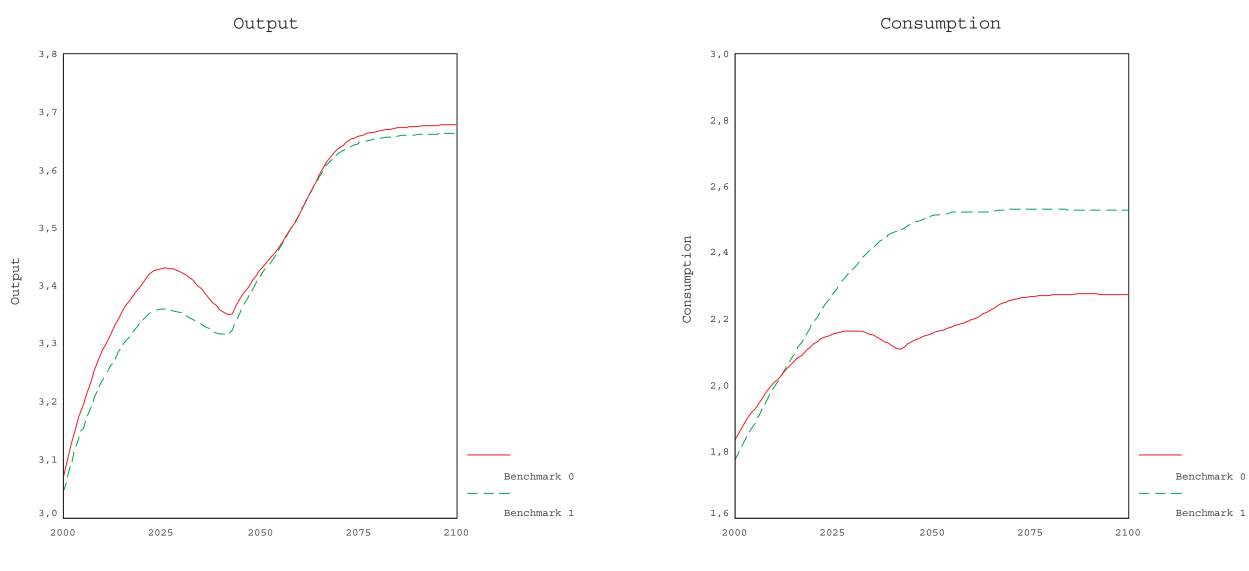
In the next figure we compare the consumption tax rate in both models economies.



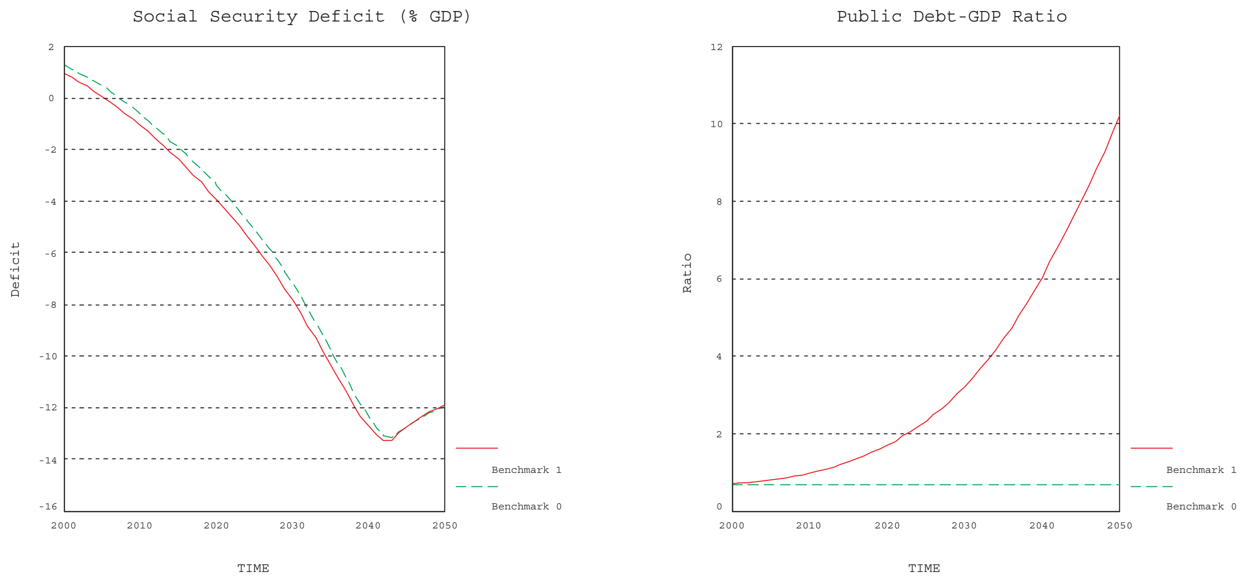
As was expected, the consumption tax rate is lower under the regime that assumes external debt financing of pension system deficit. The next figures show the paths for capital and labor supply.



The lower consumption tax rate implies, through a positive wealth effect, higher consumption, saving, and leisure. Also, households consume more, as is shown in the next figure.



Note that the higher capital and the lower effective labor imply a lower interest rate and a higher wage rate under Benchmark 1. The higher leisure and the higher wage rate under Benchmark 1, make no significant difference in social security contributions and benefits, so we do not appreciate significant differences in the social security deficit, as is shown in the next figures.

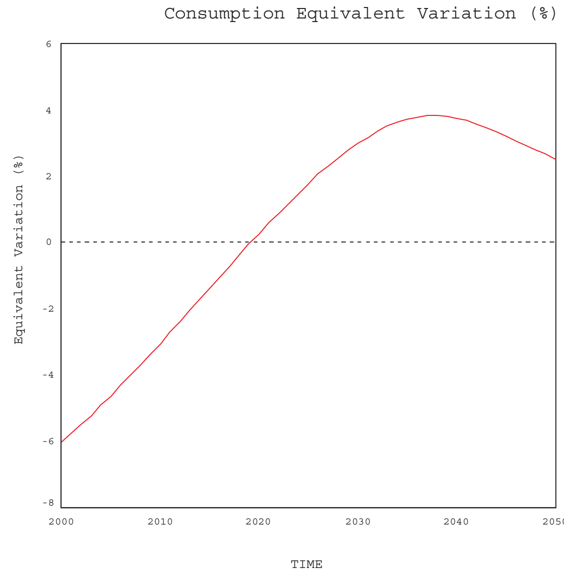


Note the growth of the public debt to output ratio. At 2050, this ratio reaches a value of more than 10.

