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Departamento de Economía
Universidad Carlos III de Madrid
Calle Madrid, 126
28903 Getafe (Spain)
Fax (34) 91 624 98 75

THE EFFECT OF PENSION RULES ON RETIREMENT MONETARY INCENTIVES WITH AN APPLICATION TO PENSION REFORMS IN SPAIN *

Sergi Jiménez-Martín[1] and Alfonso R. Sánchez[2]

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, because ot the interaction between age-related penalties and the minimun pension. Both findings perfectly accommodate the retirement hazard of medium and low earners respectively. In contrast, high earners (those that have their contributions capped) despite having strong incentives to retire at the Early Retirement Age, do not 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.

Keywords: Retirement, Social Security, Monetary incentives, Reform, Spain.

JEL Classification: H3, H5.

[1] Universidad Carlos III de Madrid, Departamento de Economía; E.mail: jimenez@eco.uc3m.es
[2] Universidad Carlos III de Madrid, Departamento de Economía; E.mail: amartin@eco.uc3m.es

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1 Introduction

Social Security systems in developed countries nowadays are faced with two –greatly documented– processes, that clearly threaten their financial sustainability: the aging of the population and the tendency towards early retirement. In the present work this second point is analyzed, in particular the links between (early) retirement behavior and the institutions or *details* that compose a particular pension system. There are two reasons for this interest. First, early retirement has a very important impact on Social Security burden and its prospects 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 great 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 on various levels such us the study of implicit incentives (for example, Gruber and Wise [9] or Blöndal and Scarpetta [3]); reduced-form models of retirement (such us Samwick [18]); models of conditional consumer decisions in a given economic environment (Stock and Wise [20] or Rust [17]); and dynamic general equilibrium models where the agents interact in a public legislation framework (for example, İmrohoroğlu et al. [11]). For the Spanish case it is worth mentioning some work on reduced-form models of retirement such as Alba-Ramírez [2]; or Dynamic General Equilibrium models (Rojas [16], Arjona [1] or Conesa and Garriga [8]) and, finally, evaluation of implicit incentives such as Boldrin et al. [4].

In line with [9] and [4] we dissect the effects of the key ingredients of a pension system on 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 [13] it is shown that, for many workers, financial incentives reasonably approximate the optimal retirement rule from a life cycle consumption-leisure model.[3]

In more detail, we analyze the financial incentives to keep working or retire 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, contribution and benefit caps. In such context the properties of incentive measures are analyzed from a diversity of angles: age profile (as in [9], the real wage level and the wage real rate of growth. To check the implications of the analysis, we construct simulated cases using the parameters (detailed in the appendix A) that characterized the 1985 Spanish pension system.

We find that the interaction between age penalties and the minimum pension causes strong incentives to retire for low earners. Alternatively, "average" earners have no incentives to retire at the early retirement age since they are unaffected by the minimum pension. Both findings practically mimic the observed retirement patterns for the low and the "average" Spanish earners.

[1] Proposals to reform Social Security legislation (see Kalisch and Aman [14] for a summary of reform processes across OECD countries), that eventually aim at substantial cuts in future commitments, have been based on the financial difficulties foreseen for PAYG systems. In Spain, as noted by Herce and Alonso-Messeguer [10], an important fiscal imbalance in the public pension system from 2020 onwards is expected.

[2] The earliest example of incentive indicators can be found in Lazear [15]. For the first time, the remuneration received by an aged worker is considered to be not only his nominal wage but also the changes produced in his rights to a company pension by his decision to keep working.

[3] There is a notable exception: the case of high earners whose contributions and benefits are capped. For them financial incentives and the marginal utility derived from work can differ substantially.

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 for these workers, the change in Social Security Wealth relative to the wage and the marginal utility from work, differ substantially. Finally, other elements of the system, such as the fiscal system or the contribution caps are, for a majority of workers, definitively less important.

What are the facts to explain in the Spanish case? 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.[4]. For men in contribution groups 1–4 the hazard peak at 65 is the only very important one. Alternatively, for men in contribution groups 5–10 both the peak at 65 and 60, the first year at which benefits become available, are evident.[5] In the second and fourth rows of Figure 4 we present hazard rates for individuals aged 60 and 65 by the percentile of the expected wage at age 60. Low earners, most likely affected by benefits floors, exit at 60 in a much higher fraction 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 diminish both the previous incentives to retirement and the Social Security liabilities. Still, it produces some redistribution from above average pensions to below average pensions, because of the different shape of the wage profile for those groups of workers. 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 reform proposals aimed at motivating people to keep working beyond the normal retirement age and find that for a moderate premium the retention effect is of little importance.

The structure of the rest of the document is as follows. In section 2 we describe the public framework win which the analysis is undertaken. Section 3 reviews the incentive's measuring instruments. 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. Finally, section 6 summarizes 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.

[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 60 years for men (women) is 361.361 (306.644) 1995–pesetas and 182.189 (130.740) pesetas for groups 1–4 and 5–10, respectively. The data comes from register data from working histories [see Boldrin et al. [4] 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 are caused by the small number of observations at that ages). Alternatively, the peak at age 60 is either less evident or non-existent. As noted by Boldrin et al. [4], the main cause of that fact is that an important fraction of women are ineligible for early retirement benefits.

– Contribution caps: minimum and maximum level of contributions.

– Minimum/maximum pensions and their family considerations.

– Survival pensions and other tokens of generosity.

The combination of some or all of these elements configures a particular PAYG system. In our work 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 history penalization schemes (P1). (2) Norms that specifically affect individuals with extreme levels of income and/or benefits: tax allowances (P2); 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 income from a certain number of previous wages –updated for inflation (P00); a progressive tax system (P01); and a Social contributions system (P02), characterized by a constant payroll tax rate c, that finances the pension system.

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 for $j = \{\tau - 1, \ldots, \tau - R\}$, which for the moment coincide with real labor income before taxes (W):

$$P(\tau) = B(R, \bar{R}, \tau) = \frac{1}{R}\left\{\sum\nolimits_{j=1}^{R-\bar{R}} BC_{\tau-j} + \sum\nolimits_{j=R-\bar{R}+1}^{R} BC_{\tau-j}\frac{I_\tau}{I_{\tau-j}}\right\} \tag{1}$$

the $\bar{R}$ farthest BC_τ are updated for inflation (I_τ). Once $P(\tau)$ is computed, its value remains constant.

