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The effect of pension rules on retirement monetary incentives with an application to pension reforms in Spain *

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Abstract

In this work we theoretically disentangle the effects of pension provisions on a variety of financial incentives to retirement, trying to reconcile them with some key Spanish retirement patterns. We find that the «average» individual, who is never affected by any cap of contributions or benefits, has weak incentives to retire early and strong incentives to retire at the normal retirement age. Alternatively, individuals at the bottom of the wage distribution have strong incentives to retire as early as possible, as a result of the interaction between age-related penalties and the minimum pension. Both findings perfectly accommodate the retirement hazard of medium and low earners respectively. In contrast, high earners (those that have their contributions capped) do not retire early despite having strong incentives to do so. This is because, for those workers, financial incentives are not a good proxy for the marginal utility from working. Finally, we analyze the reasons behind the failure of the 1997 reform in improving the sustainability of the Spanish public pension system.

Keyworkds: retirement, Social Security, Monetary incentives, Pension Reform, Spain.

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1. Introduction

Social Security systems all around developed world are faced nowadays with two —widely documented— processes, that clearly threaten their financial sustainability: the aging of the population and the tendency towards early retirement. In the present work we fo-

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cus on this second issue, in particular the links between (early) retirement behavior and the institutions or *details* a particular pension system is composed of. There are two reasons for this interest. First, early retirement has a very important impact on Social Security burden and the prospect of achieving a stable financial equilibrium [1]. Second, the decisions to enter and exit the labor market affect the dynamics of productivity and hence employment. This is the case because lowering retirement age eliminates large amounts of human capital, and reduces the incentives for its accumulation.

The analysis of the effect of public regulations on retirement decisions has been addressed in the literature at various levels such us the study of implicit incentives (for example, Gruber and Wise (1999) or Blöndal and Scarpetta (1998)); reduced-form models of retirement (such us Samwick (1998)); models of conditional consumer decisions in a given economic environment (Stock and Wise (1990) or Rust (1997)); and dynamic general equilibrium models where the agents interact with a public institutional framework (for example, İmrohoroğlu *et al.* (1999)). For the Spanish case it is worth mentioning some work on reduced-form models of retirement such as Alba-Ramírez (1997); or Dynamic General Equilibrium models (Rojas (2000), Arjona (2000) or Conesa and Garriga (1999)) and, finally, evaluation of implicit incentives such as Boldrin *et al.* (1999).

In line with Gruber and Wise (1999) and Boldrin *et al.* (1999) we dissect the effects of the key ingredients of a pension system in the financial incentives to retire [2]. This type of analysis exhibits several comparative advantages over more orthodox behavioral models, such as computational simplicity, capacity to reproduce legal characteristics with a degree of detail that cannot be achieved otherwise, and a very easy application to policy analysis. Furthermore, in Jiménez-Martín and Sánchez (2003) it is shown that, for many workers, financial incentives reasonably approximate the optimal retirement rule in a life cycle consumption-leisure model [3].

More precisely, we analyze the financial incentives to stay in the labor force in a sequence of pension frameworks. We start off with a pension system characterized by a benefit formula, a fiscal system and a contribution rule. On top of this system we add, one by one, age and contribution history penalties, tax allowances, and finally, caps in benefits and contributions. In all cases, we analyze the properties of the incentive measures from a diversity of angles: according with the individual's age (as in Gruber and Wise (1999)), real wage level or wage growth rate. The implications of the analysis are illustrated with simulated cases, using the parameters of the 1985 Spanish pension system (as detailed in appendix A).

We find that the interaction between age penalties and minimum pension generates strong incentives to retire for workers at the bottom of the wage ladder. Alternatively, «average» earners have no incentives to retire at the early retirement age since they are unaffected by the minimum pension. Both findings successfully mimic the observed retirement patterns for both «low» and «average» Spanish wage-earners. However, in the case of high earners whose contributions and benefits are both capped, financial incentives fail to replicate the empirical retirement hazard at 60. This is so because the change in Social Security Wealth (relative to wages) differs substantially from the marginal utility derived from staying active.

Finally, other elements of the system, such as the fiscal rules or the contribution caps are, for a majority of workers, definitively less important.

What are the basic facts to be explained in the Spanish case? In the top row of Figure 4 we present the 1995 retirement hazard by age and gender for contribution groups 1 to 4 and 5 to 10 [4]. For men in contribution groups 1/4 only the peak at the age of 65 (in the hazard rate) is really relevant. In contrast, for men in contribution groups 5/10 both the peak at the age of 60 (when benefit first become available) and at the age of 65, are clearly identifiable [5]. In the second and fourth rows of Figure 4 we present hazard rates for individuals aged 60 and 65, as a function of the percentile of the expected wage at the age of 60. Low earners, most likely affected by benefits floors, exit at 60 in a much higher proportion than medium or high earners. The evidence is less clear for women aged 60, for two reasons: their careers are much more erratic and many of them do not have the right to retire early. Finally, hazard at age 65 is, regardless of the gender, important at all considered wage levels.

In our analysis of the recent 1997 Spanish pension reform, we find that it fails to reduce both the importance of the incentives to retire early and the size of the Social Security's liabilities. Still, it produces some redistribution from above average pensions to below average pensions, stemming from the different shape of the wage profile in either case. We show that there are several (marginal) modifications of that reform that can reduce both early retirement incentives and the liabilities of the system. Finally, we explore two proposals aimed at providing incentives to stay in the labor force beyond the normal retirement age. We fail to find strong retention effects for moderate premiums.

The structure of the rest of the document is as follows. In section 2 we describe the framework where the analysis is undertaken. Section 3 reviews the instruments we use to measure the incentives. The theoretical results are described in section 4. In section 5 we describe the Spanish Social Security system and analyze a recent reform bill and some other reform proposals. We conclude in section 6 with a brief summary of our findings.

2. The configuration of a PAYG public pension system

The individual decision to retire is affected by several public provisions. Acquiring consciousness of this variety is interesting in the sense that it reveals the existence of more tools for intervention than those considered in many quantitative studies of the pensions system reform. In short, we mention:

— The formula for benefits and the fiscal and contribution rules.

— The eligibility criteria and the penalty for insufficient contributions.

— The possibility of early retirement and its penalization.

— Contribution caps: minimum and maximum level of contributions.

— Minimum/maximum pensions and their family considerations.

— Survival pensions and other tokens of generosity.

Every particular pension system is made up of a combination of some or all of these elements. In this paper we articulate the revision of the pension system in two blocs: (1) Norms that affect all individuals [the benefit formula, the fiscal and contribution rules (P0), and the age- and contribution record penalties (P1)]; and (2) Norms that specifically affect individuals with extreme levels of income and/or benefits [tax allowances (P2) and maximum and minimum contributions (P3) and benefits (P4)].

2.1. Benchmark pension framework (P0)

The benchmark framework introduces the minimal elements that define a pension system in a stationary environment: A formula for computing the retirement benefit as the average wage income (updated for inflation) over a number of periods preceding retirement (P00); a progressive tax system (P01); and a system of social contributions (P02), taking the form of a constant payroll tax rate c, from which the system raises its revenue.

The Public Sector awards a retirement benefit, P, to any individual older than τ_m. The payment or *benefit base* is computed as the average of the last R annualized pensionable incomes, $BC_j\, j = \{\tau-1, ..., \tau-R\}$, which, for the moment, coincide with real labor income before taxes (W):

$$P(\tau) = B(R, \overline{R}, \tau) = \frac{1}{R}\left\{\sum_{j=1}^{R-\overline{R}} BC_{\tau-j} + \sum_{j=R-\overline{R}+1}^{R} BC_{\tau-j}\frac{I_\tau}{I_{\tau-j}}\right\} \quad [1]$$

Note that only the $\overline{R}$ farthest BC_τ are updated for inflation (I_τ). Once $P(\tau)$ is computed, its value remains constant for the rest of the individual's life.

Both labor and pension income are subject to taxation. We assume a progressive tax scheme, with tax rates growing linearly with the size of the taxable earnings. In this case, the *net* real labor income w is given by:

$$w_\tau = W_\tau - [\eta_0 + \eta_1(1-c)\, W_\tau]\,[(1-c)\, W_\tau] - C_\tau = \vartheta_w(w_0, \gamma; \eta_0, \eta_1, c)\, W_\tau \quad [2]$$

where $C = cW$ denotes social contributions and ϑ_w will be called the wage tax wedge. In a similar fashion, net pensions can be expressed $p(\tau) = \vartheta_p(w_0, \gamma; \mu_0, \mu_1)\, P(\tau)$. Both tax ratios ϑ_w and ϑ_p, depend on the wage growth rate (γ) and its initial level (w_0), apart from the parameters of the tax system. The ratio $\vartheta(w_0, \gamma; \mu_0, \mu_1, c) = \vartheta_p/\vartheta_w$ or pension tax generosity will be useful when studying the effects of fiscal progressiveness on incentives.

2.2. Penalization schemes for early retirement and for insufficient contributions (P1)

When determining the initial benefit, penalization schemes are commonly imposed on individuals who either retire before a «normal retirement age» (τ_N, the first age at which full benefits are available) or have an insufficient number of contributions, $n(\tau)$. We consider the following age ($AP(\tau)$) and contribution history ($HP(n(\tau))$) penalization schemes:

$$AP(\tau) = \begin{cases} 0 & \text{if } \tau < \tau_M \\ \alpha_0 + \alpha_1(\tau - \tau_M) & \text{if } \tau_M < \tau \leq \tau_N \\ 1 & \text{if } \tau > \tau_N \end{cases} \quad [3]$$

$$HP(n(\tau)) = \begin{cases} 0 & \text{if } n(\tau) < n_m \\ \kappa_0 + \kappa_1(n(\tau) - n_m) & \text{if } n_m \leq n(\tau) < n_M \\ 1 & \text{otherwise} \end{cases} \quad [4]$$

where τ_M is the first age at which benefits become available and $n(\tau)$ stands for the number of years of contribution accumulated at age τ. Thus in economy P1 the initial (real) retirement benefit is given by:

$$P(\tau) = AP(\tau)\ HP(n(\tau))\ B(R, \overline{R}, \tau) \quad [5]$$

2.3. Tax-free allowances (P2), min/max contributions (P3) and pensions (P4)

We introduce these provisions in three steps. First, in P2 we consider tax-free allowances on labor and pension income, $\underline{W}_A$ and $\underline{B}_A$, respectively. Second, in P3 we assume a minimum level of mandatory contributions, $\underline{C}_A$ (anchored in the calendar year A) that replaces wage earnings whenever they fall short of this minimum. This minimum is assumed to growth at the constant rate μ. Similarly, we assume the existence of a maximum level of contributions $\overline{C}_A$ which grows at the constant rate $\overline{\mu}$. Finally, in P4 we consider a unique minimum pension scheme that complements the pension whenever it falls below that minimum. Its evolution over time is entirely characterized by a starting level $\underline{P}_A$ and a constant rate of growth ρ, namely the *generosity* of the system. The scheme for the maximum pension works in a completely parallel way, being described by the parameters $\overline{P}_A$ and $\overline{\rho}$.