In order to quantify the welfare effects of the two different ways of financing the pension system deficit, I use the consumption equivalent variation measure, EV_t. Specifically, I compute the average expected utility in both models economies at every period. Let V_{0t} and V_{1t} denote the average expected utility at period t in *Benchmark 0* and *Benchmark 1* respectively. Then, the period t consumption equivalent variation is defined as:

$$EV_t = \left(\frac{V_{1t}}{V_{0t}} \right)^{\frac{1}{\gamma(1-\sigma)}} \tag{31}$$

For example, an EV_t of 0.05 implies that the average household in the *Benchmark 0* model economy has to be given a 5% higher consumption in all the possible nodes of its remaining lifetime, in order to have the same expected utility as the average household in the *Benchmark 1* model economy. The results are shown in the next figure.



Surprisingly, the average household is better off in the *Benchmark 0* model economy, until the year 2020. This is because the higher consumption tax rate is more than compensated by the higher capital rental rate. However, after 2020, the very high consumption tax rate makes this average household worse off in comparison to the average household in the *Benchmark 1*.

7 Transitions and the pension system

The aims of this section are twofold. First, I want to know if there are significant differences in the projected pension system deficits under the two model economies. And second, I want to know the effects of both the demographic and educational transitions on this deficit.

In order to carry out these tasks, I make the following strategy. I run four different transitions in both model economies, and I compute the social security deficit in all of them.

In the first one, it is assumed that after 1997, there is no demographic transition and the shares of educational types within workers are at their 1997 values. I call this first experiment *no transition*[21].

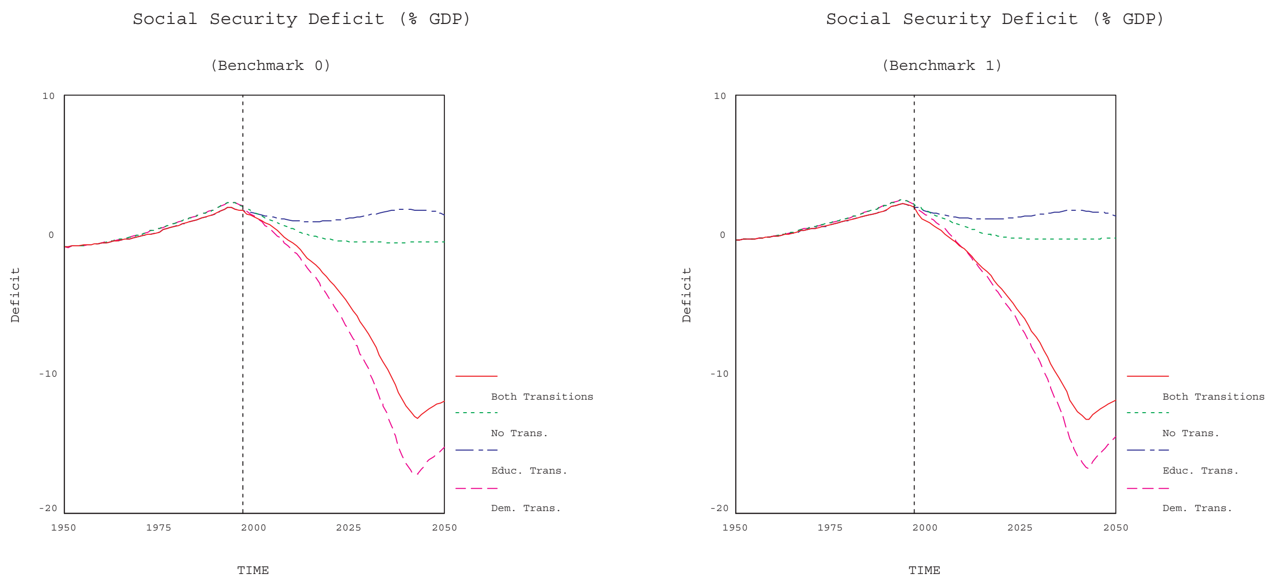
In the second transition, I continue to assume that there is no demographic transition after 1997, but I allow a complete educational transition. In other words, educational shares within workers become stationary in 2050, and the educational transition ends in 2086 as the educational shares for the retirees are still changing after year 2050. I call it *educational transition*.

The third transition assumes that, as in *no transition*, after 1997 the shares of educational types within workers are constant at their 1997 values, but I allow the demographic transition. That is, after 1997, age dependent fertility rates change in the way that we impose in section 5.2. I call it *demographic transition*.

[21]Note that these assumptions have two implications. First, the measure of newborns by educational type is constant from the year 1953, as the maximum working period extends for 45 years. And second, the educational transition ends in 2033 as the educational shares for the retirees are still changing after the year 1997.

Finally, I compute the social security deficit in the context of both the demographic and the educational transitions after 1997, and I call it *both transition*.

The results are shown in the following figure



We see that the expected social security deficit is mainly due to the Spanish demographic transition. In addition, the social security deficit as a percentage of the model economy output in the context of both the demographic and educational transitions is lower than in the context of only the demographic transition for the year 2050. This is because less productive workers pay less social security contributions by 13.9%. Also, less productive workers collect lower retirement pensions at retirement. Consequently, the average pension of retirees decreases by 4.6%. The smaller reduction in benefits than in contributions is principally explained by the minimum pension. Specifically, since there are more non-high school workers in *demographic transition* than in *both transitions*, and most of them receive this minimum pension, it implies that the reduction in the social security benefits is smaller than without this minimum scheme.

Finally, note the magnitude of the social security deficit in the context of both the demographic and the educational transition: in the year 2050 the model economies predict that it will be around 11% of GDP.

8 Reform

In this section I compare the dynamic results under two different policy regimes. In the first regime, rules are kept as they were. In the second regime, government increases the number of years of contributions that are used to compute the pensions, from the last 15 years prior to retirement, to the entire working lifetimes of the agents. This new regime is adopted in 2005, and it only applies to current workers. I also assume that one year prior, households did not expect the new social security rules.

8.1 Pension, retirement, and the social security deficit

A. *Benchmark 0*

I show the results in the year 2050, concerned with the average pension in the economy and the average retirement age in Table 18.