The individual pays taxes for her labor and/or pension income following a progressive tax scheme where tax rates grow linearly according to taxable earnings. Under this scheme the net real labor income w is given by,

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

where $C = cW$ denotes social contributions and ϑ_w will be called the wage tax wedge. In a similar fashion for pensions we obtain, $p(\tau) = \vartheta_p(w_0, \gamma; \eta_0, \eta_1)\, P(\tau)$. Note that both tax ratios ϑ_w and ϑ_p, apart from tax parameters, depend on both the wage growth rate (γ) and its initial level (w_0). The ratio $\vartheta(w_0, \gamma; \eta_0, \eta_1, c) = \vartheta_p/\vartheta_w$ or pension tax generosity will be useful when studying the effects of fiscal progressivity 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 retire before a "normal retirement age" (τ_N, the first age at which full benefits are available) or having an insufficient number of contributions. 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 became available and $n(\tau)$ represents the number of years of contribution at age τ. Thus in economy P1 the initial (real) retirement benefit is given by:

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

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 in case they lie underneath this minimum and varies according to a constant real rate of growth μ. Similarly, we assume that there exists a maximum level of contributions $\bar{C}_A$ which evolves with time according to a constant rate $\bar{\mu}$. Finally, in P4 we consider a unique minimum pension scheme that substitutes the pension when it falls below that minimum. Its evolution over time is entirely characterized through 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, described by respectively $\bar{P}_A$ and $\bar{\rho}$.

3 Incentives measurement instruments.

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

A1 Individual perspective: only the income that can be personally enjoyed is considered.

A2 Labor income and pensions are respectively the only source of income while active and retired.

A3 There is a positive conditional probability of dying at any age in $\{1, \ldots, F-1\}$. At age F such probability is one.

A4 The individual does not expect future changes in public regulations.

Definition of incentives

Under such conditions we define the following incentive's measures for immediate retirement of an individual aged τ years old $[\tau_0, \cdots, T]$:

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

$$rr(\tau) = E_\tau[p(\tau)/w_\tau]$$

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

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

where $\beta = 1/(1+r)$ denotes the time discount factor which is related to a fixed interest rate r and $\phi(i|\tau)$ 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.[6]

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

Implicit tax, $tax(\tau)$**:** Value of postponing retirement expressed as a fraction of the future expected wage $tax(\tau) = -acr(\tau)/w_\tau$

3.1 Simulation design and base case characteristics

We set up a longitudinal experiment that consists in placing a base case individual in a simple economic and institutional environment and computing her $tax(\tau)$ as she ages between $\{\tau_0, \ldots, T\}$. At age τ_A her age profile is anchored to a calendar year that is the reference for the institutional parameters (detailed in appendix A) and real quantities. This context will be useful both for dissecting the effects of the various pension rules and for exploring the effects of 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 some of those characteristics are either fixed or parametrized as follows:

- Only member of an individual family with a constant mortality hazard ϕ, independent of age.
- An initial nominal wage, w_0, and contribution history of $n(\tau_0)$ years at τ_0.
- Continuous working history from τ_0 to τ, which implies that $n(\tau+1) = n(\tau)+1$.
- A constant rate of growth, λ, of the nominal wage, which implies that $w_\tau = (1+\lambda)\, w_{\tau-1}$

4 Incentive analysis.

In this section we obtain simplified expressions of the incentive measures that will eventually help explain their dependence on the key ingredients of the pension system. Let us start with a decomposition of the social security wealth in case of immediate retirement,

$$SSW(\tau,\tau) = \sum\nolimits_{j=\tau}^{F-1} \beta^{j-\tau}(1-\phi)^{j-\tau}p(\tau) = p(\tau)\sum\nolimits_{j=\tau}^{F-1} d^{j-\tau} = p(\tau)AT(\tau,F) \quad (6)$$

where $\beta(1-\phi) = d$, p is the initial pension and $AT(\tau,F)$ is, from the perspective of age τ, the "Benefits Accumulator" from τ to $F-1$. The Benefit Accumulator depends on life horizon and

[6] Coile and Gruber [7] have recently proposed the use of a generalized version of the accrual, namely the "peak value".

future discounting. In case the individual considers postponing retirement by one year he would obtain:

$$SSW(\tau+1,\tau) = p(\tau+1)AT(\tau+1,F) - c\,W_\tau \tag{7}$$

Denoting by $\psi = \Delta p(\tau)/p(\tau)$ the growth rate of real benefits, then the Social Security accrual in case retirement is postponed one year is:

$$acr(\tau) = p(\tau)(\psi AT(\tau+1,F) - 1) - c\,W_\tau \tag{8}$$

from this expression, for ages $\tau \geq \tau_M$, a simple formula for the unit horizon *tax* incentive is immediate:

$$tax(\tau) = rr(\tau)(1 - \psi AT(\tau+1,F)) + K \tag{9}$$

where K is a function of labor and income tax parameters. In case retirement at ages $\tau \in [\tau_0, \ldots, \tau_M - 1)$ -where benefits cannot be received- is considered, by following similar arguments, we find that:

$$tax(\tau) = -rr(\tau)\psi AT(\tau_M, F) + K \tag{10}$$

These formula are valid regardless whether the individual exhibits a constant (γ) or a variable real wage rate of growth. The key results with a wage process exhibiting a constant growth rate are presented next. The results under a "more realistic" quadratic wage process are commented in 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 on 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 first row of Figure 1 two elements affect retirement incentives. The first one is the fact of having reached the age at which benefits are first available. The exit incentives are always lower when the actual age is below that age because waiting an extra year does not reduce the period in which benefits are received. The second is the individual's wage profile shape parameter, γ, which is inversely related to the *tax*: $\partial tax(\tau)/\partial\gamma < 0$. In such context, it is easy to proof that there exists a trigger rate $\overline{\gamma} = 1/AT(\tau+1,F)$, slightly increasing with age, above which there are incentives to continuing work. This is because the only thing that could increase the individual's Social Security wealth is a wage increase large enough so as to increase the benefit base in such a way that offsets the benefits foregone during the additional year of work. It should be clear that this can happen only if γ is positive and sufficiently large.

A third element also merits our 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 continuing work 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:

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

where $(\partial\vartheta_p/\partial\tau)/\vartheta_p$, which captures the effect of the progressivity of the system, smoothes out the influence of the wage profile on the change in the benefit from postponing retirement by one period.

Under such circumstances the threshold of existence of incentives to continuing work ,$\bar{\gamma} > 0$, is higher; the $tax(\gamma)$ curve slightly flattens; and, the evolution of the $tax(\tau)$ curve is marginally altered although the pattern remains essentially flat; finally, since the $sign\{\partial tax(w_0)/\partial w_0\} = sign\{\gamma\}$ the richer the individual the higher the tax 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 progressivity that would be necessary to make these alterations quantitatively important seems to be empirically irrelevant.

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 for one period is reduced by the amount of contributions paid during the extra year of work. On the other hand, a given $acr(\tau)$ represents now a larger fraction of wages net of contributions. Formally, the replacement rate takes now the value $rr^{02} = rr^{00}/(1-c)$, exacerbating the incentives encountered in P00. Therefore for individuals with $tax > 0$ in P00 both effects unite to increase incentives to exit. Alternatively, when $tax < 0$, both 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 first age of entitlement to a pension; 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 progressivity (P01) or contribution payments (P02) are considered.

