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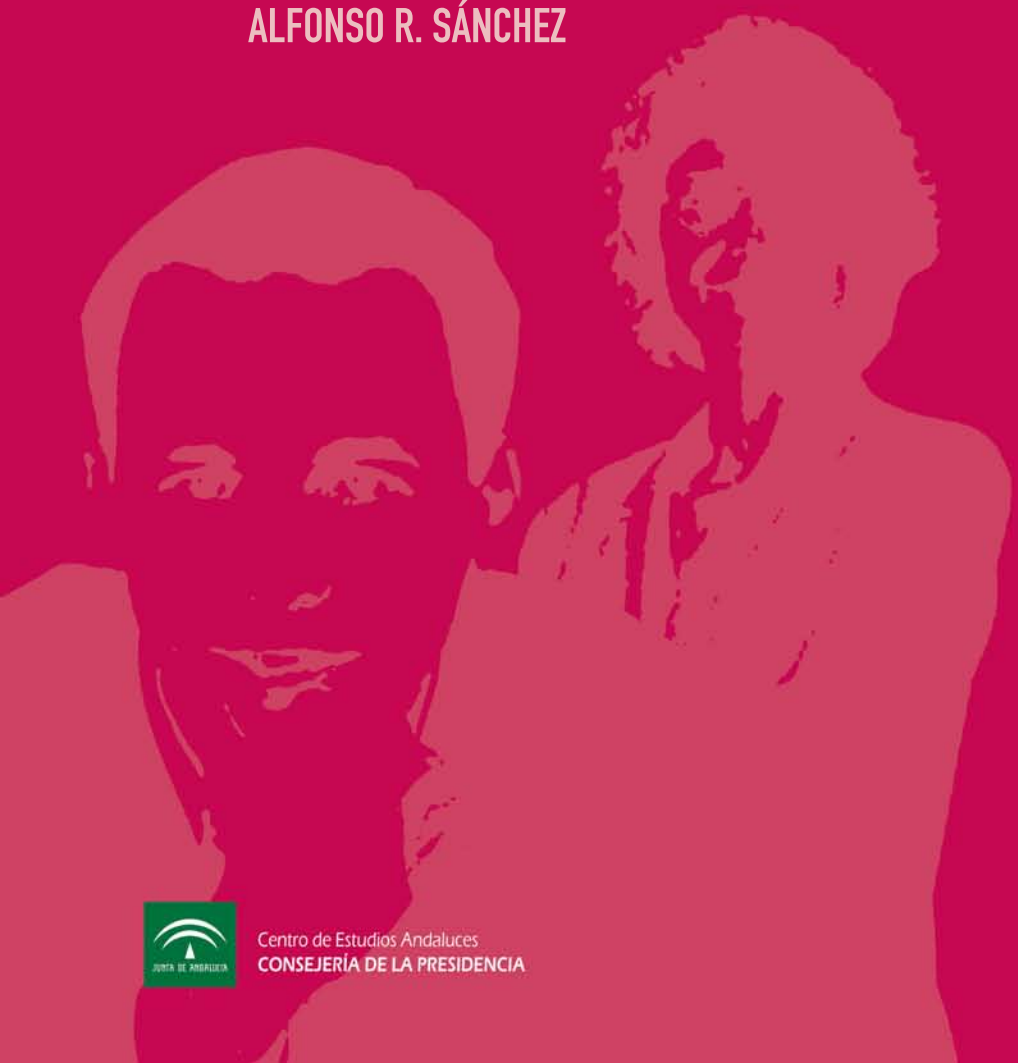

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SOCIAL SECURITY AND THE SEARCH BEHAVIOR OF WORKERS APPROACHING RETIREMENT*

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RESUMEN

En este artículo se explora la relación entre desempleo, jubilación y los programas públicos asociados a estas situaciones laborales (prestaciones por desempleo y pensión de jubilación). Se contribuye, por tanto, a la literatura que trata de ofrecer un mejor entendimiento del comportamiento laboral de trabajadores de edades avanzadas, lo cual tiene especial interés desde que la crisis en el sistema de pensiones es un tema relevante en las economías actuales. Nuestro análisis combina el desarrollo de un nuevo modelo teórico con la exploración detallada de las regularidades empíricas mediante una muestra de trabajadores en base a la Muestra Continua de Vidas Laborales. El modelo es una extensión del modelo estándar de búsqueda de empleo, donde se reproduce el contexto no estacionario al que se enfrentan los trabajadores próximos a la edad de retiro (las circunstancias cambian a medida que aumenta la edad del individuo) y se exploran las interrelaciones entre las prestaciones por desempleo y la pensión de jubilación en dicho contexto donde, además existe incertidumbre.