3. Incentives measurement instruments

Incentive's measures are conditional on the following set of assumptions:

- **A1** Individual perspective: only the income that is personally enjoyed is considered.
- **A2** Wages (pensions) are the only source of income while the worker is active (retired).
- **A3** There is a positive conditional probability of dying at any age in $\{1,..., F-1\}$. At age F such probability is one.
- **A4** The individual does not expect changes in future public regulations.

Definition of incentives

In these circumstances, we define the following incentive's measures for immediate retirement of an individual aged τ years old, with τ in $[\tau_0,..., T]$:

Replacement rate, $rr(\tau)$: Expected net real benefit in case of retirement at age τ divided by w at τ.

$$P(\tau) = AP(\tau)\ HP(n(\tau))\ B(R, \overline{R}, \tau)$$

(Horizon h) Social Security wealth, $SSW(\tau + h, \tau)$: Current period τ expectation of the discounted present value of the flow of net pension benefits due from retirement at $\tau + h$ until F.

$$SSW(\tau + h, \tau) = E_\tau[\sum_{j=\tau+h}^{F} \beta^{j-\tau}\phi(j|\tau)\, p_j(\tau + h) - \sum_{j=r}^{r+h-1} \beta^{j-\tau}\phi(j|\tau) C_j\ ]$$

where $\beta = 1/(1 + r)$ denotes the time discount factor, which is related to a fixed interest rate r and $\phi(i \mid \tau)$ denotes the probability of being alive at i conditional on survival until age τ.

Horizon 1 accrual, $acr(\tau)$: Value of postponing retirement one period from τ, in terms of change in the Social Security Wealth [6].

$$acr(\tau) = SSW(\tau + 1, \tau) - SSW(\tau, \tau)$$

Implicit tax, $tax(\tau)$: Value of postponing retirement expressed as a fraction of the expected wage w_τ:

$$tax(\tau) = -acr(\tau)/w_\tau$$

3.1. Simulation design and base case characteristics

We undertake a longitudinal experiment. We place a *base-case* individual in a simple economic and institutional environment and follow her as she becomes progressively older (in the age range $\{\tau_0,..., T\}$). In particular, we compute the tax rates $tax(\tau)$ that she experiences at every age. To make explicit the calendar-time setting of the experiment, we link age τ_A for our base-case individual with a specific calendar year (that is then used as reference for the institutional parameters and for the conversion to real quantities. See the details in appendix A). This context will be useful when dissecting the effects of the various pension rules and when exploring the effects of some recent reforms of the Spanish PAYG system.

One of the essential traits of the set of public regulations is that individuals that differ in age, labor history (occupation, contribution regime, participation and wage history) and family or personal characteristics (survival) are treated differently. In the next section we study a base case in which those characteristics are parameterized as follows:

- She is the unique member of an individual family with a constant (age independent) mortality hazard φ.
- She has an initial nominal wage, w_0, and a contribution history of $n(\tau_0)$ years at τ_0.

- There are no interruptions in her working record from τ_0 to τ, implying that $n(\tau + 1) = n(\tau) + 1$.
- Her nominal wage growths at a constant rate λ, ie. $w_\tau = (1 + \lambda)\, w_{\tau-1}$.

4. Incentive analysis

In this section we obtain simplified analytical expressions of the incentive measures. They will be very helpful in highlighting the dependence of the incentives on the key ingredients of the pension system. Let us start with a decomposition of the social security wealth in case of immediate retirement,

$$SSW(\tau, \tau) = \sum_{j=\tau}^{F-1} \beta^{j-\tau} (1-\phi)^{j-\tau} p(\tau) = \sum_{j=\tau}^{F-1} d^{\,j-\tau} = p(\tau) AT(\tau, F) \qquad [6]$$

where $d = \beta(1 - \phi)$, p is the initial pension and $AT(\tau, F)$ is the «Benefits Accumulator» from τ to $F - 1$ (from the perspective of age τ). The Benefit Accumulator depends on the life horizon and the future discounting. In case the individual considers postponing retirement by one year, the new social security wealth would be:

$$SSW(\tau + 1, \tau) = p(\tau + 1)AT(\tau + 1, F) - cW_\tau \qquad [7]$$

Denoting by $\psi = \Delta p(\tau)/p(\tau)$ the growth rate of real benefits, the Social Security accrual associated to a 1 year postponement in retirement is:

$$acr(\tau) = p(\tau)\,(\psi AT(\tau + 1, F) - 1) - cW_\tau \qquad [8]$$

which leads to a simple formula for the unit-horizon *tax* incentive (for ages $\tau \geq \tau_M$):

$$tax(\tau) = rr(\tau)(1 - \psi AT(\tau + 1, F)) + K \qquad [9]$$

where K is a function of labor and income tax parameters. By similar arguments, the tax associated with retirement in the age range $(\tau_0, \ldots, \tau_M - 1)$ (benefits are not immediately available) is:

$$tax(\tau) = -rr(\tau)\, \psi AT(\tau_M, F) + \mathrm{K} \qquad [10]$$

Note that these formulae are valid regardless whether the real wage growth rate is constant (γ) or variable. The former case is explored in the next subsection, while the latter (results under a «more realistic» quadratic wage process) is left to section 4.2.

4.1. Incentive analysis when the real rate of growth of wages (γ) is constant

4.1.1. *Benchmark pension system (P0)*

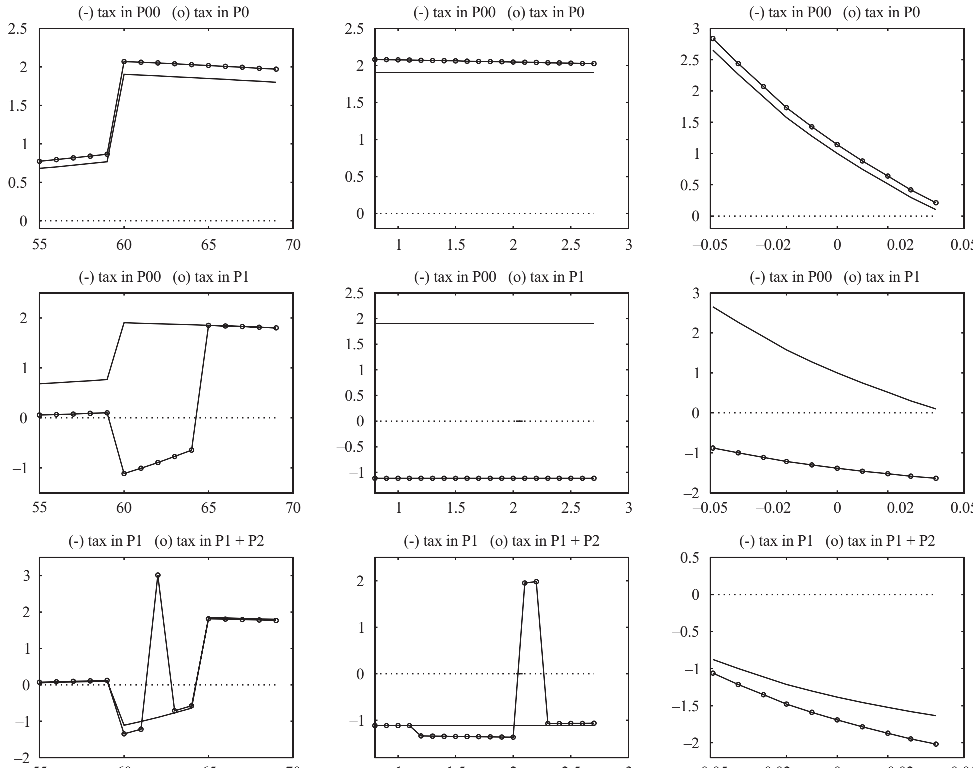
We review the incentive effects prevailing in the institutional setting P00 (benefit formula), P00 + P01 (fiscal system) and P00 + P02 (contribution system).

A. Benefit computation formula: P00

In the context of P00, the nominal benefit equals the benefit base. Furthermore, when γ is constant the benefit base is a fixed fraction of the current real wage. Hence, the replacement rate (rr^{00}) is given by:

$$rr^{00} = \frac{1}{R}\left\{ \frac{(1+\lambda)^{R-\bar{R}}-1}{\lambda(1+\lambda)^{R-\bar{R}}} + \frac{(1+\gamma)^{\bar{R}}-1}{\gamma(1+\gamma)^{R}} \right\}$$

As shown in the top row of Figure 1, two elements have an impact on the retirement incentives. The first one is age: it makes a difference if the worker is older than τ_M, the age at which benefits are first available. The exit incentives are always lower before τ_M because waiting an extra year does not reduce the period in which benefits are received. The second element is γ, the parameter giving shape to the individual's wage profile. It has an inverse re-



tax(τ), left; *tax*(w_0), center; and *tax*(γ), right, in economies P1, and P1+ceilings
Parameter reference: P1+P30: $\tau = 60$, $w_0 = 0.700$, $\gamma = -0.020$; P1+P31: $\tau = 60$, $w_0 = 5.5$, $\gamma = -0.020$.

Figure 1. The effect on *tax* of contribution and pension ceilings

lation with the *tax*: $\partial tax(\tau)/\partial\gamma<0$. In such a context, it is easy to proof that there exists a trigger rate $\bar{\gamma} = 1/AT(\tau+1, F)$, slightly increasing with age, above which workers have an incentive to stay active. This is because the only thing that could increase the individual's Social Security wealth is a wage jump large enough that the increase induced in the benefit base offsets the foregone benefit (during the additional year of work). It should be clear that this can only happen if γ is positive and sufficiently large.

