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by

J. Ignacio García Pérez*

Alfonso R. Sánchez Martín**

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* U. Pablo de Olavide, FEDEA & FCEA.

** U. Pablo de Olavide.

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Jorge Juan, 46
28001 Madrid -España
Tel.: +34 914 359 020
Fax: +34 915 779 575
infpub@fedea.es

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J. Ignacio García Pérez
U. Pablo de Olavide, FEDEA & FCEA

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Abstract

This paper explores the links between unemployment, retirement and their associated public insurance programs. The analysis combines the development of a life-cycle model of search and retirement with a detailed exploration of the empirical regularities using a Spanish administrative data-set based on employment histories. Our ultimate goal is to uncover the relative contribution of bad institutional incentives versus poor labor demand to the observed low reemployment rates of Spanish workers aged 55 or over.

We find that the low labor supply of the unemployed younger than 60 (the minimum retirement age) is, according to our model, largely the product of the poor conditions in the Spanish labor market. The disincentives in the regulations would *not* stop these workers from searching if presented with higher job offer rates. In sharp contrast, improvements in incentives will make a real difference for workers over 60. In particular, we explore the effects of changing the pension rules to link early retirement penalties to the age when the individual stops paying contributions. This reform removes the incentive to stay unemployed without searching, encouraging individuals to either retire or actively engage in a search process. As a result, the implicit financial liabilities of the pension system are reduced, to the extent that it would be possible to compensate all the workers that suffer direct welfare losses through the reform.

Keywords: unemployment, retirement, pension reform, search models.
JEL codes: J64, J68, J26

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†**Corresponding author:** Dep. Economía, U. Pablo Olavide. Ctra de Utrera Km 1, 41013, Sevilla, Spain. *Email*: arsanmar@upo.es

1 Introduction

The Spanish labor market has a long-standing tradition of not being particularly friendly to elderly workers. At the time of writing, the employment rates of workers aged 50 to 64 are among the lowest in OECD countries (52% in Spain vs. 58% in the EU-15). It has been so for a long period of time, even after the sharp improvement in employment recorded in the last cyclical expansion 2000/2008 (the employment rate for those aged 50-59 rose from 52% in Q1-2000 to 63% in Q2-2008). This tendency was abruptly ended by the current recession, which has sent the unemployment rate in this age range skyrocketing to more than 19% (from 5.3% in Q3 2007). Unemployment data are particularly important as a signal of a dysfunctional labor market. For the older workers, unemployment is supposed to be a transitory stage in the process of returning to the labor force or before a permanent withdrawal from the job market. However, the incidence of long-term unemployment (+1 year) is particularly high in this group (39% vs. 25% in the 16/64 age group), ending, in most cases, in withdrawal from the labor force. The observed reentry rates are remarkably low indeed (in Spain, the quarterly reemployment hazard is less than 13% in the age range 55/59 and a meager 1.5% in 60/65). To complete the overall picture, it is interesting to note that a very small proportion of the unemployed declare they are actively searching for a new position.[1]

The **traditional interpretation** of these facts emphasizes two separate aspects. On the one hand, *demand-side* considerations seem to play a major role in the behavior of this segment of the labor market. According to common wisdom, Spanish corporations do not find it to their advantage to attract the older unemployed back to work. A number of reasons (ranging from the rigidity of remuneration practices to large productivity deficits versus their younger workmates) are usually invoked to explain this behavior.[2] On the other hand, searching and re-training are assumed to pose especially high welfare cost for workers of advanced age.[3] Legislators and policy makers have been especially sensitive to these issues in Europe. When a profound industrial crisis followed the oil shocks of the 70's, they were quick to provide special *protection* for those workers. It took the form of early-retirement programs and (in some cases) taylor-made unemployment insurance schemes for older workers. As a result, benefits for the unemployed over the age of 50 are typically higher or can be drawn for longer periods than for the younger unemployed, and the conditions regarding their availability for work and job-seeking are often relaxed. This situation is common throughout Europe (as discussed in more detail below). It seems fair to say that efficiency considerations did not played a major part at the time these new rules on pension and unemployment benefits (UBs) were introduced: welfare considerations were a priority. The implicit disincentive to work posed by the regulations may even have been perceived as a virtue in the seventies.[4] This perception, however, has been progressively called into question in the

[1]Fewer than 17% of the unemployed aged 50-54 reply that they are actively looking for a new job in the full sample of the European Community Household Panel (1994-2001). This number falls to less than 3% for those aged over 60. In Spain, the values are a slightly higher: 17.5% and 3.7%, respectively, according to the Spanish Labor Force Survey in 2006-2009.

[2]Understanding the rationale behind the behavior of corporations goes beyond the scope of the paper. It would undoubtedly demand a paper of its own.

[3]See, for example, Van Ours (2009) on the productivity of the older workers.

[4]Another rationale behind the institutional changes introduced was the widespread belief that, *by forcing*

last two decades. The problem is easy to state: once the new institutions are in place, it is no longer obvious whether the low employment of the senior workers is due to the lack of demand or is a result of the implicit subsidy to stay out of the labor force. The current institutional design creates the conditions for strategic individuals and corporations to use unemployment and pension rules to transfer to the general population the costs of a *quasi-voluntary* early retirement. This has evident direct costs on public finances (leading to higher taxation), but also very important opportunity costs in terms of wasted resources or their inefficient allocation.[5] In a Europe struggling to regain competitiveness (as exemplified by the Lisbon Agenda), these considerations have had an increasing bearing on the decisions of national governments and on the recommendations of the European Commission.[6]

In this paper we focus on the impact of public rules on the labor supply of the older workers in Spain. The Spanish case is particularly interesting for several reasons. First, public insurance (pensions and unemployment) are, by far, the main sources of income for older people (with private pensions playing a relatively unimportant role and with the state providing universal health insurance). For this reason, modeling pension and UBs results in a very good representation of the budget sets for a majority of the population. Second, in its present form, public regulations provide well-defined and easily quantifiable incentives. *Formal* early retirement is discouraged by reducing the pension between 6 and 8% for each year before the Normal Retirement Age (NRA). Yet, at the same time, an *informal* early-retirement route via unemployment is possible, combining a very generous UB for up to two years, followed by a small UB subsidy available until the old-age pension is drawn. Note that the requirement to seek and accept job offers during the unemployment spell is not effectively enforced by the authorities[7]. It not surprising to find, then, that the unemployment route is the preferred one for workers that leave the labor force before the NRA: there are very few direct transitions from employment into retirement before 65 (Figure 1). Among the unemployed, the correlation between decisions and incentives is impressive. Figure 2 summarizes the evidence. Workers made redundant in their mid-fifties tend to retire at 60, the Early Retirement Age (ERA), after very long unemployment spells that use both the contributive UB and the subsidy.[8] Workers who lose their jobs later limit their use of the unemployment program to the generous first two years, retiring in large numbers after just 24 months. It is revealing to see a spike of retirement at a duration of two years among workers who started their unemployment spell aged 58/59: it means most of them

elderly workers into retirement the employment opportunities of the young were fostered.

[5]A rough estimation of the amount of misused resources is available in chapter 1 of Gruber and Wise (1999).

[6]They underlie recent reform proposals aimed at *"reducing significantly the length of the period between the end of the last job and the take-up of a statutory pension"* (Report of the Social Protection Committee of the European Union 2008). Reforms phasing out the rules favoring the older unemployed over the younger ones and increasing the incentives for employers to hire older workers are also frequent across the EU countries.

[7]For example, according to the Spanish Labor Force Survey, by the end of 2006 only 27% of the those receiving Unemployment Benefits and aged 50 or over declare they are searching for a new job. This rate has increased over the past two years due in all probability to the current economic crisis in Spain, and is now around 47%.

[8]Workers who start their unemployment spell aged 54/55 (ie. within 5 to 6 years of the ERA) retire after being unemployed between 54 and 74 months, ie. after between 4.5 and 6.2 years. Similarly, workers fired in the 56/57 age-range (3/4 years before the ERA) retire after unemployment spells of 30/50 months, ie after 2.5/4.2 years.

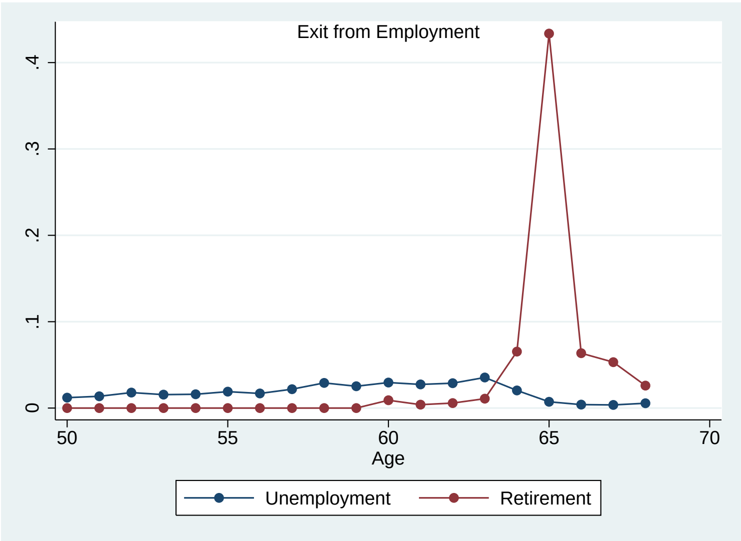

Figure 1: Quarterly exit probabilities from employment, conditional on age. MCVL-2009

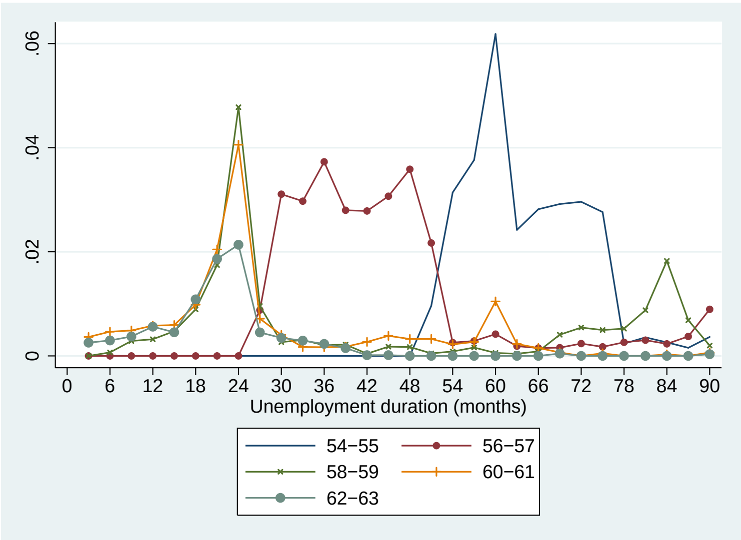

Figure 2: Quarterly exit probabilities from unemployment, conditional on the duration of the unemployment spell (in months) and the age at the moment of separation from the latest employment. MCVL-2009

delay retirement after 60 to take advantage of the unemployment program. The same pattern is observed for workers made redundant after 60. In short, workers and employers seem to be using the UBs to "formally" stay in the labor force but without searching, both before and after the ERA.

We focus our quantitative analysis on the Spanish case, but we must emphasize that the underlying economic processes in other European Countries are very similar. The situation regarding early retirement in Germany and France (just to name two of the larger EU countries) is remarkably close to that in Spain: the UB is generous and the unemployed are exempted from job-seeking before retiring at the ERA of 60.[9] Unsurprisingly, the early retirement route via unemployment is very popular in both countries (see chapters 3 and 4 in Gruber and Wise (1999)). After 60, unemployment may be used (unofficially) to reduce penalties in Germany, while in France the disincentive is even greater (as retirement after being made redundant automatically guarantees the maximum pension replacement rate).

Our paper adds to a growing body of **literature** that explores the effects of unemployment insurance (UI) on employment incentives from a life-cycle perspective. On the theoretical side of the literature, the optimality of conditioning the size of UBs to an individual's age is a key finding in Michelacci and Ruffo (2009). In a life-cycle model with human capital accumulation and endogenous search effort, they find that the optimal UB for older workers (45+) should be significantly lower than that for younger workers.[10] Note that their analysis abstracts from the role of retirement and the pension system, which is the central ingredient of our modeling effort. Our paper also differs on the analysis of institutional reforms, as we stop wide short of attempting a fully fledged analysis of optimal design. The optimal integration of the UI and pension programs is explored in Stiglitz and Jun (2005). They consider the integration of UBs with a system of (government provided) life-cycle pension accounts. In essence, the system allows unemployed individuals to borrow from their personal accounts, leading to better job search incentives and welfare gains (in the presence of capital markets imperfections). This paper is an exponent of a wider literature advocating the development of Unemployment Insurance Accounts (UIA)[11]. As mentioned above, our paper advocates a joint treatment of unemployment and

[9]French unemployed over the age of 57 are exempted from job seeking and entitled to full unemployment compensation until they meet the conditions for a full retirement pension. The only requirement to qualify for "préretraite" is to be at least 57 years old and have contributed for more than 10 years (or being just 55 with 40 years of contributions). In Germany the "Social Code" provides unemployed individuals aged 58 or older with the option to draw unemployment benefits without declaring their willingness to take up employment. In return, however, the applicants must commit themselves to apply for old-age pension at the earliest possible date (meaning they will suffer the penalty of a reduced old-age pension).

[10]The previous literature on the optimal design of unemployment benefits with *imperfect information* and *hidden actions* (as exemplified by Hopenhayn and Nicolini (1997), Kocherlakota (2004) or Chetty (2008)) does not consider the age dimension.

