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Fostering job search among older workers: the case for pension reform *

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Abstract

The job search demands made upon older unemployed workers in developed economies have traditionally been very relaxed. This has recently changed in some European countries (eg. Germany and Finland), as part of an effort to increase the labor force participation of older workers. Is this new approach appropriate? There is some disagreement among academics about the optimality of this new policy stance. We contribute to this debate by exploring the consequences of institutional reform in Spain, a country with a high rate of unemployment and a tolerant attitude toward the use of unemployment benefits as early retirement income. We develop an applied model of job-search and retirement behavior; calibrate it to the specificities of the Spanish case and successfully verify its empirical validity. We use the model to explore the effects of a change in the pension rules to link early retirement penalties to the age when an individual stops paying contributions. This reform removes the incentives to remain unemployed without searching, encouraging individuals to either retire or actively engage in job seeking. It results in welfare losses, especially for those workers that respond by changing behavior; yet the reform also raises enough extra resources whereby the public authorities may more than compensate all the affected workers.

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1 Introduction

Since the mid 1970s, a variety of early retirement provisions have been part of the public pension systems in most EU and OECD countries. From 2004 onwards, more than half of EU Member States had standard early retirement provisions and special disability and unemployment insurance mechanisms for their older workers. The latter were routinely used as "alternative early retirement routes", offering special provisions such as exemption from the requirement to search for a job or extended unemployment benefits (Peters et al. (2004)).

In Germany, for example, the statutory retirement age was 65 before the latest (2007) reform and will be steadily increasing from 2012 to 2029 to the age of 67. Yet, at the same time, there were at least seven different possible exit routes involving much earlier withdrawal from the labor force (see chapter 6 in Borgmann (2005)). Some of them allowed collecting benefits as early as the age of 58, without incurring the 3.6% annual penalty for standard early retirement (which, incidentally, was introduced only in 2000, while the early retirement option had been in place since 1972). Until the 2007 reform, the unemployment pathway was one of the most popular routes into retirement. Workers could effectively stop working at 58 and collect benefits without showing any willingness to seek employment. At the age of 61 they could apply for a special program of "benefits due to age after unemployment" that would cover them till the statutory retirement age. Arrangements of this type were common in most European countries. As a result, the share of exits through unemployment stood at around 15% on average for EU Member States and exceeded 25% in seven countries.[1]

During the nineties, economists quantified the size of the early retirement incentives built into pension rules (eg, Blondal and Scarpetta (1998)) and the labor supply losses resulting from those policies (Gruber and Wise (1999)).[2] At the same time, governments gradually woke up to the consequences of population aging for the financial solvency of their pension systems. Governments eventually began introducing tighter rules for the access of older workers to "irregular" early retirement schemes. In the EU, this was part of a broader effort to increase labor force participation among older workers (the "Lisbon Agenda"). The profound financial crisis that began in 2008 has only accelerated this process. In its latest white paper, Commission (2012), European authorities placed the demand to "*restrict access to early retirement schemes and other early exit pathways*" at the top of its five recommendations, second only to the remit to link retirement ages to increases in life expectancy. In fact, several countries have recently adopted such measures as restricting the duration of unemployment benefits, extending supervision of job search activities to the older unemployed, increasing the age limits for the principle of "availability to work" and changing the rules on rejecting job offers for those with unemployment benefits. In countries such us Germany or Finland, the early exit route via unemployment has already largely been closed.

Is this new policy approach the right one? Does it really pay to foster the search effort of

[1]Denmark, Spain, France, Lithuania, Portugal, Finland and Slovakia. See graph 6 in Commission (2008).

[2]Blondal and Scarpetta (1998) show the major financial consequences for workers who, ignoring the early retirement incentives implicit in disability and unemployment benefits rules, postpone retirement until the age of 70. The cumulative losses in social security benefits add up to several multiplies of a worker's average annual earnings (eg, as much as ten years' income in countries such as Sweden and Austria).

workers approaching retirement? Although economists tend to value favorably the increase in labor supply resulting from the new, stricter policy stand, there is no unanimity regarding its welfare consequences. In the past, a lax stand on early retirement garnered widespread approval on the grounds that, by pushing older people out of the labor market, the authorities were creating more favorable conditions for younger generations.[3] This "lump of labor" theory has largely been discredited today (Munnnell and Wu (2012)), but some scholars have propounded new arguments based on much sounder economic principles.

For example, Bhattacharya et al. (2004) explore a search and matching framework where some *publicly induced* retirement is optimal, but not with the intensity that seems to be observed in reality. This is partly because the creation of new vacancies through retirement results in a negative externality on aggregate matching possibilities. Cremer et al. (2006) build a theoretical justification for "Canada Dry pensions" (the authority-sanctioned misuse of unemployment benefits). In their model, the lax policy stand can act as an imperfect and indirect screening device, that mitigates the policy imperfections created by asymmetric information (companies know about worker productivity, while governments lack that information). The same conclusion is reached in Hairault et al. (2012) when addressing the optimal design of a duration-conditional unemployment scheme. The key ingredient for their result is that older workers have a shorter expected time-duration *on the job* after re-entry. This weakens their search incentive. Consequently, to induce job search, the optimal unemployment profile must be strongly decreasing. It must pay very high benefits at the beginning of the unemployment spell for workers close to retirement, followed by a sharply decreasing pattern as unemployment lengthens. The cost of such a profile would, however, be too high for the unemployment insurance agency. It would prefer to provide the soon-to-be retired unemployed with a flat rate of unemployment benefit, even if this means they do not seek employment.[4]

This paper focuses on the impact of pension and unemployment rules on labor supply in Spain. Even within the context of today's troubled European labor markets, the Spanish situation stands out. In comparison to its Europeans peers, its unemployment rate is much higher and its employment rates for workers close to retirement are lower (around 45% vs. more than 57% in the UK or Germany). The re-entry rates observed following unemployment spells initiated after the age of 50, for example, are extremely low. In our *Muestra Continua de Vidas Laborales* data set (referred to henceforth as MCVL and described in detail in section 3.1.1) the quarterly reemployment hazard is less than 13% for workers in the 55-59 age range and a paltry 1.5% for those in the 60-65 bracket. Furthermore, their self-declared search intensity is also remarkably weak.[5]

The Spanish case is also particularly well-suited for modeling for at least two reasons: first,

[3]Historically, fostering early retirement was one of the ideas behind the creation of the Social Security. A review of the changing shapes of publicly induced retirement can be found in Bhattacharya et al. (2004). Early retirement policies can be linked to these historical tendencies.

[4]As an alternative, the authors propose taxing pensions in proportion to unemployment duration as a way of inducing optimal behavior. Their calculations for the French labor market point to savings of 35% of the current unemployment insurance costs for workers five years prior to retirement. Note that this analysis is undertaken in an infinite horizon model with exogenous retirement and where age is not explicitly modeled.

[5]In the 2000-2010 Spanish Labor Force Survey, fewer than 27% of those unemployed aged 50-54 are actively looking for a new job. This number falls to fewer than 11% for those aged over 60.

because public pensions and unemployment benefits are the main sources of income for the retirees (with private pensions playing a relatively unimportant role and with the state providing universal health insurance); second, because public regulations provide well-defined and easily quantifiable incentives. Formally, early retirement (ie, claiming pension benefits before the Normal Retirement Age, NRA, of 65) implies a relatively severe permanent reduction in pension benefits (between 6 and 8% per annum, depending on personal circumstances). At the same time, however, the system also provides an alternative, unofficial route into early retirement through unemployment insurance (UI).[6] It combines a very generous contributive benefit for up to two years, followed by a small unemployment subsidy available until the pension is drawn. Unemployed workers are formally expected to seek and accept job offers during the unemployment spell, but this requirement is not effectively enforced by the labor authorities.

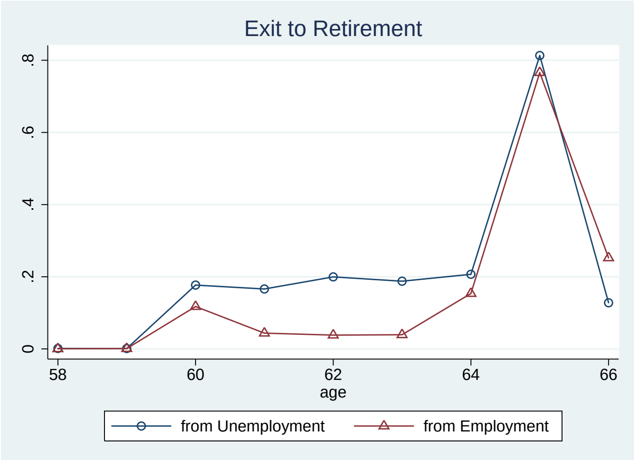

Figure 1: Quarterly exit probabilities from employment and unemployment to retirement, conditional on age. MCVL-2011

The impact of this set of rules on the observed behavior of Spanish workers is dramatic. Most early withdrawals from the labor force involve the use of the UI system, with standard direct transitions from employment into retirement playing a much smaller role (Figure 1). Figure 2 adds to this conclusion by showing a range of different behaviors conditional on the age of separation from the last job. The right-hand figure shows workers entitled to both UI contributory benefits and unemployment subsidies, while workers in the left-hand figure are covered only by the initial UI contributory benefits. We find that workers made redundant in their mid-fifties (up to 58) tend to retire at 60, the Early Retirement Age (ERA), after very long unemployment spells.[7] This pattern is largely independent of the availability of unemployment subsidies. In contrast, the behavior of workers who lose their jobs later is strikingly different. Those without subsidies limit their use of the unemployment program to the period covered

[6] Disability pensions are another alternative exit gateway, although they have been more strictly monitored in recent times. See eg, Boldrin, Jiménez-Martín, and Peracchi 1999.

[7] For example, those 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.

by contributive benefits and, consequently, retire in large numbers after just 24 months. Those people covered by subsidies remain unemployed for much longer.

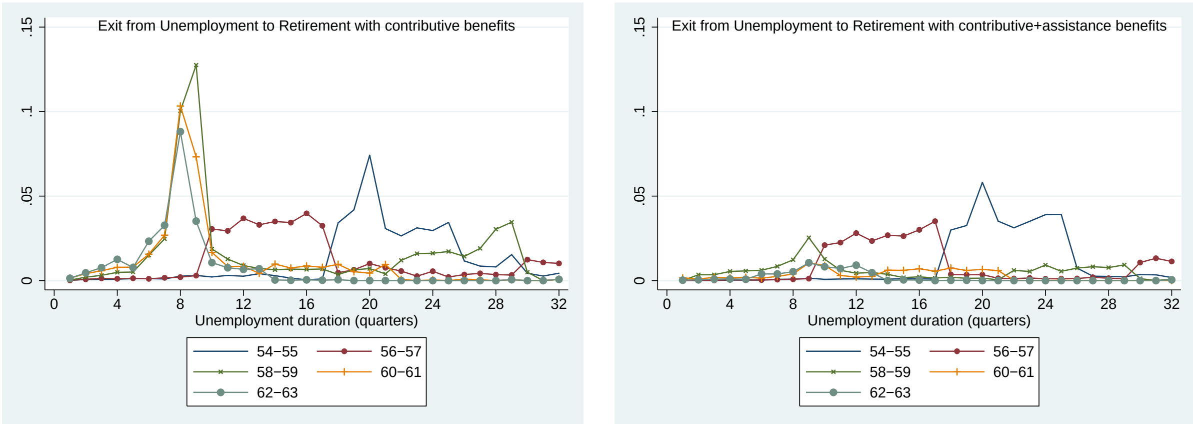

Figure 2: Differences in retirement hazards depending on the ability to extend contributive unemployment benefits with UI subsidies.