A third element also deserves some consideration. Recalling that $d = \beta(1-\phi)$, it is interesting to note that since $sign\{\partial tax(\tau)/\partial d\} = -sign\{\gamma\}$ the higher (lower) the individual discounts the future (ie, mortality risk) the lower (higher) her incentives to stay in the labor force when $\gamma < 0$ ($\gamma > 0$).

B. Progressive Fiscal System: P01

Under the progressive fiscal system described in section 2.1 both the replacement rate (rr) and the rate of growth of the net real benefit (ψ) are functions of the individual's age, wage level and wage profile:

$$rr^{01} = rr^{00}(\gamma)\,\vartheta(w_0,\gamma;\eta_0,\eta_1,c)\,;\quad \psi \simeq \gamma + (\partial\vartheta_p/\partial\tau)/\vartheta_p \qquad [11]$$

where $(\partial\vartheta_p/\partial\tau)/\vartheta_p$, a ratio depending on the progressiveness of the system, smoothes out the sensitivity of *changes* in the pension benefit (induced by postponing retirement one period) to the wage profile.

In this case the threshold for positive incentives to work, $\bar{\gamma} > 0$, is higher; the curve relating the tax rate and γ (ie $tax(\gamma)$) slightly flattens; and the evolution of the $tax(\tau)$ curve is only marginally altered, remaining essentially flat; finally, since the $sign\{\partial tax(w_0)/\partial w_0\} = sign\{\gamma\}$ we find that, ceteris paribus, the richer an individual is, the higher the *tax* she faces, when $\gamma > 0$. So, strikingly, richer individuals are more strongly expelled (when the *tax* is positive) or more weakly retained (when the *tax* is negative). However, the degree of progressiveness that would be needed to make these alterations quantitatively important seems far larger than the empirically relevant values.

C. Social contributions: P02

The effect of the contributions is twofold. On one hand, since $K = c/(1-c)$ in equation [9] is positive, Social Security wealth obtained when retirement is postponed one period is reduced by the amount of contributions paid during the extra year of work. On the other hand, any given $acr(\tau)$ represents now a larger fraction of the *net* wages (net of contributions). Formally, the new replacement rate is $rr^{02} = rr^{00}/(1-c)$, exacerbating the incentives encountered in P00. Therefore, for individuals with $tax > 0$ in P00 both effects reinforce each other to increase incentives to exit. Alternatively, when $tax < 0$, the two processes go in opposite directions and the former result changes for γ sufficiently large.

D. Summary of incentive effect in P0

Thus, in the context of P0 the $tax(\tau|w_0; \gamma)$ is almost constant before the age of first entitlement τ_m; it increases notoriously at that age and remains practically constant therefrom. However, those individuals with steeper wage profiles (ie greater γ) are pushed towards retirement with greater strength. Both patterns are created by the benefit formula (P00) and do not significantly vary when fiscal progressiveness (P01) or contribution payments (P02) are considered.

Bearing these results in mind, we continue our analysis by enlarging the pension system in P00 with penalization schemes (P1) (ie, for simplicity we abstract from the progresivity of the fiscal system and the existence of contributions from here onwards). We then consider tax-free allowances (P2), min/max contributions (P3) and pensions (P4). All these cases are explored in two contexts: in the minimum pension system P00 and in the pension system enlarged with penalties P00+P1. In this way we can separately identify the incentives affecting «extreme» individuals (subject to truncations) from those affecting «normal» or «average» individuals. The key results from the analysis are summarized in Table 1.

Table 1
Summary of the incentive results in P00 and P00+P1

	Provision	Effect on P00	Effect on P00+P1
P01	Fiscal progressivity	$\gamma < 0$: Retains $\gamma > 0$: Expels	Expels $\forall$ γ
P02	Social contributions	Expel	$\gamma < \bar{\gamma}$: Expel otherwise: Retain
P1	Age and history penalties	Retain	—
P20	Labor income tax-free allowances	reduce the absolute value of the incentive	idem
P21	Pension tax tax-free	γ<= 0 and ($\tau < \tau_N$): expel γ <= 0 and ($\tau \geq \tau_N$): retain	idem idem
P30 (for $\mu < 0$)	Minimum contribution	$\gamma < \mu$: Retains otherwise: Expels	idem
P31 (for $\bar{\mu} < 0$)	Maximum contribution	$\gamma < \mu$ Retains otherwise: expels	idem
P40 (for $\rho > 0$)	Minimum benefits	$\gamma < 0$: Retains otherwise: Expels	Expels $\forall$ γ
P41 (for $\bar{\rho} < 0$)	Maximum benefits	$\gamma < 0$: Retains otherwise: Expels	Expels $\forall$ γ

Notation. *Retain* (*Expels*): reduces (increases) $tax(\tau)$; *Moderates*: reduces $|tax(\tau)|$ in absolute value; γ: threshold for a sign switch of the *tax* in each economy.

4.1.2. *Age and contribution history penalization schemes* (P1)

Two remarkable effects show up in the context of P1. First, there is an obvious reduction in the replacement rate, which becomes $rr^{P1} = AP(\tau)\ HP(n(\tau))\ rr^{00}$. Second, the change in the benefit resulting from staying active one more period rises as a result of the penalty schemes being strictly decreasing in age. Reflecting this, ψ changes to $\psi^{P1} = \sigma + (1 + \sigma)\ \gamma > \psi^{00}$, with σ a strictly positive function of age and of a number of parameters: $\sigma = \sigma(\alpha, \kappa, \tau, n(\tau)) > 0$.

We detect three important consequences of the change in ψ. First, the threshold for positive incentives to work falls. It typically becomes negative at early ages. Second, as illustrated in the left central panel of Figure 1, the shape of the age profile of the *tax* rates changes abruptly: At ages $\{\tau_0,..., \tau_M - 1\}$ the *tax* falls; at age τ_M a marked negative jump appears, in clear contrast with what was observed in P0 (top left panel of Figure 1); in the age range $\{\tau_M + 1,..., \tau_N\}$ the *tax* remains relatively low, although it increases slightly with age until τ_N where a sudden positive jump allows it to catch up with its P00 value. Notice that there is another possible jump, of smaller magnitude, when the insufficient contribution penalties finish [7]. Third, the importance of the wage profile on the *tax* is softened.

Regarding the effect of the record of contributions in the context of P1, intuition would suggest that individuals with incomplete histories must have less incentives to retire than people with the same characteristics (τ, w_0, γ) but complete histories, due to the fact that the former have a higher ψ than the latter. A more ambiguous result turn out after a more detailed study. On one hand, there is an abrupt increase in the incentives with the end of history penalties (when the number of years of contribution reaches n_M). On the other hand, for active workers the incentive can increase or decrease with $n(\tau_0)$ depending on age and wage profile. Grossly summarizing, we could say that individuals with incomplete history *in most cases* have more incentives to keep working than their analogous with complete histories, while age turns out to be a key variable when comparing among individuals with incomplete histories. At early ages the *tax* decreases with $n(\tau_0)$ (except for highly decreasing profiles), a pattern that progressively reverses itself as the individual ages.

Summing up: the simultaneous consideration of P0 and P1 (see the central panels of Figure 1 and Table 1) unveils the incentives experienced by «average» workers. The essential features are: (1) age penalties create a clear retention incentive at age τ_M, that gets progressively weaker with age and suddenly disappears at age τ_N; (2) for a fixed age, γ still has a moderate influence on the sign and level (in absolute value) of the incentive; (3) before τ_M the *tax* is positive for individuals with a moderately decreasing salary $\gamma < k_1$ and negative otherwise; finally (4) the wage level makes no difference as far as retirement incentives are concerned.

What retirement pattern would be compatible with such incentives? That featuring an exit rate increasing with age, with a pronounced peak at age 65. Early retirement at 60 would be chosen by a minority (only individuals with a very decreasing profile). Among people of the same age, exit rates would be decreasing in the wage profile and flat in the wage level.

4.1.3. *Wage and benefit tax allowances* (P2)

While the retirement incentives of «average» individuals are unaffected by tax allowances, those of low earners, as illustrated in the bottom row of Figure 1, can be either reduced (because of the substitution of net by gross wages) or disrupted by small jumps at the ages or wage levels separating the regions where tax allowances change form enabled to disabled and vice versa. In either case, the effects are of small importance.

Tax-free allowances on retirement benefits are, by far, much more important. On one hand, both *rr* and ψ increase, generating a step in the age-profile of the incentive and reinforcing the effect of the fiscal system. On the other hand, very intense punctual incentives to work are created at the age where the tax-free allowance activates (when $\gamma < 0$), with the opposite happening at the age where the tax-free allowances are deactivated (when $\gamma > 0$). These incentives show up as sudden discontinuities in the pattern of incentives by age. The relevance of such discontinuities dampens when generalized incentive's measures, such as the horizon-h *tax*, are considered.

In most cases, both age or history penalization schemes increase the range of individuals (specially those characterized by $\gamma < 0$) that are affected by tax allowances on pensions. As the individual ages and, consequently, penalties become less severe, the benefit tax-free allowance can become no longer binding and incentives to stop working may appear (see the left bottom corner of Figure 1 for an illustration).

4.1.4. *The effect of floors and ceilings on contributions and benefits* (P3 and P4)

As a rule, ceilings and floors on contributions and pensions reduce the dependence of the incentive on personal characteristics. This is so because when the thresholds are fully binding, the accrual becomes constant regardless of the labor income level and/or profile. However, this general *equalizing* effect varies sharply with the particular threshold.

Ceilings: Maximum contribution and pension (P31 and P41).