[11]Brown et al. (2008) is probably the technically most advanced paper of this literature, started by Feldstein and Altman (2007) with and application to the US. The advantages of the integration of public insurance systems are not limited to pension and unemployment, as shown by, for example, Bovenberg and Sorensen (2004). The analysis of a joint UI-pension system is, however, more developed. This probably reflects the practical interest of this inquiry: Chile has actually used UIA as the core of its new unemployment insurance systems (including a guaranteed minimum benefit). Austria and several Latin American countries have included UIA to provide for severance payments without eliminating pre-existing UI systems.

pension benefits, but from a different perspective. The advantages of the joint treatment in our work stem from the effects on optimal *retirement* and search behavior, while we ignore savings considerations. The key contribution of our model, then, is the extension of the traditional search model to include the alternatives of retirement and non-participation (understood as staying in the labor force without searching) in a life-cycle setting. The first explicit integration of search and life-cycle features can be credited to Hairault et al. (2010). The target in this case is showing the influence of the distance to retirement on the labor supply of older workers in France. As in our paper, this study combines an empirical analysis and the development of a formal model. The differences in the modeling and the focus of the papers are, however, numerous: Hairault et al. (2010)) interpret the data as the steady state of a model with stochastic aging, while we implement a non-stationary, life-cycle analysis that explicitly takes into account the impact on workers' decisions of UBs and pension rules, previous employment history and the length of the unemployment spell.[12] We therefore add to existing retirement literature by formally exploring the unemployment path into retirement.[13] We also contribute to the literature on search models, by considering non-participation decisions in a non-stationary environment including the risk of dismissal.[14]

We have three specific **research targets**: (i) check whether we can rationalize the basic observed labor supply patterns among older workers with a stylized search/retirement model; (ii) quantify the extension of the "opportunistic", "no-search" behavior of the Spanish unemployed under the current institutions (and clarify its relative contribution to the low reemployment hazard versus more standard low-demand considerations), and, finally, (iii) explore the impact on the search effort, welfare and the total cost for the public system of incentive-improving changes in the regulations. To find answers to these research questions we have to start by finding specific values for the set of (unobservable) parameters characterizing preferences, search costs and job opportunities. We follow a *reveal preference* strategy: we select the values that best match a set of empirical moments describing retirement, reemployment and reentry wages in our empirical sample[15]. We subsequently simulate the model to predict the aggregate labor supply, implicit pension liabilities and welfare of each of the individuals in our empirical sample, under different institutional environments.

[12]Note that the importance of duration in the French case is smaller than in the Spanish or German cases. In these countries the income provided by the UB drops sharply when the duration of the spells exceeds some particular thresholds, triggering acute behavioral responses in individuals. This effect is crucial in, for example, Launov & Walde (2010)), who recently set about explaining the aggregate unemployment rate in Germany. In France, in contrast, the jobless are entitled to the full benefit throughout the unemployment spell.

[13]The state of the art in the modeling of optimal retirement is represented by the models in Rust and Phelan (1997), French (2005), Van der Klaauw and Wolpin (2008) and Benitez-Silva et al. (2006) .

[14]The possibility of non-participation in an otherwise standard search model was first analyzed in Van den Berg (1990). More recently, Frijters and Van der Klaauw (2006) estimate a structural, non-stationary search model with non-participation, where the state of inactivity (considered as an absorbing one) is unrelated to economic conditions. Our analysis improves upon the former by considering the fundamental non-stationarity induced by age considerations, and upon the latter by providing a full economic description of the non-participation state (ie, retirement).

[15]We work with a large sample of administrative records from the Social Security administration (MCVL, Muestra Continua de Vidas Laborales)

We find that, firstly, observed labor behavior at older ages is reasonably well reproduced with our stylized economic model. It reveals a widespread "opportunistic" behavior by the unemployed: a fraction of around 50% of them act as if they were effectively early-retired. This figure climbs to almost 70% in the ages immediately around 60, the ERA. The model rationalizes this as the optimal reaction to an environment that combines poor incentives, relatively mild search costs and remarkably weak labor demand (the annual job-arrival rate is only around 50%, and the wages tendered are substantially lower than those enjoyed in their previous unemployment spells). The key role played by a weak labor demand is confirmed by simulating a counterfactual environment featuring the same institutions and a larger job-offer rate. The model predicts a large shift from "opportunistic" behavior to active labor search under those circumstances, although the gains are mostly concentrated before the age of 60. After the ERA, incentives do have a very relevant impact on behavior. A perfect enforcement of the unemployment law (making it impossible to draw benefits without searching) would appreciably improve the observed +60 reentry rates, *under current labor market conditions*. The case for institutional reform is stronger when the fiscal balance of the pension system is taken into account. If we classify individuals as early-retired when they stop paying contributions (to eliminate the incentive to delay retirement), we achieve both appreciable increases in labor supply and sizable reductions in the implicit liabilities of the pension system. These financial gains are large enough to fully compensate the welfare losses inflicted by the reform on a subset of individuals.

The structure of the paper is as follows. The theoretical model is presented in section 2, starting with a brief discussion of the empirical evidence it seeks to replicate. Our empirical strategy is discussed next in section 3. It includes a discussion of the quantitative performance of the model, in the light of the empirical evidence. Our simulation experiments, including our policy reform proposals, are analyzed in section 4. Finally, section 5 concludes. A number of technical details and additional results are confined to dedicated appendices at the end of the paper.

2 The model

In this section we describe the details of our search/retirement theoretical model. We start in section 2.1 with an overview of the basic empirical evidence. This evidence is a fundamental input in the specification of the model. It also provides the natural backdrop against which we judge its performance. The model's technical details are reviewed in sections 2.2 to 2.4.

2.1 Basic Stylized facts

The empirical evidence comes from the last issue of a Spanish administrative data-set called *Muestra Continua de Vidas Laborales*, MCVL08 hereafter. This data-set includes information up to 2008 on the complete labor histories of more than one million Spanish workers. A complete description of the database, along with a detailed reduced-form econometric analysis can be found in García-Pérez et al. (2010a). In this paper we focus on a relatively narrow sub-sample

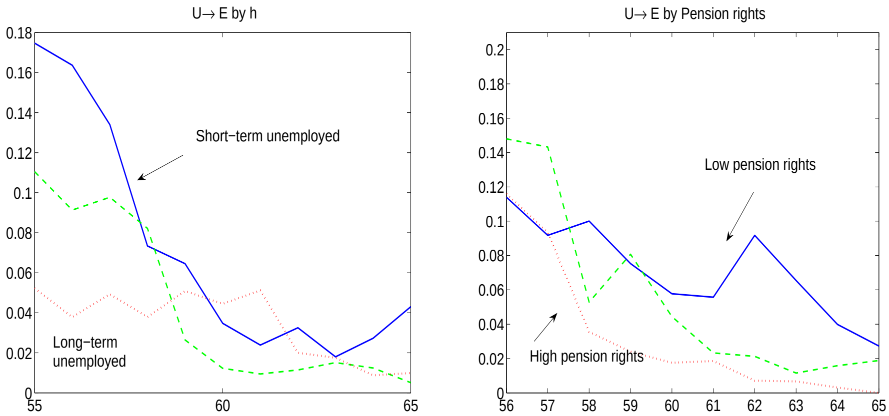

Figure 3: **Transition from Unemployment to Employment**: Quarterly reemployment hazard by age and duration (left panel) and by age and pension rights (right panel).

Figure 4: **Reentry wages**: accepted wages by workers reentering the labor market by age and duration (left panel) and by age and pension rights (right panel).

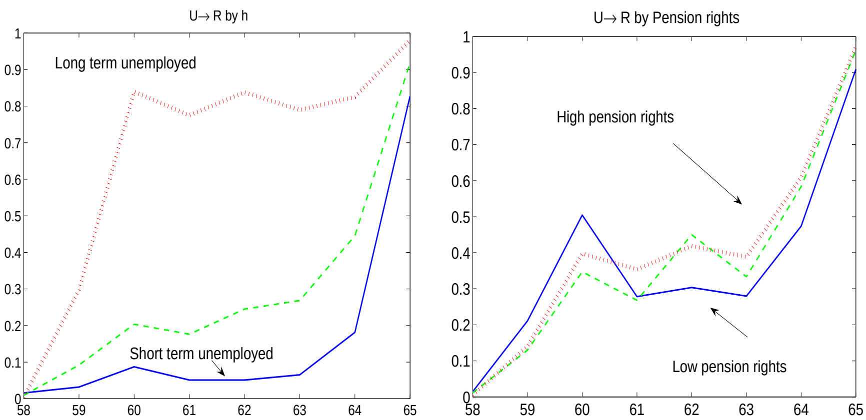

Figure 5: **Transition from Unemployment to Retirement**: Annual retirement hazard by age and duration (left panel) and by age and pension rights (right panel).

selected to guarantee that the economic incentives of the individuals are clearly identified.[16]

Figures 3 to 5 provide a visual summary of the main empirical patterns and, consequently, of the essential regularities we wish our model to reproduce. Each graph has age on the horizontal axis and three lines corresponding to a partition of the sample in as many groups of workers. The sample in the right hand side panels is split according to the size of pension rights, PR, with percentiles 1/3 and 2/3 of the total distribution as thresholds.[17] The sample in the left hand side panels is split according to the duration of the unemployment spell, h (1 year, 2 years or more). It is immediately apparent that behaviour is heavily dependent on the age of the individuals, the duration in unemployment and the income available at each stage (provided by the clearly interconnected pension and unemployment programs).[18]

Reemployment has a well reported negative duration dependence, with the short-term unemployed showing remarkably larger reemployment hazards at all but the earliest ages included in the sample (left panel in Figure 3). The graphs also illustrate a (less documented) strong negative dependence on age, attenuated to some extent after the ERA of 60. The sensitivity to income is shown in the right panel in the figure, revealing how high pension rights systematically reduce the probability of reentering, although, again, the monotonicity is weakened before 58. The role of pensions has much greater impact on the wages of the unemployed that return to the labor force (right panel in Figure 4): considerably higher wages need to be offered to attract workers with high pension rights. The dependence on age and duration is less marked, but still clear. The presence of sample selection effects after 60 is also very apparent in the pattern of accepted wages (and, to a lesser extent, in the patterns of reentry hazards discussed above).[19] Finally, Figure 5 shows the strong dependence of retirement on age, pension rights and, especially, unemployment duration. The importance of the first two is well documented (Boldrin et al. (1999), Jiménez-Martín and Sánchez Martín (2007)). The impact of duration, in contrast, was largely overlooked in the previous literature, naturally leading us to pay special attention to it in our modeling effort.

2.2 Model structure

We model the search, participation and retirement behavior of unemployed workers in the age range $a \in \{55, 70\}$ at one particular point in time. Time is assumed to be discrete, with one period in the model standing for one year of biological time. All agents in the model face the

[16]We consider males of 55 years of age or older, affiliated to the General Regime of the Spanish Social Security system, who are entitled to receive UBs and old-age pensions upon retirement. The sample belongs to the interval preceding the first major change in pension regulations (which took place in 1997). We exclude individuals who sign Special Agreements with the Social Security, and individuals with missing information that prevent us from computing their accrued pension rights.

[17]The accrued pension rights of a worker at a point in time are an average of his/her gross labor income (subject to a cap and a minimum) in the immediately preceding fifteen years of work. See section 2.3.

[18]The evidence conditional on the size of the unemployment benefit is omitted for space reasons. It is qualitatively very similar to that shown in relation to pension benefits. See García-Pérez and Sánchez Martín (2010) for more details.

[19]The unemployed that stay after 60 differ in some dimensions from those that retire at earlier ages. This composition effect is not formally explored in the current version of the model. Note, in any case, that the proportion of the unemployed in the sample decreases markedly after 60.

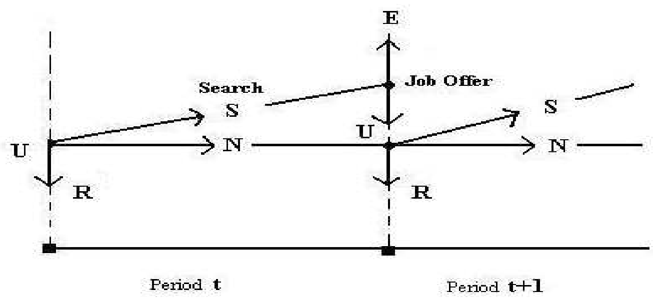

Figure 6: Timing of decisions and disclosure of information in the model.

same survival uncertainty, represented by the (age-conditional) survival function S_a. Labor market uncertainty depends on the state of the individual as described below. There are no other sources of uncertainty.

At the beginning of any period, individuals of all ages can be in one of three mutually exclusive labor states: employed, unemployed or retired. Retirement is a purely passive state, associated with the receipt of the pension benefit, B, and with a permanent withdrawal from the labor force. Employed workers have a time invariant real wage, w, and face a constant probability δ of being fired at the end of the current period. After the ERA, they have the option of voluntarily leaving the labor force and start drawing the pension benefit.[20] In this paper we focus our attention on the behavior of the unemployed. Figure 6 visually summarizes the different options available to them. Immediately after the dismissal, three courses of action are possible: retire immediately (path R in the graph), actively search for a new job (S) or remain inactive (N). An active search strategy involves paying some upfront search costs in exchange for a probability λ_h of receiving a job offer at the beginning of the next period. This probability decreases over the duration of the unemployment spell, which we represent by h. The offer is fully characterized by the wage, which is a random draw from a distribution $F(w|\hat{w})$. The mean of the wage offered is an increasing function of the size of the accumulated pension rights $\hat{w}$.[21] If the offer is rejected, the individual can either remain unemployed for another period or retire immediately (again, after the ERA). Unemployed workers who opt for "non-participation" (ie "stay inactive" while still formally enroled in the unemployment protection system) do not incur in any search cost in the present, but do not receive a job offer in the next period either. The public administration does not enforce the legal obligation to search in order to receive an UB. Consequently, a non-participating unemployed receives the same income as that obtained by one that engages in active searching: the UB (b in the formal model). In section 4.2.2 we explore the consequences of granting the UB only to the unemployed who search. Finally, we assume

[20] We do not report the optimal retirement decisions of employees in the paper, but we do take them into account in all our calculations (eg, when an unemployed individual decides whether to accept or reject a job offer). We do not allow employees to go into voluntary unemployment in this paper. This possibility is explored in an economic environment very closed to that in this paper in García-Pérez et al. (2010b). This strategy is found to be optimal for a very small proportion of the individuals in the sample.