Given these results, in the next section we start analyzing the incentive effects of both penalization schemes (P1) are analyzed on the top of P00. We follow reviewing tax-free allowances (P2), min/max contributions (P3) and pensions (P4) on the top of both P00 and P00 + P01. This last step aims at differentiating the incentives affecting an 'extreme' individual (subject to truncations) from those affecting a 'normal' or 'average' individual. The key results from the analysis are summarized in Table 1.

4.1.2 Age and contribution history penalization schemes (P1).

In the context of P1 two effects appear that are important for retirement incentives. First of all, there is an obvious reduction in the replacement rate, that becomes $rr^{P1} = AP(\tau)HP(n(\tau))\, rr^{00}$. Second, the increase in benefit due to postponing retirement one year grows because penalization are strictly decreasing in age. Reflecting this fact, ψ changes to $\psi^{P1} = \sigma + (1+\sigma)\gamma > \psi^{00}$, where σ, which always is greater than zero, is a function $\sigma = \sigma(\alpha, \kappa, \tau, n(\tau)) > 0$.

We detect three important consequences of the change in ψ. First, the threshold for incentives to continuing work falls. Typically becomes negative at early ages. Second, as illustrated in the left central panel of Figure 1, the shape of the *tax* age profile changes abruptly: At ages $\{\tau_0, \ldots, \tau_M - 1\}$ the *tax* falls; at age τ_M a decreasing discontinuity appears that contrasts with what was observed in P0 (top left panel of Figure 1; finally, at ages $\{\tau_M + 1, \ldots, \tau_N\}$ the *tax* increases with age until τ_N where a sudden jump of the *tax* is observed. Notice that there another possible jump, of smaller magnitude, at the end of history penalties.[7] Third, the importance of the wage profile on the *tax* is softened.

Regarding the effect of the contribution history in the context of P1 intuition would suggest that individuals with incomplete histories must have less incentives to retire than people with the same (τ, w_0, γ) but complete histories, due to the fact that they have a higher ψ than them. A more detailed study throws down a more ambiguous result. On one hand, there is an abrupt increase in the incentive when history penalties end at the contribution period n_M. On the other hand, while they are active 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 between individuals with incomplete histories. At early ages the *tax* decreases with $n(\tau_0)$ (except for highly decreasing profiles), a pattern that progressively inverts itself as the individual ages.

Simultaneous consideration of P0 and P1 (see the central panels of Figure 1 and Table 1) shows "average" workers' incentives: (1) the age penalization scheme creates a clear retention incentive at age τ_M, increasing exit incentives in the age range $[\tau_M + 1, \ldots, \tau_N - 1]$ followed by an abrupt jump when τ_N is reached; (2) for a fixed age, γ moderately influences 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 $\gamma < \kappa_1$. For the rest of the people the pension formula discourages early retirement; finally, (4) the wage level is almost irrelevant.

What is the likely the retirement pattern compatible with such incentives? An increasing with age exit rate, with a pronounced peak at age 65. Early retirement at 60 would be chosen by a minority (only individuals with a very decreasing profile). Amid 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 retirement incentives of "average" individuals are unaffected by tax allowances, that of low earners, as illustrated in the bottom row of Figure 1, can be either reduced (because of the substitution of the net wage by the gross wage) or disrupted by small jumps at the points separating the regions where tax allowances are enabled or disabled. In either case, the effects are of small importance.

[7] Decreasing *tax* profiles are possible at ages $\{\tau_M + 1, \ldots, \tau_N - 1\}$ for individuals with increasing wages.

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 $\gamma < 0$) and very intense punctual incentives to exit are created at the age the tax-free allowances are deactivated (when $\gamma > 0$). These incentives appear as sudden discontinuities in the pattern of incentives according to age. The relevance of such discontinuities diminish 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. When the individual ages and, consequently, penalties are less severe, the benefit tax-free allowance can be 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 the labor income level and/or profile. However, this general *equalizing* effect sharply varies with the particular threshold.

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

The ceiling on contributions becomes fully operative when all wages that enter in the formula for the *benefit base* are above the legislated maximum. In such case, (8) can be expressed as:

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

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:

$$acr(\tau) = -C_\tau - \overline{p}_\tau \tag{13}$$

Both (12) and (13) reflect an accrual that is *essentially* independent of the individual labor income process. Notice that when both penalties are not binding $\psi = 0$ and thus both (12) and (13) fully coincide. 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. The latter fact greatly dampens the effect of the maximum contribution. 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 a very high initial wage level –central column– or real rate of growth of the wage –right column) 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.

[8] Before τ_m the opportunity cost do not include the lost pension, irrespective of how it is computed.

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).

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 first age of 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, for instance, Spanish empirical patterns– is stronger the lower the salary considered. Notice that this case is the one empirically relevant 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 $\tau_m, \tau_m+1, \tau_m+2$. 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 ages above 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 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 is reduced as a result of $AT(\tau, J) < AT(\tau, F)$. 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 age and contribution penalties fostering early retirement behavior. Note that this distortion will be more important as time passes because 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. [5]; 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 we have simulated incentive profiles with a quadratic wage process in which the curvature is parameterized through $\tilde{\gamma}$, the incremental rate between ages τ_0 and τ_N.

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

[9] When the threshold is binding at age τ $acr(\tau) = -C_\tau - \underline{P}_\tau$ so as 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 [19], page 9–. In the new public pension scheme the pensionable earnings ceiling is indexed to wages.

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 until the pattern of the *tax* is left nearly flat at $\tilde{\gamma}$.

5 An application to the Spanish Social Security reform analysis.

In this section we, first, describe the Spanish Social Security General Regime (RGSS). Second, we check whether the empirical retirement patterns of workers enrolled the RGSS match the theoretical incentive profiles we have described in the former section. Third, we evaluate the implications of the 1997 reform in terms of retirement incentives of that reform. Finally, a few reform proposals aimed to motivate workers to stay in the labor market beyond 65 are discussed.

5.1 Spanish Pensions System: RGSS

Next we shall describe before and after the 1997 reform the rules governing the RGSS, that currently covers over 70 percent of the total number of affiliates to the Spanish Social Security System.

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 share 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 that range 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 percent, of which 23.6 percent is due by the company and the remaining 4.7 percent by the worker.

In order to have the right to a retirement pension, a minimum of 15 years of contributions is required, two of which must lie in a period of ten years immediately before retirement.