The ceiling on contributions becomes fully operative when all the wages entering the *benefit base* are above the legislated maximum. In such case [8] can be expressed as:

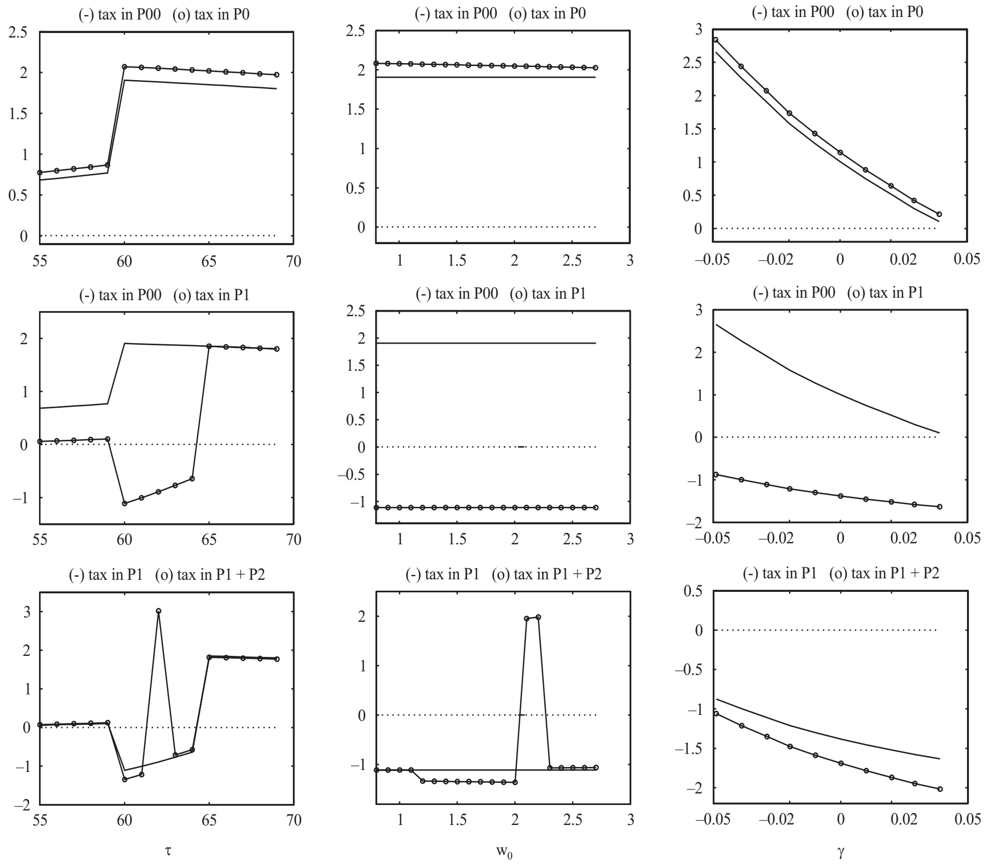
$$acr(\tau) = -\overline{C}_\tau - \overline{p}_\tau + \overline{p}_\tau \, \psi \, AT(\tau+1, F) \qquad [12]$$

where $\overline{p}_\tau$ is the real pension when $B(\tau) = B(\overline{C}_\tau)$, and ψ is its rate of change. When the ceilings on pensions are immediately binding after retirement the accrual is given by:

$$[13] \quad acr(\tau) = -C_\tau - \overline{p}_\tau$$

Both [12] and [13] reflect an accrual that is *essentially* independent of the individual labor income process. The implication for the *tax* is clear: the larger the wage, the closer the *tax* is to zero. There is, however, a remarkable difference between the effects of both truncations: the maximum benefit cancels out the effect of age penalties whereas the maximum contribution does not. For this reason the effect of the maximum benefit is, as a rule, much more important.

Figure 2 makes the entire story apparent: 1) For extreme wage processes (either very high initial wage levels or growth rates) both regulations make the *tax* go to zero. 2) Maximum pensions turn the (typically) negative sign of the *tax* in the early retirement ages into a positive one. This makes the *tax*, in practice, flat for $\tau > \tau_m$ [8]. In contrast, the maximum contribution barely modifies the *tax* at those ages. 3) The simultaneous consideration of both thresholds (bottom row of Figure 2) clearly shows that the quantitative effect of maximum pensions is predominant.

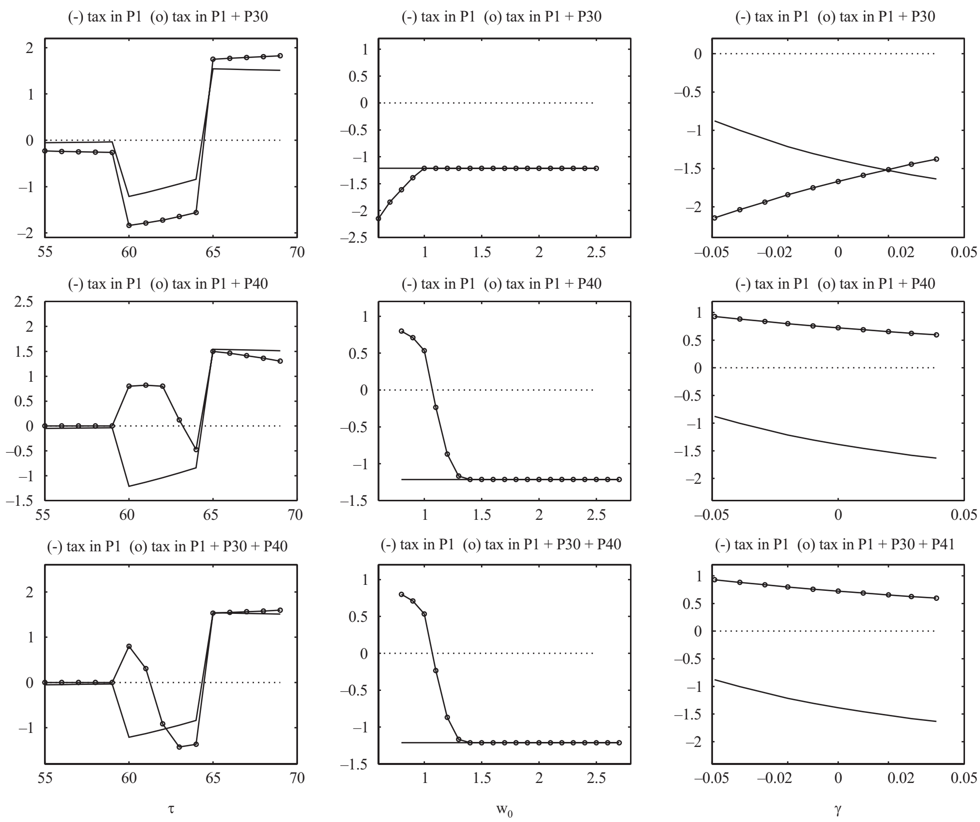


tax(τ), left; *tax*(w_0), center; and *tax*(γ), right, in economies P0, P1, and P1+P2
Parameter reference: P0, P1: $\tau = 60$, $w_0 = 1.2$, $\gamma = -0.029$; P1+P2: $\tau = 60$, $w_0 = 1.7$, $\gamma = -0.029$.

Figure 2. The effect on *tax* in economics P0, P1 and P1 + P2

Floors: minimum contribution and pension (P30 and P40)

The effect of floors (the minimum contribution and minimum pension) is similar to that of ceilings: the analytical expressions are completely analogous and the accrual becomes essentially flat when the floors are fully binding. As a result, the absolute value of the *tax* becomes arbitrarily large as lower values of w_0 or γ are considered (see the right and central panels of Figure 3).



tax(τ), left; *tax*(w_0), center; and *tax*(γ), right, in economies P1, and P1+floors
Parameter reference: P1+P30+P40: $\tau = 60$, $w_0 = 0.800$, $\gamma = -0.020$; P1+P31+P41: $\tau = 64$, $w_0 = 5.033$, $\gamma = -0.039$
.

Figure 3. The effect on *tax* of contribution and pension floors

Some specific observations are, however, in order: 1) The existence of a minimum wage regulation reduces the effects of floors, specially in the case of the minimum contribution (which usually is related to the minimum wage). 2) Very low salaries are typically associated to a positive *tax* at the age of first entitlement to benefits. (see the central top panel of Figure 3 for an illustration). Furthermore, the minimum pension blocks the incentive effects of both age and history penalization schemes. This creates a selective expulsion effect before the normal retirement age on low-income workers, which (in accordance with Spanish empirical patterns) is stronger the lower the salary considered. Notice that this is the empirically relevant case for the long term unemployed, whose unemployment benefits fall with the unemployment spell. 3) When considering both floors simultaneously, as in the bottom panels of Figure 3, the effect of the minimum benefit largely dominates that of the minimum contribution at the ages τ_m, $\tau_m + 1$, $\tau_m + 2$. However, as the individual approaches τ_N the effect of minimum contribution gains weight. 4) It is not the minimum pension by itself what increases the retirement incentives but the interaction with age penalties. Notice that, in the simulated case, the *tax* at all ages beyond τ_N (where the penalties play no role) is *reduced* by the benefits' floor. This can be explained by considering the analytical expression of the accrual when the threshold is not immediately binding:

$$acr(\tau) = -C_\tau - p(\tau) + p(\tau)\ \psi\ AT(\tau, J)$$

where J is the minimum pension's first-binding age. In absence of penalties, individuals with $\gamma < 0$ have $\psi < 0$ and, in consequence, a negative accrual (positive *tax*). When the threshold is binding, the negative third term in the accrual's expression is reduced, as $AT(\tau,J) < AT(\tau,F)$. The constraint accrual is then *less* negative and the expulsion effect is undoubtedly reduced [9].

Summing up, we have reported how the floors and ceilings on benefits block the incentive effects created by the age and contribution penalties, with the result of fostering early retirement. Note that this distortion will be more important as time passes for two reasons. First, the legislated ceiling typically grows at a lower rate than wages. A good example can be found in countries where earnings ceilings are price-indexed (eg Sweden) [10]. In Spain, the increasing incidence of the contributions ceiling has been documented in Boldrin *et al.* (2002); Secondly, as the wage dispersion increases, the floor on benefits may also remain binding for a significant part of the labor force.

4.2. Monetary incentives under a concave wage profile

In order to explore the influence of the wage profile in the results obtained so far, we have simulated the incentives prevailing when the age-profile of wages is quadratic. The curvature of the process is parameterized through $\tilde{\gamma}$, the incremental rate between ages τ_0 and τ_N:

$$w_\tau = w_0 \left(1 + \tilde{\gamma} (\frac{\tau - \tau_0}{\tau_N - \tau_0})^2 \right) \qquad [14]$$

As commented at the beginning of section 4, expressions 9 and 10 are still valid in this context. Thus, most of the effects found in the linear case remain unaltered. The most noticeable differences, which arise through a more active role of the benefit formula, are summarized as follows:

- The incentive increases strongly with age. The reason is twofold: first, because of wages fall faster than benefits, which implies an increasing replacement rate; second, because of the increase in $1 - \psi\, AT(\tau + 1, F)$ derived from the accelerated fall in ψ.
- The importance of the profile $\tilde{\gamma}$ on the sign and the level of the incentive is lower. The consideration of age penalties accentuates this effect to the point that the profile of $tax(\tilde{\gamma})$ is left nearly flat in $\tilde{\gamma}$.