[21] Pension rights $\hat{w}$ are an average of the wages obtained in previous employment spells. They can be taken as a proxy of the productivity of the individual, implying a signaling effect that can result in higher wage-offers by employers.

nobody remains actively employed after the age of 70.

2.3 Institutions

Unemployment benefits

The UB scheme pays a proportion $b_h < 1$ of the wages enjoyed in the immediately preceding job, although the wage/benefit proportionality is broken by a minimum b_{min} and a maximum b_{max} imposed on the final benefits. Furthermore, the replacement rates b_h decrease with our discrete measure of the duration of the current unemployment spell, h. In the population at large, individuals can receive the contributive UBs for a maximum of two years. Besides, the unemployed older than 52 are also entitled to a specific subsidy $b^s_{\min}$ (75% of the minimum wage) till their retirement, regardless of the duration of their unemployment spell. Equation (1) shows how all these elements feature in our model:

$$b(\pi, h) = \begin{cases} Max\{b_{min},\ Min\,\{b_1\pi, b_{max}\}\ \} & \text{if } h = 1 \\ Max\{b_{min},\ Min\,\{b_2\pi, b_{max}\}\ \} & \text{if } h = 2 \\ b^s_{\min} & \text{if } h = 3 \end{cases} \tag{1}$$

The public employment agency (INEM) not only provides immediate income to the unemployed, but also protects their future pension income by paying their pay-roll taxes to the Social Security system. These social contributions are a fixed proportion of the individual "pensionable wage" (the labor income considered by the pension authorities when determining the pension benefit). In the current system, INEM contributes the full previous wages of those unemployed with a duration of less than two years (h $\leq$ 2), and the minimum contribution in the case of a longer duration (h=3). Note, finally, that we do not consider workers covered by *Special Agreements* with the pension administration.

The pension system

A public pension can be claimed at any age after the ERA (N_m in the following equations), conditional on a complete withdrawal from labor market activities. The pension benefit for each worker is computed in two steps. First, an individual-specific component related to the worker's previous earnings is calculated. Next, this benefit is subsequently compared with the legal minimum and maximum pensions prevailing in each year to determine the final effective payment. Formally, the individual component, $\tilde{B}$, depends on retirement age, τ, and on the accrued *pension rights* of the retiree, $\hat{w}$:

$$\tilde{B}(\hat{w}, \tau) = \mu(\tau)\,\hat{w} \tag{2}$$

The age-dependant replacement rate $\mu(\tau)$ reflects an annual penalty of μ_1 percentage points for retirement before the NRA (N):

$$\mu(\tau) = \begin{cases} \mu_0 & \text{if } \tau < N_m \\ \mu_0 + \mu_1(\tau - N_m) < 1 & \text{if } \tau \in \{N_m, \ldots, N-1\} \\ 1 & \text{if } \tau \geq N \end{cases} \tag{3}$$

with $\mu_0 = 1 - \mu_1(N - N_m)$. Accrued pension rights ("*Base Reguladora*") is a moving average of total labor earnings in the D years immediately before retirement, $\hat{w}$:

$$\hat{w}_\tau = \frac{1}{D}\sum_{i=1}^{D} w_{\tau-i}$$

Unfortunately, implementing this formula in the model implies large computational costs. Instead, we simplify the dynamics of $\hat{w}$ by assuming that, for an individual with current labor income w, the one-year update in pension rights is:[22]

$$\hat{w}_{\tau+1} = \hat{w}_\tau + \frac{w - \hat{w}_\tau}{D} \tag{4}$$

Finally, the scheme is made progressive by the inclusion of maxima and minima in the final payment. This breaks the strict proportionality between the effective benefit $B(\hat{w}, \tau)$ and pension rights:

$$B(\hat{w}, \tau) = \begin{cases} B_{\min} & \text{if} \quad \tilde{B}(\hat{w}, \tau) < B_{min} \\ \tilde{B}(\hat{w}, \tau) & \text{if} \quad B_{min} \leq \tilde{B}(\hat{w}, \tau) \leq B_{max} \\ B_{\max} & \text{if} \quad B_{max} < \tilde{B}(\hat{w}, \tau) \end{cases} \tag{5}$$

The effective benefit $B(\hat{w}, \tau)$ is first computed when the individual retires and kept subsequently constant in real terms throughout the rest of his/her life.[23]

2.4 Optimal Behavior

For the unemployed that incurred search costs in the previous period, we assume that all labor uncertainty is solved at the beginning of each period. Subsequently, they take the decision of whether to accept or reject the wage offer they may have received and (in the case of rejection) whether to remain unemployed or retire from the labor force. The unemployed who did not search in the past may reconsider their decisions and search during the current period, remain unemployed without searching or retire. Finally, employees must decide on whether to keep working for the same wage or to retire. As discussed before, we do not allow voluntary transitions from employment into unemployment. In all cases we assume individuals to be expected utility maximizers and make decisions by comparing the expected discounted utility obtained from the flows of income and leisure resulting (given the institutional environment described above) from the different alternatives. Formally, individuals of age a maximize expected utility at that age:

$$V_a = \max_{\{e_a\}_a^{\overline{N}}} E\left[\sum_{i=a}^{T} \beta^{i-a}\, u(y_i, e_i)\right] \tag{6}$$

where $\{e_a\}$ stands for the sequence of present and future labor states from age a till the maximum possible working age, $\overline{N}$ (70 in the base calibration). The posibles values of e_a are $\{E, S, N, R\}$

[22]The approximation is exact under our assumption of constant wages for employees.

[23]We do not consider a number of relatively minor details of the pension and fiscal systems. In particular, we do not include pension reductions due to an insufficient number of contributive years, which have a minor effect on the pension of a reduced number of workers in our sample.We also ignore the effects of income taxation.

representing Employment, unemployment with Search, unemployment without search (Non-participation) and Retirement. T is the maximum longevity, β is a constant discount factor representing a pure preference for earlier consumption, and individual preferences are represented by an additively separable and age-invariant function of income and the labor state, $u(y, e)$. More precisely, period utility depends on the current income flow, y, and on the labor state, e, as follows:

$$u(y,e) = \frac{[\,y\,(1+\nu(e))\,]^{1-\eta}}{1-\eta} \qquad \text{with} \qquad \nu(e) = \begin{cases} 0 & \text{if } \; e = E \\ l^s & \text{if } \; e = S \\ l & \text{if } \; e = (R,N) \end{cases}$$

where η measures the curvature of the objective function (which, in turn, determines both the degree of risk aversion and the willingness to substitute income intertemporally) and $\nu(e)$ represents the variation, with the labor state, in the value of the time that is not devoted to labor-market activities. In our base specification, we normalize this value to zero for employees and assume a positive value (l) for non-participants and retirees and a smaller -albeit still positive-one (l^s) for the unemployed that search. l^s is smaller than l to capture the costs associated with the search process, including the cost of re-training and the possible 'stigma' cost of staying unemployed.

As usual with nonlinear stochastic dynamic programs, there are no analytical solutions for the individual problem. Instead, we work with a recursive representation of the problem in (6), and characterize its solution via the sequence of value functions associated with each age and labor state. These value functions are solved numerically by backward induction starting at $\overline{N}$. The formal description of the value functions is provided in appendix A.1. A discussion of the properties of optimal behavior is postponed to section 3.2, where we compare the model predictions to the original data.

3 Calibration of the model's parameters

In this section we discuss our strategy to select the parameters that constitute the benchmark case throughout the rest of the paper. We start in section 3.1 by describing the *revealed preference* approach we implemented. The chosen parameters and the quantitative predictions of the resulting model are then reviewed in section 3.2. We pay special attention to verify the extent to which the model can reproduce the empirical stylized facts in section 2.1. Overall, this section provides the reader with the fundamental results of the calibration process, leaving more specific details to appendix B. Finally, appendix D explores the robustness of our main findings to alternative sets of parameter values (both individual and institutional).

3.1 *Revealed preference* approach

The model's parameters can be classified into two broad categories depending on the availability of directly observable empirical counterparts. On the observable side, we have the parameters controlling human longevity and the institutional details of pension and unemployment schemes.

In the group without direct observable counterparts we find the parameters of individual preferences and the parameters that control the demand side of the labor market.[24] For the latter group we implement a *minimum distance* strategy. We choose a set of empirical properties and search for the parameters that make the model reproduce them as closely as possible. More formally, we select a set of empirical moments, m, that we consider especially relevant for our analysis. We then find the value of the model's parameters, θ, that generates a set of simulated moments, $\hat{m}(\theta)$, whose distance with respect to their empirical counterparts is minimum:

$$\theta = arg \min_{\theta \in \Theta} \; ||m - \hat{m}(\theta)||$$

We target a total of 25 empirical moments: (1) the conditional retirement probabilities by age in the 60/65 range; (2) the conditional reemployment probabilities by age in the 55/65 range and (3) the reentry wages in the same age range.[25] The notion of distance implemented in the calculation corresponds to a quadratic norm, with each individual moment weighted accordingly to its share in the empirical sample. Finally, we use a grid-search method to find the best fit between the model's predictions and the data. The details of the implemented numerical solution procedure are presented in Appendix B. Overall, our approach belongs to the general category of "methods of simulated moments", although we differ from the standard econometric literature in its numerical implementation: we favor the robustness of a grid-search method over the speed and precision of more conventional estimation mechanisms.

3.2 Parameters, model predictions and empirical counterparts

The set of parameter values resulting from our calibration procedure is shown in table 1. The parameters describing the pension and unemployment schemes reproduce their direct empirical counterparts as of 1997.[26] Retirement pensions are, then, first available at the age of 60, with an annual early-retirement penalty of 8% of accrued pension rights. $\hat{w}$ is computed to approximate a moving average of the 8 years immediately before retirement (according to equation (4)). A full pension is granted at the NRA of 65. The values of the minimum and maximum pensions amount to 0.9 and 4.3 times the minimum wage, respectively. The minimum pensions is increased by 12% after 65. Unemployed workers receive 65% of their previous wages as benefits during the first year out of work (an average of 70% being provided in the first six months, and 60% provided thereafter). This value of 60% continues in the second year and it is set to just 75% of the minimum contribution (6.2 thousand euros) in subsequent years. The general proportionality

[24]Note that we can observe the wages of the unemployed reentering the labor force, but we cannot directly observe the properties of the *offered* wages.

[25]The targeted moments capture changes at a point in time in the labor situation of the individuals in our empirical sample. The initial distribution of the individuals according to the model's *state variables* (age, duration, previous wages and pension rights) is taken directly from the data.

[26]After 1997 the institutional environment has been remarkably unstable in Spain, with small changes in the pension rules being introduced in 1997, 2002 and 2007. Given the complexity of the simultaneous modeling of several institutional arrangements, we opted for a more straightforward analysis: (1) calibrate the model using the behavior observed before the 1997 reform; (2) use the resulting parameters in our subsequent experiments and (3) check the robustness of our findings to the changes introduced in the pension system after 1997 (ie, we check that our main results still hold true in an environment featuring the most recent legislative changes).

of benefits and wages (for durations of less than two years), then, is broken by the minimum subsidy and a ceiling of twice the minimum wage.[27] Finally, we calibrate the dismissal rate, δ, to 6.7%, the average annual value observed in the entire MCVL sample for workers in the 55-65 age range. This is coherent with our treatment of transitions from employment into unemployment as an exogenous process.

	Preferences			**Labor Market parameters**	
β	0.91	Annual discount factor	λ_1	0.5	Job offer arrival rate h=1
η	6	Risk aversion	λ_2, λ_3	0.38	Arrival rate for h=2,3
l	0.3	Extra value of income (inactive)	δ	0.067	Probability of dismissal
l^s	0.2	Extra value of income (search)	G	0.05	Wage growth with $\overline{w}$
			σ	5.6	Std. of wage offers
	Pensions			**Unemployment**	
N_m/N	60/65	Early/Normal Ret. age	b_1, b_2	0.65;0.6	Benefit coverage h=1,2
μ_1	0.08	Annual early ret. penalty			
B_{max}	26.69	Maximum pensions	b_{max}	$2\,\underline{w}$	Maximum benefit
B_{min}	5.62	Minimum pensions	b_{min}	$\underline{w}$	Minimum benefit
B^{65}_{min}	6.26	Min. pension +65	b^s_{min}	$0.8\,\underline{w}$	Unemployment subsidy
D	8	Lags in pension formula	$\underline{w}$	6.2	minimum wage
	Social Contributions				
ς	0.356	Pay-roll rate	$\underline{\varsigma}$	7.29	Minimum contribution
$\overline{\varsigma}$	31.29	Maximum contribution			

Table 1: Parameter values in the benchmark economy (all amounts are expressed in thousands of euros and 2002 prizes). See table 2 for the values of the mean of the process of wage offers. Preference and Labor Market parameters are recovered via *reveal preference*.