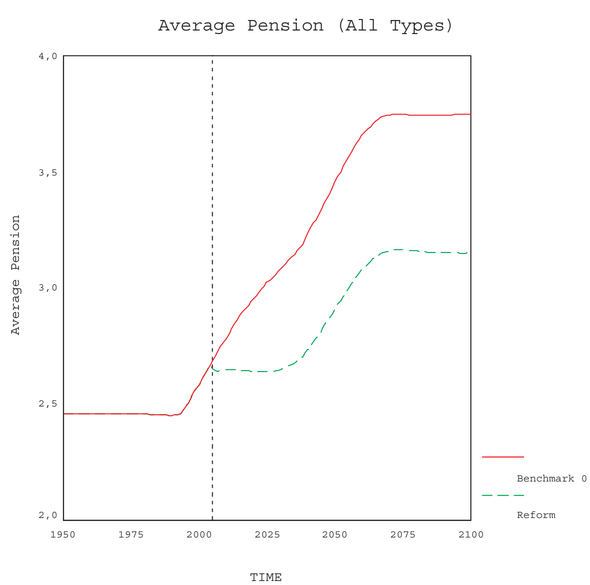
Table 18: Retirement and Average Pension in 2050

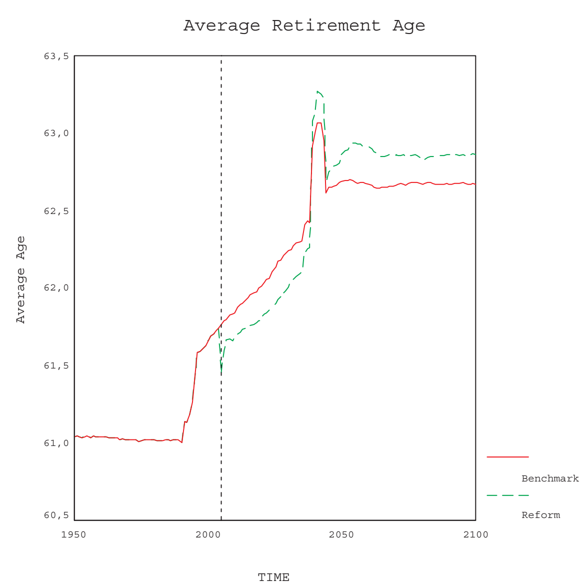
	Benchmark 0	Reform	$(R-B)$
Average Pension	3.4	2.9	–0.5
Average Retirement Age	62.6	62.8	0.2

After the reform, the average pension of the economy decreases by more than 15%. This is due to households being less productive when at a younger age. Specifically, the decrease in the pensions by educational types are the following: 6% for workers with non-high school education, 22% for workers with high school education, and 20% for college workers.

The results for non-high school workers are because the number of years used to compute the pension makes little difference since they have a flatter life cycle labor income profile, and also because a larger number of households of this type receive the minimum pension.

On the other hand, the results for college workers are due to the fact that for some of them, their average labor income is higher than the maximum pension. Hence, the maximum pension avoids a bigger drop in their pension claims after the reform.





Note the peak in the average retirement age at the year 2045. This is because in that year, the capital to labor ratio reaches the maximum level during the transition. Consequently, the opportunity cost to retire, the wage rate, is also at the maximum level.

The reform changes the average value of pensions, but it does not change the retirement behavior of households. This is because minimum pensions play a very significant role in determining retirement behavior under the current system, and the reform that I study leaves minimum pensions unaltered.

Just after the reform, there is a small decrease in the average retirement age. It is mainly driven by low productive workers who have a pension claim before the reform, which is slightly higher than the minimum pension. These households would decide to keep working under unchanged rules, in spite of the low productivity, as the reduction in the pension claim due to the low labor income is compensated by reduction in the early retirement penalization. However, the pension claims of these households after the reform decrease until reaching the minimum pension. In the new regime, these households decide to retire because they do not face the early retirement penalization, since the minimum pension eliminates this penalization.

Finally, note that in both transitions, the average retirement age increases because educational transition leads to bigger shares of households with high school and college studies. They find it more convenient to retire later because the foregone labor income is higher for more productive types.

In Table 19, we report the Social Security Budget.

Table 19: Social Security Budget in 2050 (%GDP)

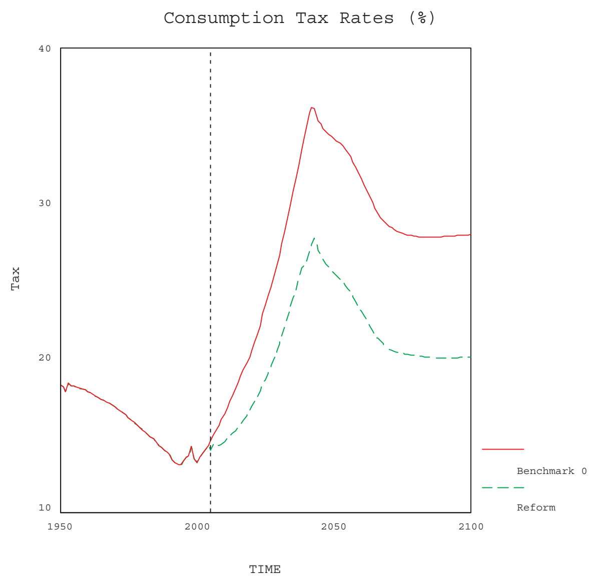
	Benchmark 0	Reform	$(R-B)$
Revenues	16.61	16.50	–0.11
Payments	28.57	23.11	–5.46
Deficit	11.96	6.61	–5.35

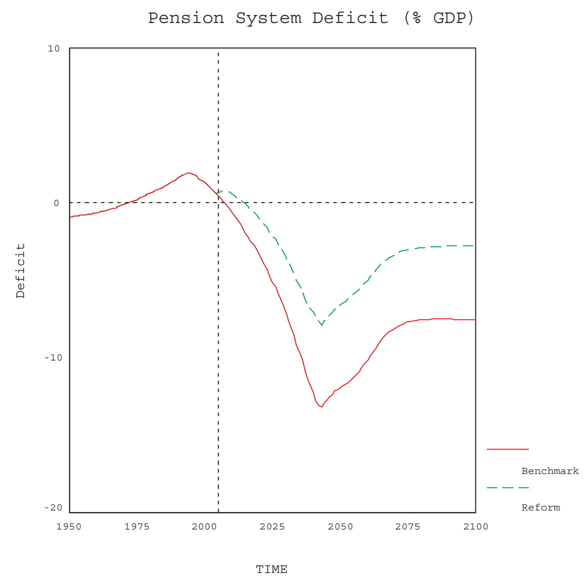
The full impact of the reform operates through these three effects: lower pensions, a higher retirement age, and a different consumption tax rate. As a consequence, the social security deficit decreases from 11.9 to 6.6% of GDP[22]. .