5.1.2 Benefit computation

Consider a 65 year old person who fulfills the eligibility criteria, who retires in month t after having contributed $n > 15$ years. His first theoretical monthly benefit, under the system in place from 1985 to 1997, can be expressed as, $P_t^{85} = HP^{85}(n)\, B_t^{85}$, where the benefit base B_t^{85} is a weighted average of the monthly pensionable wage or base of contribution BC_{t-j} for which he has contributed to Social Security during the 96 months (eight years) that came immediately before retirement:

$$B_t^{85} = \frac{1}{112}\left(\sum\nolimits_{j=1}^{24} BC_{t-j} + \sum\nolimits_{j=25}^{96} BC_{t-j}\,\frac{I_{t-25}}{I_{t-j}}\right), \tag{15}$$

where I_{t-j} is the Consumer Price Index for the month j before retirement. Thus, earnings in the last two years before retirement are not adjusted for inflation. For earlier months, they are adjusted and converted to money equivalents of the 25th month before retirement. 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

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

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

5.1.3 Early retirement

The normal retirement age is 65, but early retirement as from age 60 is permitted (with a penalty of 8 percent per year anticipated on 65) provided that the individual started contributing to the Social Security system before 1967.

It should be stressed 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 possible substitution of a "bad" wage period 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 percent of the benefit base, while in the second case it only increases from 98 to 100 percent.

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, summing other incomes, the individual does not earn more than a certain annual amount (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 them, 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 few representative empirical hazard using information from a sample of working histories from the Spanish RGSS in 1995[11] to check to what extend theoretical incentive

[11] See Boldrin et al. [4] for a description of the source

profiles are able to match empirical retirement hazards. In 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. Contribution groups 1–4 and 5–10 can be assimilated respectively to individuals with high–medium and medium–low incomes.[12]

For men in contribution groups 1–4 the hazard peak at 65 is the only very important one. Alternatively, for men in contribution groups 5–10 both the peak at 65 and 60, the first year at which benefits become available, are evident. For women (third row of that figure, 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 are caused by the small number of observations at that ages). Alternatively, the peak at age 60 is either less evident or non-existent. As noted by Boldrin et al. [4], this is likely to be caused because of the fact that an important fraction of women are ineligible for early retirement benefits.

In the second and fourth rows of Figure 4 we present hazard rates for individuals aged 60 and 65 by 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 fraction 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.

5.3 The 1997 reform

The 1997 reform introduced three changes. (i) The number of reference years in the formula starts to increase by one every year from eight up to fifteen to be reached by 2002. (ii) The penalty for insufficient contribution changes in the following way:

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

(iii) The early retirement penalty is reduced –from 8 percent to 7 percent– for those who have contributed for more than 40 years by the time of retiring. Note that this change provides an extra incentive of 5 percent for those who have contributed more than 40 years when they reach 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 see them reduced during the last years of their labor 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 60 and 64 years old and reach, within this period, 40 years of contribution, while leaving the rest of individuals unaffected.

Jiménez-Martín and Sánchez [12] show that only (i) is quantitatively important. Analyzing the RGSS sample they find that between ages 50 and 65 the contribution bases between 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

[12] The expected average monthly income at 60 years for men (women) is 361.361 (306.644) 1995–pesetas and 182.189 (130.740) pesetas for groups 1–4 and 5–10, respectively.

from high earners' 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 [4] 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 shape parameter of the wage profile. For increasing profiles, $\gamma > 0$,the reform always reduces the implicit debt while for decreasing ones, the debt augments for a broad range of wage levels. Second, the reform is especially beneficial for individuals with 40 years of contribution by age 60. Alternatively, for those who only have 30 years of contribution by age 60 the reform is only beneficial from age 63, depending on the value of γ. 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 evaluate the reform on the light of the stylized model presented in section (4).

5.4.1 Evaluation of contribution history reforms.

We consider the effects of modifications in the contribution history penalties for individuals with average income (not affected by wage level thresholds). The analysis to economy P00 + P1 where the key qualitative results are evident. Recall that in this economy the expression of the incentive is given by:

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

Let us consider a new penalization scheme that while leaving unchanged the thresholds n_m, n_M, modifies the amount of the penalties to new values $\kappa_0' < \kappa_0$ and $\kappa_1' > \kappa_1$ implying that $HP' < HP$.

The change in the incentive is driven by the simultaneous alteration 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:

$$\psi' > \psi \Leftrightarrow \sigma' > \sigma \Leftrightarrow \kappa_1'/\kappa_1 > \kappa_0'/\kappa_0 \tag{17}$$

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 is 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 a individual with higher γ are considered. In fact, for extremely positive wage profiles the reform may reduce the incentives to keep working.

In order to be more precise we turn to the comparison of the incentives faced by a base case individual under three alternative contribution history schemes: before the 1997 reform (base or 1985 system), after that reform (namely, the **Concave Reform**) and under the following alternative scheme (namely, a Convex HP reform):

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

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

For the concave reform, the threshold γ^* is positive, thereby retaining all individuals that are characterized by a decreasing wage profile (that is the less skilled). 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 (less than 10 percent) of male workers 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.

To conclude this section let us now review how the Social Security debt towards an archetypal individual (average wage and softly decreasing profile) as a function of retirement age varies with the alternative contribution history schemes (see the left top panel of Figure 5). Given that both reforms increase penalties with respect to those existing before the 1997 reform, it is clear that both suppose a relief for the Social Security's burden. In any case, it becomes clear looking at the figure that the convex reform would suppose considerably superior savings, especially if workers were to respond to the higher permanence incentives by postponing their retirement age.

5.4.2 Reform of the age penalization

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 5.1.3 and the alternative reform follows next:

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

For both reforms the penalization is lower than in the initial situation, so that $AP' > AP$ which implies that $rr' > rr$. What is really different between both reforms is the range of ages for which they imply a bigger reduction of the AP. The 1997 reform reduces the AP a 5 percent by age 60, four by age 61 and so on, whereas the alternative AP reform gives percent at 60, to percent at age 61 and so on. As for ψ, we find a condition that is analogous to the one found in (17):

$$\psi' > \psi \Leftrightarrow \sigma' > \sigma \Leftrightarrow \alpha_1'/\alpha_1 > \alpha_0'/\alpha_0 \tag{18}$$

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 retains the individuals. 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 these ages where the financial cost of the alternative reform for the Social Security is lower than the cost of the 1997 reform. In any case, if individuals were to respond favorably to the retention incentives, the most feasible situation would be that the system be forced to face higher costs in the case of the new reform as the retirement age increases. Only if retirement were to be postponed until 65 would the additional cost of the new reform be zero.