Preference and labor-market parameters are revealed by comparing the data and the model's predictions. We summarize those predictions in two ways: by simulating the behavior of the individuals in our empirical sample and by studying the numerically computed policy functions of the individual problem. Figure 7 illustrates the former by plotting the age-profiles of retirement and reemployment hazards observed in the data and those obtained through the aggregation of the model predictions. The average reentry wages of the model and those from the data are also provided. The optimal retirement policy and reservation wages obtained with the baseline calibration are reproduced in appendix B.2. [28]

The identifiability of the parameters is not a trivial task in our model, given its complex and highly non-linear character. In general, all parameters exert influence to some extent on each of the three dimensions of observable behavior that we focus on (reemployment and retirement

[27]This value is a compromise between the number for those with more than two descendants (2.25) and the value for smaller families (1.75).

[28]More disaggregated comparisons of the data vs. the model predictions are presented in section 3 of our companion paper García-Pérez and Sánchez Martín (2010). We also include there the value functions obtained in all the experiments reported in the paper.

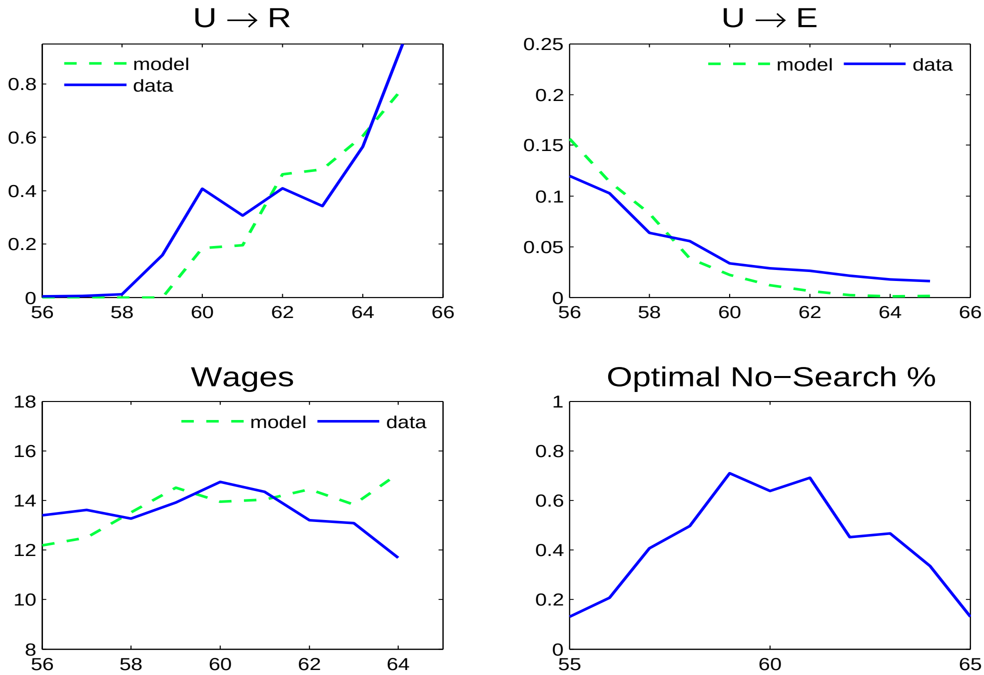

Figure 7: Benchmark theoretical predictions (green, dashed line) vs. empirical data (blue, continuous line): retirement and reemployment hazards (top panels), reemployment wages (bottom left panel) and predicted incidence of non-participation by age (bottom right panel).

decisions and reentry wages). Nevertheless, most parameters tend to have clearly stronger effects on some particular dimensions, which facilitates an articulated review of their identification properties. We review each parameter in turn, starting with preference parameters. The discount factor β intervenes in all the margins in the model, but is particularly influential on early retirement choices. To generate a reasonable amount of retirement at the age of 60 we need a β of 0.91 (or a 9% annual discount), which means that our individuals are more impatient than what is normally found in the literature.[29] On the other hand, to get a relatively flat retirement hazard rate in the intermediate ages (over 60 but before the NRA, when pension rules induce a marked jump in retirement) we also need individuals with relatively high risk aversion, η, or, equivalently, weakly inclined towards the intertemporal substitution of consumption. Highly flexible individuals would easily endure low levels of current consumption in expectation of a higher pension in the future (ie, they will tend to postpone retirement as long as possible). This (interacted with the pension rules) would produce a sharply increasing profile of retirement after 60, which is at odds with the empirical evidence. With a value of $\eta = 6$ our model is capable of producing a sustained flow of retirement between 62 and 65, although the model predictions fall short for the age of 61. Note that high values of η also make the individuals more reluctant to engage in searching and, consequently, to reenter the labor market. Our simulations show,

[29]In reality, the discount factor is most certainly heterogeneously distributed across the population. Previous studies (eg. Gustman and Steinmeier (2002)) find that early retirement is largely due to a relatively small group of highly impatient individuals. In our framework with homogeneous preferences, this feature leads to a high average discount factor.

	Bottom tertile	Intermediate tertile	Top tertile	σ
Model wage offers	8	8.6	9.5	5.6
Sample wage (previous employment)	12.4	16.8	21.8	6.57

Table 2: Observed previous wages vs. estimated offered wages. Top line: Mean offered wages in the model by broad group of pension rights (split according to percentiles 1/3 and 2/3) and standard deviation of the process of wage offers (assumed constant for all pension groups). Bottom line: observed distribution of wages in the preceding employment spell, conditional on the level of accrued pension rights. All figures in thousand Euros and 2002 prizes.

however, that the characteristics of the labor-market are more determinant in this sense (see below). To finish with retirement, the general *level* of the retirement hazard (especially the size of the peak at 65) is mostly controlled by l, the value of time when the individual is neither working nor searching.

Identifying the properties of the labor market is of special importance to the aim of this paper. To achieve this, we essentially base ourselves on the model predictions in terms of reemployment hazard and reentry wages, as retirement behavior shows very little sensitivity to changes in the offer rates and the properties of wages. Again, something not too far from a partition of the parameter space is observed, with the arrival rate λ having a disproportionate effect on the reentry hazard, while the mean and variance of wage offers exert a more direct influence on accepted wages. The low reentry hazards in the data, therefore, clearly reveal a difficult environment for the older unemployed. Our best fitting parameter of reentry rates is only 50%, accompanied by an appreciable process of *hysteresis* (identified by the drops in reentry rates with the duration in unemployment). Engaging in a search process in the Spanish labor market is, according to our model, a rather risky endeavor for those approaching retirement. The income prospects for job-seekers do not seem to be very favorable either. We assume a log-normal process for wage offers, with a constant variance σ^2 and a mean that depends on the size of the accrued pension rights of the individual (split into three groups according to the empirical percentiles 1/3 and 2/3). [30] Table 2 reproduces the parameters that best match the observed reentry wages, along with the average sample wage in the previous spell for the three broad groups of accrued pension rights. The sacrifice in labor income induced by the unemployment spell is very important, ranging from 30% to 55%. An interesting property of the data is the observation of a slightly decreasing profile of accepted wages with age, a property that has an important bearing on the selection of the only remaining preference parameter: the value of time while searching, l^s. We obtain a good match by selecting a rather high value. A larger difference $l - l^s$ will strongly discourage job-seeking at older ages for all but the workers with higher previous income. This will result in an increasing profile of accepted wages by age.

[30] Formally, $w \sim logN(\psi, \sigma^2)$) where the first moment changes with pension rights. There are actually only two parameters: ψ_1 (the mean associated with the bottom tertile of accrued pension rights) and a constant growth rate G. For the intermediate and top tertiles, the means are computed: $\psi_i = (1+G)^{i-1}\psi_1$ with $i = \{2, 3\}$.

A relatively large value of l^s avoids this counterfactual prediction.

3.2.1 Empirical performance

Figure 7 illustrates the empirical performance of the model by comparing the data and the model predictions in three dimensions: the conditional probabilities of reemployment and retirement by age and the reentry wages by age. Additionally, in Figure 14 (in appendix B.3) we arrange the model predictions in the same way as we did with the data in Figures 3 to 5 in order to facilitate the comparison. Starting with Figure 7, it seems clear to us that our highly stylized model does a reasonable job in reproducing the broad patterns in the data. The model successfully reproduces the decreasing reemployment hazard by age; the mildly increasing pattern of retirement by age, including the large spike at 65 and (to a lesser extend) the spike at 60.[31] It also replicates the average level of accepted wages, although it tends to show a slightly increasing trend that is not present in the data. It very accurately reproduces the dramatic increase in retirement for those who have been unemployed for more than two years (bottom left panel in Figure 14), the contribution to retirement at 60 by workers with low pension rights and the larger incidence of retirement at all other ages among workers with high pension rights (bottom right panel in Figure 14). Finally, it also successfully captures the higher reentry rates of workers with a short unemployment record and with low pension rights (top panels in Figure 14) and the high reentry wages enjoyed by workers with large pension entitlements (middle-right panel in Figure 14).[32]

Obviously, some discrepancies do reveal themselves. In particular, we find that the model does not generate enough early-retirement, underpredicts reemployment after the age of 60 and predicts excessive reentry flows among the unemployed with higher pension rights before 60 and too little after 60. These difficulties tend to concentrate around the behaviour of the long-term unemployed and/or of individuals with above average pension rights. They may point towards some data problems, but they also suggest the need for improvements in the specification of the model, especially the inclusion of some additional unobserved heterogeneity.[33]

[31] A more disaggregated comparison of the data vs. the theoretical prediction is provided in our companion paper García-Pérez and Sánchez Martín (2010). In particular, we present retirement hazards by age and broad group of pension rights. We find that the model does generate a remarkable spike at the age of 60 for workers with low pension rights ie. workers subject to minimum pensions. At the same time, the peak is hardly visible in the aggregate data, due to the behavior of the workers with high pension rights: the model predicts a relatively high incidence of retirement before 65 among them, and this tends to blur the importance of retirement at the ERA.

[32] Note that, with a coarse grid of just three possible durations, our model cannot reproduce the spike in reentry rates observed around 24 months (Figure 2). It reproduces the smaller reentry rates observed, on average, among the unemployed with durations of more than two years versus the unemployed with shorter durations. It also predicts a strong behavioral reaction to the change in incentives after crossing the 2-year threshold: reservation wages drop by as much as 40% in the years before the NRA (Figure 11 in Appendix 3).

[33] In principle, the inclusion in the model of, for instance, two groups with low/high values of leisure or time discounting may lead to some degree of self-selection at the age of 60, implying that the unemployed still active after the ERA will have better reemployment possibilities. The resulting model is, however, substantially more complex to handle and the calibration of the distribution of the extra amount of heterogeneity is particularly challenging. In particular, we have followed a *revealed preference* approach to solve a model including heterogeneity in the discount factor. The resulting model provides a better reproduction of the retirement peak a the age of 60, but the improvement obtained does not seem to compensate for the extra cost of the enlarged model. We leave further

Eco	Age range		Labor Supply		NPC
		Ret	Search (Reenter)	NP	
BASE	55/59	0	0.551 (9.9)	0.449	
	60/65	0.380	0.085 (1.0)	0.535	155.5
λ=1	55/59	0	0.815 (27.8)	0.185	
	60/65	0.375	0.181 (4.1)	0.443	137.3
Law	55/59	0	0.704 (10.8)	0.296	
Enforc.	60/65	0.448	0.536 (4.3)	0.016	150.2
Separate	55/59	0	0.652 (11.75)	0.348	
μ	60/65	0.581	0.346 (5.3)	0.070	146.7

Table 3: Simulation Results: labor supply and financial cost associated with each institutional environment. The labor supply columns report the proportion of workers whose optimal decision is to retire (*Ret*), *Search* or stay inactive (*NP*). It also reports the reemployment hazard (*Reenter* value in brackets). The Net Pension Cost (NPC) is in thousand euros per person.

4 Policy Experiments

After testing the model's ability of the model to reproduce the empirical evidence with a reasonable degree of success, we proceed to use our economic model for policy analysis. Our first step is to explore the extension of non-participation in the benchmark case (Section 4.1). We then explore its main determinants along with its financial and welfare consequences. We do so by analyzing the optimal individual behavior predicted by the model (and its aggregate consequences) in certain alternative economic environments. Tackling our research questions head on, we compare the role played by the institutional design versus the weak opportunities offered by the labor market in inducing a low search effort. This is explored in Section 4.2. Next, in Section 4.3 we consider an alternative design of the pension system for the older unemployed, aimed at fostering labor participation. We explore the optimal labor supply in the new institutional framework, along with the associated costs for the Public Insurance System and the welfare gains/losses inflicted on different individuals (in comparison to the *status quo*).

4.1 Incidence of voluntary non-participation among the unemployed: benchmark case

One of the key issues addressed in this work is the use of unemployment insurance without searching. This is unobservable, but can be inferred from the solution of our theoretical model. We compute the extension of this practice in our empirical sample by measuring the proportion of individuals for whom this behaviour is optimal. The aggregate value is reported in the fifth column of Table 3 (under the heading NP), and the results by age are shown in the bottom-right graph in Figure 7. The figures speak for themselves. In the sample as a whole, the best course of action for roughly one out of every two unemployed is, in fact, to stop searching. This

improvements along this line for future research.

proportion reaches a staggering 2 out of 3 among those in the 58 to 62 age range. It means that this practice becomes widespread as individuals approach the ERA, and remains so until almost the NRA. The natural conclusion is that, far from just a theoretical possibility, the strategic use of unemployment insurance seems to be a prevalent practice among older Spanish unemployed workers.