This improvement in the financial condition of the social security system implies that a smaller consumption tax rate is needed to balance the budget, from 34.1% before the reform, to 25.4% after the reform[23].

[22]Under the two regimes, both the government consumption-output ratio, G_t/Y_t, and the public debt-output ratio, B_t/Y_t, are kept constant at the values 17.6 percent and 66.7 percent respectively.

[23]Remember that the consumption tax rate adjusts in order to balance the government budget constraint.





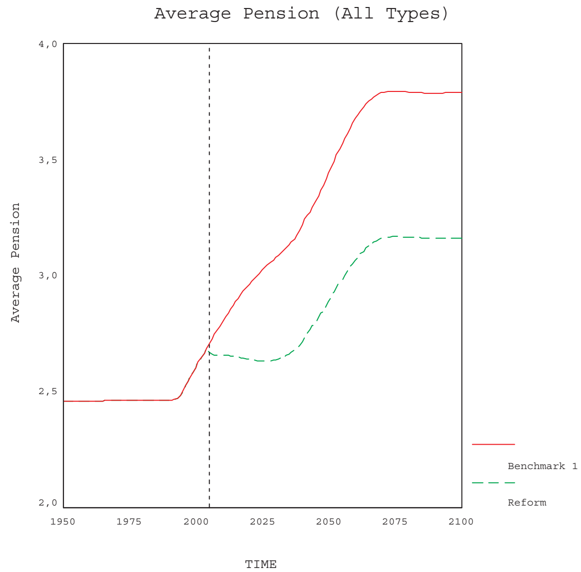
B. *Benchmark 1*

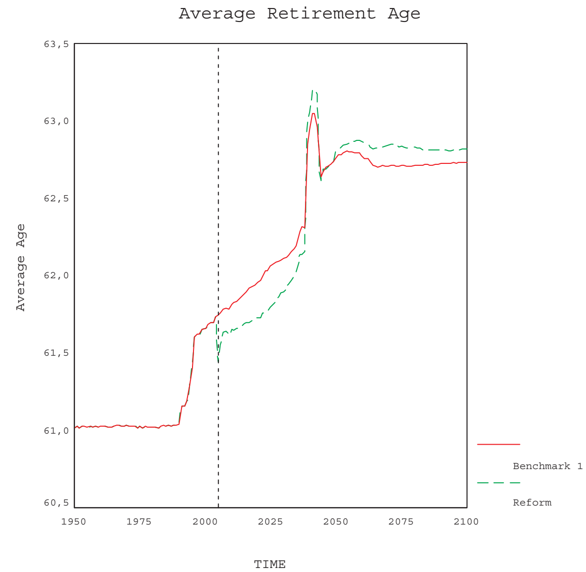
I show the results for the year 2050, concerning the average pension in the economy and the average retirement age in Table 20.

TABLE 20: RETIREMENT AND AVERAGE PENSIONS IN 2050

	Benchmark 1	Reform	$(R-B)$
Average Pension	3.4	2.8	–0.6
Average Retirement Age	62.7	62.8	0.1

After the reform, the average pension of the economy decreases by 16%. Also, the decrease in the pensions by educational types are similar to those in *Benchmark 1*. In the next figures, I show the dynamic results for this variable and also for the average retirement age.





Again, the reform changes the average value of pensions, but it does not change the retirement behavior of households.

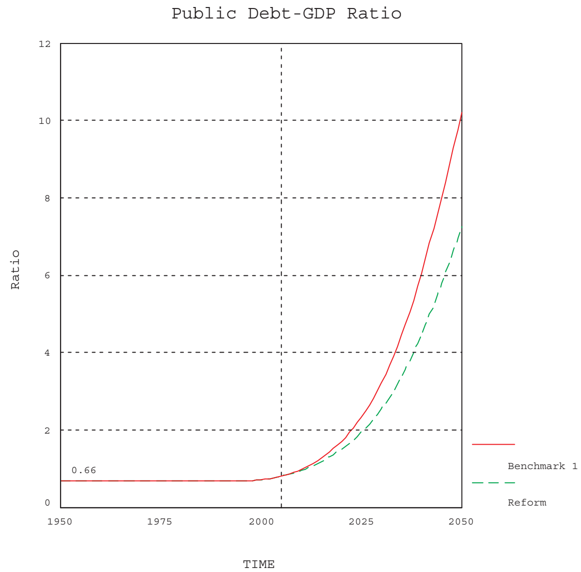
In Table 21, we report the Social Security Budget.

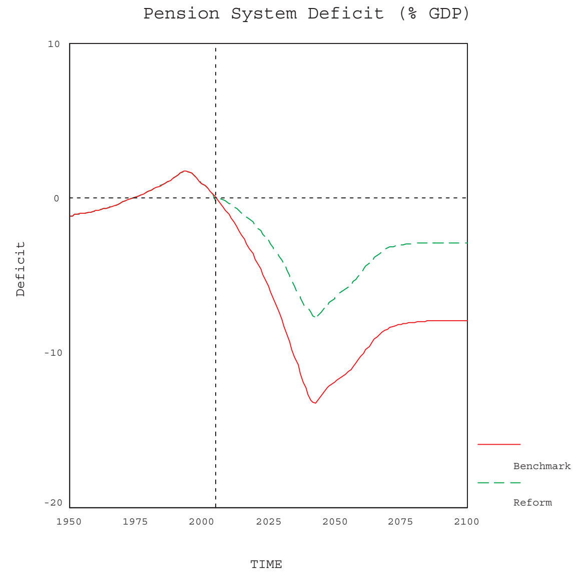
TABLE 21: SOCIAL SECURITY BUDGET IN 2050 (%GDP)

	Benchmark 1	Reform	$(R - B)$
Revenues	16.62	16.56	–0.06
Payments	28.52	23.01	–5.51
Deficit	11.90	6.45	–5.45

Again, the full impact of the reform operates through these three effects: lower pensions, a higher retirement age, and a different consumption tax rate. As a consequence, the social security deficit decreases from 11.9 to 6.4% of GDP. The improvement in the financial condition of the social security system implies a smaller public debt to output ratio. It goes from 10.2 before the reform to 7.2 after the reform[24].