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

In this section, we study the effect of the extension the number of years of contribution that enter in the formula of the benefit base, R, to a higher value R', as is proposed in the 97 reform. At first glance, it is easy to show that the new replacement rate in P00, $rr^{'}$, is greater (lower) than the initial one only for 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. It only strengthen its level: at the early retirement age (where the penalties lead to a negative threshold $\bar{\gamma}$, usually lower than the steepness of the profile of the archetypal worker) the reform increases the incentive to keep working; alternatively, at an age near τ_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, in Spain pension rules 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 mandatory workers contributions (1/6th of Social contributions in the Spanish case) for 65+ workers. Notice that this reform increases the net wage and reduces the replacement rate; and (2) Permitting the AP to be greater 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 the "average worker" in the age range, $\tau \geq \tau_N = 65$ and subject to pension system P0. Under the proposed modification of mandatory contributions after age 65, the new *tax*, is given by:

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

where $\vartheta' = \vartheta_p/\vartheta'_w = \vartheta_p/(1-\eta_0-\eta_1 W)$. So as,

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

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 for this reform the progressivity of the income tax is crucial to generate any retention effect. However, the retention does not seems to be enough to offset the ascending step that the *tax* shows at age τ_N.

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

The proposed reform introduces a small alteration of the penalty formula (3) after age 65. represented as follows

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

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', $\psi' = \overline{\alpha}_1 + (1 + \overline{\alpha}_1)\,\gamma$ which implies that $tax' - tax < 0$ if the following inequality holds:

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

So, given the fact that $\varphi > \gamma$, the premium cannot be extremely generous to motivate workers to keep working. Despite so, 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 with roominess at all ages between 65 and 70.

6 Conclusions

In this work we analyze the effect of pension provisions and fiscal norms on the individual financial horizon one *incentives* to retirement. We 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 mechanism by which Social Security forces early retirement of low-wage workers.

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 and the Early Retirement Age τ_m. We find a remarkably clear *negative* relation at the age of 60 (τ_m in the Spanish System), while no defined pattern emerges at 65 (τ_N). This new evidence complements the well known finding of abrupt spikes in retirement hazards at both ages.

We next 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 strongly change with age, as a result of the interaction between the pension formula and early retirement penalties. First, individuals have mild incentives to retire before the first age at which benefits are first available because the pension is unavailable before τ_m. Second, two forces pull in different directions after τ_m: the opportunity cost of the pension lost 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 note 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 isolating the benefit dynamics form the labor income dynamics. Given the fact that 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 $\{\tau_m, \ldots, \tau_N\}$ (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 quantitatively important cases on the other. Still, it produces some redistribution from above average pensions to below average pensions, because of the different shape of the wage profile for those groups of workers. We propose some small modifications in the design of the age and contributions penalties, which would achieve a simultaneous reduction in the retirement incentives (for those previously cited groups) and in the expected Social Security debt.

Finally, on regard the evaluation of some recent reform proposals aimed at diminishing the actuarial unfairness of the Social Security formula after age 65 we find that for a moderate premium the retention effect is of little importance.

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Appendix

A Calibration of the theoretical economy for the Spanish case

We replicate the 1993 institutional framework, a few years before the 1997 reform. The anchor age τ_A is 60 years old and the simulation period $\{\tau_0, \ldots, T\}$ is $\{55, \ldots, 70\}$. 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	$\bar{C}_A$	4.057
α_1	0.08	κ_1	0.02	η_1	0.022	$\underline{\mu}$	-0.007	$\bar{\mu}$	-0.006
τ_M	60	n_m	15	$\underline{W}_A$	1.0	$\underline{P}_A$	0.579	$\bar{P}_A$	3.438
τ_N	65	n_M	35	$\underline{B}_A$	1.2	$\underline{\rho}$	-0.006	$\bar{\rho}$	-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 the one that is applied to the worker for all concepts. As for the contribution minimum, we select $\underline{C}_A$ the value in force for group of contribution 5. In order to parameterize its time evolution, we took the average real growth rate between 1984 and 1997. For the contribution maximum, we proceeded in a similar fashion with respect to the base level $\bar{C}_A$. Calibrating $\bar{\mu}$ is a more delicate matter due to the effort that has been put into the homogenization between categories for this variable. The result is that, from the beginning of the nineties, categories 1–4 have a common contribution maximum. This was achieved by increasing somewhat abruptly the contribution maximums of categories 2 to 4, while the first's maximum followed a smooth pattern of real value loss. This last pattern, less business cycle related and more fundamental, is the one that we wanted to include in the model, so we selected the average growth value starting from the moment when the maximum of the represented category reached the maximum of category 1, that is, in 1989. As for minimum benefits, we reflected the values for single men under 65. Finally, for the fiscal system, we fitted by Least Squares the relation between contributory basis and payments that surges from 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)
$\tilde{\gamma}$	=	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 years required to achieve full pension rights
$\kappa_0,\ \kappa_1$	=	parameters of the history penalty filter
$\underline{C}_t,\ \overline{C}_t$	=	Legal floor & ceilings contributions
$\underline{C}_A,\ \overline{C}_A$	=	Anchor levels for minimum and maximum contributions
μ, $\overline{\mu}$	=	Legal floor & ceilings growth rates
$\underline{\overline{p}}_\tau$	=	real pension when all relevant contributions are truncated
ψ	=	pension growth rate when all contributions are truncated

Fiscal system		
ϑ_w, ϑ_p	=	Wage and pension fiscal ratios earnings
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	=	CPI 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
$\alpha_0,\ \alpha_1$	=	$AP(.)$ parameters
$\underline{P}_t,\ \overline{P}_t$	=	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 measures		
$[\tau_0, \ldots, T]$	=	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
$\phi(j\|\tau)$, ϕ	=	Conditional and conditional constant survival probabilities
$d = \beta(1-\phi)$	=	effective discount factor
$AT(i, F)$	=	$\sum_{j=i}^{F-1} d^{j-\tau}$ or benefits acumulator
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

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 allowances	$\gamma <= 0$ and $(\tau < \tau_N)$: expel $\gamma <= 0$ and$(\tau \geq \tau_N)$: retain Punctual steps: $\gamma < 0$ Retain $\gamma > 0$ Expel	idem idem idem
P30 (for $\mu < 0$)	minimum contribution	$\gamma < \mu$: Retains otherwise: Expels	idem
P31 (for $\bar{\mu} < 0$)	maximum contribution	$\gamma < \bar{\mu}$ 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