The non-participation decision of the unemployed may have important consequences for the financial balance of the public insurance mechanisms. To check this issue, we calculate the per capita financial cost for the combined "pension + unemployment" systems of each of the individuals in our empirical sample. More precisely, we compute each individual's Net Pension Cost (NPC): the expected present discounted values of the flow of future pension and unemployment payments net of any social contributions that the individual may pay to the system. The formal definition of the NPC is provided in Appendix C.1.[34] The average figure found in the benchmark case is slightly higher than 155,000 euros. This value will provide the yardstick to measure the potential financial gains of alternative institutional environments in the following sections.

In our model, the widespread optimality of "non-search" behaviour stems from the interaction of four factors: preferences (the discount factor, β, and the degree of risk aversion η), search costs (in terms of sacrificed leisure time, $l - l^s$); the expected gains from searching (depending on the arrival rate of job offers and their generosity) and, finally, the details of the pension/unemployment system. Our *reveal preference* experiment uncovered a population of impatient and risk averse individuals, facing a relatively modest cost of search. This, however, does not induce them to engage in a widespread effort to return to work. The rationale lies in the institutional disincentives and in the poor opportunities and fundamental uncertainties offered by the Spanish labor market. Still, these findings do not settle our fundamental question: will this behavior vanish in an environment with more labor-friendly institutions? Or is it all the result of poor labor demand, with the institutions playing merely a welfare-enhancing role for the unemployed? The next section addresses these questions via specific simulations.

4.2 Non-participation, labor demand and incentives.

We explore the relative contribution of poor incentives and poor labor demand to the low reentry rates observed by analyzing two alternative economic frameworks. First, (section 4.2.1), we consider a significant improvement in the conditions of the labor market, keeping the institutional environment unchanged. With this experiment we explore whether poor incentives would prevent an increase in labor supply even in the presence of a more receptive labor market. Subsequently (section 4.2.2), we conduct the complementary experiment of computing how much labor supply would be released if the prohibition to remain unemployed without searching were effectively implemented.

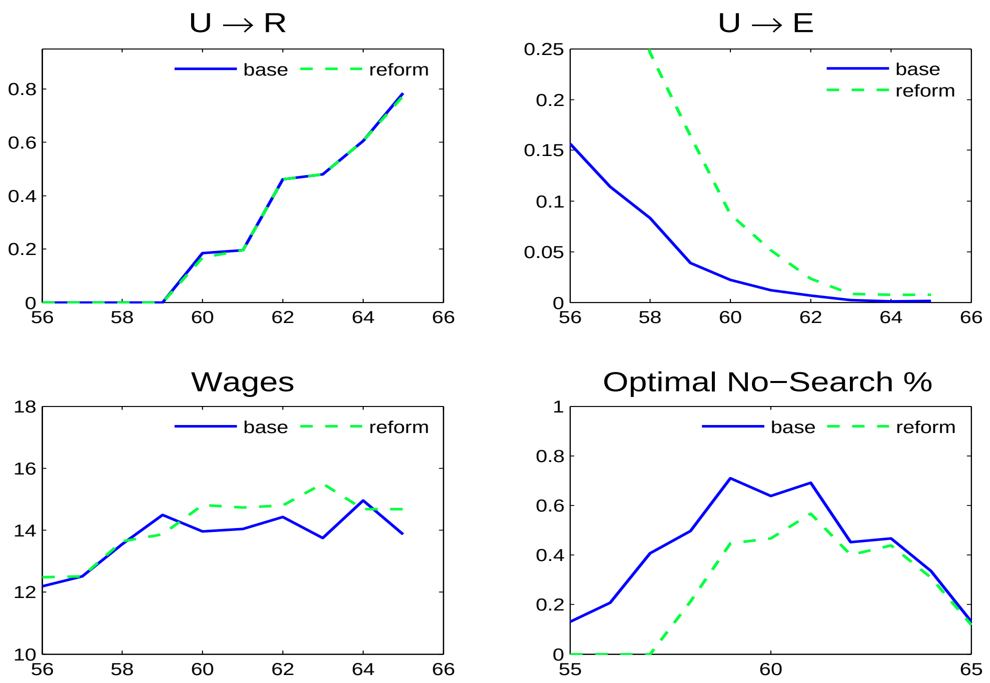

Figure 8: **Improved Labor Market conditions**: Model prediction in the benchmark case (-) (λ=45%) and with secure arrival of job offers. λ=100% (- -)

4.2.1 Non-participation under improved labor market conditions

In this section we test our conjecture about the existence of a relevant voluntary component in the low reentry rates among the unemployed close to retirement. We do so with a simple counterfactual experiment: we compute the optimal behavior of the unemployed in an environment with the same institutions as in the benchmark, but with a significantly improved labor market. Specifically, we eliminate the risk implicit in the arrival of job offers: we assume that any unemployed worker (with a duration inferior to one year) that engages in an active search effort will definitely receive a job offer. We still assume some *hysteresis* for durations of more than one year in the unemployment program (ie. we do not change the 25% annual reduction in the arrival rate for the unemployed with longer durations). The aggregate results in this new environment are reproduced in rows 3 and 4 in Table 3 (economy λ=1) and illustrated in Figure 8.[35]

Unsurprisingly, the presence of brighter employment prospects makes searching the option of choice for significant parts of the sample. More precisely, two broad groups of workers shift in large numbers from their previous decision to stay inactive: long-term unemployed (h=3) younger than 60 (ie, ineligible for retirement) and unemployed workers of any duration at the

[34]Note that the calculation incorporates the optimal behaviour of the individual in each possible labor state and is a function of his/her observable characteristics.

[35]To keep the length of the work within reasonable limits we do not reproduce the new individual policy functions here. Once more, we refer the interested reader to the companion paper García-Pérez and Sánchez Martín (2010).

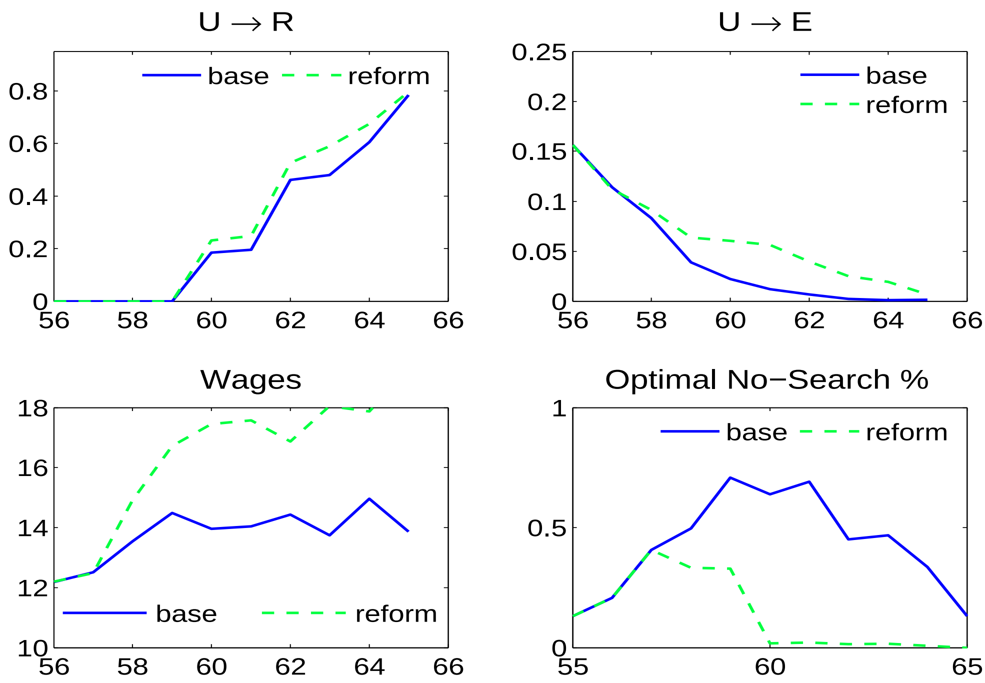

Figure 9: **Perfect enforcement of the Unemployment Law**: Model prediction in the benchmark case (-) and with contributive benefits restricted to active job-seekers (- -)

age of 60. As a consequence, the share of non-participants before the ERA shrinks to less than half the value in the benchmark, and we observe a three fold increase in their predicted reemployment hazard. Once the individual becomes elegible for old-age pensions, however, the gains in the reemployment rates are very modest. The reemployment hazard in the 60/65 age range experiences a fourfold increase, but the absolute figures are still very small, with an average value of just 4.1%. This is so because staying inactive remains a very popular choice after 60, being selected by 44% of the unemployed (down from 54% in the benchmark). Overall, our simulations indicate that poor labor market conditions are extremely important for the incidence of inactivity *before the ERA*, but a relatively minor factor over the age of 60. The advantages of the "inactivity path" into retirement are simply too strong to be offset by improved chances in the search for an acceptable reentry offer. The disincentive effects of the current institutional framework, therefore, play a clearly non-trivial role in the low reemployment rates observed after 60.

4.2.2 Perfect enforcement of unemployment law

According to current Spanish law, the perception of the contributory unemployment benefit as described in equation (1) in Section 2.3 is conditional on being actively involved in the search for a new job. However, this requirement is hardly ever implemented in practice.[36] In this section

[36]In most cases, individuals are simply required to periodically report to their respective Job Centres. They may also be required to attend specific job offers, but this involves nothing more than an interview with the prospective employer.

we explore the consequences of a perfect enforcement of this rule. We assume that all the unemployed who decide to stay inactive will receive only the minimum unemployment benefit, b_{min}, rather than the contributive benefit corresponding to their individual characteristics. This is tantamount to assuming that the System can observe the decisions of individuals, which for obvious reasons is hardly realistic. Still it is an interesting environment for quantifying the loss of labor supply due to the tolerance of "opportunistic" behavior by the unemployed.

The results of the experiment are reproduced in the 5th and 6th rows of Table 3 and in Figure 9. Two powerful messages clearly emerge: first, even under rather stricter conditions, the option of inactivity is still attractive for a large number of unemployed *before the ERA*. Second, voluntary nonparticipation essentially disappears after 60. Most individuals who preferred to stay inactive in the benchmark will now opt for an active search. This new behavior is widespread, but slightly more prevalent among workers with short durations and average and above average previous wages and pension rights. As a result, average reentry wages spectacularly escalate with age. The size of the reentry flows, however, does not increase that dramatically, as the weak labor market conditions render a large part of the search effort fruitless. Another contributor to the still low reentry rates is endogenous: the availability of pensions leads to high reservation wages and, consequently, widespread rejection of low-income job offers. Overall, the reentry hazard multiplies by four after 60 (from 1.0 to 4.2 %), and improves modestly (around 1 extra percentage point) before the ERA. These figures also reflect that a small part of the unemployed older than 60 change their behavior for immediate retirement in the new context. Finally, the financial condition of the system improves as a result of the improvements in labor participation. The gains are, however, quite small (we measure an average reduction in the Net Pension Cost in our sample of just around 3%) This is a modest achievement, especially bearing in mind that we have not taken into account the costs associated with the implementation of the institutional change in the calculation of the NPC.

4.3 Pension formula reform for the unemployed

Our interpretation of the results in the previous section is that (without denying the contribution of labor-demand considerations) incentives are an important determinant of low reemployment rates, particularly after the age of 55. Consequently, we find it worthwhile to explore real-world mechanisms capable of providing a better set of incentives than those in the benchmark. In this section we provide such an alternative, constructed around the idea of modifying the pension rules of those workers that access retirement following the "unemployment route".[37]

A key aspect for the appeal of inactivity is the automatic increase in the value of the pension while the worker remains unemployed. This is a result of the automatic reduction (at least in the 60/65 age range) in the early retirement penalties. Therefore, a straightforward way to prevent voluntary inactivity is by severing this link. This can be achieved in a simple way by making the early retirement penalty dependant on the age when the worker stops paying social contributions. This implies a penalty when compared to current rules, which consider the age

[37] As an alternative strategy to mitigate the moral hazard problem, we have explored the possibility of making the terms of public unemployment insurance tougher. The results seem to be much less encouraging. The details are available in García-Pérez and Sánchez Martín (2010).

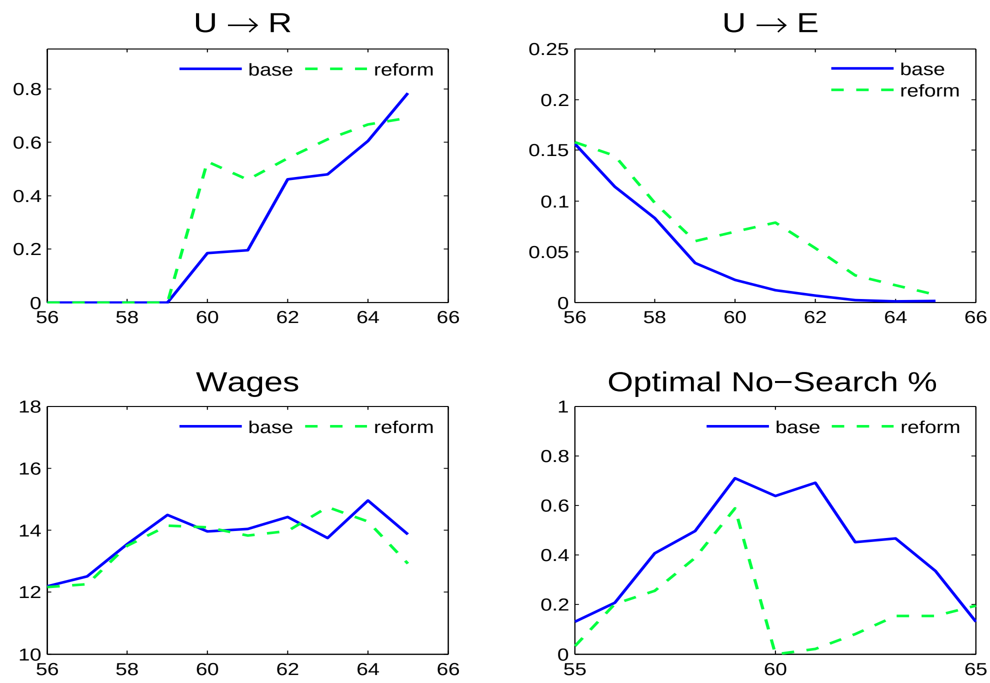

Figure 10: **Pension benefit reform**: Model prediction in the benchmark case (-), and with early retirement penalties fixed at the effective age of exit from employment (- -)

when the individual claims the pension benefit for the first time. This reform would amount to changing the replacement rate $\mu(a)$ in equation (3) to $\mu(a-h)$. In the new system, if somebody is made redundant at -for instance- the end of the year when he/she is 59, the corresponding pension rights, $\hat{w}$, will be equally punished if the worker retires immediately (a=*60*, h=*0*) or if he/she waits for one year (a=*61*, h=*1*) or longer. This change eliminates the incentives to stay idle while drawing unemployment benefits.[38] The idea is to provide the incentives for the voluntary, immediate retirement of the unemployed who do not search (in line with -although not quite as straightforwardly- the recent reform in the German regulations discussed in Section 1).