5. An application to the analysis of the Spanish Social Security reform

In this section we explore the empirical relevance of the theory developed in the previous sections, and explore the impact of some reforms of the pension system in Spain. We start by describing the General Regime of the Spanish Social Security system (RGSS). We then check whether the empirical patterns of retirement for workers enrolled in the RGSS match our theoretical incentive profiles. Finally we evaluate the implications of the 1997 reform in terms of retirement incentives, and consider a few proposals designed to give workers enhanced incentives to stay in the labor market beyond 65.

5.1. Pension rules in the General Regime (RGSS)

We next provide a brief introduction to the pension rules in the General Regime (RGSS), the most important pension scheme in the Spanish Social Security System (covering over 70 percent of the currently affiliated workers). We review its main characteristics both after and before the changes implemented in 1997.

5.1.1. *Financing and eligibility of the RGSS*

The RGSS is a social protection system financed by the affiliates' salary contributions. The contributions are a fixed proportion of the pensionable earnings, a doubly censored version of earnings. Both the censoring from below (minimum level of contributions) and from above (maximum) vary according to professional category. Presently, eleven categories or contribution groups can be distinguished. For the first seven groups, ranging from Engineers and College degree holders to Administrative Auxiliaries, minimum and maximum are computed for monthly salaries. For the remaining categories, minimum and maximum are computed on a daily basis. The current rate of contribution is 28.3 %, of which 23.6 % is due by the company and the remaining 4.7 % by the worker.

A minimum of 15 years of contributions is required to be entitled to a retirement pension, with the restriction that the final two must be within the ten years immediately before retirement.

5.1.2. *Benefit computation*

Consider a 65 year old person fulfilling the eligibility criteria, who retires in month t after having contributed to the system for $n > 15$ years. Under the system in place from 1985 to 1997, his first theoretical monthly benefit is $P_t^{85} = HP^{85}(n)B_t^{85}$, where the benefit base B_t^{85} is a weighted average of his monthly pensionable wage (base of contribution) BC_{t-j} during the 96 months (eight years) immediately preceding retirement:

$$B_t^{85} = \frac{1}{112}\left(\sum_{j=1}^{24} BC_{t-j} + \sum_{j=25}^{96} BC_{t-j}\frac{I_{t-25}}{I_{t-j}}\right), \qquad [15]$$

where I_{t-j} is the Consumer Price Index observed j months before retirement. Thus, earnings in the two years immediately before retirement are not adjusted for inflation, while earlier pensionable wages are converted into real terms but according with the price index prevailing 25 months before the moment when retirement actually happened. The benefit base is divided by 112 because pensions (and, usually, salaries) are paid in 14 monthly installments, whereas Social Security contributions are levied on 12 installments. The penalty for insufficient contribution (HP^{85}) depends on the number of yeas of contribution and is equal to

$$HP^{85}(n) = \begin{cases} 0, & \text{if } n < 15, \\ .6 + .02(n-15), & \text{if } 15 \le n < 35, \\ 1, & \text{if } 35 \le n. \end{cases}$$

Thus, after contributing for 15 years the benefit is already equivalent to a 60 percent of the benefit base. After contributing for 35 years the benefit equals the full benefit base and there is no further advantage in contributing additional years, although these contributions are mandatory until retirement.

5.1.3. *Early retirement*

The normal retirement age is 65, but early retirement from the age of 60 is permitted, with a 8 percent annual penalty for every year retirement is brought forward from 65. This early retirement option is only granted to the cohorts of workers affiliated before 1967.

It should be stressed that there are no clear incentives to postpone retirement beyond 65, especially for those who have already contributed for 35 years when they reach 65. The only indirect incentive to postpone retirement comes from the potential substitution of a «bad» wage record for a «good» one. For those who have contributed for less than 35 years there exists a small direct incentive derived from the increase in the history penalty. Note that the incentive to work an extra year is different for two individuals of ages 60 and 65 having contributed 34 years each. In the first case the benefit increases from 56.8 to 68 % of the benefit base, while in the second case it only increases from 98 to 100 %.

5.1.4. *Maximum and minimum benefit and indexation rules*

Benefits are subject to a maximum that is legislated every year. For example, in 1996 the maximum was 3.9 million pta./year, corresponding to approximately 4,3 times the minimum wage and 1,63 times the mean wage for industry and services.

If the computed retirement benefit falls below the applicable minimum benefit (880.180 ptas./year in 1996 for people over 65 in charge of a spouse) and, if taking into account all other sources of income, the individual earn no more than a certain annual threshold (785.476 ptas. in 1996 as a general rule and 916.267 when there is a dependent spouse), he receives a complement up to the minimum benefit of his class or, alternatively, up to the annual threshold marking the limit to the right to complements.

Until 1986, benefits were indexed to real wage growth. From that year on, they are indexed only to expected inflation, measured by the Consumer Price Index (CPI). However, due to periodical tokens of generosity, minimum pensions are linked to real wage growth in practice.

5.2. Hazard patterns of workers under the RGSS

In this section we construct a number of representative empirical hazards, using information from a sample of administrative records from the Spanish RGSS in 1995 [11]. We use this information to check whether the theoretical incentive profiles are able to match the empirical retirement hazards. When doing so we control for the following heterogeneity dimension: gender, age, contribution group and expected wage level at age 60. In the top row of Figure 4 we present the 1995 retirement hazard rates by age and gender for contribution groups 1/4 and 5/10, which can be assimilated to individuals with high-to-medium and medium-to-low incomes respectively [12].

For men in contribution groups 1/4 the hazard peak at 65 is the only really important one. In contrast, for men in contribution groups 5/10, both peaks at 65 and 60 (the year when benefits are first available) are evident. For women (third row of Figure 4), whose sample size is much smaller, the patterns are somewhat erratic. In fact, only the peak at 65 is very important (peaks at latter ages being the result of the small number of observations available). Alternatively, the peak at age 60 is either less evident or non-existent. Boldrin *et al.* [4] suggest that this may be caused by an the fact that an important fraction of women fail to comply with the eligibility criteria for early retirement benefits.

In the second and fourth rows of Figure 4 we present hazard rates for individuals aged 60 and 65 as a function of the percentile of the expected wage at age 60. For men aged 60, regardless the group of contribution, the figure is almost identical to the central top panels of Figure 3. Low earners, most likely affected by benefits floors, exit at 60 in a much higher proportion than medium or high earners. The evidence is less clear for women aged 60, for two reasons: their careers are much more erratic and many of them do not have the right to retire early. Finally, hazard at age 65 is, regardless of the gender, important at all considered wage levels.

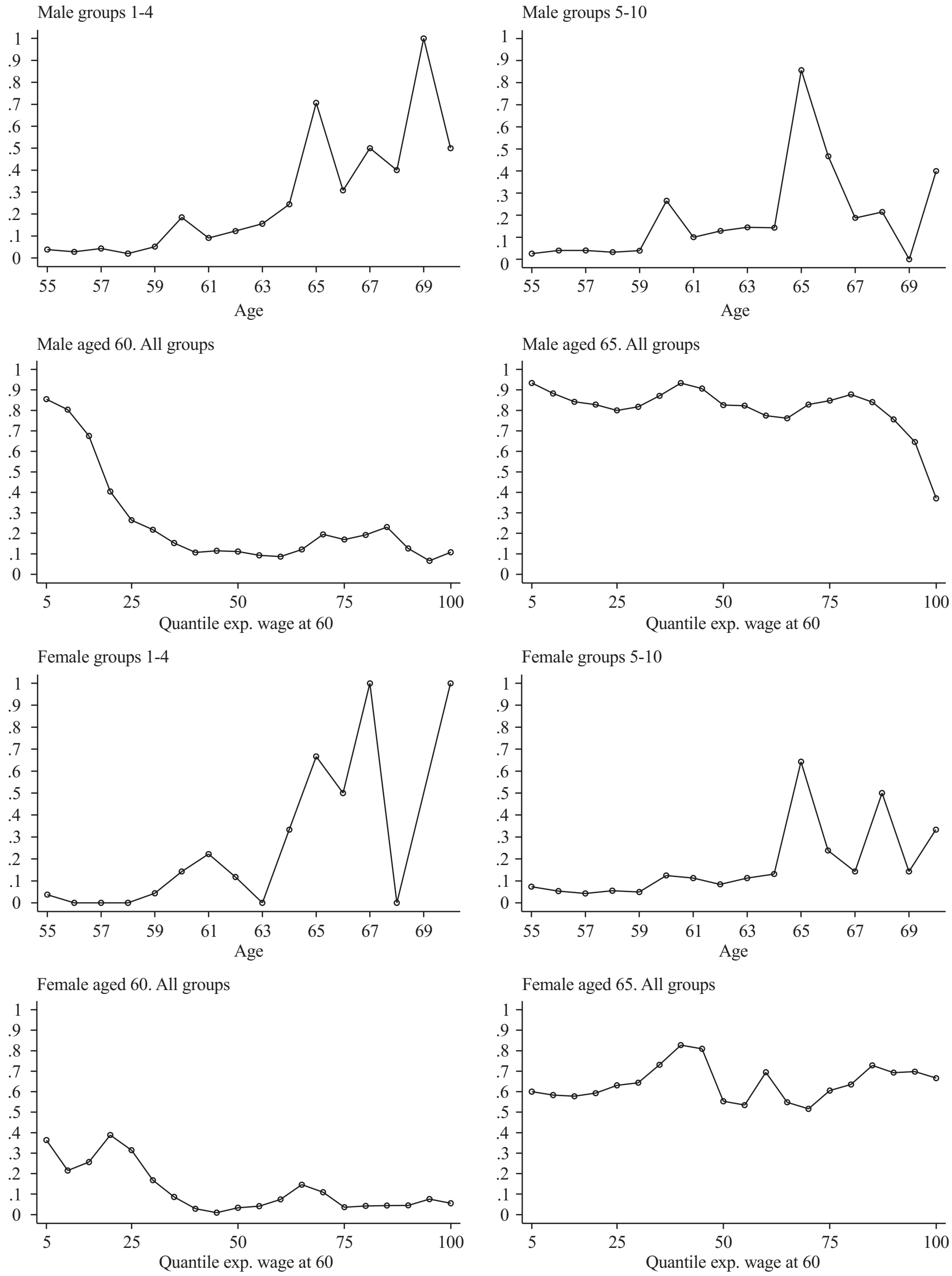


Figure 4. Exit rates by age and expected wage at age 60 in HLSS/RGSS, 1995-sample

5.3. The 1997 reform

The 1997 reform introduced three changes: (i) The number of reference years in the pension formula was set to go up from eight to fifteen years, on a year by year basis (the process should be over in 2002); (ii) The penalty for insufficient contributions was replaced by the following schedule:

$$HP^{97}(n) = \begin{cases} 0 & if \quad n < 15 \\ .5 + .03(n-15) & if \quad 15 \leq n < 25 \\ .8 + .02(n-25) & if \quad 25 \leq n < 35 \\ 1 & if \quad 35 \leq n \end{cases}$$

and (iii) the early retirement penalty was reduced from 8 to 7 percent, for workers with a record of contributions of more than 40 years at the time of retirement. Note that this change provides an extra incentive of 5 percentage points to those who have contributed more than 40 years when they become 60 years old.