In light of the previous evidence, it seems reasonable to contend that institutional changes would have an impact on individual behavior. A more profound question is whether encouraging search among older Spanish workers is the correct policy option (from a broader welfare perspective). This paper strives to contribute to this debate by using calibrated simulations. We build, calibrate and simulate a model of optimal search and retirement behavior adapted to the Spanish institutional environment. After testing the model's ability to match the basic empirical patterns (in a large sample of administrative records from the Spanish Social Security System), we use it to simulate the reactions to alternative institutional environments. We can summarize our findings as follows. First, we show that a stylized model of search and retirement can very accurately reproduce the age-patterns of labor supply and re-entry wages in Spain. The parameters that deliver a good empirical match reveal an environment with rather high search costs for individuals and poor labor demand conditions for older workers (summarized in relatively small average wage offers, and a sizeable chance of failing to receive any offer at all). Rational behavior in such an environment includes widespread voluntary non-participation by the older unemployed. The empirical success of the model encourages us to embark on policy analysis. Therein lies the paper's second contribution: we use the model to explore the benefits and costs of fostering search efforts in Spain. We proceed in two steps: first we explore an environment in which the fiscal authorities can enforce the search request as a prerequisite for unemployment insurance. We find a strong labor supply reaction to this theoretical environment, with large associated savings in the net pension liabilities of the pension system. In a second step, we consider a real-world reform aimed at capturing some of those efficiency gains by eliminating the incentive for an "opportunistic" use of the UI system. If we classify individuals as early-retired when they stop paying contributions (to mitigate the incentive to delay retirement), we achieve both appreciable increases in labor supply and sizable reductions in the implicit liabilities of the pension system. Our simulations show that these financial gains are large enough to fully compensate for all the welfare losses inflicted by the reform. Overall, we find that inducing search among the unemployed close to retirement is cost-effective in the Spanish case.

The structure of the paper is as follows. The theoretical model is presented in section 2, including a review of the relevant labor and pension institutions in Spain. Section 3 discusses our empirical strategy, introduces the fundamental regularities in the data and reviews the model's quantitative performance. Our simulation experiments, including a policy reform proposal, are presented in section 4. Finally, section 5 concludes.

2 A stylized model of Individual Behavior

This section describes our model of optimal search and retirement behavior, paying special attention to the institutional background and the recursive structure of the problem. We consider individuals who behave as rational utility maximizers, endowed with a correct understanding of the economic environment. They may live up to T years (100 in our baseline calibration), but they are subject to mortality risk, represented at each age a by the set of conditional probabilities of surviving to age a', $S_a(a'),\ 55 \le a < a' \le T$. Both the employed and the unemployed face additional uncertainty related to the labor market. The employed face an age-varying risk of dismissal, $\delta(.)$, while those among the unemployed that are seeking jobs are uncertain about the arrival of job offers, $\lambda(.)$, and their associated wages, w. There are no other sources of risk in the model.

Individual preferences are represented by a constant intertemporal discount factor, β, and by a period utility function $u(y, l)$. Utility is assumed to be increasing in the flow of income (y) and in the amount of leisure (l) associated with the *action* taken by the individual in the period considered.[8] The precise functional form of this function is discussed in section 3.2. Individual rationality implies that, starting in their early fifties, individuals choose their labor status in each period in such a way that the resulting sequences of income and leisure flows maximize their expected discounted utility $U_a = E[\sum_{i=a}^{T} \beta^{i-a} u(y_i, l_i)]$ at each age. As usual with complex life-cycle, stochastic models, we actually work with a *recursive formulation* of the individual problem in the age range of interest (55 to 68 in our case). Section 2.2 deals with the construction of the relevant value functions, but we first introduce the Spanish labor and pension institutions in the next section.

2.1 Labor and Pension Institutions

The Spanish **unemployment insurance** (UI) system fits well within a "continental" model of unemployment protection. UI benefits in Spain, ("prestación contributiva", $b(\pi, h)$), are linked to the workers' previous earnings, π, and to the duration of the unemployment spell, h. The

[8] Note that our database of administrative records fail to provide information on savings and accumulated assets. We therefore model utility as a function of income (rather than consumption). Empirically, consumption tracks income closely at older ages *on average* (arguably, because most accumulated assets in Spain are illiquid and households pass them on to future generations). Yet we can only acknowledge that this feature can be very important for some workers and will be considered in future extensions of this work. Some work on this issue is being done in Benitez-Silva et al. 2012.

replacement rate decreases over the duration of the unemployment spell (65 and 60 % for the first and second year respectively).[9] Yet this proportionality between benefits and previous earnings is broken by the existence of legal limits on minimum and maximum annual payments, b_{min} and b_{max}, respectively. When the length of the unemployment spell exceeds two years, the system provides a means-tested unemployment assistance benefit ("subsidio de desempleo") until retirement (for the unemployed aged 52 or more). Historically, the size of this unemployment subsidy b^s_{min} has been around 75% of the minimum wage. As in most EU Member States, the system includes a set of sanctions to be imposed on the recipients of benefits with an insufficient attachment to the labor market (eg, unwillingness to participate in training programs or to attend job interviews arranged by the public employment agency, INEM). In practice, however, these sanctions are largely overlooked (Peters et al. (2004), section 6.2).

Besides supporting the disposable income of the unemployed, INEM protects their future pension income by paying pay-roll contributions on their behalf to the Social Security system. These contributions are a fixed proportion of the individual "pensionable wage" (the part of labor income used to determine the future pension benefit). In the system in place over the time-span covered by our data (2002-2008), INEM contributes the full previous wages of those unemployed with a duration of less than two years (h $\leq$ 2), and a 125% of the minimum contribution, $minC$, in the case of a longer duration.

Regarding the **pension system**, we focus here on the "General Regime" of the system, which is also fairly standard within the context of Spain's European counterparts.[10] During the time interval covered by our analysis, the Normal Retirement age (NRA) was 65, but a pension could be claimed as early as 60 (the legal Early Retirement Age, ERA).[11] Receiving the pension benefit is conditional upon a complete withdrawal from labor market activities. The annual individual benefit is computed in several steps:

1. First, an individual-specific component linked to the worker's age and previous earnings, $\tilde{B}(\hat{w}, \tau)$, is calculated. Formally, $\tilde{B}$ is the product of an age-dependant replacement rate, $\mu(\tau)$, and the workers' accrued pension rights, $\hat{w}$. The replacement rate is a linear function of the retirement age:[12]

$$\mu(\tau) = \begin{cases} \mu_0 + \mu_1(\tau - \text{ERA}) & \text{ERA} \leq \tau < \text{NRA} - 1 \\ 1 + \mu_1^{+65}(\tau - \text{NRA}) & \text{NRA} \leq \tau \end{cases} \tag{1}$$

   There is, therefore, an annual penalty of μ_1 percentage points for early retirement and a bonus of μ_1^{+65} for each year retirement is postponed after the NRA. The accrued pension

[9] The average replacement rate in EU countries exceeds 60%, see Peters et al. (2004)).

[10] We do not cover certain tailor-made early-retirement routes made possible within the current system under the legal figure of a "Special Agreement". They are arranged on an individual basis, but typically involve some cooperation from employers (sometimes in connection with collective redundancies).

[11] The 2011 reform is progressively increasing the NRA to 67 for most workers. The ERA was increased after the 1997 reform to 61 and then to 63 by the 2011 reform but, due to the long implementation phase for these reforms, these changes do not affect the workers covered by our analysis.

[12] 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.

rights, $\hat{w}$, are based on a moving average of covered labor earnings in the D years immediately before retirement: $\hat{w}_\tau = \frac{1}{D}\sum_{i=1}^{D} w_{\tau-i}$. Covered earnings are the fraction of total gross labor earnings lying within an annually legislated maximum and minimum (C_{max} and C_{min}). As reproducing the exact formula in the model implies extreme computational costs, 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:[13]

$$\hat{w}_{\tau+1} = \hat{w}_\tau + \frac{w - \hat{w}_\tau}{D} \tag{2}$$

2. The strict proportionality between pensions and previous individual income is broken by making the effective initial benefit, $B(\hat{w}, \tau)$, subject to a pair of annually-set minimum and maximum payments:

$$B(\hat{w}, \tau) = \begin{cases} B_{\min} & \text{if} \quad \tilde{B}(\hat{w}, \tau) < B_{min} \\ \tilde{B}(\hat{w}, \tau) & \text{if} \quad B_{min} \leq \tilde{B}(\hat{w}, \tau) \leq B_{max} \\ B_{\max} & \text{if} \quad B_{max} < \tilde{B}(\hat{w}, \tau) \end{cases} \tag{3}$$

3. Finally, pension payments after retirement increase with the retail price index, keeping $B(\hat{w}, \tau)$ constant in real terms throughout the pensioner's life.

2.2 Recursive representation of the individual problem: Labor States and Individual Decisions

At the beginning of each period (assumed to represent one year of biological time), individuals may find themselves in one of three mutually exclusive *labor states*: Employment, Unemployment or Retirement (E, U, R). In our model retirement is a passive state, so we only have to consider the choices of the employed and the unemployed, which are as follows:

- At the beginning of period a, **the employed** can either remain in work for the rest of the period or retire. The life-cycle utility derived in each case is represented by the worker's value functions $E_a^W(.)$ and $E_a^R(.)$, respectively. They provide the present, discounted utility derived from the current choice and from behaving optimally in all subsequent periods. The total value of being employed at the beginning of each period (before the current choice is made) is represented by the *total* value function:

$$V_a^E = Max\{E_a^W, E_a^R\} \tag{4}$$

- **Unemployed workers** have three possible courses of action at the beginning of period a: search for a new job, remain unemployed without searching (non-participation) or retire immediately. The life-cycle utility associated with each of those options is represented by the value functions $U_a^S()$, $U_a^N()$ and $U_a^R()$. The *total* value of starting a period as unemployed is:

$$V_a^U = Max\{U_a^S, U_a^N, U_a^R\} \tag{5}$$

[13] For the employed, this approximation is exact under the assumption of constant wages.

The following paragraphs review the optimal choices in each *labor state* and the construction of their associated value functions.

Labor choices among unemployed workers

The main focus of our modeling effort in this paper is the behavior of the unemployed. As indicated above, a worker starting a period as unemployed can retire, search for a new job or remain unemployed without searching. The economic value of each of these options is as follows:

1. **Retirement**

   Our model treats retirement as an absorbing state (which is roughly in line with the very low employment rate observed among Spanish pensioners). Individuals take no further actions in this state and simply collect the pension benefit B and enjoy the full allocation of their time endowment, $\bar{l}$, to leisure. Thus, the only personal information needed to compute the economic value of this option is the accrued pension rights $\hat{w}$ at the beginning of the period. The associated value function is:

   $$U_a^R(\hat{w}) = \sum_{i=a}^{T} \beta^{i-a}\, S_a(i)\, u(\, B(\hat{w}, a),\, \bar{l}\,) \tag{6}$$

   where $B(\hat{w}, a)$ is computed according to the Spanish institutional rules (eq (1) to (3)). It should be noted that, due to the extreme borrowing constraints implicit in our model, we consider only retirement at ages equal to or above the ERA.

2. **Non-participation (inactivity while in the UI system)**

   In accordance with the empirical evidence presented in the introduction, we allow the unemployed to choose inactivity while remaining in the UI program. By proceeding in this manner, the unemployed avoid all the costs associated with an active labor search. This comes at the price of forgoing any chance of receiving a job offer in the immediately ensuing period.

   To compute the current unemployment benefit, b, we now need to store the value of the wage in the previous employment spell, π, and the duration of the current unemployment spell in years, h. We also need to keep track of the accumulated pension rights, $\hat{w}$, to compute the value of future retirement. Formally, the value of the inactivity choice at age a is:

   $$U_a^N(\pi, \hat{w}, h) = u(b(\pi, h), \bar{l}) + \beta_{a+1}\, V_{a+1}^U(\pi, \hat{w}', h+1) \tag{7}$$

   where $\beta_{a+1} = \beta\, S_a(a+1)$ is the total discounting factor at age a, $V_{a+1}^U(.)$ is the value of starting the following period as unemployed (defined in eq. (5)) and $\hat{w}'$ is the future value of the accrued pension rights (updated according to expression (2)). It should be noted that the value of leisure in this state is assumed to be equal to that enjoyed under retirement, $\bar{l}$. We are assuming that our unemployed workers are, therefore, effectively exempted from any job-search requirements the labor authorities may impose.