Por medio de simulaciones en base a una calibración de los principales parámetros del modelo, mostramos como las tasas de re-empleo y jubilación de los trabajadores en nuestra muestra pueden ser racionalizadas como respuestas óptimas a tanto las condiciones del mercado de trabajo como a los incentivos que ofrece el sistema de provisión pública. Unas prestaciones por desempleo generosas (para una duración de hasta dos años) junto con unas penalizaciones por jubilación anticipada altas, hacen óptimo para un amplio grupo de trabajadores permanecer desempleados sin buscar un nuevo empleo a la espera de jubilarse sin penalización a la edad normal de jubilación. Este problema de riesgo moral puede aliviarse sustancialmente a través de un diseño institucional alternativo. De hecho, fijando una penalización por jubilación anticipada de acuerdo a la edad a la que el individuo abandona el empleo (y no a la edad a la que pide la pensión) se obtienen unos resultados mucho más beneficiosos: aumenta la oferta de trabajo a estas edades, se reduce el coste financiero para la Seguridad Social (tanto en prestaciones por desempleo como en gasto en pensiones) y se generan recursos adicionales capaces de compensar, incluso, por la pérdida de bienestar de aquellos trabajadores directamente afectados por la reforma.

ABSTRACT

This paper explores the links between unemployment, retirement and their associated public insurance programs. It is a contribution to a growing body of literature focused on a better understanding of the labor behavior of advanced—age workers, which has gained importance as the pension crisis looms. The analysis combines the development of a new theoretical model and a detailed exploration of the empirical regularities using the Spanish Muestra *Continua de Vidas Laborales* (MCVL) dataset. The model is a *ext*ension of the standard search model, designed to reproduce the non—stationary environment faced by workers approaching retirement and to explore the interaction of unemployment benefits and retirement pensions. Via calibrated simulations we show that the basic empirical reemployment and retirement patterns can be rationalized as the optimal responses to both the labor market conditions and the institutional incentives. Generous Unemployment Benefits (for durations of up to two years) together with very significant early retirement penalties, make optimal to stay unemployed without searching for large groups of unemployed workers. This moral hazard problem can he substantially alleviated through institutional reform. Setting the early retirement penalties according to the age when the individual withdraws from the labor force (rather than when he/she claims the pension for the first time) seems particularly beneficial. It increases the labor supply, reduces the financial cost for the social security system and generate enough extra resources to compensate for the welfare loss of those unemployed directly hit by the reform.

KEYWORDS: Retirement, job search, unemployment benefit, calibration

JEL Code: J64, J68, J26

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1 Introduction

In the last three decades, a large majority of OECD countries has seen a widespread tendency towards lower employment rates among its older workforce. At the same time, the impact of declining birth rates and rising life expectancies is becoming progressively more evident on the size and age structure of the population in those countries.[1] These demographic changes are expected to have profound implications on the economy of OECD countries and their capacity to finance their welfare and health care systems. Pension reforms fostering higher labor force participation has been a widespread reaction to the gloomy demographic prospects. In particular, elegibility conditions and statutory retirement ages has been changed in a large number of countries.[2] Roughly speaking, these reforms have tried to foster longer working careers by discouraging the early take up of pension benefits. However, the insufficiency of these measures alone has become progressively more apparent, as we have gained consciousness of the complexity of the paths of early exit from the labour market. Unemployment and disability benefits, in particular, have received increasing attention from both academics and policy makers.[3] This reflects the striking increase in the incidence of both contingencies among workers older than 50 years of age. Unemployment in particular is supposed to be a transitory stage in the process of returning to the labor force or before a permanent withdrawal form the job market. However, the incidence of long-term unemployment is bigger in this group and the observed reentry rates are remarkably low (in Spain, the annual reemployment hazard is less than 13% in the age range 55/59 and a meager 1.5% in 60/65). It is even more revealing that, according to answers to specific questions in labor surveys, the job-search effort among the older unemployed is extremely small.[4]