It should be clear that (i) reduces the benefit base for those workers whose real pensionable earnings grow continuously with age, and increases it for those who suffer reductions during the last years of their active working life; (ii) reduces the theoretical benefit for those workers who have contributed for less than 25 years, thereby increasing their probability of being trapped by the minimum benefit; finally (iii) increases the replacement rate of those who retire between the ages of 60 and 64 and reach, within this interval, 40 years of contributions, while leaving the rest of individuals unaffected.

Jiménez-Martín and Sánchez Martín (2000) show that only (i) is quantitatively important. When analyzing the RGSS sample, they find that the contribution bases in the age range 50-65 are decreasing for workers in groups 5/10 and non-decreasing for workers in groups 1/4. Consequently, taking into account the difference in the wage levels of these two groups (i) may lead to a redistribution from high earners' pensions to low earners' pensions. In contrast, they show that measures (ii) and (iii) only affect particular groups of individuals. For example, measure (ii) is of little importance for men since only 10 percent of males have contributed for less than 25 years when they turn 60. The situation for women is just the opposite since most of them have contributed for less than 25 years (79.2 percent of those in groups 5/10). However the real incidence of that reform, as described in Boldrin *et al.* (1999) is of limited importance since many women do not have the right to retire early. Finally, the impact of measure (iii) is of little importance since in neither case the fraction of those that have accumulated 40 years of contributions when they turn 60 is greater than 10 percent.

In Table 2 we explore the effects of the reform on the implicit Social Security debt. First of all, the impact depends on the life-cycle dynamics of wages. For monotone increasing wage profiles (ie, $\gamma > 0$) the reform always reduces the implicit debt, while for decreasing ones the debt augments for a broad range of wage levels. This is illustrated in the lower part of the table, for workers retiring at the age of 60. Second, the reform increases the system's

Table 2
Implicit Social Security debt under the 1997 system relative to the 1985 system

Age	Base case. Average wage at age 60			
	Forty years of contribution		Thirty years of contributions	
	$\gamma = -2$	$\gamma = 2$	$\gamma = -2$	$\gamma = 2$
55	0.905	0.923	0.903	0.921
...	...	...	...	...
59	1.038	1.016	0.918	0.895
60	1.026	0.981	0.937	0.891
61	1.026	0.951	0.962	0.888
62	1.035	0.925	0.996	0.885
63	1.048	0.904	1.030	0.883
64	1.059	0.890	1.059	0.890
65	1.095	0.888	1.095	0.888
66	1.137	0.885	1.137	0.885
...	...	...	...	...
69	1.559	0.878	1.559	0.878

% average wage	Base case at age 60			
	Forty years of contribution		Thirty years of contributions	
	$\gamma = -2$	$\gamma = 2$	$\gamma = -2$	$\gamma = 2$
25	1.000	1.000	1.000	1.000
50	1.208	0.984	1.113	0.978
75	1.190	0.981	1.099	0.891
100	1.027	0.981	0.937	0.891
150	0.953	0.953	0.863	0.863
200	0.953	0.953	0.863	0.863

Base case: Single, contribution group 5, average wage in 1993 and subject to the rules described in Appendix.

debt with workers of average wage, negative γ and 40 years of contributions at the age of 60. In contrast, for those who only have 30 years of contribution when they turn 60, the reform alleviates the debt in case of retirement before the age of 63. In summary, the reform fails to lower the Social Security debt in many, quantitatively important, cases.

5.4. Analysis of the 1997 reform

In this section we use the stylized theoretical model presented in section (4) to evaluate the 1997 reform.

5.4.1. *Evaluation of contribution history reforms*

We consider the effects of modifications in the insufficient contribution penalties for individuals with average income (ie, not affected by wage level thresholds), which fits in the framework of pension system P00 + P1. Recall that the analytical expression for the incentive is this framework is:

$$tax(\tau) = rr^{00}\ AP\ HP\ (1 - \psi AT(\tau + 1, \tau, F)) \qquad [16]$$

Let us consider a new parametric scheme imposing uniformily heavier penalties (ie, setting $k_1 > k_1$, $k_0 < k_0$, which implies that $HP‘ < HP$). We leave the thresholds n_m, n_M unaltered.

The change in the incentive is driven by the simultaneous modification of rr and ψ. It is straightforward to show that the replacement rate falls:

$$rr' = rr^{00}\ AP\ HP' < rr^{00}\ AP\ HP = rr$$

The alteration of $\psi = \sigma + (1 + \sigma)\ \gamma$ operates through the change in σ which, in turn, depends on the relative change in the two parameters of the filter:

$$\psi' > \psi \Leftrightarrow \sigma' > \sigma \Leftrightarrow \kappa_1/\kappa_1 > \kappa_0/\kappa_0 \qquad [17]$$

Despite the simplicity of the partial effect on the replacement rate and the parameter ψ, the joint effect requires more elaboration: in most cases $tax(\tau)’ < tax(\tau)$, so the reform tends to reduce the incentives to retire for workers with a positive tax and to increase the incentives to work for people with a negative one. However, this effect weakens when individuals with higher γ are considered. In fact, for extremely positive wage profiles the reform may reduce the incentives to keep working.

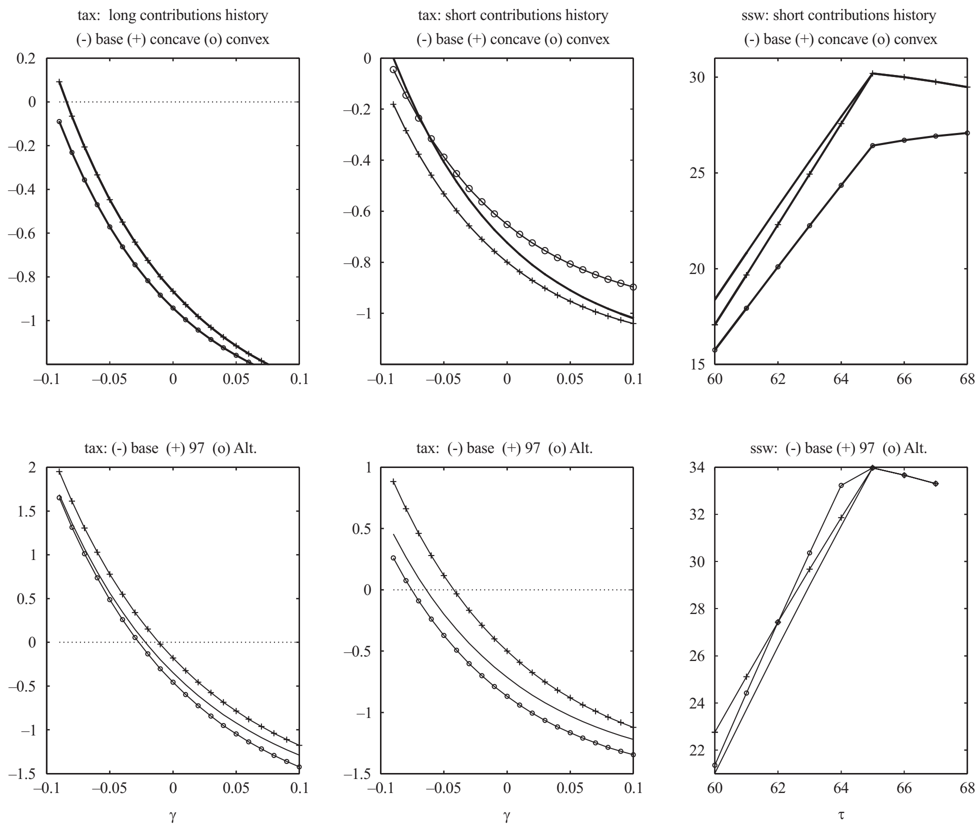
We can get to more precise conclusions by comparing the incentives faced by *a base case* individual under three alternative penalties schemes: those in place before the 1997 reform (base or 1985 system), after that reform (namely, the **Concave Reform**) and under the following alternative scheme (namely, the Convex HP reform):

Convex HP reform:

$$HP(n(\tau)) = \begin{cases} 0 & \text{if } n(\tau) < 15 \\ 0.5 + 0.02(n(\tau) - 15) & \text{if } 15 \le n(\tau) < 25 \\ 0.7 + 0.03(n(\tau) - 25) & \text{if } 25 \le n(\tau) < 35 \\ 1 & \text{otherwise} \end{cases}$$

The left and central top panels of Figure 5 present the *tax* at age 60 as a function of γ under the three penalty schemes, for individuals with 30 and 20 years of contribution respectively. The *Concave* reform does not introduce significant changes in the incentives of workers with a record of $n(\tau) \in \{25,35\}$ when compared to the previous (1985) scheme, whereas the *Convex* reform introduces a clear retention effect, inversely related to the value of γ. For individuals with shorter histories ($n(\tau) \in \{15,25\}$) the result depends on the wage profile.

Useful information about the impact of the reforms can be obtained by checking the impact of the reforms on the threshold γ^*. For the concave reform γ^* is positive, thereby retain-



Reference. History of contributions: long $n(_0) = 30$; short $n(\tau_0) = 20$. Individual characterization: left and middle panels: $w_0 = 24$, $\tau = 60$ (left bottom panel $\tau = 64$); right panel: $w_0 = 2.4$, $\gamma = -0.02$.