3. **Job Search**

The value of becoming involved in an active job search is represented by $U_a^S(.)$ and depends on the same set of economic characteristics $(\pi, \hat{w}, h)$ as in the non-participation state. It is the sum of two factors: (1) the immediate utility of searching $u(b(\pi,h), l^S)$, where we combine the income from the unemployment benefit and a reduced value of leisure ($l^S < \bar{l}$) that reflects the costs of searching and re-training; and (2) the expected future value from search, EVS:

$$U_a^S(\pi, \hat{w}, h) = u(b(\pi, h), l^S) + \beta_{a+1}\, EVS_{a+1}(\pi, \hat{w}', h+1) \tag{8}$$

The general expression of the expected future value is:

$$EVS_a(\pi, \hat{w}, h) = \lambda(.)\, E_w[\, Max\{\, V_a^U(\pi, \hat{w}, h), E_a^W(w, \hat{w})\,\}\,] + (1 - \lambda(.))\, V_a^U(\pi, \hat{w}, h) \tag{9}$$

where V_a^U is the value function associated to starting period a as unemployed (eq. (5)) and where the rate of arrival of job offers $\lambda(.)$ is a function of age and unemployment duration.

The search option is risky because future job offers may involve relatively low wages and (if $\lambda(.) < 1$) they may even fail to materialize altogether. The EVS term captures these two uncertainties, together with the utility value arising in each eventuality. The first of the two sums in EVS captures the expected value of future wages once a job offer has materialized, while the second sum captures the residual value when the search effort fails and no job offer is forthcoming. In more detail:

(1) If the offer of a job paying wage w is received, the individual must decide whether to accept or reject it. To find the best choice, the worker compares the expected utility from reemployment at wage w, $E_{a+1}^W(w, \hat{w}')$, to the utility of starting the next period as unemployed $V_{a+1}^U(\pi, \hat{w}', h+1)$. The utility of employment is presented in eq. (11) below. It is considered in expected terms because the size of the wage offer is uncertain at the beginning of the search process. It should be noted that rejecting a job offer will normally result in a depreciation of the value of being unemployed (due to both the reduction in benefits over the course of the unemployment spell and the updating of the accrued pension rights).[14]

As usual in the literature, the job-acceptance decision is summarized, for each possible value of the state variables, by the corresponding *Reservation Wage*, $\overline{w}_a(\pi, \hat{w}, h)$. It is defined as the wage level that makes the unemployed indifferent between employment at that wage or staying unemployed for one more period. Formally:

$$E_a^W(\overline{w}_a(\pi, \hat{w}, h), \hat{w}) = V_a^U(\pi, \hat{w}, h) \tag{10}$$

(2) If no offer arrives or if the offer received is unacceptable, the associated value is that of staying unemployed one more period, ie, $V_a^U(\pi, \hat{w}, h)$. Formally, the *ex ante*

[14] As noted in our discussion in section 2.1, the unemployment authorities pay the pension contributions on behalf of the worker. Nevertheless, $\hat{w}$ will decrease whenever π is less than $\hat{w}$ (for unemployment records of under 2 years) or if $\hat{w} > 1.25\, minC$ for longer spells.

probability of this outcome is $1-\lambda(.)\,(1-F(\overline{w}'))$, where $\overline{w}'$ stands for the next period's reservation wage, $\overline{w}_{a+1}(\pi, \hat{w}', h+1)$, and F is the cumulative distribution function of future wage offers.

Overall, the optimal choice for the unemployed is found by comparing U_a^R, U_a^N and U_a^S, as already indicated in eq (5).

Labor Choices among Employees

Currently employed workers have a choice between retiring immediately or remaining employed for one more period. In this paper, we do not allow the employed to move into voluntary unemployment. The value function associated to remaining employed is:

$$E_a^W(w, \hat{w}) = u(w, l^W) + \beta_a \left[(1-\delta(.))\, V_{a+1}^E(w, \hat{w}') + \delta(.)\, V_{a+1}^U(w, \hat{w}', 1)\right] \tag{11}$$

The current utility depends on the salary and on the amount of leisure left after complying with all the professional activities ($l^W < \bar{l}$). Future utility is uncertain, as workers face both survival uncertainty and the risk of being fired and starting the next period as unemployed. The risk of dismissal, $\delta(.)$, is an exogenous function of the worker's characteristics. We assume constant real wages and update *pension rights*, $\hat{w}$, as in eq (2).

The value of retirement at age a, $E_a^R(\overline{w})$, is formally identical to that in (6) for the case of unemployed workers. Again, we assume that a direct transition into retirement is possible only after the ERA. All in all, the optimal choice for the employee is found by comparing $E_a^W(w, \hat{w})$ and $E_a^R(\overline{w})$ as indicated in (4).

The basic properties of the behavior generated by our model (along with its ability to match the observed Spanish data) are discussed in the next section, while the reader interested in a formal exploration of optimal behavior will find a more detailed analysis in Appendix A.

3 Empirical Evidence, model calibration and fit

3.1 Our empirical experiment

This section describes how we align the theoretical model in the previous section to Spain's economic circumstances during the interval 2002/2008. First, we select a "suitable" sample from the best data set available. We then calibrate the model (ie, assign values to its unobservable parameters) to reproduce some basic stylized facts obtained from our sample. We finally aggregate the model predictions for each individual in our reference sample and compare the results to their in-sample counterparts (along both calibrated and non-calibrated dimensions).

3.1.1 Sample selection

The empirical evidence comes from the MCVL Spanish administrative data set. It includes information on the complete labor histories of more than one million Spanish workers. In this paper we focus on a relatively narrow sub-sample selected to guarantee that the economic incentives of individuals are clearly identified.[15] This sample is composed of 21,902 individuals with 23,763 unemployment spells (21.1% ending in a new job, 62.6% in a transition to retirement and the rest being right-censored unemployment spells). For the unemployed returning to a new job, the average unemployment duration is 16.2 months and their average re-entry wages of 1,226 euros imply a 10% drop on their previous wages (1,358 euros, on average). The average duration is longer, around 25.7 months, for those who exit to retirement, and much longer for those in a right-censored unemployment spell (46.7 months). A complete description of the database, along with a detailed reduced-form econometric analysis can be found in García-Pérez et al. (2012).

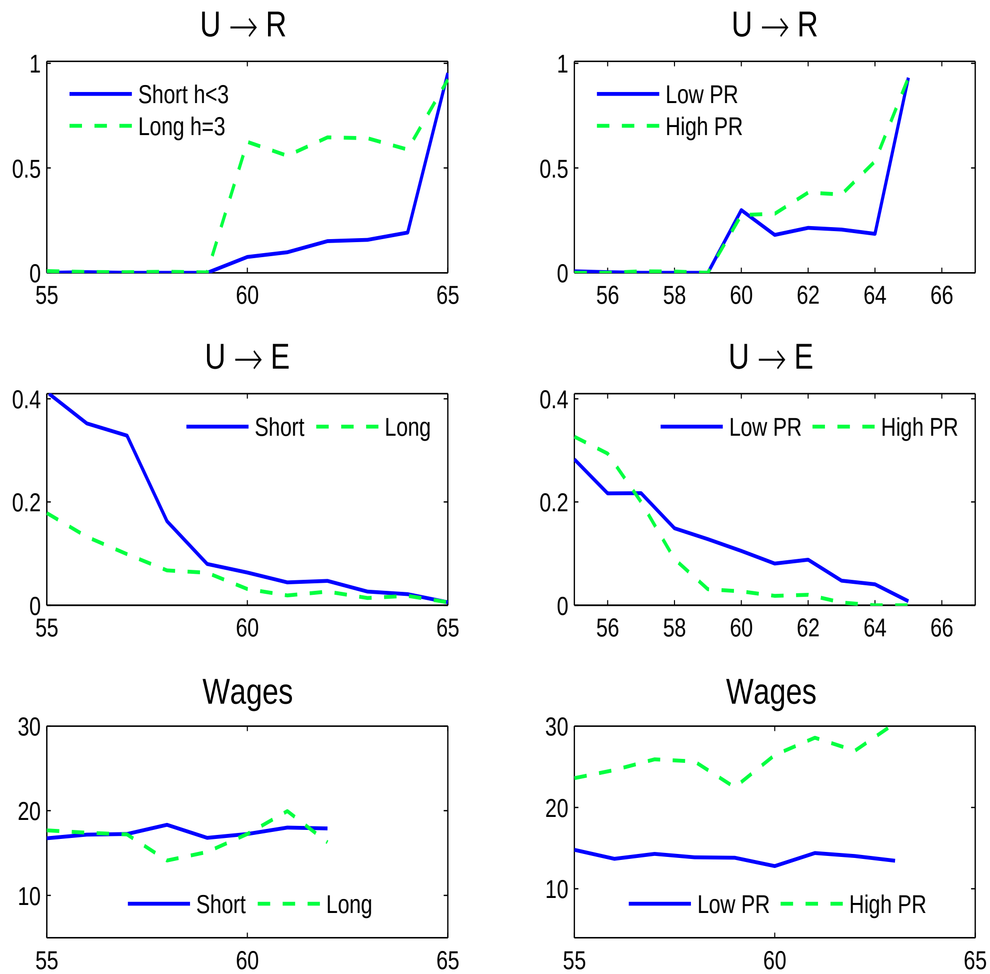

Figure 3: Empirical patterns by age. From top to bottom: average retirement hazard ($U \to R$), re-entry hazard ($U \to E$), and re-entry wages, conditional on (left column) unemployment duration, h, and (right column) accrued pension rights, PR.

[15]We consider males aged 55 years or older, affiliated to the General Regime of the Spanish Social Security System, who are entitled to receive contributory UI benefits and pensions upon retirement. We exclude individuals entitled to disability benefits and those with missing information that prevent us from computing their accrued pension rights. Furthermore, we consider only individuals with stable labor market careers (meaning those employed for at least 80% of their working lives and with fewer than 10 unemployment spells during such time).

3.1.2 Main empirical regularities

Age, duration of the unemployment spell and the size of the accrued pension rights emerge as the fundamental predictors of behavior. This can be appreciated in Figure 3, which provides a visual summary of the main behavioral regularities in the data. Each graph has age on the horizontal axis and two lines corresponding either to a partition of the sample according to the duration of the unemployment spell (h) (on the left-hand panels) or to the size of the accrued pension rights, $\hat{w}$ (on the right-hand panels). The blue, continuous line corresponds to short unemployment spells (under 20 months) or small accumulated pension rights (below the 1/3 percentile of the overall empirical distribution). The green, dashed line corresponds to long unemployment spells (over 20 months) or large accumulated pension rights (above the 2/3 percentile of the distribution). The main empirical patterns can be summarized as follows:

Retirement depends heavily on age, pension rights and, above all, unemployment duration (top panels in Figure 3). While the importance of the first two elements is well-documented from the study of transitions starting from employment (eg, Boldrin et al. (1999) or Jiménez-Martín and Sánchez-Martín (2007)), the relevance of duration has been largely overlooked in previous studies.

Reemployment has a well-recorded negative dependence on unemployment duration, with the short-term unemployed showing significantly greater reemployment hazards at all the ages considered (left-middle panel in Figure 3). The graphs also illustrate a strong negative dependence on age (less well documented), attenuated to some extent after the ERA. Finally, workers with high pension rights re-enter employment in much smaller proportions after the age of 58, with the opposite being observed in the preceding years.[16]

Re-entry wages (lower panels of Figure 3) do not show much variation by age or unemployment duration, but they are appreciably bigger for workers with large accumulated pension rights.

Finally, it is important to recall from the introduction (Figure 2) that being entitled to unemployment subsidies leads to different behavior, specially regarding retirement. In particular, workers without the ability to collect unemployment subsidies are strong contributors to the flows of early retirement in the data (at age 60 and 61).

3.2 Calibration

The model's parameters can be classified into two broad categories depending on the availability of observable empirical counterparts. On the observable side, we have the parameters controlling human longevity, the institutional details of pension and unemployment schemes and the distributions by observable characteristics. The group without direct empirical counterparts includes

[16] There is a significant change in the sample's composition around the age of 58 (see Figure 14 and the discussion in Appendix B). This suggests that sample selection may contribute to some extent to the changes in behavior observed before and after that age. However, our theoretical results clearly confirm that a substantial part of the change in behavior is a response to the change in incentives around that age.

the parameters of individual preferences and those that control the demand side of the labor market. This second group of parameters is calibrated to reproduce the average age-profiles of re-entry and retirement rates and the accepted wages of individuals re-entering employment.[17] Exceptionally, the discount factor, $\beta = 1/(1+r)$, and the degree of risk aversion, η, are set to the standard values found elsewhere in the literature (see Table 2).