[24]Remember that the public pension deficit is financed with external debt.





8.2 Average Variables, Factor Prices and Ratios

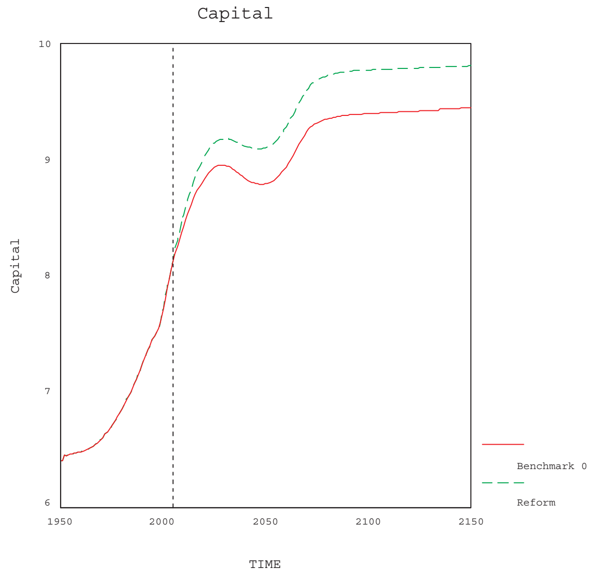
A. *Benchmark 0*

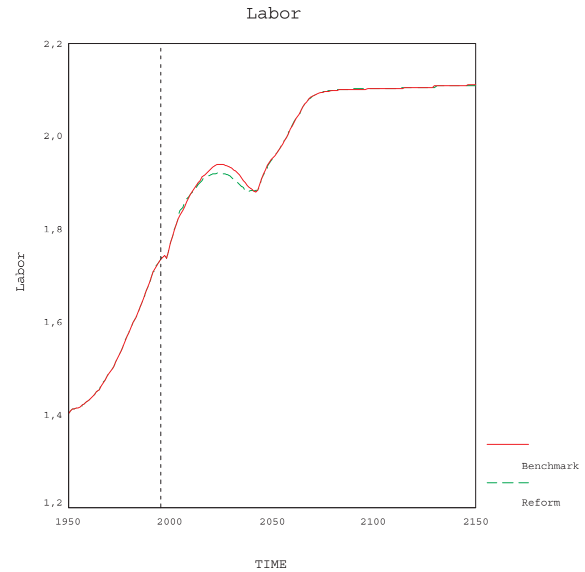
In Table 22 I report the results concerning average variables, factor prices, and selected ratios.

TABLE 22: AVERAGE VARIABLES, FACTOR PRICES AND RATIOS IN 2050

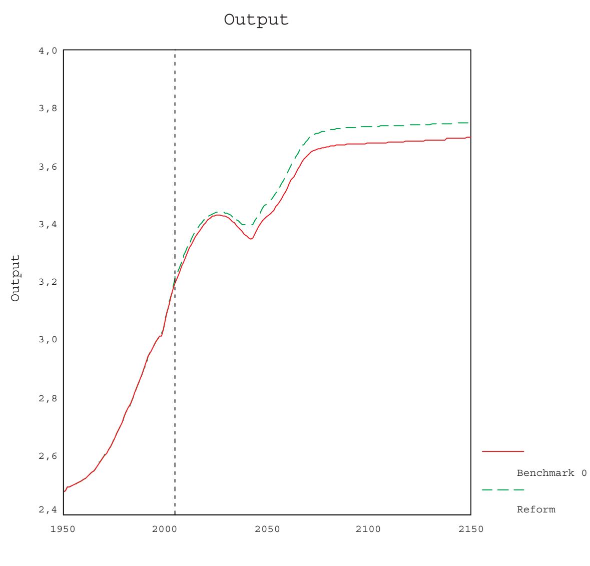
	Benchmark 0	Reform	Δ%
Y	3.42	3.46	1.16
C	2.15	2.18	1.39
I	0.70	0.73	3.93
K	8.78	9.09	3.53
L (effective)	1.95	1.94	–0.52
K/Y	2.56	2.62	2.34
I/Y(%)	20.67	21.21	2.64
r(%)	6.69	6.21	–7.18
w	1.10	1.11	0.90
τ_c(%)	34.17	25.47	–25.47

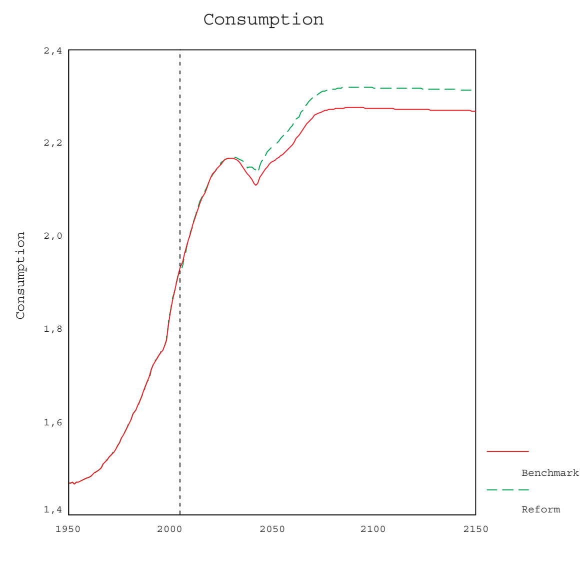
First, note that no significant variation is observed in labor per capita. This is because the higher average retirement age is compensated by a decrease in the average share of disposable time allocated to the market. And second, the capital stock of the economy is 3.5% higher because the pension decreases by more than 15.0%.





Output per capita increases because the physical capital increases. Moreover, just after the reform, no significant variation is observed in consumption. This is because retirees consume more because they face lower taxes, but workers consume less, because they must save more in order to increase their wealth for the retirement period. Finally, in the long run, the lower consumption tax rate implies a higher consumption, in spite of the lower pensions.