Figure 5. Early retirement and insufficient contribution penalties: *tax* and SSW after several alternative reforms

ing all individuals that are characterized by a decreasing wage profile (normally the less skilled workers). Alternatively, under the convex reform, the threshold γ^* is typically negative and quite large in absolute value, which implies that the exit incentives increase for all the individuals characterized by $\gamma < \gamma^*$. However, for male workers, the latter case is practically irrelevant due to the small fraction of them (less than 10 percent) that have accumulated less than 25 years of contributions at age 60. The situation is radically different for women, since a majority of them have accumulated less than 25 years of contributions at age 60.

We conclude this section by exploring the impact of the alternative contribution-history schemes on the Social Security debt. In the right top panel of Figure 5 we show the social security wealth of a representative individual (with average wage level and a mildly decreasing wage profile) as a function of retirement age. As both reforms increase penalties with respect to those existing before the 1997 reform, it is clear that both result in a relief for the Social Security's burden. In any case, the graph makes clear that the convex reform would imply considerably larger savings, especially if workers were to respond to the higher incentives to work by postponing their retirement age.

5.4.2. *Reform of the early retirement penalty scheme*

We now compare the effect on the incentives of the 1997 reform and an alternative reform with respect to the age penalization scheme applicable before 1997. The first one was described in 3 and the alternative reform follows next:

In this section we study the effect of the changes in the age-of-retirement penalty scheme introduced by the 1997 reform (point (iii) in section 3). We compare with the scheme in place before the reform (section 3) and with an alternative reform characterize by the following age penalties:

[**Alternative AP Reform**:]

$$AP(\tau) = \begin{cases} 0 & \text{if } \tau < \tau_M \\ 0.61 + 0.09(\tau - \tau_m) & \text{if } \tau_M \leq \tau \leq \tau_N \\ 1 & \text{if } \tau > \tau_N \end{cases}$$

Both reforms leads to smaller penalization than in the initial situation (ie, $AP' > AP$) which implies larger replacement rates $rr' > rr$. The real difference is in the timing of the alleviation. The 1997 reform reduces AP by 5 percentage points at the age of 60, by four points at 61 and so on, whereas the alternative AP reform allows a one percent reduction at 60, two percent at age 61 and so on.

We explore the impact on ψ first. We find an analytical condition analogous to [17] in the previous section:

$$\psi' > \psi \Leftrightarrow \sigma' > \sigma \Leftrightarrow \alpha_1/\alpha_1 > \alpha_0/\alpha_0 \qquad [18]$$

Both reforms have opposite consequences for ψ: while the 1997 reform reduces it, the alternative reform increases it. The simulation results, presented in the left and central bottom panels of Figure 5, are in this case sufficiently clear: while the 1997 favors early retirement, the alternative AP reform has the opposite effect. Since the differential effect of these two measures is higher at early ages, it is interesting to stress (see the right bottom panel of Figure 5) that it is precisely at those ages when the financial cost for the pension system of the alternative reform is lower than the cost of the 1997 reform. In any case, if individuals were to respond favorably to the retention incentives, the final costs would most likely be higher under the alternative scheme (as the effective retirement age should go up). Only if retirement were to be postponed until 65 would the new reform have no additional costs.

5.4.3. *Increasing the number of years of contributions used to compute the benefit base*

In this section, we explore an extension in the number of years entering in the pension formula's benefit base, ie we assume R to be increased to R', as in the 1997 reform. It is easy to show that the new replacement rate in P00, *rr´*, is greater (lower) for workers with decreasing (increasing) wage profiles. Since $1 - \psi\, AT(\tau + 1, F)$ does not change, this reform cannot change the sign of the *tax* for any individual. Therefore, it only strengthen the level of the inicial incentive: at the early retirement age (where the penalties lead to a negative threshold $\bar{\gamma}$, usually lower than the steepness of the wage profile of the representative worker) the reform increases the incentive to keep working; alternatively, at ages closer to γ_N the threshold $\bar{\gamma}$ is positive and the reform reinforces the incentive to retire.

5.5. Introducing incentives to postpone retirement beyond 65

As in many economies, pension rules in Spain are actuarially unfair in case of delaying retirement beyond 65. Recent reform proposals (to be applied by 2002 or 2003) aim to extend active live by partially eliminating this discrimination. In this section we analyze two of the various possibilities that can help to motivate workers to keep working after 65: 1) Eliminating the workers's part of the total contribution (1/6th of Social contributions in the Spanish case) for individuals working beyond 65; and 2) Allowing the age penalty scheme AP to take values larger than one after age 65, thereby increasing the benefit after age 65.

5.5.1. *Eliminating mandatory contributions for 65+ workers in P0*

Consider the case of an «average worker» considering working beyond 65 ($\tau \geq \tau_N = 65$) in the context of the pension system P0. If mandatory contributions were lift after age 65, the new *tax*, would be:

$$tax' = \vartheta'\, rr^{00}\, (1 - \psi\, AT(\tau + 1, F))$$

where $\vartheta' = \vartheta_p / \vartheta'_w = \vartheta_p/(1 - \mu_0 - \mu_1 W)$. Note that this reform increases the net wage and reduces the replacement rate. Consequently, the change in the tax rates takes the form:

$$tax' - tax = rr^{00}\, (1 - \psi\, AT(\tau + 1, F))\, \vartheta_p \left[\frac{1}{\vartheta'_w} - \frac{1}{(1-c)\vartheta_w} \right] - \frac{c}{1-c}$$

It is straightforward to show that $\vartheta'_w > (1 - c)\, \vartheta_w$, which implies that $tax' < tax$, so that the reform decreases the incentives for all ages above τ_N. Notice that the progressivity of the income tax is crucial for this reform to generate any retention effect. However, the retention does not seems to be enough to offset the jump in the *tax* at age of τ_N.

5.5.2. *Increasing the replacement ratio for workers 65 + in P00 + P1*

This alternative reform introduces a small alteration of the penalty formula [3] after age 65. The new analytical expression is:

$$AP(\tau) = \begin{cases} 0 & if \quad \tau < \tau_M \\ \alpha_0 + \alpha_1(\tau - \tau_m) & if \quad \tau_M \le \tau < \tau_N \\ 1 + \overline{\alpha}_1(\tau - \tau_N) & if \quad \tau_N \le \tau \end{cases}$$

where $\overline{\alpha}_1$ is the premium to keep working after age 65. Under such circumstances, we find that,

$$tax' - tax = \frac{rr\,HP}{1-c}[AP(1 - \varphi AT(\tau+1, F)) - (1 - \psi' AT(\tau+1, F))]$$

where, under pension system P00+P1', $\psi' = \overline{\alpha}_1 + (1 + \overline{\alpha}_1)\gamma$. This implies that $tax' - tax < 0$ if the following inequality holds:

$$AP < \frac{1 - \gamma AT(\tau+1, F)}{1 - \varphi AT(\tau+1, F)} \qquad [19]$$

Given the fact that $\phi > \gamma$, this expression provides an upper bound on the generosity of the premium. It is easy to see, in any case, that for a premium equal to the Spanish age penalty (i.e., $\overline{\alpha}_1 = 0.08$) and a real rate of interest of 3 percent, the inequality holds comfortably at all ages between 65 and 70.

6. Conclusions

In this work we analyze the effect of pension provisions and fiscal rules on the individual financial *incentives* to retire. We also show how this type of theoretical analysis can greatly enhance our understanding of empirical retirement patterns in Spain. In particular, we identify the precise economic mechanisms by which Social Security pushes low-wage workers into early retirement.

Our first contribution is empirical: we (non-parametrically) estimate the retirement hazard as a function of the expected (at age 60) wage level, at the key ages for the Public Pension System: the Normal Retirement Age τ_N (65) and the Early Retirement Age τ_m (60). We find a remarkably clear *negative* relation at the age of 60, while no defined pattern emerges at 65 (τ_N). This new evidence complements the well known findings about abrupt spikes in retirement hazards at both ages.

We then proceed to show how both patterns can be rationalized as the optimal response to the incentives created by fiscal and social security regulations. To achieve this, we compute the theoretical analogs of the empirical findings above: the *life cycle* profile of retirement incentives faced by agents of different wage levels, and the *wage level* profile of retirement incentives faced by agents at different ages.

The life cycle incentives experienced by the average worker vary strongly with age, as a result of the interaction between the pension formula and the early retirement penalties. The incentives to retire before the age of first entitlement are mild as the pension is not part of the opportunity cost of working. After τ_m two forces pull in different directions: the opportunity cost of the foregone pension and the imposition of early retirement penalties. Particularly in the Spanish case, this second effect creates a very strong incentive to keep working until τ_N. Finally, after τ_N the impact of the penalties disappears, the opportunity cost is at its maximum, and the average wage dynamics (which operate through the pension formula) tend to reduce future pensions. All these forces together produce a sharp reduction in the incentives to keep working, and provide a convincing explanation for the huge spike in retirement hazard at the normal retirement age.

Life cycle incentives are very different for workers on both tails of the earnings distribution, as they become subject to the floors and ceilings on pensions and contributions. Minimum pension is the most powerful device. By blocking the effect of early retirement penalties, it creates a strong incentive to retire at τ_m on low income workers. This can account for the age 60 spike on the hazard by age, and for the decreasing profile on the hazard by wage at 60.

It is important to remark the critical role that age penalties play in this result. All the caps and ceilings of the system, particularly minimum pensions, have the additional effect of pulling apart the dynamics of the pension benefit form that of labor income. As earnings tend to decrease at advanced ages, this isolation effect has the unexpected impact of *reducing* the incentive to retire stemming from decreasing wage dynamics. This means that all thresholds have an *expulsion* effect in the age range $\{\tau_m,..., \tau_N\}$ (when the age penalties guarantee that postponing retirement results in a larger benefit), and a *retention* effect after τ_N. It is also interesting to note that the expulsion effect is lower for workers on the upper tail of the income distribution. This is so because both the maximum pension and the maximum contribution reduce the size of the benefit, which increases the opportunity cost of leaving the labor force. A final aspect that deserves careful consideration is the process of annual updating on the legislated values of the floors and ceilings. If they fail to keep pace with wage increases (as in recent years), the incidence of the «truncations» on retirement behavior is due to increase.