Pensions		**Unemployment**	
Early/Normal Ret. age	60/65	Benefit coverage h=1	0.65
Annual early ret. penalty, μ_1	0.07	Benefit coverage h=2	0.6
Initial replacement rate, μ_0	0.65		
Bonus Post 65, μ_1^{+65}	0.02		
Maximum pensions, B_{max}	26.69	Maximum benefit, b_{max}	10.1
Minimum pensions, B_{min}	6.14	Minimum benefit, b_{min}	4.68
Minimum pensions, B_{min}^{65}	6.63	Unemployment subsidy, b_{min}^s	4.0
Lags in pension formula, D	15		
Social Contributions			
Pay-roll rate, ς	0.356	Minimum contribution, C_{min}	7.29
Maximum contribution, C_{max}	31.29	Min. contrib. subsidy, C_{min}^s	6.2

Table 1: Institutional non-calibrated parameters: Values assigned to observable parameters in the benchmark economy (all nominal amounts are expressed in thousands of 2002 euros).

3.2.1 Observable parameters

We explore the labor behavior of individuals in the 55-68 age range, assuming an annual time-frame for individual choices. The initial distribution of workers by "type" (with and without unemployment subsidies) and according to our state variables (age, unemployment duration, previous wages and accrued pension rights) corresponds to the sample average observed in the 2002-2008 period.[18] The continuous state variables $(\pi, \hat{w}) \in \Pi \times \hat{W}$ are discretized as part of our numerical procedure.[19] Survival probabilities are set according to mortality tables provided by INE (Spain's Institute of Statistics) for the sample period.

The values of the model's institutional parameters are summarized in Table 1. The unemployment benefit b is set to 65% of the previous wage during the first year of the unemployment

[17]In total, we look for six parameters by matching 20 sample moments.

[18]The sample distribution by age, type (with/without unemployment subsidy) and duration in unemployment is presented in Figure 14 in Appendix B. We have chosen 2002-2008 as the simulation period because of the stability of the institutional parameters over those years.

[19]The grids are designed to guarantee the presence of a sufficient number of sample observations in each cell on the grid. The resulting grid is the Cartesian product of the following sets (all nominal values are in thousands of 2002 euros):

$$\Pi = \{8.0\ 12.4\ 16.4\ 20.6\ 25.1\ 29.5\ 33.1\ 36.7\} \quad \hat{W} = \{7.1\ 10.3\ 13.1\ 16.1\ 19.0\ 21.8\ 24.8\ 28.0\}$$

spell, and to 60% during the second (albeit necessarily ranging between a floor b_{min} and a ceiling b_{max}). For longer spells, workers are divided according to their entitlement to social assistance (b^s_{min}). Retirement pensions are first available at the age of 60, with an annual early-retirement penalty of 7%. $\hat{w}$ is computed to approximate a moving average of the 15 years immediately before retirement (according to equation (2)). A full pension is granted at the NRA of 65 (with a 2% annual bonus for those that retire after the "legal" age). The minimum and maximum pensions are regularly changed as part of the annual government budget. The average values for the period are reproduced here. Finally, the pension and unemployment systems are financed with a fixed contribution rate of 35.6% of the covered wage (gross labor income, with a minimum $C_{min} = 7.3$ and a maximum $C_{max} = 29.8$ thousand euros). The covered wage applied to workers receiving the unemployment subsidy is 6.2.

The calibration of the observable parameters is completed with the exogenous dismissal rates δ. We set their values to the sample average in the selected period conditional on age, previous wages and accrued pensions rights. The resulting rates range from 3.8% to 14.6%.

3.2.2 Unobservable parameters

Table 2 presents the calibrated preference and labor-market parameters, while Figure 4 shows the quality of the match between the model and the data resulting from these parameters. Preferences are represented with a discount factor $\beta = 1/(1+r)$ and an additively separable and age-invariant function of income y and labor state, e:

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

η measures the curvature of the objective function and $\nu(e)$ represents the variation, with the labor state, in the value of the time not devoted to labor-market activities. We normalize this value to zero for employees and assume a positive value (l) for non-participants and retirees and a smaller one (l^s) for unemployed job seekers. 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 remaining unemployed. We take standard values for β and η, while the leisure parameters l and l^s are identified from their impact on re-entry rates and accepted wages.[20]

Labor market properties are captured by the job-offer rate λ and the associated distribution of offered wages, F_w. The job-offer arrival rate is assumed to depend on age and on the duration of the unemployment spell:

$$\lambda_a(h) = \lambda_0 \cdot [1 - I(h>1)\lambda_h] \cdot [1 - I(a>59)\lambda_a]$$

[20] η is difficult to pin down because it controls both the degree of risk aversion and the (inverse of the) willingness to substitute income intertemporally. Standard macroeconomic models use relatively low values, in the range between 1 and 4. See, for example, page 50 in Auerbach and Kotlikoff (1987) or, for econometric estimations, page 31 in Van der Klaauw and Wolpin (2008). The measure and structure of the discount factor is an active area of research, but most econometric estimates in life-cycle contexts tend to produce values close to 1. An example can be found on page 815 of Rust and Phelan (1997).

		Preferences			Labor Market parameters
β	0.97	Annual discount factor	λ_0	0.6	Base job-offer arrival rate
η	2	Risk aversion	λ_h	0.5	Factor reduction in λ due to $h > 1$
$\bar{l}$	0.3	Leisure AVI (Retirement)	λ_a	0.8	Factor reduction in λ due to $a > 59$
l^S	0.0	Leisure AVI (search)	μ	9.7	Wage offer mean (thousands of 2002 euros)
			σ	8.9	Wage offer dispersion (std)

Table 2: Values assigned to unobservable parameter in the benchmark economy AVI=added value of income.

where $I(.)$ represents an indicator function of a particular event (being in long-term unemployment or older than 59). If we keep λ constant in our model we still predict a drop in re-entry rates as the individual grows older, but the quantitative importance of this process is smaller than in the data. For longer durations, however, the model with fixed λ predicts decreasing reservation wages and increasing re-entry rates (in contrast to the evidence). Therefore, to match the process of "hysteresis" observed in the data we must impose a decreasing rate of job-offers from the model's supply side. Finally, the wage associated with each job offer is assumed to be log-normally distributed, with mean μ and variance σ^2. The parameters with the best empirical fit (Table 2) indicate a fairly large dispersion of offered wages around a very modest average.

All in all, the results of the calibration exercise reveal two important properties of the search process. First and foremost, large search costs are needed to rationalize the observed data. An unemployed person actively searching for a job experiences a relative drop in leisure (vis a vis a similar inactive unemployed person) equivalent to that suffered by a full-time worker (vis a vis a retiree of similar characteristics). Secondly, searching is also considerably risky. The probability of a person who has been unemployed for less than a year receiving an acceptable job offer is between 20 and 30% (at the age of 55) and drops slightly with age (as the reservation wages increase). At the age of 60 those probabilities fall to the 12-22% range. For the long-term unemployed, this probability is precisely around 15%. This is partly endogenous (due to relatively high reservation wages), but largely the result of the poor dynamism of the Spanish labor market.

3.3 Empirical performance of the model

Figure 4 illustrates the success of our calibration strategy by comparing the data and the model predictions in the three targeted dimensions (reemployment and retirement rates by age and re-entry wages by age). It is apparent that our highly stylized model does remarkably well at reproducing the broad empirical patterns by age. It should be emphasized that the model's ability to capture the general trends in the data is not the result of the exogenous process assumed for the rate of arrival of job offers. The assumed exogenous trends by age and duration help to fit the data quantitatively, but the model reproduces most qualitative patterns even with a constant λ. Going beyond the calibrated dimensions, Figure 5 compares the differences in

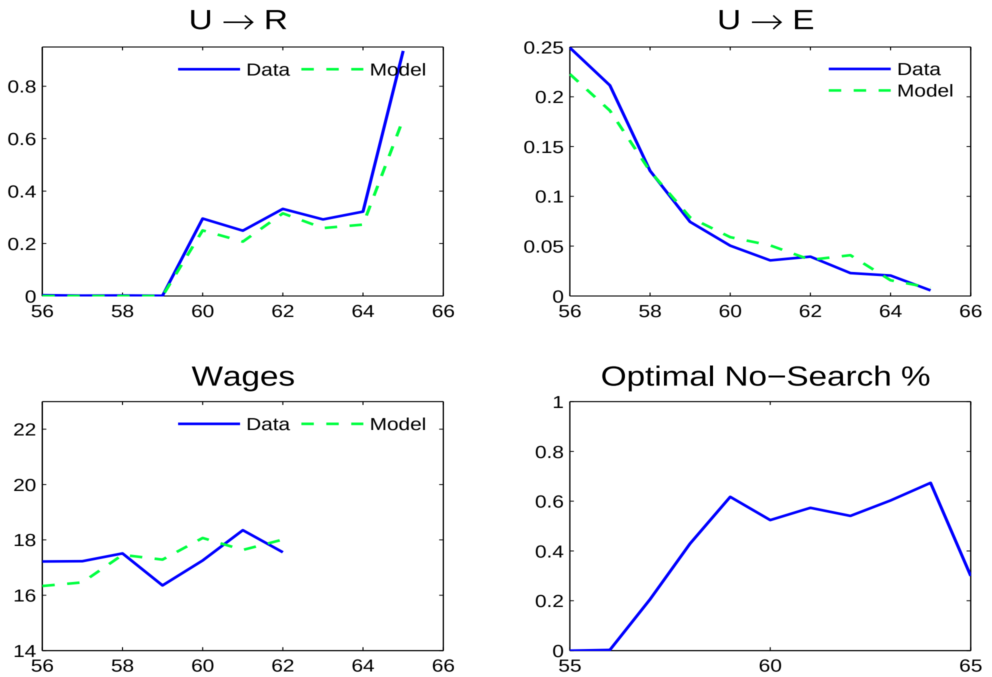

Figure 4: Benchmark theoretical predictions (green, dashed line) vs. empirical data (blue, continuous line): retirement $U \to R$ and reemployment $U \to E$ hazards (top panels), average accepted reemployment wages, AAW, (bottom left panel) and predicted incidence of non-participation by age (bottom right panel).

behavior for long vs. short-term unemployed and for workers in the two tails of the distribution by pension rights. To facilitate the comparison with the data, the graphs are arranged in a similar way to the graphs in Figure 3. Additionally, Figures 12 and 13 in Appendix A.2 directly compare the data and predictions for each disaggregated group. The graphs do indeed speak for themselves: there are some quantitative discrepancies, but the model accurately reproduces the different actions of workers of different characteristics. For example, its ability to match the re-entry and retirement patterns of workers with different pension rights is especially outstanding. There are only two areas in which the model underperforms: (i) it fails to generate the large differences observed in the data between the re-entry wages of workers with high vs. low pension rights, and (ii) it fails to predict any direct retirement among the short-term unemployed (while there is a small proportion in the data). These two drawbacks (especially the first one) can be addressed by introducing some additional structure into the model.[21] Nonetheless, we also see some merit in the clarity that a simple, straightforward model provides. After programming and solving several more complex versions of the benchmark model, we conclude that the simpler model presented in the paper generates a more transparent match for the observed data and a more convenient framework for the policy analysis.

[21] For example, it is reasonable to expect higher wage offers for workers with larger previous wages (which manifest themselves as larger accumulated pension rights).