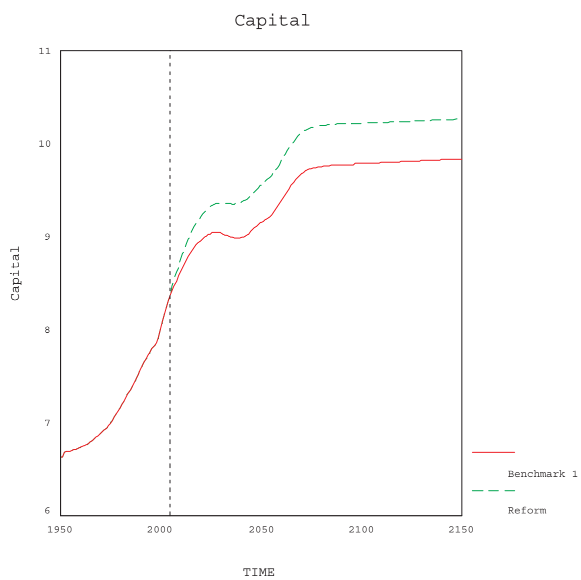
B. *Benchmark 1*

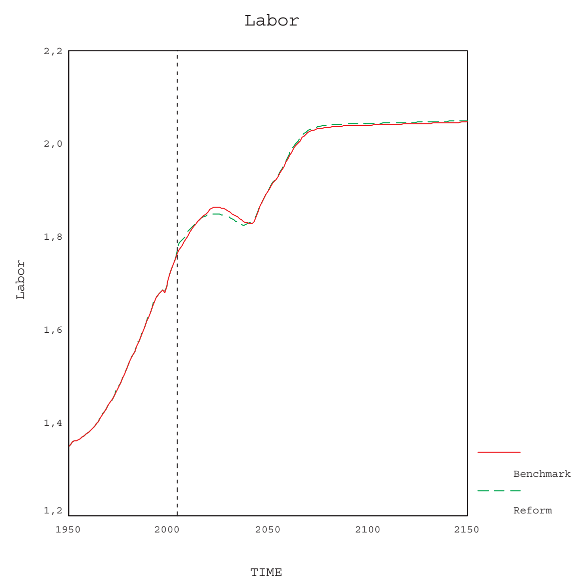
In Table 23 I report the results concerning average variables, factor prices, and selected ratios.

Table 23: Average Variables, Factor Prices and Ratios in 2050

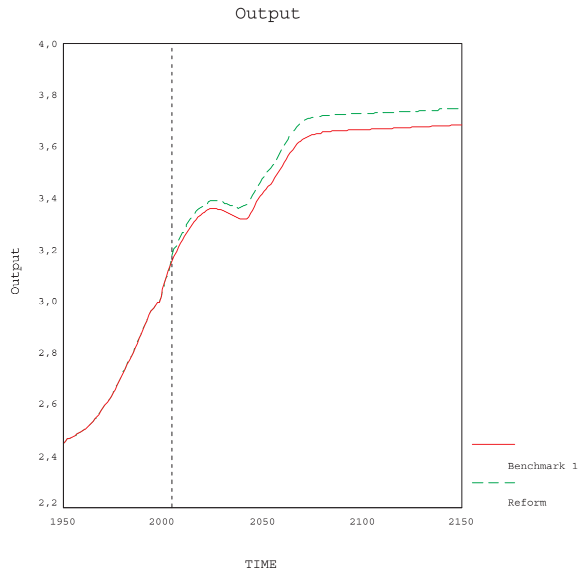
	Benchmark 1	Reform	Δ%
Y	3.41	3.47	1.75
C	2.51	2.36	–5.98
I	0.74	0.78	4.76
K	9.14	9.54	4.37
L (effective)	1.89	1.89	0.00
K/Y	2.67	2.74	2.62
I/Y(%)	21.85	22.47	2.83
r(%)	6.00	5.63	–6.17
w	1.12	1.14	1.78
τ_c(%)	8.51	9.36	9.98

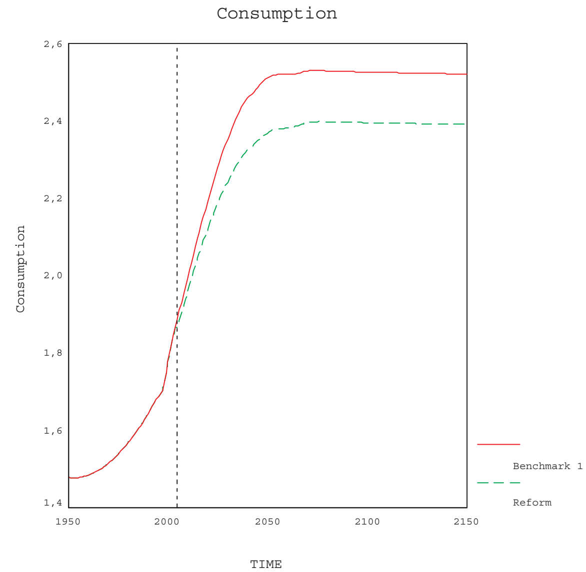
Again, note that no significant variation is observed in labor per capita. This is also because the higher average retirement age is compensated by a decrease in the average share of disposable time allocated to the market. The capital stock of the economy is a 4.3% higher because the pension decreases by 18.0%.



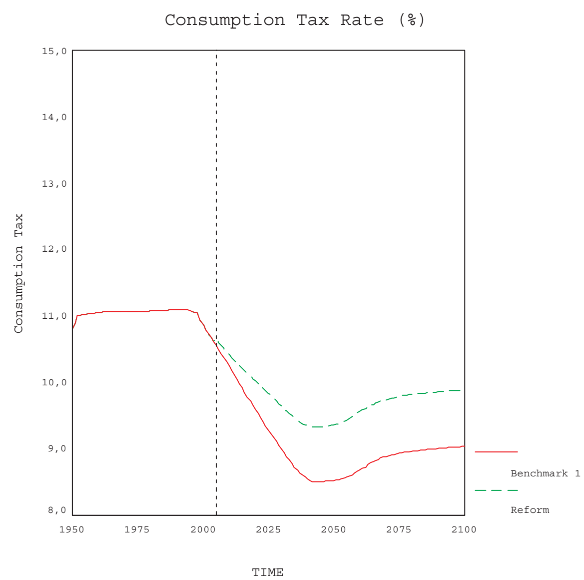


Again, output per capita increases because the physical capital increases. However, I find here that consumption decreases. This is because the lower pensions and the higher savings.





Finally, and given the smaller tax base, the consumption tax rate increases in order to finance the government consumption.