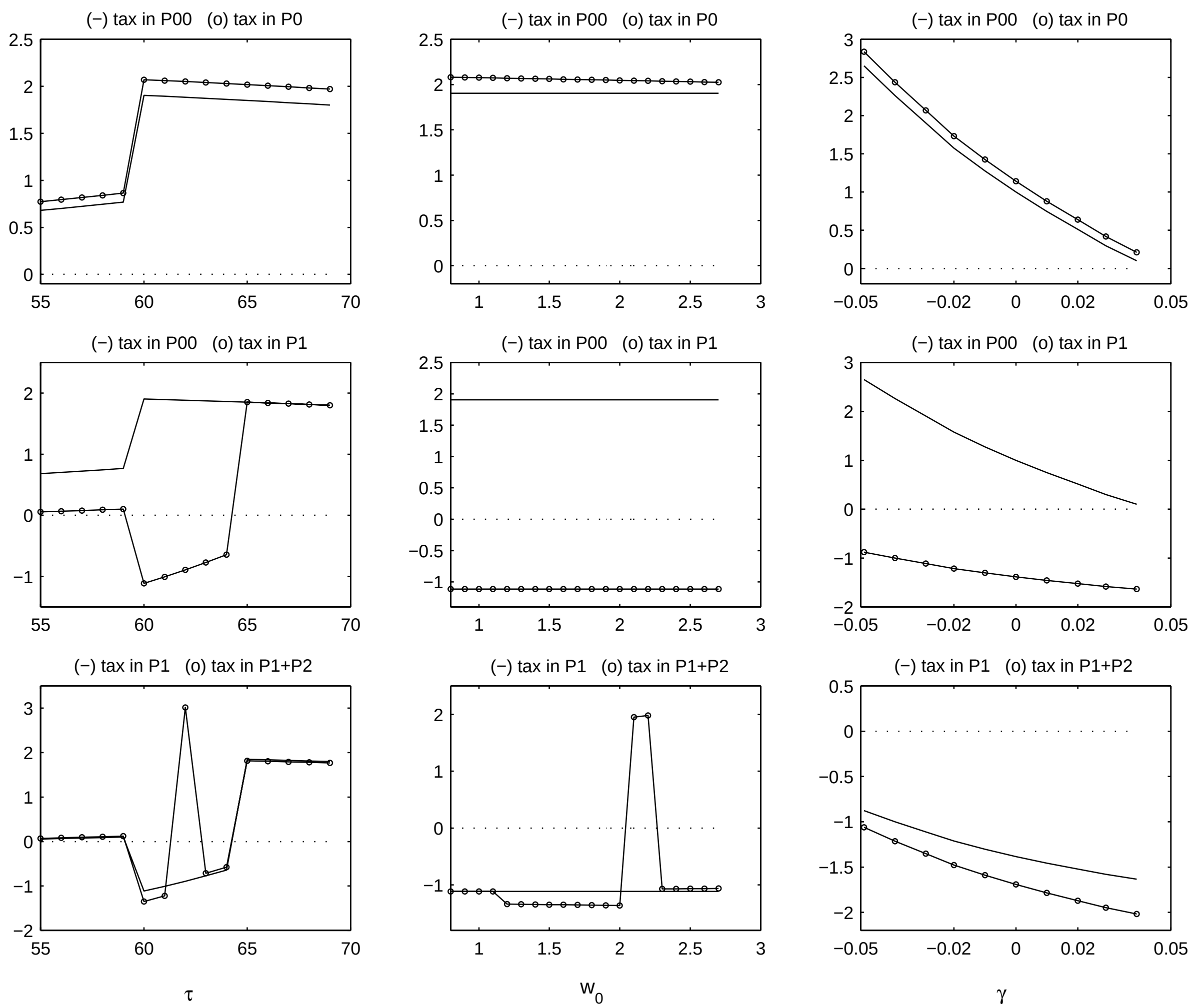
Notation. *Retain* (*Expels*): reduces (increases) $tax(\tau)$; *Moderates*: reduces $|tax(\tau)|$ in absolute value; $\bar{\gamma}$: threshold for a sign switch of the *tax* in each economy.

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

	Base case. Average wage at age 60			
	Forty years of contribution		Thirty years of contributions	
age	$\gamma = -2$	$\gamma = 2$	$\gamma = -2$	$\gamma = 2$
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
	Base case at age 60			
	Forty years of contribution		Thirty years of contributions	
% average wage	$\gamma = -2$	$\gamma = 2$	$\gamma = -2$	$\gamma = 2$
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

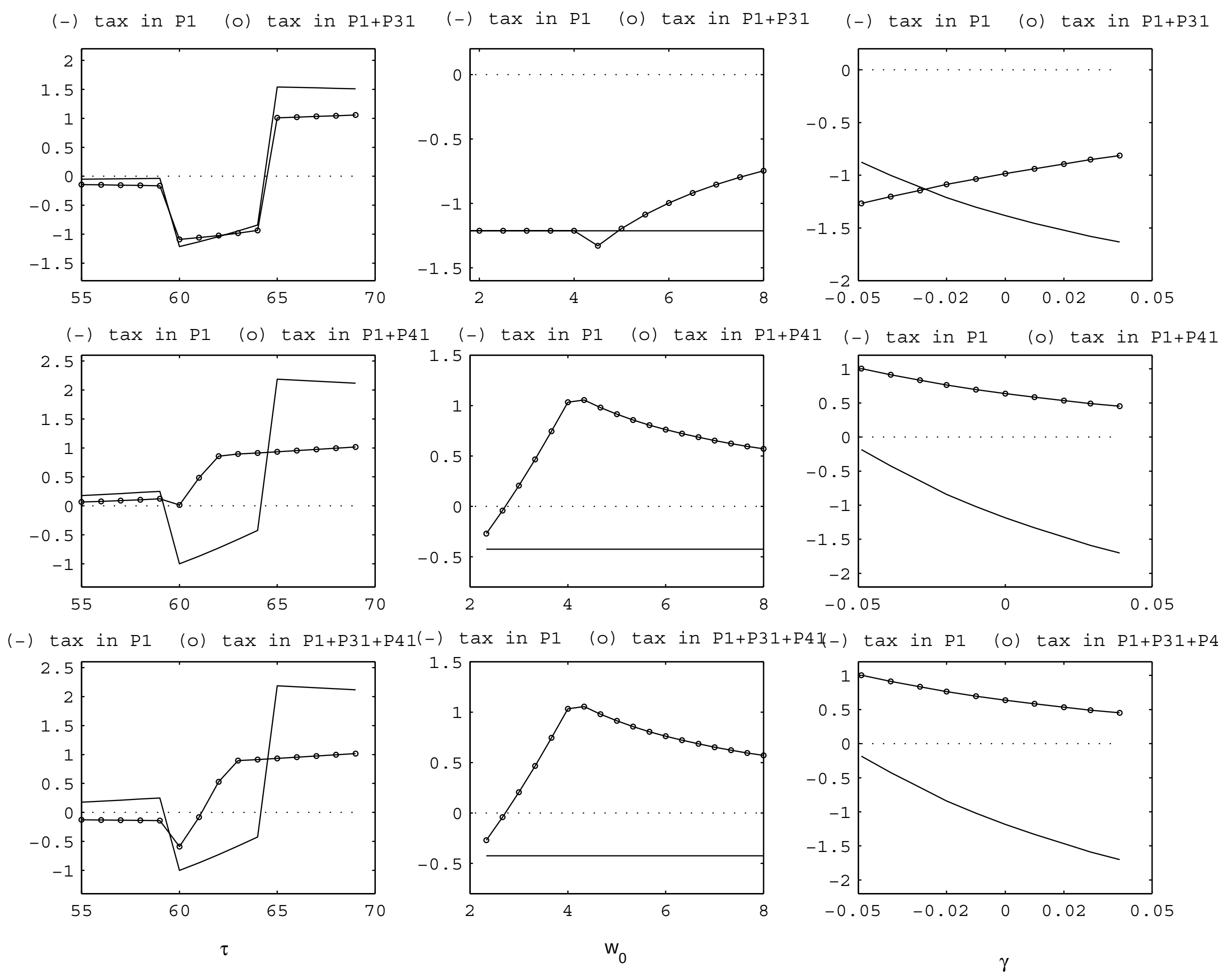
Base case: Single, contributing at group 5, average wage in 1993 and subject to the rules and parameters of the system described in the Appendix