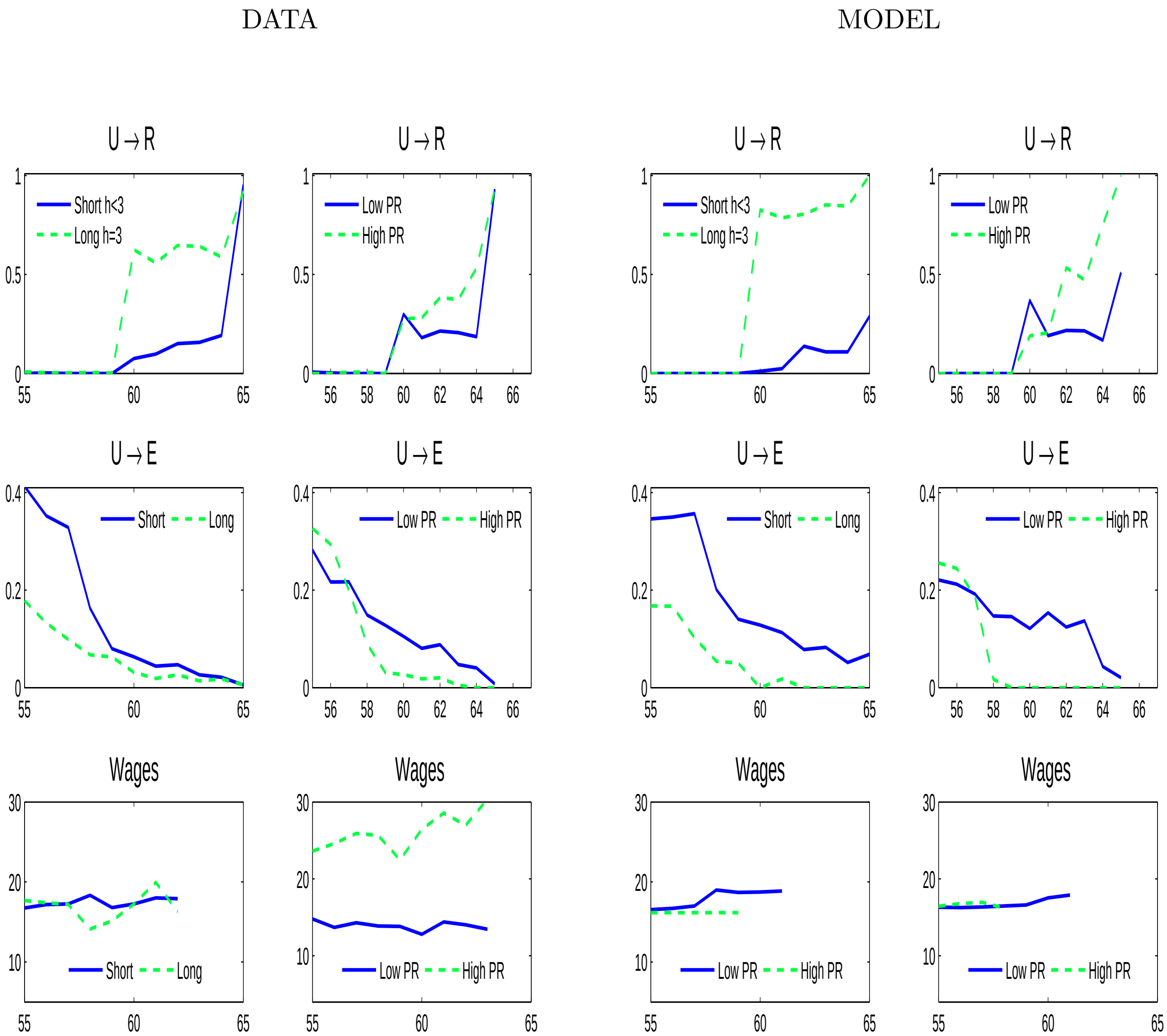

Figure 5: Data vs. model predictions by age, conditional on unemployment duration and accrued pension rights (PR).

4 Simulation analysis: search and pension reforms in Spain

Once equipped with a fully calibrated quantitative model, we are in a position to explore the extension of voluntary non-search behavior and the type of workers more likely to be involved in it. This is the task assigned to section 4.1. We then ask ourselves to what extent the low reemployment rate is a product of non-search behavior. For a first assessment, we simulate an alternative institutional environment in which this type of behavior is precluded by design (section 4.2). In section 4.3 we then consider a parametric reform of the pension/unemployment rules capable of delivering part of the advantages of a stronger attachment to the labor market. It is in this final environment where we explore the costs-effectiveness of fostering the job search effort.

4.1 Voluntary non-participation in the benchmark economy

Table 3 displays the aggregation of the predictions of our benchmark model for the individuals in our reference sample. The overall non-participation figures can be found under the "NP" heading on the 5th column in the table. More disaggregated results by age were shown in the bottom-right panel of Figure 4. The numbers are large: the best possible course of action for more than half the individuals (in the 60-64 age range) is to remain unemployed without searching. Before the ERA, this choice is largely confined to long-term unemployed workers (see Table 11 in Appendix A.2). However, once the age of 60 has been reached, it becomes more widespread, affecting a majority of those who have been unemployed for less than two years. Only workers with very small pension rights (who prefer to search) and the very long-term unemployed (who opt for retirement) shy away from voluntary non-participation.

Economy	Age range	Labor Supply			NPC1	NPC1	EV1
		Ret	*Search* (*Reenter*)	*NP*	Total	Annuity	
BASE	55/59	0	65.0 (14.5)	35.0			
	60/65	27.7	15.6 (4.2)	56.6	196.6	12.88	
PLE: Perfect	55/59	0	83.2 (19.7)	16.8			
Law Enforcement	60/65	36.4	60.0 (16.0)	3.6	177.8	11.63	
Separate	55/59	0	70.9 (16.0)	29.1			
μ	60/65	57.2	33.9 (7.7)	8.9	173.5	11.33	0.92

Table 3: Simulation Results: Proportion of workers whose optimal decision is to retire (*Ret*), *Search* or stay inactive (*NP*); reemployment hazard (*Re-enter*, in brackets); NPC1 (total and annuity) is the Net Pension Cost in thousand of euros per person; EV1 is the welfare change (reformed vs. BASE economy) measured by an Equivalent Variation. Both NPC1 and EV1 apply only to the unemployed with durations of less than 1 year.

The non-participation decision of a large part of the unemployed may have major consequences for the financial balance of the public insurance mechanisms. To assess this factor, we calculate the financial burden represented by each of our sample individuals on the combined "pension & unemployment" system. More precisely, we compute each individual's Net Pension

Cost (NPC): the expected discounted value of the flow of future pension and unemployment payments received from the system, net of any future social contributions paid into the system. The calculation incorporates the optimal individual behavior in each possible labor state and is a function of each person's observable characteristics. The formal definition of the NPC is provided in Appendix C. The total NPC is then converted into an equivalent annuity to facilitate the comparison with the welfare measure used below. In our benchmark simulation, we find that, on average, workers at the beginning of their unemployment spell (ie, with h=1) are owed 197 thousand euros by the public insurance system (NPC1 value in Table 3). This is equivalent to an *annual* cost of almost 13 thousand euros. These values will provide the yardstick to measure the potential financial gains (and welfare impact) of alternative institutional environments in the following sections. Yet before making that comparison, we address the question of whether the widespread resort to non-search behavior will vanish in an environment with more labor-friendly institutions and, more importantly, whether such a change will have a major impact on observed employment rates.

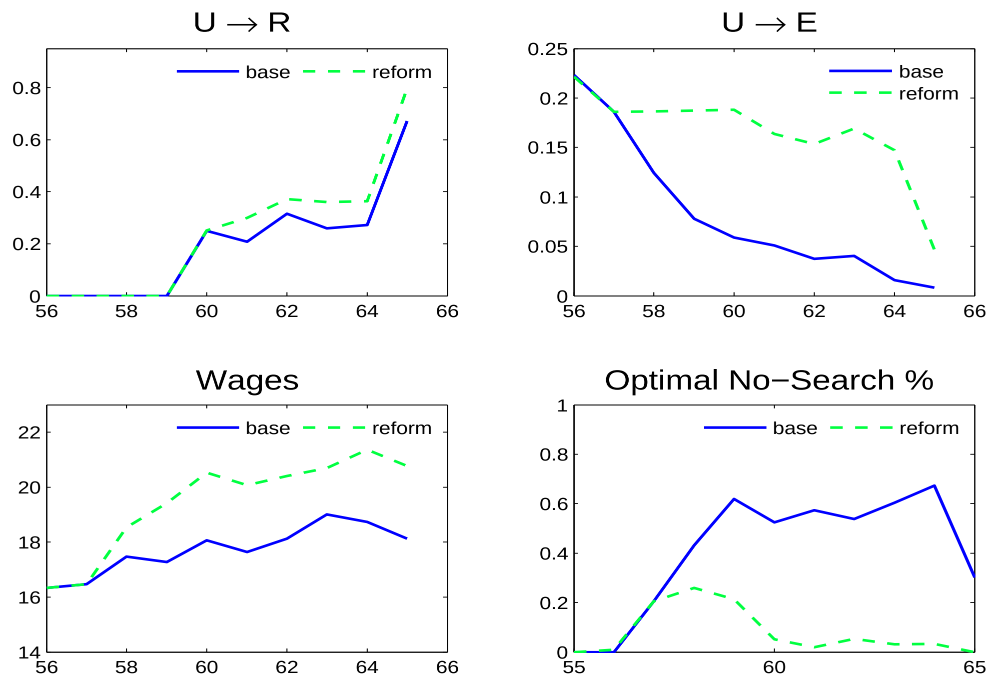

Figure 6: **PLE Experiment**: Model predictions in the benchmark economy (-) versus an economy with perfect enforcement of the legal search requirements, PLE (–).

4.2 Perfect enforcement of the search requirement (PLE)

According to current Spanish legislation, the collection of the contributory unemployment benefit is conditional on being actively involved in the search for a new job. However, this requirement is hardly ever implemented in practice. This section explores 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 monitor the decisions of individuals, which, for obvious reasons, is hardly realistic. It is still an interesting environment for quantifying the maximum loss of labor supply and pension costs due to the tolerance of "opportunistic" behavior by the unemployed.

The experiment's results are reproduced in the 5th and 6th rows in Table 3 and in Figure 6. Two powerful messages clearly emerge: first, the voluntary choice of non-search behavior becomes rather marginal before the ERA and essentially disappears after the age of 60. Second, most individuals who preferred to stay inactive in the benchmark will now opt for an active search. This new behavior is specially prevalent among workers with short durations and average and above average pension rights. As a result, average re-entry rates and wages spectacularly escalate (by comparison to the benchmark) in the 58-64 age range. Even when dealing with a remarkably weak labor market for older workers, our simulation predicts a steady re-entry rate of almost 20% before the age of 60 and of 16.5% between the ERA and 65. There is some increase in the incidence of retirement, but its quantitative importance is small. These results suggest that better incentives can *potentially* generate large efficiency gains in the Spanish case. However, whether all those potential gains can actually be achieved by a real-world reform remains to be seen. The next section seeks to capture some of those gains by changing the pension rules applied to those that access retirement via unemployment.

4.3 Reform of the pension rules applied when retiring from unemployment

A key reason why inactivity is appealing in our benchmark scenario is because the individual pension value typically *increases* while the worker remains unemployed. This is a result of the automatic reduction in the early retirement penalties as retirement is delayed. In contrast, the value of the accrued pension rights tends to diminish, but the former effect is typically greater. As a result, severing this link is a direct way of preventing voluntary inactivity. This can be achieved in a straightforward manner by making the early retirement penalty dependant on the age when *the worker* stops paying social contributions (rather than on the age when the individual claims the pension benefit for the first time, as is currently the case). This reform amounts to changing the replacement rate $\mu(a)$ in equation (1) to $\mu(a-h)$. Let us consider, for example, somebody made redundant the day before their 60th birthday. If $\hat{w}_{60}$ represents the value of their accrued pension rights, an immediate retirement would result in a pension benefit of $0.65 \times \hat{w}_{60}$. Delaying retirement by one year increases this value to $0.72 \times \hat{w}_{61}$. In contrast, under the new system the incentive to remain inactive while collecting unemployment benefits disappears: after one year, the pension replacement rate will still be 65% of pension rights.[22] Unfortunately, eliminating the "perverse" incentives hidden in the current rules comes at a price: a very harsh treatment of the unemployed that search unsuccessfully. We would consequently expect the unemployed with low reemployment prospects to largely self-select into retirement after the reform.

Figure 7 and the bottom rows in Table 3 illustrate the results of this reform. The labor

[22] There may still be some incentive to remain 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.