8.3 Welfare

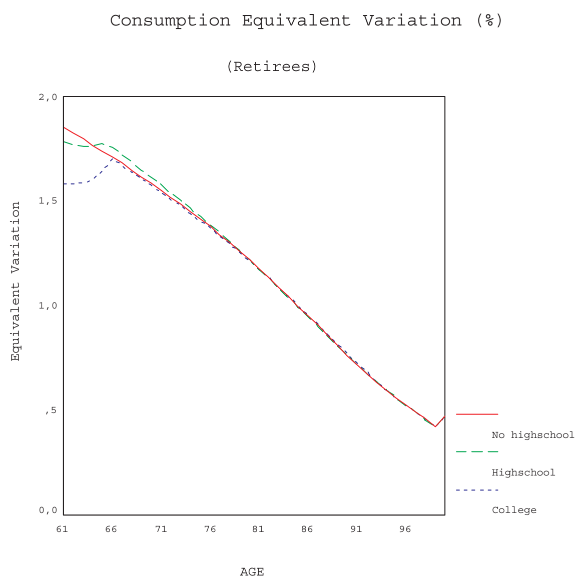
In order to quantify the welfare effects of the reform, I will use consumption equivalent variation measure, EV. I quantify the welfare change for every household alive at the moment of the reform by asking by how much this individual's consumption has to be increased in all future periods and contingencies before the reform, so that his expected utility equals that under the new public pension rules. In other words, I compute:

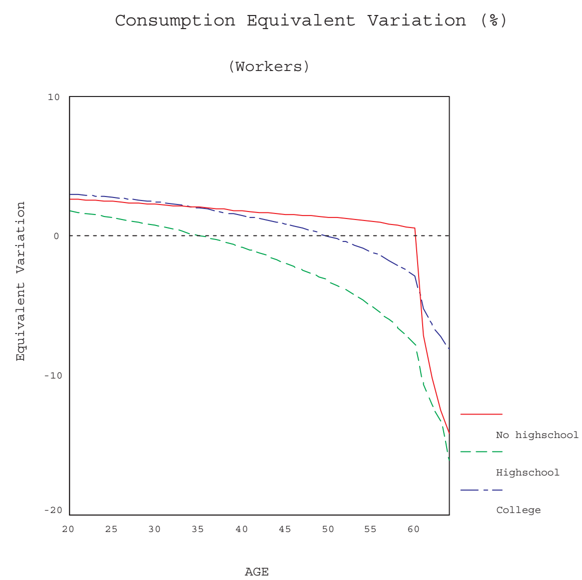
$$EV_h = \left(\frac{V_R(h,j,s,e,b',a)}{V_B(h,j,s,e,b,a)} \right)^{\frac{1}{\gamma(1-\sigma)}} \tag{32}$$

where b' is the pension claim after the reform, and $V_B()$ and $V_R()$ stand for the value functions before the reform and after the reform, respectively. For example, an EV_h of 0.05 implies that if the policy reform is put into place, then an individual with education h, will experience an increase in welfare due to the reform, equivalent to receiving 5% higher consumption before the reform in all the possible nodes of his remaining lifetime.

A. *Benchmark 0*

The reform implies a welfare gain for the population of 1.03%. This gain is distributed in the following way. All the retirees at the moment of the reform are better off because they receive the same pension and they have to pay lower taxes.





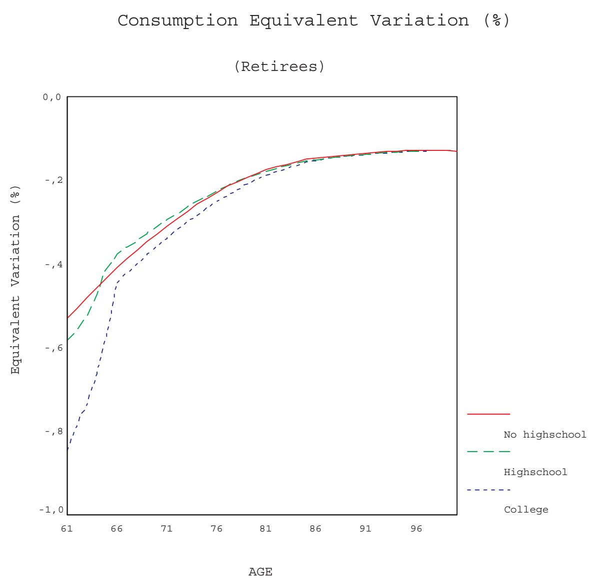
We see that some workers are worse off after the reform. This is because the decrease in their pension claims cannot be compensated by the lower consumption tax rate. The biggest losses are for those who face the biggest pension drops, the high school workers.

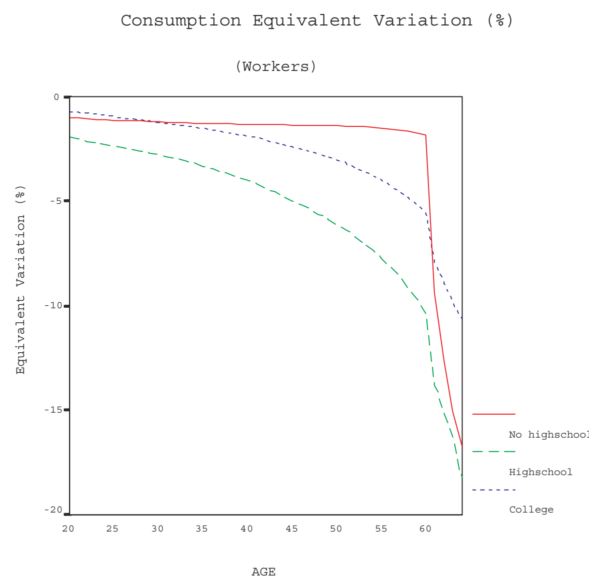
Looking within educational types, we see that the older the worker, the higher the welfare loss. After age 60, the drops in pensions are very high. For instance, these drops are around 26% and 23% for high school and college workers.

On the other hand, non-high school workers are better off until the age of 60 because the moderate drop in their pensions is compensated by the lower consumption tax rate. However, from age 61, these workers are worse off. The reason is the following: before the reform most of these workers had pension claims higher than the minimum pension, so after the reform the decrease in their pensions is about 15%. Note that these results apply to on a reduced number of households because of the low employment rate between ages 60-64.