Figure 1: $tax(\tau)$ in economies P0, P1 and P1+P2 for a constant γ.



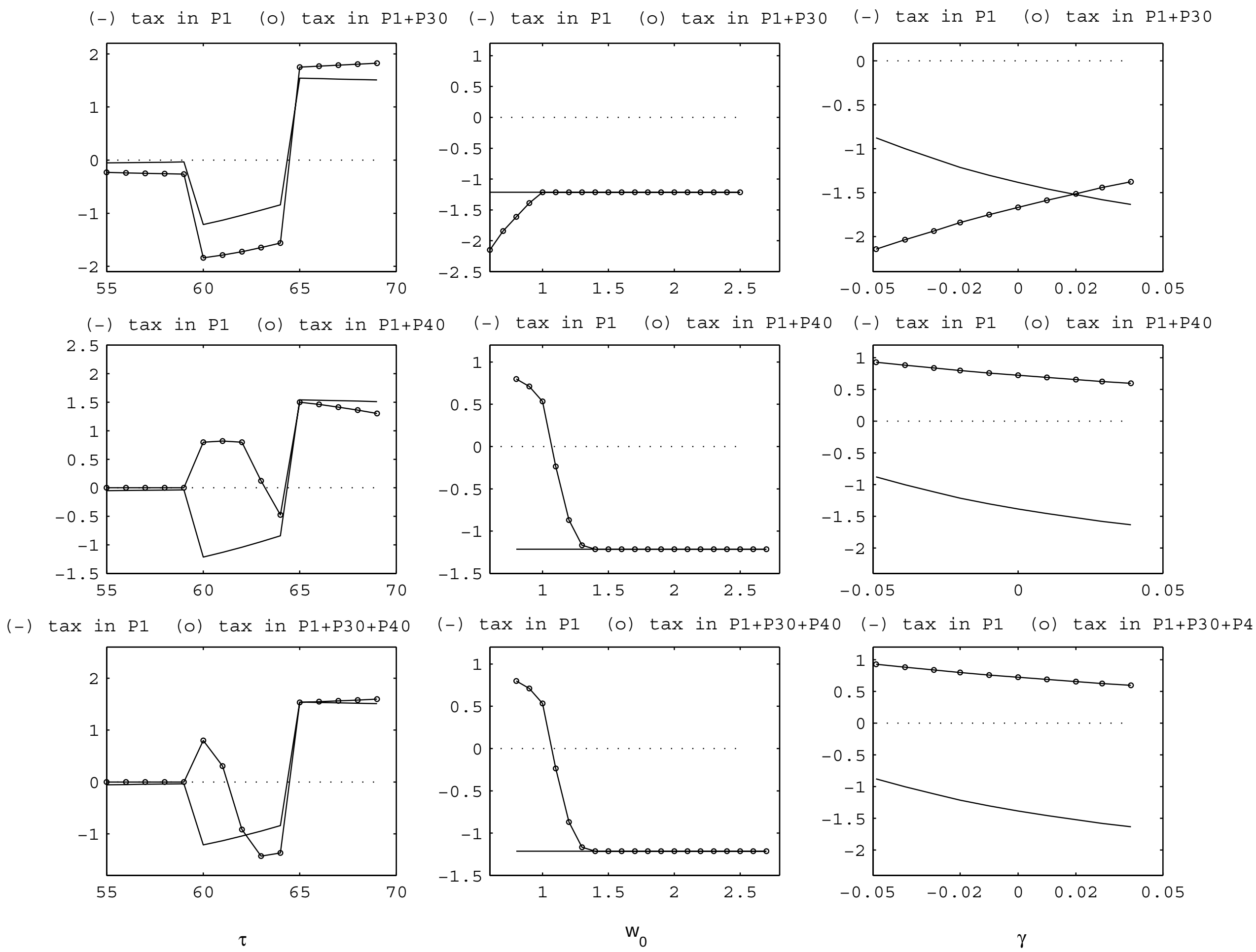
Reference: P0, P1: τ =60, w_0 =1.2, γ =-0.029; P1+P2: τ =60, w_0 =1.7, γ =-0.029.

Figure 2: The effect on $tax(\tau)$ of contribution and pension ceilings for a constant γ.



Reference: P1+P30: τ =60, w_0 =0.700, γ =-0.020; P1+P31: τ =60, w_0 =5.5, γ =-0.020.

Figure 3: The effect on $tax(\tau)$ of contribution and pension floors for a constant γ.



Reference: P1+P30+P40: τ =60, w_0 =0.800, γ =-0.020; P1+P31+P41: τ =64, w_0 =5.033, γ =-0.039.