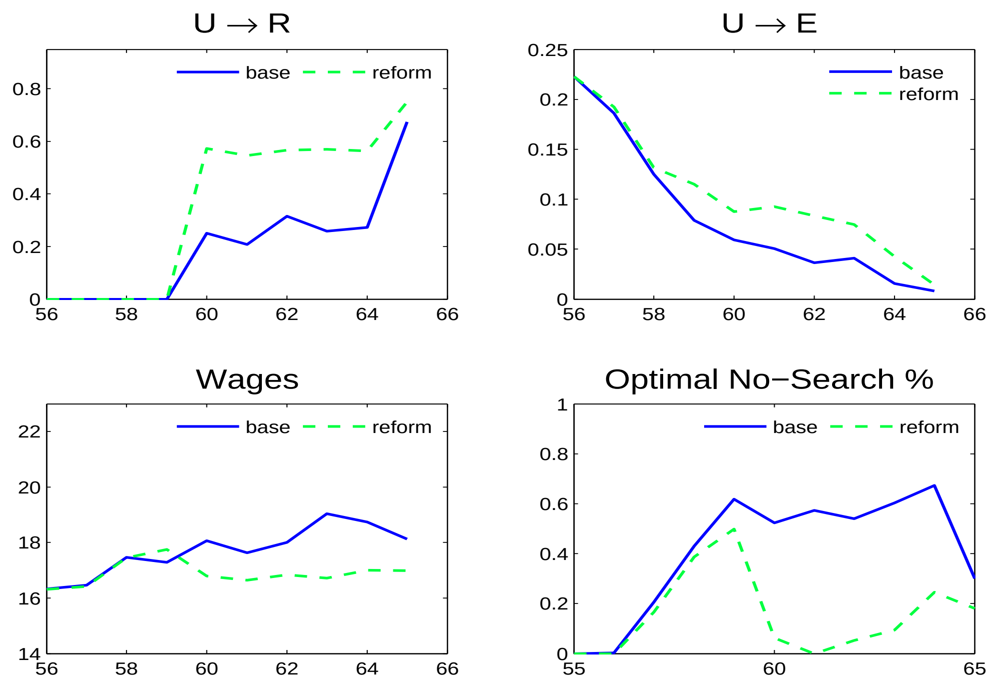

Figure 7: **Pension reform Experiment:** Model predictions in the benchmark economy (-) vs. the reformed economy (Early retirement penalties fixed at the effective age of withdrawal from employment) (−)

supply consequences are appreciable despite the harsh treatment of unsuccessful searches: the proportion of unemployed workers that opt for searching doubles in the 60-64 age range, leading to an almost twofold increase in reemployment rates. This higher re-entry also reflects a drop in reservation wages, brought about by a clear erosion of the value of delayed retirement. Searching, however, changes little before the ERA (as there is nothing in the reform to encourage job seeking among those that are simply waiting to claim the pension benefit at 60). The strongest impact is felt, as expected, on retirement (which also sees a twofold increase in its incidence rate). The changes in behavior are concentrated among the short-term unemployed aged 59 or over. Those with average or below average pension rights tend to intensify their search effort, while those with above average pension rights tend to choose to retire earlier than in the benchmark.

The budgetary consequences of the reform are also very important. In the new environment, pensions are less generous and workers remain in the labor force longer, paying more contributions. As a result, the net financial condition of the combined Social Security system records a rather healthy improvement. On average, each new unemployed person in our sample costs the system 174 thousand euros, which is a 12% reduction from the 197.5 thousand estimated in the benchmark. In terms of the compensating annuity, the average annual savings amount to more than 1.5 thousand euros per worker. Part of these financial gains stems from the extra product generated by all the new employment induced by the reform. Unfortunately, a significant part of these gains also arises from the relatively large pension drops incurred as the duration of the unemployment spell increases. It is therefore essential to explore whether these financial gains are large enough to compensate for the welfare losses the reform inflicts upon some workers.

To test for the possibility of an overall welfare improvement, we compute the Equivalent Variation (EV) associated with the introduction of this institutional change (in relation to the initial benchmark). For each individual, the EV is defined as the income they would be willing to forgo (measured as an annual constant payment) to avoid the introduction of the reform under study.[23] We focus on the results obtained for those at the beginning of the unemployment spell, on the understanding that the change would not be retroactively imposed on the long-term unemployed at the start of the reform. The results by age are presented in Table 4.

Age	Pension savings	EV1	EV1 (% previous wage)
55	0.11	0.00	0.00
56	0.11	0.00	0.00
57	0.08	0.02	0.10
58	0.14	-0.03	-0.10
59	1.71	0.98	3.89
60	2.58	1.79	7.21
61	2.30	1.39	5.76
62	2.19	1.22	5.10
63	1.77	1.13	4.97
64	1.11	0.69	3.25
65	0.29	0.19	1.01
Average	1.50	0.92	3.82

Table 4: **Pension reform**. Net pension savings and welfare changes (Equivalent Variation for workers starting their unemployment scheme, EV1) from the pension reform. The EV is presented in absolute terms and as a % of previous wages. Pension savings and absolute EVs are averages by age in thousands of 2002 euros

The reform has a generally negative impact on the welfare of the individuals in our sample; yet the size of the welfare losses is small in most cases. On average, an annuity of 940 euros would be enough to guarantee the initial utility level after the reform. This is equivalent to, on average, slightly less than (a permanent drop of) 4% of the annual wage earned in the last employment spell. Behind the average figure there naturally lies a quite substantial variation

[23] Consider an individual in state x. Denote by $U_b(x)$ the maximum life-cycle utility achieved by the individual in the benchmark economy and by $U_{ref}(x)$ the maximum value obtained under the reformed economy. To compute the equivalent variation EV(x), we first obtain a pure annuity payment, $y_i(x)$, that results in the same total life-cycle utility in the two environments considered: $\sum_{a=\tau}^{T} u(y_i(x)) = U_i(x) \quad i = \{b, ref\}$. We keep all the individual decisions (both in the present and in the future) unchanged in this calculation. The EV(x) is simply $y_{ref} = y_b + EV(x)$, ie, the annuity payment that, when added to the benchmark annuity, matches the reformed annuity. We interpret this value as the amount of money the individual in state x will be willing to pay to avoid the implementation of the reform (ie, to remain in the benchmark). To evaluate the overall convenience of the reform, we compare the EV with the changes induced by the reform in the net pension cost, expressed as an annuity. Our definition of the welfare measure guarantees that both concepts are defined in a homogeneous way.

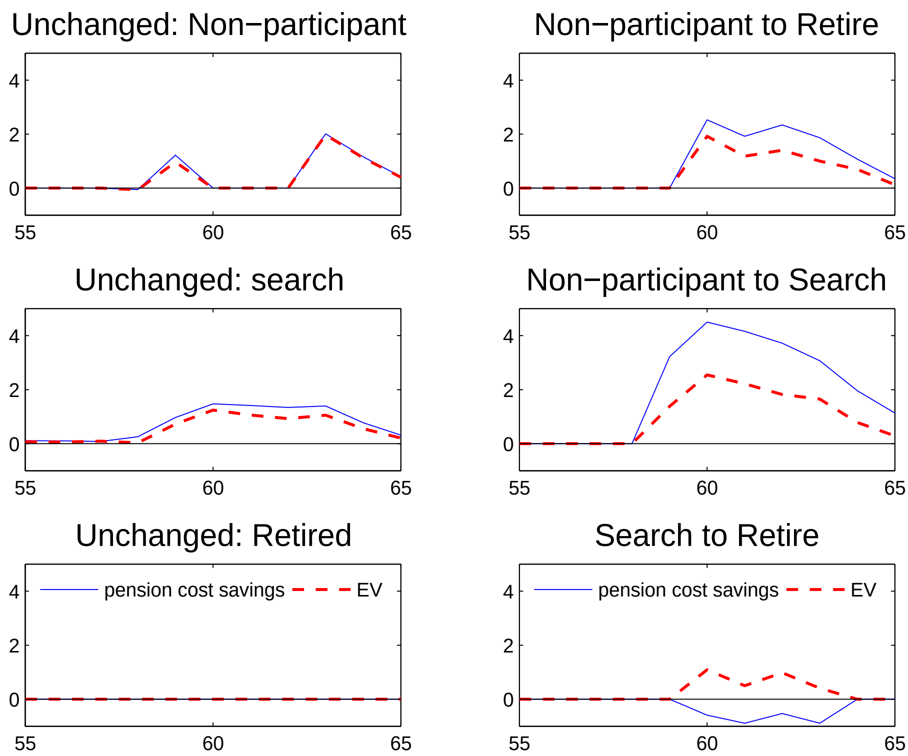

Figure 8: **Pension reform**. Net pension savings and welfare changes (absolute values in thousands of euros) according to the change in behavior induced by the reform.

in the welfare impact. The most important losses are concentrated in the 60-64 age range, peaking at the ERA. For the workers observed at that age, the damage inflicted by the reform is, on average, equal to an annuity of 7.4% of the previous wage. But the pain is also rather unequally spread according to previous wages and pension rights. Some workers avoid losses entirely (those that chose to retire before the reform), while those that choose not to participate in the benchmark suffer rather heavy losses. In absolute terms, the largest Equivalent Variation occurs among the unemployed with high previous wages and pension rights, peaking at above 3 thousand euros. In relative terms, losses are higher among the unemployed with low previous wages and average pension rights (with maximums peaking above 12% of previous wages). To explore these heterogenous effects further, Figure 8 decomposes the welfare losses induced by the reform (and also the associated pension savings) according to the changes in behavior

	Unchanged behavior			Change behavior		
	RET	Search	NP	NP to Search	NP to Ret	Search to Ret
Prob	10.1	43.2	5.0	19.6	21.5	0.5

Table 5: **Pension reform**. Sample distribution (in %) of the changes in behavior induced by the reform.

generated. The left-hand panels reflect the impact on workers whose behavior is unchanged, while the right-hand panels reproduce the consequences for workers that change behavior (from non-participation to both retirement and search, and from search to retirement). Note that a few more combinations of choices are possible, but their relevance in our sample is negligible. The sample distribution of the combinations explored is provided in Table 5. Two clear messages emerge from the graphs in Figure 8. First, workers observed before the age of 58 and workers opting for retirement before the reform are unaffected. All other workers are affected. Second, welfare losses are greater among the unemployed whose previous optimal choice was to remain unemployed without searching.

In principle, the income saved by the pension authorities could be channeled to the workers experiencing welfare losses after the reforms. To explore this possibility, Figure 8 shows the net pensions savings generated by the reform (expressed as an annuity and averaged by age). The overall value obtained in the entire sample is 1.5 thousand euros, well above the 0.94 needed to offset the welfare losses. The graphs display where this difference is obtained. For the unemployed whose actions are unchanged, the pension savings and welfare losses are almost identical. Appreciable differences appear only once behavior has been modified. When the reform leads to shifts from searching into retirement, the result is negative (net pension liabilities increase). These situations are, however, a very small proportion of the total (less than 1%). In all other cases, the savings are substantially higher than the compensations (especially when the change in behavior is from non-participation to search). Overall, the simulated financial savings achieved by the reform more than compensate for the welfare losses generated. We can conclude that, if the labor market conditions remain unaltered after the reform, the simulated experiment leads to a net welfare improvement.

5 Conclusions

This paper is a contribution to the debate on the convenience of encouraging the search effort of workers approaching retirement. As in other European countries, the Spanish system of pension and unemployment insurance creates large incentives to remain inactive among older unemployed workers. This alternative exit route implies a two-years delay between the age when a worker effectively stops searching and the age when the pension benefit is formally claimed (collecting unemployment benefits in the meantime). For households lacking other sources of income, this gap can be much larger (thanks to specific unemployment subsidies). With the help of a search and retirement model, we have documented the rationality and widespread extension of this phenomena among the unemployed aged 55-67 over the 2002-2008 interval. The prevalence of this practice enhances the welfare of certain specific groups of workers at the expense of the general fiscal burden borne by the Spanish tax payer. This paper explores a feasible pension reform that effectively terminates the incentive to stay inactive without searching. In our alternative environment, older workers are forced to either intensify their search effort or accept the standard early-retirement penalties in the event of an early withdrawal. Our simulations predict that this reform generates enough pension savings to more than compensate for all the welfare costs incurred. Overall, the paper provides academic support for the convenience of reforms that effectively close down the alternative early-retirement routes via unemployment (mirroring the recent legislative changes implemented in Germany and Finland, for example).