B. *Benchmark 1*

The reform implies a welfare loss for the population of -1.83%. This loss is distributed in the following way:





Here we see that all the retirees at the moment of the reform are worse off because they receive the same pension and they have to pay a higher consumption tax. Also, all workers are worse off. This is because they will collect lower retirement pensions on retirement.

Again, the biggest losses are for those who face the biggest pension drops, the high school workers. Looking within educational types, we see again that the older the worker, the higher the welfare loss. This is because there is less time remaining to implement new optimal labor-leisure decision.

Finally, and as in *Benchmark 0*, older workers experience bigger losses. The reason is that most of the households which remain in the labor market are highly productive workers who had high pension claims before the reform, so they face the biggest drops in their pension claims.

8.4 Inequality

A. *Benchmark 0*

In Tables 24, 25, and 26 I report the distributions of income, earnings, and wealth respectively.

Table 24: Households Income Distribution in 2050(%)

		Lowest Groups (%)			Quintiles					Top Groups (%)		
	Gini	1	1–5	5–10	1st	2nd	3rd	4th	5th	10–5	5–1	1
Benchmark 0	0.40	.0	0.5	0.9	4.1	10.6	17.2	23.0	45.1	10.2	12.7	5.7
Reform	0.39	.1	0.6	0.9	4.4	11.0	17.4	22.4	44.8	10.2	13.0	6.0

As is shown, no significant variation is observed in income distribution. This is due to several effects: a lower inequality in the pension and wealth distributions, and a higher inequality in earnings distribution. Note that the lower inequality in the pension distribution is related to the drops in the pensions by educational types.

Table 25: Households Earnings Distribution in 2050 (%)

		Lowest Groups (%)			Quintiles					Top Groups (%)		
	Gini	1	1–5	5–10	1st	2nd	3rd	4th	5th	10–5	5–1	1
Benchmark 0	0.54	.0	.0	.0	0.6	5.5	15.0	23.5	55.4	12.3	16.6	7.4
Reform	0.55	.0	.0	.0	0.5	5.6	14.9	23.5	55.6	12.9	17.1	7.6

After the reform, workers change the profile of hours worked from older to younger ages. Since most of non-high school workers will collect the minimum pension when retired, they also make a small reduction in hours worked. Consequently, there is a small increase in earnings inequality.

Table 26: Households Wealth Distribution in 2050 (%)

		Lowest Groups (%)			Quintiles					Top Groups (%)		
	Gini	1	1–5	5–10	1st	2nd	3rd	4th	5th	10–5	5–1	1
Benchmark 0	0.61	.0	.0	.0	0.0	3.5	11.2	23.6	61.7	14.9	18.8	7.9
Reform	0.60	.0	.0	.0	0.0	3.7	12.4	23.9	60.0	14.8	17.8	7.2

The small decrease in wealth inequality is because younger workers save more after the reform. This is because after the reform they change the profile of hours worked from older to younger ages. In addition, they have to pay a lower consumption tax. These two effects imply that younger workers are less liquidity constrained, so they save more.

B. *Benchmark 1*

In Tables 27, 28, and 29 I report the distributions of income, earnings, and wealth respectively.

Table 27: Households Income Distribution in 2050(%)

		Lowest Groups (%)			Quintiles					Top Groups (%)		
	Gini	1	1–5	5–10	1st	2nd	3rd	4th	5th	10–5	5–1	1
Benchmark 1	0.40	.1	0.6	0.9	4.1	10.6	17.2	22.8	45.4	10.2	12.8	5.9
Reform	0.40	.1	0.6	0.9	4.2	10.7	17.4	22.1	45.6	10.3	13.4	6.2

Again, no significant variation is observed in income distribution.

Table 28: Households Earnings Distribution in 2050 (%)

		Lowest Groups (%)			Quintiles					Top Groups (%)		
	Gini	1	1–5	5–10	1st	2nd	3rd	4th	5th	10–5	5–1	1
Benchmark 1	0.54	.0	.0	.0	0.4	5.6	15.1	23.5	55.4	12.2	16.6	7.4
Reform	0.55	.0	.0	.0	0.5	5.7	14.8	23.4	55.7	12.9	17.2	7.7

After the reform, workers change the profile of hours worked from older to younger ages. Since most of non-high school workers will collect the minimum pension, they also make a small reduction in hours worked. Consequently, there is a small increase in earnings inequality.

Table 29: Households Wealth Distribution in 2050 (%)

		Lowest Groups (%)			Quintiles					Top Groups (%)		
	Gini	1	1–5	5–10	1st	2nd	3rd	4th	5th	10–5	5–1	1
Benchmark 1	0.63	.0	.0	.0	0.0	2.9	10.0	22.5	64.6	15.6	20.0	8.6
Reform	0.62	.0	.0	.0	0.0	3.0	11.5	22.9	62.6	15.4	18.9	7.8

The small decrease in wealth inequality is because younger workers save more after the reform. This is because after the reform they change the profile of hours worked from older to younger ages. Also, they face a higher wage rate. In addition, since they consume less, they save more.

9 Conclusions

In this article, I construct an overlapping generations model which combines various features of model economies described elsewhere in the literature, and I calibrate it to the Spanish economy. I find that my model economy replicates the basic facts of the retirement behavior of Spanish households, and many of the aggregate and distributional features of the Spanish economy.

I then use my model economy to evaluate the aggregate, distributional, retirement, and welfare consequences of increasing the number of years of contributions that are used to compute the pensions. I find that the reform improves the financial viability of the public pension system through lower benefits, and that it leads to an increase in the capital stock, output, and consumption of the model economy. The reform also brings about welfare gains for the households that are retired when it is adopted. Finally, I find that the reform changes income and earnings inequality very little.

The reform changes the average value of pensions, but it does not change the retirement behavior of households. This is because minimum pensions play a very significant role in determining retirement behavior under the current system, and the reform that I study leaves minimum pensions unaltered. Specifically, under the current system, every worker is entitled to receive the minimum pension regardless of the number of years during which he has contributed to the system. Moreover, since minimum pensions are exempt from early retirement penalties, the strong incentives to continue working associated with these penalties disappear. Consequently, every worker who is only entitled to a minimum pension chooses to retire at age 60 (the earliest possible retirement age) both in the benchmark and in the reformed model economies.

In future research I intend to use the model described in this article to study other parametric reforms and a fundamental reform that would substitute the current pay-as-you-go pension system with a fully funded system based on mandatory savings.

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