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

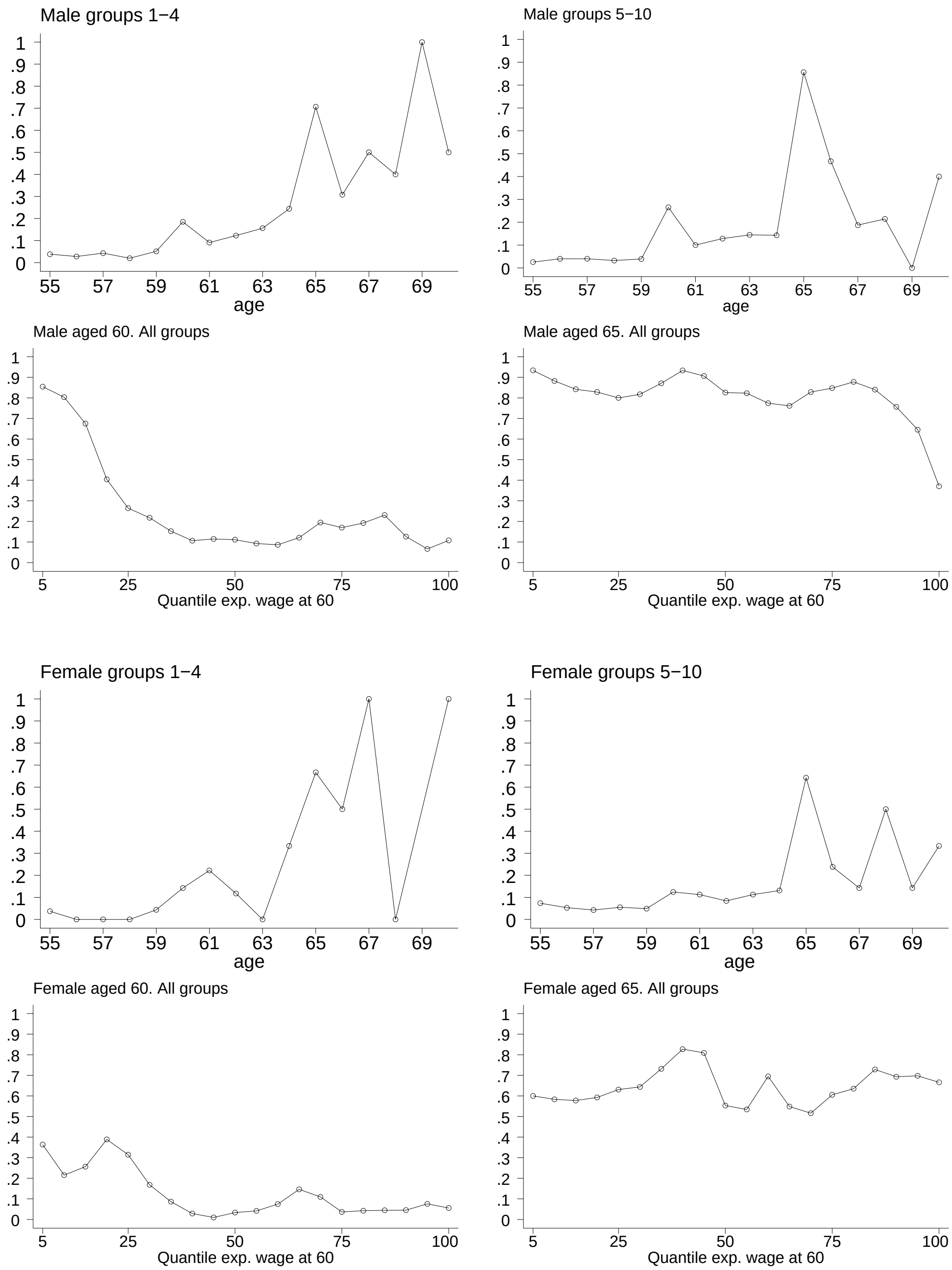
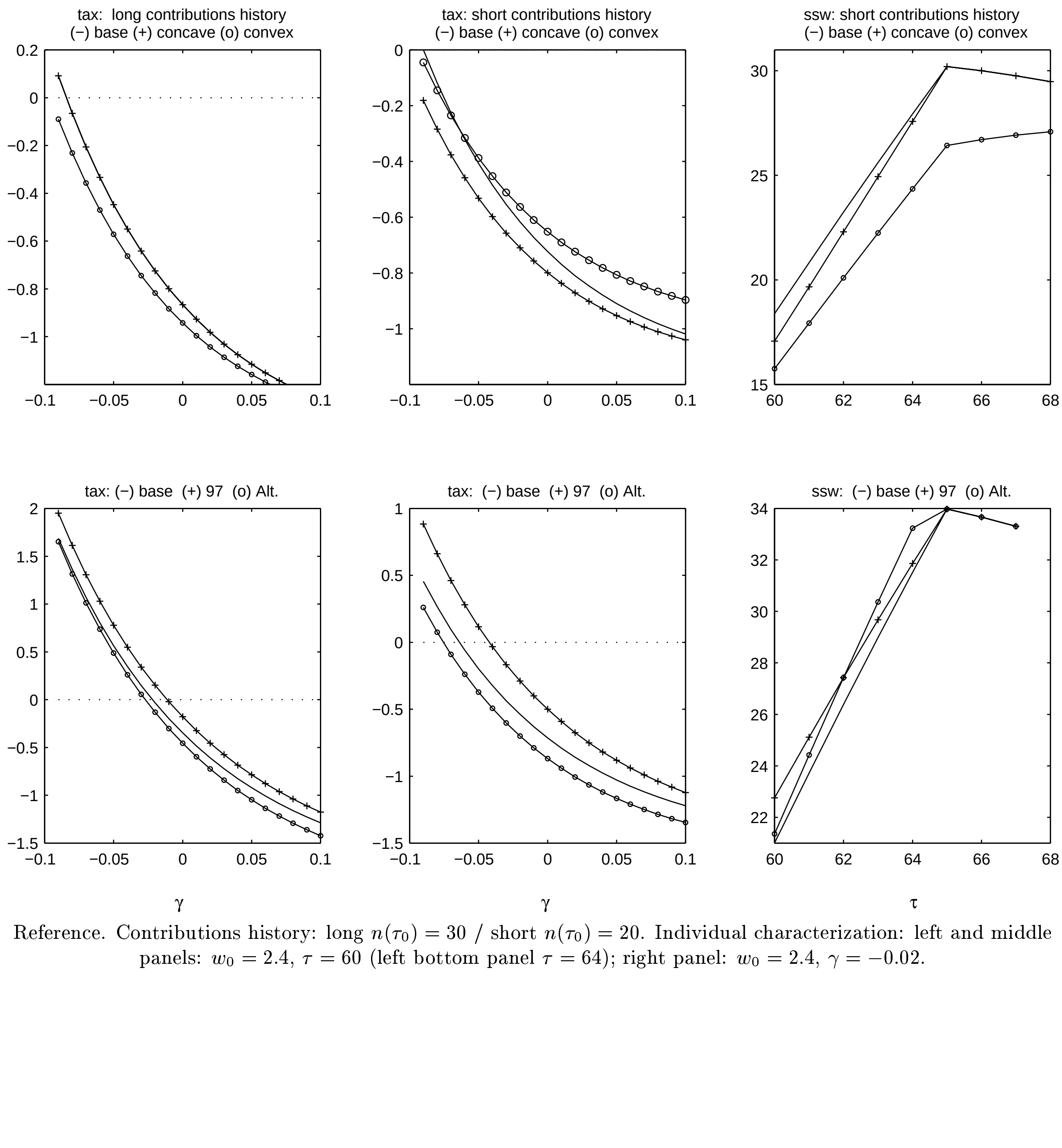


Figure 5: *tax* and SSW from alternative reforms of history and age penalties.



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