As always, it is important to bear in mind the limitations of our analysis and the scope for potential improvements in the future. Our partial equilibrium analysis, for instance, detaches itself from the impact on the institutional changes on prices and labor demand. It is highly 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 model's empirical performance. In particular, the inclusion of more unobservable heterogeneity, firing costs and fiscal considerations would be especially interesting. We leave those improvements for future research.

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APPENDIX

A Optimal behavior: theory and simulated patterns

This section extends the discussion of the behavior predicted by the model. First, section A.1 reviews the theoretical foundations underpinning the choices produced by our model. Section A.2 completes the analysis by exploring some additional predictions of the calibrated model in our simulation sample.

A.1 Optimal behavior by the unemployed

Before the ERA, unemployed persons' choices were limited to two actions: whether to search or to "non-participate" and, if the worker did search in the previous period and receive a job offer, whether to accept or reject the offer. We now review the theoretical basis of both choices, starting with the latter.

The decision to accept a job offer

For workers approaching retirement, deciding on a job offer is more complex than for younger workers (a choice studied in depth elsewhere in the literature). The key factors for the young unemployed are the unemployment benefit and the *option value* of waiting for better offers in the future. For senior workers, pension benefits (B) play a progressively more important role, while the relevance of the *option value* diminishes with age. In all cases, reservation wages summarize the optimal choice. Figure 9 illustrates the reservation wages predicted by our model for certain selected workers. In general, they depend (see eq (10)) on comparing the values of employment at each wage (E^W, formalized in eq (11)) versus the value derived from remaining unemployed (V^U, formalized in eq. (5)). The latter, in turn, is a function of:

1. Income sources available outside employment, which are essentially determined by institutional factors: (i) the average size of the insurance benefit b; (ii) its dependence on the duration of the spell, h; (iii) its conversion into a welfare subsidy after the exhaustion of the contributory benefit; (iv) the rule applied to update pension rights while unemployed and (v) whether the legal obligation to search is effectively enforced.

   Once the ERA approaches, the details of the pension norms (early retirement penalties, μ, and the size of minimum pensions, $bmin$) becomes progressively more determining factor.

2. *The option value* depends on external factors (the conditions of the labor market) and worker-specific factors: general employability (reflected in search costs, captured by the value of leisure while searching, l^s) and the individual's risk aversion (ie, the ability to endure the uncertainty associated with searching).

The value of employment crucially depends on the expected duration of the employment spell. Duration is a function of the firing probability δ and, more importantly, of age (a link stressed in Hairault et al. (2010)). The large differences observed in reservation wages, $\overline{w}$, before and after the ERA (Figure 9) clearly point towards age as the more important of the two factors:

1. At early ages (eg. 55), reservation wages are higher among workers entitled to UI subsidies on top of regular benefits (left-hand column in Figure 9), those with shorter unemployment durations (h=1) and, to a lesser extent, those with higher previous wages π. In general, accrued pension rights are relatively unimportant at those ages.

2. As workers grow older, the reservation wage increases appreciably. The predicted wage losses after re-entry fall sharply, even becoming negative at the normal retirement age of 65. More importantly, accrued pension rights $\hat{w}$ become the key determinant of reservation wages (bottom panels in Figure 9).

Figure 9: Theoretical reservation wages by age and duration in unemployment (top panels) and by age and the size of accrued pension rights, in thousands of 2002 euros (bottom panels)

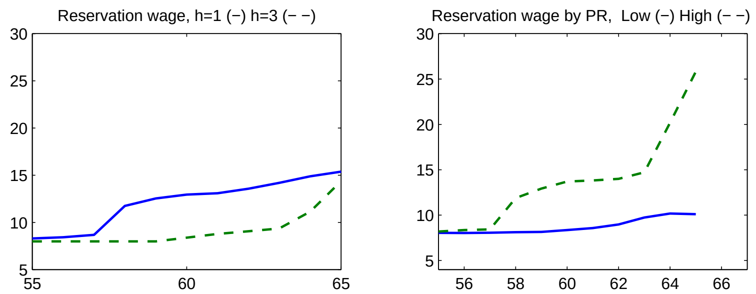

Figure 10: Average reservation wages by age in the simulation sample.

The decision to search for a job

We approach the search decision in two steps, considering the very different situations faced by workers before and after the ERA. Under the age of 60, retirement pensions are not yet available and the only alternative to searching is to remain inactive without searching. Current income will be the same in both cases, but a job seeker must pay search costs upfront (in the model, as a lower value of leisure). The compensation for that is intertemporal in nature: the worker faces a lottery (an option with a positive expected payoff but which can be rendered worthless at some future stage). The value of this option depends on both endogenous (ie, individual specific) and exogenous factors. This can be easily appreciated by combining equations (8) to (10) to obtain an analytical expression for the search value:

$$U_a^S = u(b, l^S) + \beta_a \left[V_{a+1}^U \left(1 - \lambda \bar{F}(\overline{w}_{a+1})\right) + \lambda \int_{\overline{w}_{a+1}}^{w_{max}} E_{a+1}^W(w, \hat{w}') \, dF_w \right]$$

where we simplify the notation in the text.[24] By recalling the value of non-participation, U^N, expressed formally in eq (7), we can characterize when this is the best possible choice:

$$U_a^N - U_a^S > 0 \Leftrightarrow u(b, \bar{l}) - u(b, l^S) > \beta_{a+1} \lambda \left[V_{a+1}^U \left(1 - F(\overline{w})\right) + \int_{\overline{w}}^{w_{max}} E_{a+1}^W(w, \hat{w}') \, dF_w \right]$$

- The *exogenous factors* favoring non-participation are related to a non-rewarding labor market with (1) low chances of being offered a job, λ; (2) a distribution of future wage offers F heavily biased towards small wages and (3) high firing rates (which reduce the value of E^W).
- The *endogenous factors* favoring non-search are (1) the utility cost of searching ($l^S < \bar{l}$), (2) impatience, β, and (3) the value the individual derives from starting the next period as unemployed. The latter acts both directly and through its impact on reservation wages (eq (10)).[25]

All in all, the analysis indicates that non-participation can be the best choice for workers whose skills are in low demand in the market, for those that will incur high searching costs and for those with high current unemployment income and high future pension income.

After the ERA, the retirement option has a very strong bearing on optimal decisions. As the formal analysis is somewhat more complex in that case, we postpone it until we have explored the retirement option against a simpler choice: non-participation.

Non-participation and retirement after the Early Retirement Age

[24] $U_a^S = U_a^S(\pi, \hat{w}, h)$, $b = b(\pi, h)$, $V_{a+1}^U = V_{a+1}^U(\pi, \hat{w}', h+1)$, $\overline{w}_{a+1} = \overline{w}_{a+1}(\pi, \hat{w}', h+1)$, $E_{a+1}^W = E_{a+1}^W(w, \hat{w}')$, w_{max} stands for the maximum possible wage offer and $\bar{F}(x) = 1 - F(x)$.

[25] The separation into exogenous vs. endogenous factors is only an approximation as, for example, individual reservation wages also depend on labor market conditions. It serves the purpose of emphasizing that individual specific factors can push workers towards non-participation, irrespectively of labor market conditions.

To understand the key trade-offs involved in retirement decisions it is essential to bear in mind that pensions are calculated by multiplying an early retirement penalty and an average of previous gross salaries ($B = \mu(a)\,\hat{w}$, see eq (1) and (2)). The value of retirement is simply the present discounted value of the utility derived from pensions (eq (6)). After the ERA, this value should be compared to the value of non-participation, eq (7), to determine the optimality of an immediate withdrawal from the labor force (as well as to the value of searching, as indicated below, to cover all possible choices).

It is easier to start by considering the situation of a worker who is certain to retire no later than in the next period, $a+1$, (say at the NRA) and is considering their optimal behavior in this period, a. Searching is not an option under those circumstances, and the current choice is only between retirement and non-participation. By adapting eqs. (6) and (7) to this situation, it is easy to formalize the conditions that make retirement optimal $U_a^R(\hat{w}) - U_a^N(\hat{w}) > 0 \Leftrightarrow$

$$u(B(\hat{w}),\bar{l}) - u(b,\bar{l}) > \begin{array}{c} \beta_{a+1}[U_{a+1}^R(\hat{w}') - U_{a+1}^R(\hat{w})] = \\ \beta_{a+1}\sum_{i=a+1}^{T}\beta^{i-a}\,S_a(i)\,[u(\,B(\hat{w}',a+1),\,\bar{l}\,) - u(\,B(\hat{w},a),\,\bar{l}\,)] \end{array}$$

For most workers, $B(\hat{w})$ is higher than b, implying an immediate gain from claiming the pension (ie, a positive left-hand side above). Waiting one extra year, however, tends to increase pensions, as the gain from smaller early retirement penalties typically exceeds the loss from the updating in $\hat{w}$. This makes $B(\hat{w}',a+1)$ typically higher than $B(\hat{w},a)$, resulting in a positive right-hand side. Consequently, only very impatient workers (or risk-averse workers, with a strong aversion to intertemporal substitution) will sacrifice future gains in exchange for current profits.

Relaxing the assumption of definite retirement in the next period $a+1$ or considering the possibility of searching now or in the future, introduces new elements into the calculation, but the essential intertemporal trade-off is unchanged. These new elements have already been discussed (when comparing the choice between search and non-participation before the ERA above) and can easily be adapted to the choices when immediate retirement is possible. For example, for the unemployed with good chances of finding an acceptable job, the relevant comparison is between the current gains from retirement (in terms of income and leisure) versus the possibility of higher income in the future (both while working in a new job and as a result of subsequently higher future pensions).

A.2 The model's in-sample predictions

Theory alone (at the qualitative level discussed in the previous section) is insufficient to explain observed behavior. Accordingly, we need full quantitative predictions from the model, and this can be achieved only after the model's calibration (assignment of specific parameter values) and numerical solution (as dynamic stochastic models have no closed-form solutions). Section 3 is dedicated to the former procedure. Here we briefly elaborate on the latter and complete the information in the main text on the model's quantitative predictions.

The numerical procedure followed to solve the individual problem is fairly straightforward. Numerical value functions are computed by backward induction starting at a maximum working-age $\bar{N}$ (68). At every previous age considered, each value function is solved exactly on a finite grid (whose values are presented in footnote 19). Linear interpolation is used whenever a value function has to be evaluated outside the computational grid.[26] The optimal decision rules take the form presented in Figure 11. Each array in these tables 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 $\Pi \times \hat{W}$. The decision shown in the cell defined by the i-row and j-column, $d_{i,j}$, is the optimal behavior 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.

Finally, we complete the information in the text (the average predicted behavior by age in Figures 4 and 5) by displaying the behavior when we simultaneously control for the duration of the unemployment spell h (Figure 12) and for the size of accrued pension rights (Figure 13).

B Empirical evidence: sample composition at different ages

In the simulation experiment, we explore the optimal labor flows predicted by our model in a particular empirical sample. As a result, our aggregate predictions are heavily influenced by the sample distribution of individual characteristics (age, unemployment duration, accrued pension rights and previous wages). The changing patterns of these distributions by age (for a given time interval) also reveal certain underlying behavioral regularities. Figure 14 shows some of the properties of this set of distributions, emphasizing the change in tendencies experienced at the age of 58 (ie, just two years before the ERA). A majority of the workers made redundant at this age can wait till the ERA while enjoying the (generous) contributive unemployment benefit, making them especially susceptible to (informal) early retirement. The graphs show significant changes in the sample composition at that particular age. Before that age, the sample is mostly composed of the long-term unemployed with a relatively low income (making them suitable for unemployment subsidies). By contrast, workers made redundant at the age of 58 have a higher income (both current and career income, as reflected by their accrued pension rights), whereby they are not entitled to unemployment subsidies. The firing intensity is also appreciably higher at 58 and 59, reducing the proportion of long-term unemployed in the sample. It should also be noted that the average reservation wage of certain types of workers increases significantly at the age of 58 (Figure 10). This is partly the result of changes in behavior specific to that age, although it owes a lot to the change in the sample composition. Studying the possible endogeneity of the redundancy flows at those ages is left for future work.