Figure 10 and the bottom rows of Table 3 report the results of this reform. It is very successful in fostering re-employment after 60: the hazard of those workers is more than five times larger than in the base simulation. It is *more* effective than the *perfect enforcement* reform of the previous section because (on top of generating a larger search effort) it induces a drop in the reservation wages of the unemployed. This drop is driven by the depreciation of the retirement alternative and is clearly visible in the reductions in the accepted reentry wages in Figure 10. The change in the pension formula also pushes a sizable part of the non-participant unemployed (over 60) into retirement. It is remarkable that the implicit pension drops can have effects well before the pension is effectively available. This can be appreciated in the increase

[38]There can still be some incentive to stay inactive for workers with high previous wages and low pension rights. For those workers, the dynamics of $\hat{w}$ may result in pension increases, even with constant early retirement penalties.

in the intensity of search and reemployment produced *before* the ERA. Overall, reentry rates rise by around 50%, a real achievement in the rather challenging Spanish labor market for older workers.

In the new environment, pensions are less generous and workers stay longer in the labor force, paying more contributions. It should come as no surprise that the financial balance of the combined Social Security system records a rather healthy improvement. On average, each worker in our sample costs the system 147,000 euros, which represents a 5% reduction from the 155,000 estimated in the benchmark. These savings allow compensating those workers whose welfare is compromised by the reform (and so turn our experiment into a *Pareto-improving* reform). To test for this possibility, we computed the Equivalent Variation associated with the introduction of this institutional change (in relation to the initial benchmark). For each individual, the EV is defined as the income he/she would be willing to forgo in terms of an outright payment to avoid the introduction of the reform under study. A formal definition is presented in Appendix C.2. The results are presented in table 4.

Age	Proportion	EV (absolute)	EV (% previous wage)
55	0.8008	0.7117	4.43
56	0.7472	0.6122	3.92
57	0.7018	0.4276	2.92
58	0.5515	0.2402	1.79
59	0.6253	0.9079	5.03
60	0.8039	2.2454	11.97
61	0.9524	2.8920	16.75
62	0.8568	2.9761	17.36
63	0.8225	2.6113	14.92
64	0.8101	2.8216	16.90
65	0.7568	3.2361	20.34

Table 4: Welfare change associated with the reform of the unemployed pension formula: proportion of workers with welfare losses and Equivalent Variation versus the benchmark, in absolute (thousand euros) and relative terms (proportion of the previous annual wage).

The reform has a widespread negative impact on the welfare of the individuals in our sample (75.5% of them will be willing to pay some money to avoid the reform and stay in the benchmark). Yet the size of the welfare losses is small in most cases. On average, a pay-check of slightly more than 1,600 euros would be enough to protect the utility level of all the unemployed in the original system. This is equivalent to, on average, slightly less than 10% of the annual wage enjoyed in the preceding employment spell. Naturally, behind the average figure lies a quite substantial variation in the welfare impact. The biggest figures are observed at older ages for workers with a short or average duration in unemployment. In absolute terms, the largest EV computed is slightly above 8,000 euros and corresponds to more than 100% of the annual income. But these cases are a tiny minority of those aged 64 or over and, more importantly, the simulated financial savings achieved by the reform more than compensate for the welfare losses generated. If the labor market conditions remain unaltered it seems possible to record an overall welfare improvement in the simulated experiment.

5 Conclusions

After a careful alignment of our model and the Spanish empirical evidence, we can conclude that *both* labor market conditions and institutional incentives are important to rationalize the reemployment and retirement patterns observed in the data. Our analysis clearly shows that the weak demand for older workers is not the only force behind the small reemployment hazard of the older unemployed, especially after the NRA of 60. The combination of generous UBs (for durations of up to two years), and substantial penalties for early retirement makes staying unemployed without searching an optimal strategy for roughly 50% of the unemployed in the 55/65 age range. This figure can be as high as 70% for workers on both sides of the critical institutional threshold posed by the ERA (ie. between 58 and 62 years of age).

Our simulation analysis suggests that the age of 60 is also an important threshold in terms of the effectiveness of institutional reform. Before 60, weak labor demand considerations are of paramount importance. After 60, in contrast, individuals seem much more sensitive to the incentives provided by legal provisions. Overall, a more satisfactory social outcome can be obtained by changing the pension rules applied to the unemployed. If their early retirement penalties were fixed according to the age when the individual effectively withdraws from the labor force (rather than when he/she claims the pension for the first time), the incentives to stay idle would be much smaller. That would be very effective in reducing non-participation and increasing labor supply, particularly after the ERA. Furthermore, the combination of extra contributions and reduced pension/unemployment payments significantly improves the financial health of the Social Security. Our simulations indicate that this financial gain is more than enough to compensate for the welfare loss of those that suffer as a result of the reform. Therefore, a proper redistribution of the extra output generated by the reform will lead to an overall welfare improvement.

Needless to say, our conclusions are strictly valid only in the context of the specific model employed in our simulations. When extrapolating to the real world we must be careful and bear in mind the dimensions delimiting our study. Our partial equilibrium analysis, for instance, ignores the impact on prices and labor demand of relatively large institutional reforms. It is unlikely that the induced second-round effects of the reforms would change our qualitative conclusions, but they would most certainly affect our quantitative answers. Besides, there are several promising avenues for improving the empirical performance of the model. In particular, the inclusion of more unobservable heterogeneity, firing costs and fiscal considerations are especially interesting. We leave those improvements for future research.

References

Benitez-Silva, H., Dwyer, D.S., Heiland, F., Sanderson,W.C., 2006. A Dynamic Model of Retirement and Social Security Reform Expectations: A Solution to the New Early Retirement Puzzle. Michigan Retirement Research Center Research Paper No. WP 2006-134.

Boldrin, M., Jiménez-Martín, S., Peracchi, F., 1999. Social security and retirement in Spain. In Jonathan Gruber and David Wise (Eds.), Social Security and Retirement around the World, 305–353. NBER, University of Chicago Press.

Bovenberg A. Lans and Sørensen P.B., 2004. Improving the Equity-Efficiency Trade-Off: Mandatory Savings Accounts for Social Insurance. International Tax and Public Finance, Springer, vol. 11(4), pages 507-529.

Brown A., Orszag JM., Snower DJ. 2008. Unemployment accounts and employment incentives. European Journal of Political Economy, 24, 587-604.

Casey, B, H. Oxley, E. Whitehouse, P. Antolín, R. Duval, and W. Leibfritz, 2003. Policies for an ageing society: Recent measures and areas for further reform. Economics department working papers, OECD.

Feldstein M. and Altman D., 2007. Unemployment Insurance Savings Accounts, Tax Policy and the Economy, Volume 21, pages 35-64. National Bureau of Economic Research.

French, E., 2005. The effects of health, wealth, and wages on labor supply and retirement behavior. Review of Economic Studies, 72, 395–427.

Frijters, P., Van der Klaauw,B., 2006. Job search and nonparticipation. Economic Journal, 116, 45–83.

García- Pérez, J.I., Sánchez-Martín, A., 2010. Social security and the search behavior of workers approaching retirement: companion paper. Avaliable at http://www.upo.es/econ/sanchez_martin/companion.pdf

García- Pérez, J.I., Jiménez Martín, S., Sánchez-Martín, A., 2010. Retirement incentives, individual heterogeneity and labour transitions of employed and unemployed workers. UPF Working Paper No. 1239.

García- Pérez, J.I., Jiménez Martín, S., Sánchez-Martín, A., 2010b. The reform of the social protection system in Spain: How to make work pay for senior employed and unemployed workers. Mimeo

Gruber, J., Wise, D., 1999. Social security and retirement around the World. The MIT press.

Gustman, A., Steinmeier,T., 2005. The social security early retirement age in a structural model of retirement and wealth. Journal of Public Economics, 89, 441–463.

Hairault J.O., A. F. Langot & T. Sopraseuth, 2010. Distance to retirement and older workers employment: The case for delaying the retirement age. Journal of the European Economic Association. Vol. 8, No. 5, 1034-1076.

Hopenhayn, H., Nicolini, JP., 1997. Optimal unemployment insurance. Journal of Political Economy, 105, 412–438.

Jiménez Martín, S., Sánchez Martín A., 2007. An evaluation of the life cycle effects of minimum pensions on retirement behavior. Journal of Applied Econometrics, 22, 923–950.

Kocherlakota, N., 2004. Figuring out the impact of hidden savings on optimal unemployment insurance. Review of Economic Dynamics, 7, 541–554.

Launov, A. and K. Wälde, 2010. Estimating incentive and welfare effects of nonstationary unemployment benefits. CESifo Working paper, N. 3069.

Michelacci C., Ruffo H. 2009. Optimal life cycle unemployment insurance. Mimeo

Rust, J., Phelan, C., 1997. How social security and medicare affect retirement behavior in a world of incomplete markets. Econometrica, 65, 781–831.

Stiglitz, J.E., Yun, J., 2005. Integration of unemployment insurance with retirement insurance. Journal of Public Economics, 89, 2037-2067.

Social Protection Committee, 2008. Promoting longer working lives through pensions reforms- 2nd part- early exits from the labour market. Technical report, European Commission , Social Protection Committee.

Van den Berg, G.J., 1990. Search behaviour, transitions to nonparticipation and the duration of unemployment. Economic Journal, 100, 842–865.

Van der Klaauw, W., Wolpin K.I., 2008. Social security and the savings and retirement behavior of low income households. Journal of Econometrics, 2008, vol. 145, issue 1-2, pages 21-42

Van Ours, J.C., 2009. Will you still need me when I'm 64? De Economist, 157-4, 341-400.

APPENDIX

A The model: recursive representation and numerical methods

A.1 Recursive representation of the individual problem

In this section we review the recursive representation of the life-cycle problem of an unemployed individual (equation (6) in section 2). The solution is characterized by constructing a specific value function for each of the possible labor states e of the individual (Employment, Unemployment with search, Unemployment without search -ie. non-participation- and Retirement). These value functions are solved by backward induction starting at $\overline{N}$. At that age, everybody is assumed to leave the labor force and we only have to compute the value of retirement:

$$R_{\overline{N}}(\hat{w}) = \sum_{i=\overline{N}}^{T} \beta^{i-\overline{N}}\, S_{\overline{N}}(i)\, u(\, B(\hat{w},\overline{N}),\, R\,) = \left(\frac{[B(\hat{w},\overline{N})(1+l)]^{1-\eta}}{1-\eta} \right) \cdot A_{\overline{N}}^{T} \tag{7}$$

where $S_{\overline{N}}(i)$ stands for the survival probability to age $i \geq \overline{N}$ conditional on survival to age $\overline{N}$ and A_i^j is the expected discounted value of a constant income flow of one unit starting at age i and ending at age j. R is simply the expected discounted value of the utility derived from the drawing of pension $B(\hat{w},\overline{N})$ and the full allocation of individual time to non-market activities. As is apparent from eq. (7), $R_a(\overline{w})$ can be obtained analytically at each period. It is, in this sense, very different from all the other value functions involved in the problem.

At earlier ages, $a < \overline{N}$, we must keep track of the value functions corresponding to the four possible labor states: $\mathcal{E}, S, N, R$. We review them in turn. To simplify notation, from here onwards we denote the (one period ahead) effective discounting at age a, $\beta\, S_a(a+1)$, by β_a.

A.1.1 Employed workers

Currently employed workers may retire immediately or leave their status unchanged for one more period. In the latter case (denoted by a small e as a superscript of $\mathcal{E}$), workers face, on top of survival uncertainty, the risk of being fired and starting the next period as unemployed. This is easily reflected in the corresponding value function:

$$\mathcal{E}_a^e(w,\hat{w}) = u(w,E) + \beta_a \left[(1-\delta)\, \mathcal{E}_{a+1}(w,\hat{w}') + \delta\, U_{a+1}(w,\hat{w}',1) \right] \tag{8}$$

For any variable, a prime denotes the value of the same variable in the next period. Note that we assume constant wages and update the *pension rights*, $\hat{w}$, as in (4). The value function U is defined below, while $\mathcal{E}$ represents the total value of being employed, ie. including the option of retirement. Formally, this total value is:

$$\mathcal{E}_a(w,\hat{w}) = Max\{\, \mathcal{E}_a^e(w,\hat{w}), R_a(\hat{w})\,\}$$

The value of retirement at age $a \in [N_m, N]$ is identical to that in (7) for the case of retirement at age $a = \overline{N}$.