Regarding the evaluation of the 1997 pension reform, we have not found any substantial change in the retirement incentives, particularly on individuals who had shown a strong tendency towards early retirement in the past. Its most noticeable effects are a slight reduction in the implicit *tax* suffered by individuals with incomplete contribution histories, on one hand, and a failure to lower the Social Security debt in many empirically important cases on the other. Still, it produces some redistribution from above average pensions to below average pensions, as a result of the differences in the wage profile of each group. We propose some small modifications in the design of the age and contributions penalties, which should succeed in generating a simultaneous reduction in the retirement incentives (for the previously mentioned groups) and in the expected Social Security debt.

Finally, we have explored some recent proposals aimed at diminishing the actuarial unfairness of the Social Security formula after age 65. We find that the retention effect for moderate premiums is of little importance.

Appendix

A. Calibration of the theoretical economy to the Spanish case

We replicate the institutional framework in place in 1993. The anchor age τ_A is 60 years old and the simulation period $\{\tau_0..., T\}$ is $\{55,..., 70\}$. The discount factor d is 0.97 and the institutional parameters take the following values:

Penalties				**Fiscal system and cont.**		**thresholds**			
age		**history**		**c**	**0.061**	**from below**		**from above**	
α_0	0.6	κ_0	0.6	η_0	0.145	$\underline{C}_A$	0.88	$\overline{C}_A$	4.057
α_1	0.08	κ_1	0.02	η_1	0.022	μ	–0.007	$\overline{\mu}$	–0.006
τ_M	60	n_m	15	$\underline{W}_A$	1.0	$\underline{P}_A$	0.579	$\overline{P}_A$	3.438
τ_N	65	n_M	35	$\underline{B}_A$	1.2	ρ	–0.006	$\overline{\rho}$	–0.019

Most of them are directly taken from the values in force in the anchor year. Others, however, need some interpretation. The contribution rate c is that corresponding to workers, for whatever concept. For the contribution minimum, we select for C_A the value observed for group of contribution 5. To parameterize its time evolution, we took its average real growth rate between 1984 and 1997. For the contribution maximum, we calibrate the base level $\overline{C}_A$ in a similar fashion, while pinning down $\overline{\mu}$ is a bit more involved. This is due to a deliberate effort to get a high degree of homogenization among the diferent proffesional categories in this dimension. The result is that, from the beginning of the nineties, categories 1-4 share a unique contribution maximum. This was achieved by increasing somewhat abruptly the contribution maximums of categories 2 to 4, while letting the maximum for cat. 1 gently fall in real terms. It is this latter pattern (less prone to cyclical variation and closer, in our opinion, to a long term trend) what we wanted to include in the model. Therefore, we selected the average growth value from 1989 onwards. For the minimum benefits, we reflected the values for single workers under 65. Finally, for the fiscal system, we fitted by Least Squares the relation between the contribution bases and the tax payments suggested by equation [2]: a quadratic polynomial without a constant term.

B. Notation

Income process		
W_j, w_j	=	Before and After tax real labor income
w_0	=	Real wage level at age τ_0
λ, γ	=	Nominal and real wage growth rate (wage profile)
$\overline{\gamma}$	=	Curvature parameter of a quadratic model of wages dynamics

Contributions		
C_j, c	=	Contributions paid at age j and pay-roll tax rate
$HP^s(n(\tau))$	=	Contribution History penalty under system s=85,97
$n(\tau)$	=	Length of contributory record
n_m	=	Minimum number of years to be eligible for a pension
n_M	=	Number of yeas required to achieve full pension rights
κ_0, κ_1	=	Parameters of the insuficient contribution penalty scheme
$\underline{C}_t$, $\overline{C}_t$	=	Legal floor & ceilings contributions
$\underline{C}_A$, $\overline{C}_A$	=	Anchor levels for minimum and maximum contributions
$\underline{\mu}$, $\overline{\mu}$	=	Legal floor & ceilings growth rates
$\overline{P}_\tau$	=	Real pension when all relevant contributions are truncated
$\overline{\psi}$	=	Pension growth rate when all contributions are truncated

Fiscal system		
ϑ_w, ϑ_p	=	Wage and pension fiscal ratios
ϑ	=	ϑ_p/ϑ_w = Fiscal pension generosity
η_0, η_1	=	Tax system parameters
$\underline{W}_A$, $\underline{B}_A$	=	Labor income and pension income fiscal allowances

Pensions		
$B(R,\overline{R},\tau)^s$	=	Benefit base under system s=85,97
BC_j	=	Pensionable earnings at age j
I_j	=	Consumer Price Index at age j
$P(\tau)$, $P_j(\tau)$	=	Before and after taxes real pension in case of ret. at τ
$R(\overline{R})$	=	Number of (indexed) years included in the benefit base
τ_m, τ_N	=	Early and normal retirement ages
$AP(\tau)$	=	Penalty for retirement before τ_N
α_0, α_1	=	Parameters of the age penalties scheme $AP(.)$
$\underline{P}_t$, $\overline{P}_t$	=	Legal floor and ceiling on benefits
$\underline{P}_A$, $\overline{P}_A$	=	Anchor level for minimum benefit
$\overline{P}_A$	=	Anchor level for maximum benefit
ρ, $\overline{\rho}$	=	Legal floor and ceiling growth rates

Incentive measurement instruments		
$[\tau_0, ..., T]$	=	Range of possible retirement ages
τ_A	=	Anchor age for calendar time events
$rr(\tau)$, $(rr^{Pxx}(\tau))$	=	Replacement rate (in pension system Pxx) at age τ
$SSW(\tau + h, \tau)$	=	Social Security Wealth in case of retirement at $\tau + h$
$acr(\tau)$, $tax(\tau)$	=	Accrual and implicit tax at age τ
$\beta = 1/(1 + r)$	=	Market discount factor
F	=	Maximum length of life
$\phi(j\vert\tau)$, ϕ	=	Conditional survival probabilities (age-dependant or constant)
$d = \beta(1 - \phi)$	=	Effective discount factor
$AT(i, F)$	=	Benefit acumulator $\sum_{j=i}^{F-1} d^{j-r}$
ψ	=	Growth rate of real benefits
$\overline{\gamma}$	=	Marginal wage growth rate (for negative tax)
σ	=	Combined penalties filter growth rate
J	=	First binding age for benefit truncation

Notes

1. The financial problems PAYG systems are bound to meet have triggered a substantial number of reform proposals, most of them including sizable cuts in future commitments. See Kalisch and Aman (1998) for a summary of reform processes across OECD countries. In Spain, as noted by Herce and Alonso-Messeguer (2000), it is expected an important imbalance in the public pension finances from 2020 onwards.
2. The first examples of incentive indicators can be traced back to Lazear (1976). In that paper, the remuneration received by a senior worker encompasses not only his nominal wage but also the increase in pension rights accrued by his decision to stay active.
3. There is one notable exception: the case of high earners whose contributions and benefits are capped. For this particular group of workers the financial incentives and the marginal utility derived from work can differ substantially.
4. Contribution groups 1/4 and 5/10 can be assimilated respectively to individuals with high/medium and medium/low incomes. The expected average monthly income at the age of 60 for a male (female) worker belonging to groups 1/4 was 361.361 (306.644) in 1995 pesetas. The corresponding figure for groups 5/10 worker was 182.189 (130.740). The data comes from a database of administrative records from the social security system (see Boldrin *et al.* [1999] for a description of the source).
5. For women, whose sample size is much smaller, the patterns are somewhat erratic. In fact, only the peak at 65 is very important (peaks at latter ages mainly reflect sample noise induced by the small number of observations available). The peak at age 60 is either less marked or all together non-existent. As noted by Boldrin *et al.* (1999), the main cause for that latter observation might be that an important fraction of women are ineligible for early retirement benefits.
6. A generalized version of the accrual, namely the «peak value», has been recently introduced in Coile and Gruber (2000).
7. Decreasing *tax* profiles are possible at ages $\{\tau_M + 1, ..., \tau_N - 1\}$ for individuals with increasing wages.
8. Before τ_m the opportunity cost do not include the lost pension, irrespectively of how it is computed.
9. When the threshold is binding at age τ the accrual is $acr(\tau) = -C_\tau - \underline{P}_\tau$ and the final effect on the incentive is unclear: the negative effect derived from the fact that $\gamma < 0$ is removed but, at the same time, the opportunity cost of the lost pension grows.
10. This fact has been taken into account in the recent reformulation of the Swedish pension system —see Scherman (1999), page 9—. In the new public pension scheme the pensionable earnings ceiling is indexed to wages.
11. See Boldrin *et al.* (1999) and (2002) for a description of the source.
12. The expected average monthly income in 1995 for a 60-years-old men (women) was 361.361 (306.644) pesetas for workers in groups 1 to 4. The corresponding figures for workers in groups 5/10 were 182.189 (130.740) pesetas.

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Resumen

En este trabajo exploramos teóricamente los efectos de las disposiciones de pensiones sobre un cierto número de medidas de incentivos financieros para la jubilación, y tratamos de reconciliar los resultados con las pautas fundamentales de jubilación en España. Encontramos que los individuos promedio (aquellos que nunca se ven afectados por los topes en las pensiones o contribuciones) tienen escasos incentivos para la jubilación anticipada y muy fuertes para jubilarse en la Edad Normal. En marcado contraste, individuos en el extremo inferior de la distribución de ingresos tienen un incentivo muy fuerte a jubilarse lo antes posible, como consecuencia de la interacción entre las penalizaciones de jubilación anticipada y la pensión mínima. Ambos descubrimientos encajan perfectamente con las probabilidades condicionadas de jubilación empíricas para trabajadores de ingresos medios y bajos respectivamente. Por el contrario, los trabajadores de ingresos altos (aquellos que ven truncadas superiormente sus contribuciones sociales) no anticipan su jubilación pese a tener incentivos importantes para hacerlo. Esto se debe a que, para estos trabajadores, los incentivos financieros no proporcionan una buena aproximación a la utilidad marginal de trabajar. Finalmente, analizamos las razones que han llevado al fracaso a la reforma de 1997 (en su intento de mejorar las expectativas financieras del sistema de pensiones español).

Palabras clave: jubilación, Seguridad Social, Incentivos monetarios, Reforma del Sistema de Pensiones, España.