The traditional interpretation of these facts emphasizes the low *demand* existing for workers of such advanced age, and the high personal costs imposed by searching and re-training at advanced ages. The concern about the welfare of senior unemployed workers has led to specific unemployment regulations, normally providing better protection than that provided for their younger counterparts.[5] This is specially true in Europe, were benefits for the unemployed over

[1] There is some evidence that in the last few years the tendency towards earlier retirement has slowed down and in some countries reversed itself. See eg. Benitez-Silva et al. (2007) for recent evidence for the US. The long-term demographic projections are, in any case, gloomy. For example, the OECD predicts that the working-age population (15/64 years) will be 18% smaller than the current one by 2050, and the number of those aged over 65 years will increase by 60%.

[2] There has been widespread delays in both the Early and Normal retirement ages in OECD countries. US and Germany are well known examples, but reforms have been attempted in many countries. See Casey et al. (2003) for a detailed enumeration. For the European Union members, the policy action has revolved around the Lisbon-2000 objectives. They set a explicit target (50%) for the employment rate of workers of more than 50 years of age in 2010.

[3] See, for instance, the report of the Social Protection Committee of the European Union, SPC (2008). The exit route via disability has been analyzed in eg. Benitez-Silva et al. (1999) for the USA and in Borsch-Supan (2000) for Europe.

[4] Less than 17% of the unemployed aged 50-54 reply that they are actively looking for a new job in the full sample of the European Community Household Panel (1994-2001). This number falls to less than 3% for those aged more than 60. In Spain, the values are a slightly bigger: 17.7% and 6.7% respectively, according to the Spanish Labor Force Survey in 2005-2006.

[5] During the industrial crisis that followed after the oil shocks in the 70's, favoring the early retirement of older

the age of 55 can be higher or can be received during longer periods than for younger unemployed and the conditions regarding the availability for work and job searching are often relaxed. France is a very good example of this situation: French unemployed of more than 57 years of age are exempted for job seeking and entitled for full unemployment compensation until they meet the conditions for a full retirement pension.[6] As discussed below, the Spanish legislation is also particularly generous with the unemployed.

This state of affairs, however, is starting to be called into question, as its consequences for the financial sustainabilitity of the public insurance schemes become more evident. The current institutional design create the conditions for strategic individuals and corporations to use the unemployment and pension rules to transfer to the general population the costs of a *quasi-voluntary* early retirement. This has evident direct costs on public finances, but also very important opportunity costs in terms of wasted resources and inefficient allocation of resources.[7] These considerations underlie recent proposals stating that the target of the reforms has to be to *"reduce significantly the length of the period between the end of the last job and the take-up of a statutory pension"*.[8] In Germany the "Social Code" still provides unemployed individual aged 58 or older the option to draw unemployment benefits without declaring their willingness to take up employment. In return, however, the applicants must commit themselves to apply for old-age pension at the earliest possible date (meaning they will suffer the penalty of a reduced old-age pension).[9]

In this paper we focus on the details of the Spanish case. In this country there are specific unemployment benefits for the old, combined with rather strong penalties for early retirement.[10] In principle, entitlement to unemployment benefits requires that the applicant should be willing to accept any suitable job offer, but this requirement does not seem to be applied in practice. Consequently, most unemployed may find it advantageous to use the unemployment benefit to stay in the labor force without searching, with the only purpose of reducing the penalties associated with early retirement. In this paper we explore to what extend the unfavorable incentives stemming from the Spanish public rules contribute to the low reemployment rates of the unemployed closed to retirement and their financial consequences for the public budget. Our final target is to understand whether better institutional designs can make the system more robust to the *moral hazard* problem associated with the provision of public insurance.[11]

workers was a popular policy measure to fight the high unemployment rates among the young. This mentality has had a clear influence on the design of specific unemployment rules for older people.

[6]The only requirement to qualify for "préretraite" is being at least 57 years old and have made social contributions for more than 10 years (or being just 55 with 40 years of contributions). The amount of this early retirement pension is around 50 and 65% of previous wages.