A.1.2 Unemployed workers

For the unemployed we consider three different value functions. We represent with $S_a(\pi, \hat{w}, h)$ the value associated with engaging in an active search process while unemployed, and with $N_a(\pi, \hat{w}, h)$ the value of avoiding search cost, at the expense of relinquishing the chance of receiving job offers in the next period. In both cases, four state variables (age, a, previous wage, π, pension rights, $\hat{w}$ and duration in unemployment, h) are needed to fully characterize the economic situation of those workers. The unemployed at the beginning of the period may also leave the labor force and retire, with value $R_a(\hat{w})$. Consequently, the total value attached to the state of unemployment at the beginning of the period, $U_a(\pi, \hat{w}, h)$, is:

$$U_a(\pi, \hat{w}, h) = Max\{S_a(\pi, \hat{w}, h), N_a(\pi, \hat{w}, h), R_a(\hat{w})\}$$

We review each component next.

The value of involvement **in an active search process**, $S_a(\pi, \hat{w}, h)$, comprises two elements: a (presumably modest) current value $u(b(\pi, h), S)$ of searching, and an expected future value of searching (EV^S) given by:

$$EV^S = \beta_a \{\lambda_h E_w[Max\{U_{a+1}(\pi, \hat{w}', h+1), \mathcal{E}_{a+1}(w, \hat{w}')\} + (1-\lambda_h)U_{a+1}(\pi, \hat{w}', h+1)]\} \quad (9)$$

where λ_h represents the arrival rate of job offers for workers with h periods in unemployment. Future pension rights are updated as in (4),[39] ie: $\hat{w}' = \hat{w} + \frac{\kappa_h \pi - \hat{w}}{D}$. In other words, the expected future value reflects two elements:

(1) If an offer of size w arrives, the individual must decide whether to accept it or reject it. The optimal decision is obtained by comparing $\mathcal{E}_{a+1}(w, \hat{w}')$ to $U_{a+1}(\pi, \hat{w}', h+1)$. Of course, at t, the size of the wage offer is uncertain. Consequently, the individual proceeds according to conditional expectations, with this accounting for the $E_w[.]$ in (9).

    As usual in the literature, the job-acceptance decision is summarized, for each possible value of the state variables, by the corresponding *Reservation Wage*, $\overline{w}_a(\pi, \hat{w}, h)$. This is the wage that makes the unemployed indifferent as to whether to take the job or remain unemployed. Formally:

$$\mathcal{E}_a(\overline{w}_a(\pi, \hat{w}, h), \hat{w}) = U_a(\pi, \hat{w}, h) \quad (10)$$

(2) If no offer arrives or if the offer received is unacceptable, the associated value is that of staying unemployed one more period, ie. $U_{a+1}(\pi, \hat{w}', h+1)$. Note the different updating of the pension rights with respect to the previous case (in the presence of an acceptable offer). The probability of *this* case is $1 - \lambda_h(1 - F(\overline{w}'))$, where $\overline{w}'$ stands for the next period reservation wage, $\overline{w}_{a+1}(\pi, \hat{w}', h+1)$.

[39] The value of κ_h is one if $h \leq 2$. For the long-term unemployed, the UI system pays the minimum contribution, which implies a variable κ.

Overall, the expected future value of searching consists of two elements: a *Stop Value* of finishing the current unemployment spell by accepting an offer immediately and an *Option Value* derived from staying unemployed and so upholding the chances of receiving an acceptable job offer in the future.

Finally, the value of **Non-Participant unemployment**, $N_a(\pi, \hat{w}, h)$, is simpler to formulate than the option with active search, as it does not involve any uncertainty (apart from survival risk):

$$N_a(\pi, \hat{w}, h) = u(b(\pi, h), l) + \beta_{a+1} U_{a+1}(\pi, \hat{w}', h + 1)$$

where pension rights are updated as in the immediately preceding case.

We can conclude by noting that the value of the retirement option for the unemployed is similar to that previously discussed for the unemployed.

A.2 Numerical solution of the model

A.2.1 Numerical representation of the Value Functions

There are no analytical solutions to the functional equations above. Consequently, we employ numerical methods to compute the optimal retirement and search decisions, calculate the value functions and explore the basic properties of the solutions. Including two continuous states, the value functions are infinite dimensional objects and can be reproduced in the computer only approximately. The use of a numerical approximation method is, therefore, unavoidable. In particular, we:

- Discretize the continuos state variables

  We build a uniform grid $\mathcal{G}$ in the State Space $\Pi \times \hat{W}$ (see Appendix B.2). In each *age* iteration, $a = \{55, \ldots, 65\}$, and for each $x_j \in \mathcal{G},\ j = \{1, \ldots, N\}$ (with N representing the number of nodes in the grid) we compute the optimal value function:

  $$U_a(x_j, h)\ j = \{1, \ldots, N\}\ h = \{1, 2, 3\}$$

  And the associated optimal decisions rules (ie, the selected optimal labor states).

- We use interpolation whenever a value function is evaluated outside the grid. For example, to compute the reservation wage of an unemployed worker in state $(\pi, \hat{w}, h, a)$ we have to be able to evaluate $\mathcal{E}_a(w, \hat{w})$ for any value of w (and not just the w that happens to belong to $\mathcal{G}$). We also have to repeatedly evaluate the future value of staying unemployed with pension rights that do not exactly match the values in the grid. The reported results correspond to a solution with linear interpolation. We have also used higher order approximating functions (splines) without encountering significant differences.

A.2.2 Design of the aggregate simulations

To evaluate the performance of the model, we compare the model-generated transition *flows* in our reference sample with their empirical counterparts. We simply compute the optimal predicted behavior for each potential individual in the sample and aggregate (using the empirical distribution by age, income and duration in unemployment). To implement this experiment we undertake a simplified Monte-Carlo simulation involving the following steps:

1. Create a large sample of individuals reproducing the empirical distribution $\mu(\pi, \hat{w}, a, h)$ with $a \in \{50, \ldots, 65\}$ $h \in \{1, \ldots, 3\}$ $\quad \pi \in \Pi \quad \hat{w} \in \hat{W}$.
2. Simulate the arrival of job offers and the size of the wage proposed, according to the parametric functions included in our model. To this end, we create a large sample of N(0,1) distributed shocks and transform them according to the assumed properties of the wage process. This sample of shocks is kept constant across all the experiments in the paper.
3. Let the individual in the simulated sample react to the job offers (and to the alternative of retiring from the labor force) in accordance with the model policy functions. Keep records of the job acceptances/retirement/non-participation decisions.
4. Aggregate the decisions, compute the implicit re-employment and retirement hazards and the wages accepted by the workers that reenter and, finally, compare them with their empirical counterparts.

B Calibration: numerical procedures and results

B.1 Method of simulated moments

The procedure to select the parameters of our benchmark calibration (ie. our "method of simulated moments") is as follows:

1. We define a range of variation and a length of step for each unobservable parameter in the model. For example, for the discount factor we explore all possible combinations between 0 and 12.5%. We start with a coarse grid and progressively increase the precision. Eg. with the discount factor, we first solve in the grid $\{0, 0.025, 0.05, 0.075, 0.1, 0.125\}$ and then focus on the most successful point to create a new, finer grid. This iterative procedure is very computationally intensive because is implemented simultaneously in all the parameters of the model. Following this general procedure, our *final* computation multi-grid was:

   Preferences: $\beta \in [0.89, 0.93]$, $\eta \in [4, 6]$, $l \in [0.3, 0.5]$, $l^s \in [0.2, 0.5]$.

   Labor Market: $\lambda \in [0.5, 0.7]$, $G \in [0, 0.1]$, $h \in [0.5, 0.9]$, $\mu \in [8, 10]$, $\sigma \in [5.5, 6.5]$

2. We solve the model at each node of the multidimensional grid. This implies computing the optimal individual behavior and simulating the aggregate performance of the model in the empirical sample of Section 2.1.

3. We compute the prediction error in each node: the differences between the observed hazards and reentry wages by age and the theoretical predictions.[40] We obtain one overall error number by averaging the errors by age (weighted according to the sample proportion by age) in the three empirical dimensions.

B.2 Benchmark results: optimal decisions and reservation wages

In this section we reproduce the optimal individual decisions in the benchmark calibration (Table 5) and certain selected properties of the associated reservation wages (illustrated in Figures 11 to 13). Each array in Table 5 reproduces the optimal behavior for a particular age and unemployment duration (h). Each cell in an array is defined by a combination of a previous wage, π, and a level of accrued pension rights, $\hat{w}$, belonging to the discretized sets:

$$\Pi = \{5.69, 8.55, 11.08, 14.0, 17.44, 19.49, 22.86, 29.78\} \; \hat{W} = \{5.12, 6.96, 9.0, 10.90, 12.89, 14.94, 16.99, 21.42\}$$

All values are in thousand of Euros and in 2002 prizes. The structure of the grids is selected to guarantee the presence of a sufficient number of empirical observations (in our reference sample) in each cell of the grid. The decision shown in the cell defined by the i-row and j-column, $d_{i,j}$, is the optimal behaviour for the individual whose previous wage is the i-th element of Π and whose pension rights are given by the j-th element of $\hat{W}$. $d_{i,j}$ takes the value "1" when search is the optimal choice; "0" if it is optimal to retire; and "N" if non-participation is best. There follows a very brief summary of the behavior detected:

Before 60, non-participation is concentrated among the long-term unemployed (h=3), although it becomes progressively more important after 58 for workers with h<1 and large pension rights.

After 60, non-participation is widespread for workers with h<3 and with higher previous wages than their accumulated pension rights (graphically, they appear below the main diagonal of each matrix). For these workers, the current pension rules guarantee an automatic upgrade of their pension rights if they stay unemployed. The situation is exactly the opposite for individuals with high pension rights and low previous wages. Not surprisingly, retirement is the optimal decision for those workers. Note, finally, that retirement is universal for the long-term unemployed (it is essentially independent of the size of their pension rights and previous wages) and that the option to search actively is only optimal for workers with low pension rights.

[40] We express the error as a percentage of the empirical value, although we modify the denominator in the cases of the reemployment and retirement hazards to avoid the numerical difficulties that arise when the empirical values are very close to zero. For example, with the reemployment hazard we compute the vector

$$err_a = (HE_a^{model} - HE_a^{data})/(1 + HE_a^{data}) \quad a \in \{55, 65\}$$

The overall error measure in each dimension is the 2-norm of the vector or errors, ie. in each dimension:

$$err = \left[\sum_a err_a^2 \right]^{1/2} \tag{11}$$

```
h =      1

    56         58         60         62         64         65
11111111|11111NNN|111N0000|11N00000|1N000000|10000000
11111111|11111NNN|111NN000|11N00000|1N000000|1N000000
11111111|111111NN|111NNN00|11NN0000|1NN00000|11N00000
11111111|1111111N|1111NNN0|11NNNN00|11NN0000|111N0000
11111111|1111111N|11111NNN|111NNNN0|11NNNN00|11NNN000
11111111|1111111N|11111NNN|111NNNN0|11NNNNN0|11NNN000
11111111|1111111N|1111NNNN|11NNNNN0|1NNNNNN0|NNNNN000
11111111|1111111N|111NNNNN|1NNNNNN0|NNNNNNN0|NNNNNN00

h =      2

11111111|11111111|111N0000|11N00000|NN000000|10000000
11111111|11111111|111N0000|11N00000|NN000000|11000000
11111111|11111111|111NN000|11NN0000|1NN00000|11000000
11111111|11111111|1111NNN0|111NN000|11NN0000|11N00000
11111111|11111111|11111NNN|1111NNN0|11NNN000|111NN000
11111111|11111111|111111NN|1111NNN0|11NNNN00|111NN000
11111111|11111111|111111NN|1111NNN0|11NNNNN0|111NNN00
11111111|11111111|11111NNN|1111NNN0|11NNNNN0|111NNN00

h =      3

11N1NNNN|N1NNNNNN|00N00000|NN000000|N0000000|0N000000
11N1NNNN|N1NNNNNN|00N00000|NN000000|N0000000|0N000000
11N1NNNN|N1NNNNNN|00N00000|NN000000|N0000000|0N000000
11N1NNNN|N1NNNNNN|00N00000|NN000000|N0000000|0N000000
11N1NNNN|N1NNNNNN|00N00000|NN000000|N0000000|0N000000
11N1NNNN|N1NNNNNN|00N00000|NN000000|N0000000|0N000000
11N1NNNN|N1NNNNNN|00N00000|NN000000|N0000000|0N000000
11N1NNNN|N1NNNNNN|00N00000|NN000000|N0000000|0N000000
```

Table 5: Optimal retirement-policy in the baseline calibration

Reservation Wages

The age of the individual has a major impact in the pattern of variation of his/her reservation wages by age, income and duration in unemployment. While some patterns are very standard (ie. similar to those described in the previous literature) at earlier ages, they become increasingly dominated by the role of pensions for older individuals. More precisely, at the younger age considered (55), the reservation wages are lower for the long-term unemployed and are flat or increase slightly with the previous wage, reflecting the details of the provision of unemployment insurance. The size of accrued pension rights is, in contrast, irrelevant. Figures 11 to 13 provide a graphical illustration of these patterns in our benchmark case. Things are different for older individuals: the reservation wages become more and more dependent on pension rights and less and less sensitive to previous wages and duration[41]. Age is also very important for the sensitivity to labor market conditions: as the individuals approach the NRA, reservation wages cease to respond to changes in both λ and $F(\cdot)$. Finally, it is interesting to note that high annual early retirement penalties (a very steep profile of μ with age) do reduce reservation wages around the ERA, making workers more willing to return to the labor force. This effect seems to be dominated by the disincentive effect of early retirement discussed throughout the paper.