[26]The results are robust to the use of other nonlinear interpolation schemes such as cubic spline interpolation.

```
            Worker with unemployment subsidy

Duration < 1 year (h=1)

    56       58        60        62        64       65
11111111|1111111N|11110000|11N00000|1N000000|00000000
11111111|1111111N|1111NN00|11NN0000|1NN00000|10000000
11111111|1111111N|1111NNNN|11NNNN00|1NNNN000|NN000000
11111111|1111111N|1111NNNN|11NNNNN0|1NNNN000|NNN00000
11111111|111111NN|111NNNNN|1NNNNNN0|1NNNNN00|NNN00000
11111111|111111NN|111NNNNN|1NNNNNN0|NNNNNN00|NNN00000
11111111|111111NN|111NNNNN|1NNNNNN0|NNNNNN00|NNNN0000
11111111|111111NN|111NNNNN|1NNNNNN0|NNNNNN00|NNNN0000

Duration > 2 years (h=3)

1111111N|111NNNNN|0NN00000|NN000000|N0000000|00000000
1111111N|111NNNNN|0NN00000|NN000000|N0000000|00000000
1111111N|111NNNNN|0NN00000|NN000000|N0000000|00000000
1111111N|111NNNNN|0NN00000|NN000000|N0000000|00000000
1111111N|111NNNNN|0NN00000|NN000000|N0000000|00000000
1111111N|111NNNNN|0NN00000|NN000000|N0000000|00000000
1111111N|111NNNNN|0NN00000|NN000000|N0000000|00000000
1111111N|111NNNNN|0NN00000|NN000000|N0000000|00000000



            Worker without unemployment subsidy

Duration < 1 year (h=1)

11111111|1111111N|11110000|11N00000|1N000000|00000000
11111111|1111111N|1111NN00|11NN0000|1NN00000|10000000
11111111|1111111N|1111NNNN|11NNNN00|1NNNN000|NN000000
11111111|1111111N|1111NNNN|11NNNNN0|1NNNN000|NNN00000
11111111|111111NN|111NNNNN|1NNNNNN0|1NNNNN00|NNN00000
11111111|111111NN|111NNNNN|1NNNNNN0|NNNNNN00|NNN00000
11111111|111111NN|111NNNNN|1NNNNNN0|NNNNNN00|NNNN0000
11111111|111111NN|11NNNNNN|1NNNNNN0|NNNNNN00|NNNN0000

Duration > 2 years (h=3)

11111111|NNNNNNNN|00000000|00000000|00000000|00000000
11111111|NNNNNNNN|00000000|00000000|00000000|00000000
11111111|NNNNNNNN|00000000|00000000|00000000|00000000
11111111|NNNNNNNN|00000000|00000000|00000000|00000000
11111111|NNNNNNNN|00000000|00000000|00000000|00000000
11111111|NNNNNNNN|00000000|00000000|00000000|00000000
11111111|NNNNNNNN|00000000|00000000|00000000|00000000
11111111|NNNNNNNN|00000000|00000000|00000000|00000000
```

Figure 11: Optimal labor decisions by age. The structure of the tables and the notation employed is explained in section A.2.

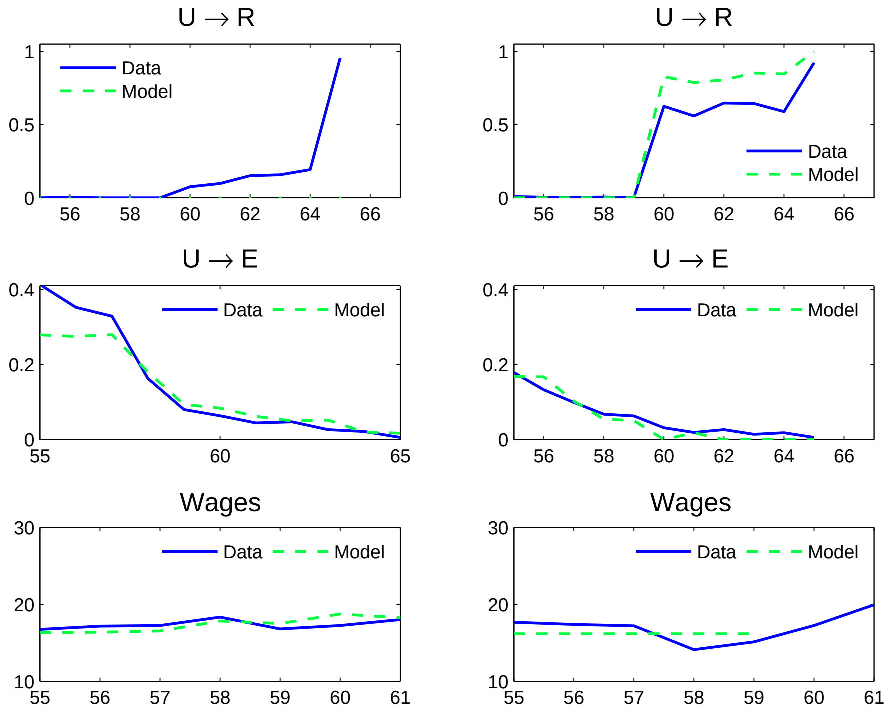

Figure 12: DATA (blue continuous line) vs. theoretical predictions (green, dashed line) conditional on the duration of the unemployment spell (short, $h < 3$, vs long $h = 3$)

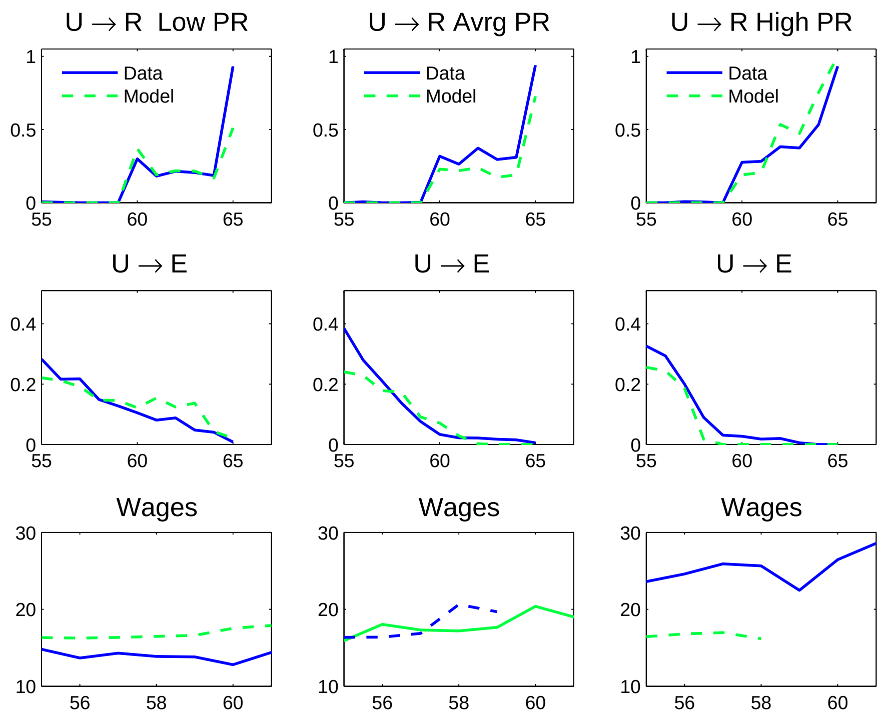

Figure 13: DATA (blue continuous line) vs. theoretical predictions (green, dashed line) conditional on the size of accrued pension rights (PR)

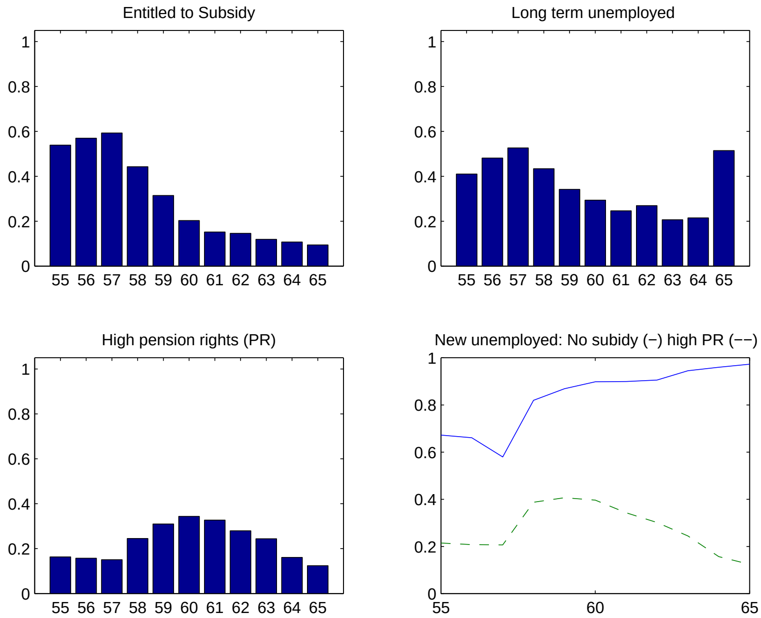

Figure 14: Distribution of the empirical sample at each age: proportion of the unemployed entitled to subsidy (top left), long-term unemployed (top right) and unemployed with high pension rights, PR (bottom left). The bottom right-hand panel shows the proportion of new unemployed (less than one year duration) without subsidy and with high pension rights (PR).

C Pension Cost Calculation

We evaluate the total cost each individual represents for the social security system by computing their Net Pension Cost (NPC). It 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 upon the observable state of the individual (age, duration in unemployment, pension rights and previous wages) and is computed recursively.

All flows are discounted to a common age (60) using the same discount factor (d, 3% in our case). In order to draw a comparison with the welfare measure implemented in the paper, the total pension costs are converted into the equivalent constant annual flow (*annuity* pension cost). The analytical expressions for the total costs 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 retirement is:

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

  $A_{i,60}^{j}$ stands for the expected present discounted value of one unit of income received in every period of the age range $\{i, \ldots, j\}$ and discounted to age 60.

- 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 the same as (12). For individuals who remain employed at that age, the implicit cost reflects the contributions paid throughout the year and the change in accrued pension rights:

$$PC^E_{N-1}(w,\hat{w}) = -cot(w)\, A^{N-1}_{N-1,60} + S_{N-1}(N)\, PC^R_N(\hat{w}')$$

Pension rights are updated as in (2). Finally, the implicit liability for the unemployed is:

$$PC^U_{N-1}(\pi,\hat{w},h) = b(\pi,h)\, A^{N-1}_{N-1,60} + S_{N-1}(N)\, PC^R_N(\hat{w}')$$

- At earlier ages $t < N-1$, the expressions for the employed and the unemployed become rather cumbersome, reflecting the individuals' different possible behavioral reactions.
  - For the employed of age t, the implicit cost $PC^E_t(w,\hat{w})$ is:

$$\begin{gathered} -cot(w)\, A^t_t + \\ +\delta\, S_t(t+1)\,[\, I^U_{t+1}(R|w,\hat{w}',1)\, PC^R_{t+1}(\hat{w}') + I^U_{t+1}(U|w,\hat{w}',1)\, PC^U_{t+1}(w,\hat{w}',1)\,] \\ +(1-\delta)\, S_t(t+1)\,[\, I^E_{t+1}(R|w,\hat{w}')\, PC^R_{t+1}(\hat{w}') + I^E_{t+1}(E|w,\hat{w}')\, PC^E_{t+1}(w,\hat{w}')\,] \end{gathered}$$

    δ is the exogenous dismissal probability. If the individual is fired at the end of t, the individual is unemployed at the beginning of age t with state $x \equiv (\pi,\hat{w},h) = (w,\hat{w}',1))$. $I^U_{t+1}(R|w,\hat{w}',1)$ and $I^U_{t+1}(U|w,\hat{w}',1)$ are indicator functions taking the value one if the optimal decision is either to retire or remain unemployed. The interpretation of $I^E_{t+1}(j|w,\hat{w}')$ $j = E, R$ is exactly the same.
  - For the unemployed of age t and state $x = (\pi,\hat{w},h)$:

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

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

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