B.3 Empirical performance of the model

Figure 14 summarizes the model predictions in our sample. It combines the behavioral content of the policy functions reviewed in the previous sections with the economic characteristics of our MCVL sample of reference. To facilitate the comparison of the theoretical predictions and the data, the information is arranged in the same way as the empirical information in Figures 3 to 5 in section 2.1.

[41]After the NRA (65) high previous wages are important only for workers whose pension rights are significantly smaller in size. This implies that the individual can increase his/her pension by delaying retirement, due to the annual updating of accrued pension rights. The differences in reservation wages with duration also disappear eventually, as most short-term unemployed also find it best to retire immediately.

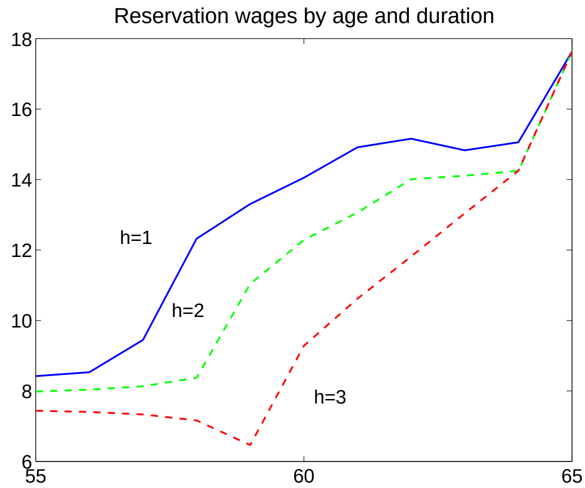

Figure 11: Reservation wage by age conditional on duration (for average π and $\hat{w}$).

Figure 12: Reservation wage by previous wage, π, conditional on age (for h=1 and average $\hat{w}$).

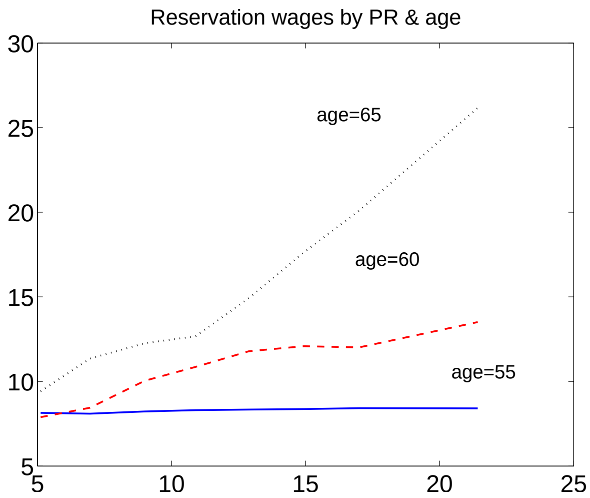

Figure 13: Reservation wage by pension rights, $\hat{w}$, conditional on age (for h=1 and average π).

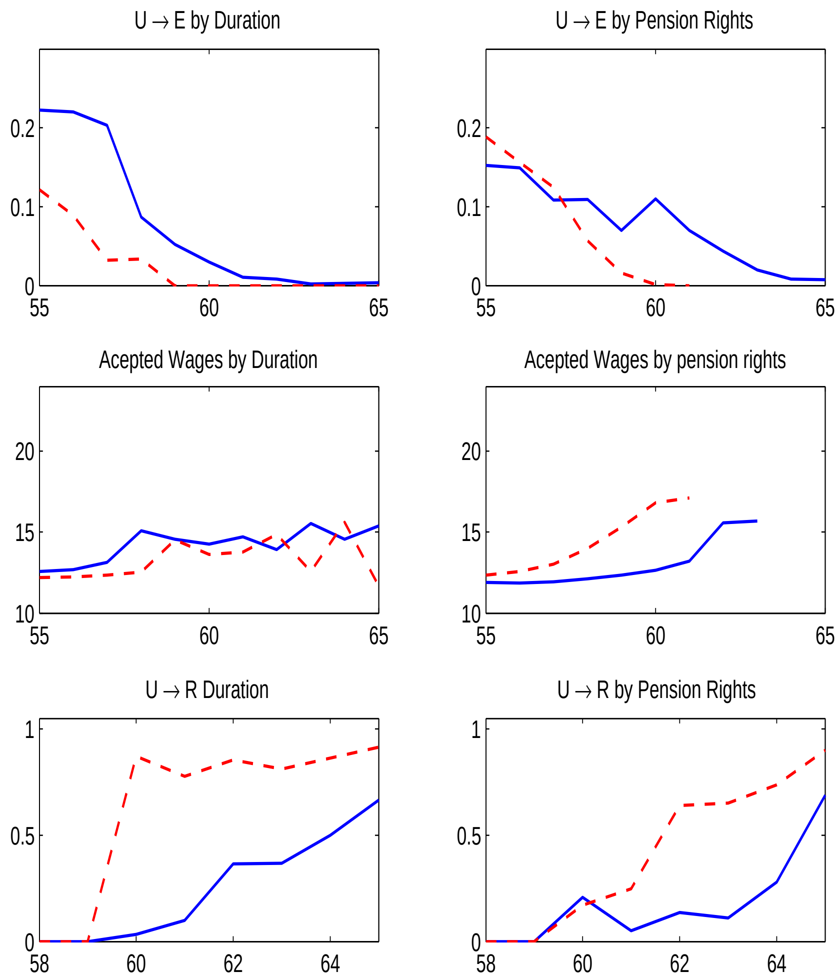

Figure 14: Model predictions for the estimation sample. Reemployment hazard, reentry wages and retirement hazard by age and duration in employment (left panels) and by age and accrued pension rights (right panels). The two lines included in each graph represent workers with duration h=1/h=3 (red, dashed line) and below and above the centiles 1/3 and 2/3 (red, dashed line) of the pension distribution.

C Policy experiment: welfare and financial computations

C.1 Pension financial cost

We evaluate the total cost that each individual represents for the Social Security (ie. the joint unemployment-pension systems) by computing his/her Net Pension Cost (NPC). This is defined as the expected present discounted value of the flows of transfers received by the individual, net of the contributions to be paid to the system. The value is conditional on the observable state of the individual (age, duration in unemployment, pension rights and previous wages) and is computed recursively. To facilitate the comparisons across individuals, all flows are discounted to a common age (60) using the same discount factor (d). It should be remembered that the calculation is intended to assess the aggregate financial liabilities implicit in a cross section observed at a specific point in time. The analytical expressions are as follows:

- The first value is computed at the maximum retirement age, N. The cost implied by an individual observed at that age making the transition from unemployment to full retirement is:

$$PC_N^R(\hat{w}) = \sum_{i=t}^{T} \left(\frac{1}{1+d}\right)^{i-60} S_t(i)\, B(\hat{w}, N) = B(\hat{w}, t)\, A_{N,60}^T \tag{12}$$

  We use the same notation as in Section A.1. In particular, $A_{N,60}^T$ is a special case of A_i^j in that section, ie. the expected present discounted value of one unit of income received in every period of the age range $\{i, \ldots, j\}$. The difference here is that we discount to age 60 rather than to age i.

- For individuals observed at the age N-1, the cost associated with retirement, $PC_{N-1}^R(\hat{w})$ responds to an expression that is identical to (12). For individuals who stay employed at that age, the implicit cost reflects the contributions paid throughout the year and the change in accrued pension rights:

$$PC_{N-1}^E(w, \hat{w}) = -cot(w)\, A_{N-1,60}^{N-1} + S_{N-1}(N)\, PC_N^R(\hat{w}')$$

  Pension rights are updated as in (4). Finally, the implicit liability for the unemployed is:

$$PC_{N-1}^U(\pi, \hat{w}, h) = b(\pi, h)\, A_{N-1,60}^{N-1} + S_{N-1}(N)\, PC_N^R(\hat{w}')$$

- At earlier ages, $t < N-1$, the expressions for employees and the unemployed become rather cumbersome, reflecting the different possible behavioral reactions of the individuals.

  - For the employees of age t, the implicit cost is:

$$\begin{aligned} PC_t^E(w, \hat{w}) = & \quad -cot(w)\, A_t^t + \\ & +\delta\, S_t(t+1)\, [\, I_{t+1}^U(R|w, \hat{w}', 1)\, PC_{t+1}^R(\hat{w}') + I_{t+1}^U(U|w, \hat{w}', 1)\, PC_{t+1}^U(w, \hat{w}', 1)\,] \\ & +(1-\delta)\, S_t(t+1)\, [\, I_{t+1}^E(R|w, \hat{w}')\, PC_{t+1}^R(\hat{w}') + I_{t+1}^E(E|w, \hat{w}')\, PC_{t+1}^E(w, \hat{w}')\,] \end{aligned}$$

where $I^U_{t+1}(R|w,\hat{w}',1)$ and $I^U_{t+1}(U|w,\hat{w}',1)$ are indicator functions taking a value of one if the optimal decision is to either retire or stay unemployed. The interpretation of $I^E_{t+1}(j|w,\hat{w}')$ with $j=\{E,R\}$ is entirely analogous. Note that if the individual is fired at the end of t, the individual is unemployed at the beginning of age $t+1$ with state $x \equiv (\pi,\hat{w},h) = (w,\hat{w}',1)$.

– For the unemployed of age t and state $x=(\pi,\hat{w},h)$:

$$
\begin{array}{rcr}
PC^U_t(x) = & b(\pi,h)\,A^t_t+ & \text{UB in t} \\
& +S_t(t+1)\,I_{t+1}(S|x)\,P^E_t(x)\,E_w[PC^E_{t+1}(w,\hat{w}')]+ & \text{Successful search} \\
& +S_t(t+1)\,I_{t+1}(S|x)\,(1-P^E_t(x))\,C^U_{t+1}(x')+ & \text{Unsuccessful search} \\
& +S_t(t+1)\,I_{t+1}(NS|x)\,C^U_{t+1}(x') & \text{Inactivity}
\end{array}
$$

where $I_t(S|x)$ and $I_t(NS|x)$ indicate the optimality of searching or staying inactive at age t and state x respectively; $P^E_t(x) = \lambda(t,h)\,(1-\Phi(\hat{w}(x)))$ is the probability of a successful search and $E_w[C^E_{t+1}(w,\hat{w}')] = \int_{\hat{w}}^{\infty} C^E_{t+1}(w,\hat{w}')\,dFw$ is the expected value of a successful search. Note finally that the value of starting the next period as unemployed is:

$$
C^U_{t+1}(x') = I_{t+1}(R|\pi,\hat{w}',h+1)\,PC^R_{t+1}(\hat{w}') + I_{t+1}(U|\pi,\hat{w}',h+1)\,PC^U_{t+1}(\pi,\hat{w}',h+1)
$$

which includes the impact of the retirement option.

C.2 Equivalent Variation

In this paper we evaluate the welfare changes associated with a reform by an Equivalent Variation (EV) in income with respect to the *status quo* (the institutional setting in the benchmark economy). The EV(x) associated with a particular change is defined as the amount of money that the individual in state x will be willing to pay to avoid the implementation of the reform (ie. to remain in the benchmark). We keep all the individual decisions (both in the present and in the future) as in the benchmark when making the calculation. Therefore, the formal definition depends on the current optimal behaviour of the individual. If it is optimal for the individual in state x to retire, the EV is implicitly defined as follows:

$$
V^{Bench}(x) = \frac{((B-EV)(1+l))^{1-\eta}}{1-\eta} + S_t(t+1)\,A^T_{\tau+1,\tau}\,\frac{(B(1+l))^{\eta}}{\eta}
$$

We follow the same notation as in section A.1. Alternatively, if searching is the optimal decision, the implicit definition is:

$$
V^{Bench}(x) = \frac{((b-EV)(1+l^s))^{1-\eta}}{1-\eta} + OV(x) + SV(x)
$$

with the Option Value of staying unemployed $OV(x) = (1-\lambda\,\overline{F}(\overline{w}'))\,U(x')$ and Stop Value of searching $SV(x) = \lambda\,E[\mathcal{E}(x')]$. Finally, if inactivity is the most highly valued option at x, the definition is:

$$
V^{Bench}(x) = \frac{((b-EV)(1+l))^{1-\eta}}{1-\eta} + \beta\,S_t(t+1)\,U(x')
$$

D Robustness of the results

	Our simulations			Standard Parameters			Social Security post-1997		
	NPC	EV	EV (%)	NPC	EV	EV(%)	NPC	EV	EV(%)
BASE	155.45			140.65			160.93		
reformed	146.69	1.6098	9.35	130.93	2.8867	16.74	146.70	1.8402	11.01

Table 6: Sensitivity analysis of the impact of changes in the pension formula

In this section we report on two sensitivity experiments. First, we consider the impact of our pension reform (section 4.3) assuming that our sample is populated by individuals with a 3% discount factor, β, and a relative risk aversion parameter $\eta = 4$. These values do not generate a good fit of the model to the data, but are routinely used elsewhere in the literature. Table 6 shows the results: all effects are qualitatively similar in the new environment; and although the financial gains and the Equivalent Variation are both larger, the conclusión that all affected workers can be compensated is unaltered. A second experiment tracks the aggregate behavior of our benchmark individual in an environment including all the more recent changes in pension rules ($D = 15, N_m = 61, \mu_1 = 0.07$ and $\mu_2 = 0.02$ (post-65 bonus)). Again, the results are qualitatively identical to those in our pre-97 simulations. The quantitative differences found do not change the potentially Pareto-improving character of the proposed reform. In short: our main policy finding stands firm against rather fundamental changes in the economic environment.

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