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

[8]Report of the Social Protection Committee of the European Union, SPC (2008).

[9]More generally, Germany and Finland are progressively phasing out the rules favoring the older unemployed over the younger ones. Reforms increasing the incentives for employers to hire older workers are also widespread across the EU countries.

[10]In Spain, the replacement rate of the final pension over the accrual pension rights is reduced by 7.5% for each year retirement is brought forward.

[11]In this sense we make a (partial equilibrium) contribution to the literature on the optimal design of unemployment benefits in a world of *imperfect information* and *hidden actions* (as exemplified by eg. Hopenhayn and Nicolini (1997), Kocherlakota (2004) or Shimer and Werning (2003)).

For our assessment of the consequences of the Spanish unemployment and pension rules we extend the traditional search model to include the alternatives of retirement and non-participation (ie. staying in the labor force without searching).[12] The model contributes to the existing retirement literature by formally exploring the unemployment path into retirement.[13] It also contributes to the literature on search models, by considering non-participation decisions in a non-stationary environment including the risk of dismissal.[14] We explore the basic theoretical predictions of the model and obtain precise quantitative evaluations with the help of calibrated simulations. The parameters of our benchmark case are selected to approximately replicate the empirical retirement and reemployment hazards, and the average accepted wages by the unemployed that reenter the labor force. Once equipped with adequate parameters, we use the model to quantify the incidence of voluntary non-participation and explore some institutional changes designed to generate better incentives in terms of labor supply. Finally, a large sensitivity analysis confirms the robustness of the findings.

We find that both the labor market conditions and the institutional incentives are important to reproduce the re-employment and retirement patterns observed in the Spanish data. *Both* elements matter: we show via simulation that even in presence of a much larger job offer arrival rate, the predicted re-employment rate would be rather small *under the current institutional setting*. This reflects the optimality of staying unemployed without search for a very large part of the population of unemployed workers. At the same time, a perfect enforcement of the unemployment law (making it impossible to get benefits without searching) would only modestly improved the observed reentry rates *under the current labor market conditions*. We have explored several institutional reforms with mixed results. A direct reduction in the generosity of Unemployment Benefits is not particularly successful, as it pushes workers mainly into retirement and generates a very small reduction in the financial cost suffered by the Social Security system. A more promising avenue focuses on redesigning the early retirement penalties of the unemployed. If the penalty were fixed according to the age when the individual effectively withdraws from the labor force (rather than when he/she claims the pension for the first time), the incentives to stay idle would be much smaller.[15] Our simulation indicate that such

[12]Including frictions in the re-employment process is probably more important at the ages considered in this paper that for younger workers. This is due to a number of elements: to the (potencial) labor market bias against older workers; to the uncertainty about the cost and usefulness of the re-training and search process; and to the existence of generous public income-maintenance programs, that make it feasible to stay out of the labor force for long periods.

[13]The state of the art in the modeling of optimal retirement is represented by the models in Rust and Phelan (1997), French (2005), Van der Klaauw and Wolpin (2005)) or Benitez-Silva et al. (2007).

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

[15]The final goal of the reform is similar to the target of the latest design of the German Social Security system, ie. to force the unemployed who are unwilling to search to take the -penalized- early retirement pension as soon as possible. The difference is that in our case the goal is not mandatory but achieved via the voluntary decisions of the unemployed.

a measure would be very effective in reducing non-participation and increasing labor supply, specially after the early retirement age. Besides, the cuts in the average financial liabilities for the Social Security system is more than enough to compensate for the welfare losses inflicted in the directly affected workers (a compensation of around 2 thousand euros should be provided, on average, to keep the welfare unchanged, while the average cost reduction exceeds 7 thousand euros per worker). This results stress the efficiency gains and social desirability of the reform.

The structure of the paper is as follows. In section 2 we present the basic empirical regularities concerning re-employment and retirement behavior in our sample of Spanish workers in the age range 55/65. These regularities provide the stylized facts that guide the specification of our theoretical model, which is discussed at length in section 3. In section 4 we review the theoretical predictions of the model. Next in section 5 we discuss the calibration strategy, the benchmark parameter values and the quantitative performance of the model. Our simulation experiments, including our policy reform proposals, are analyzed in section 6. Finally, section 7 concludes. A number of technical details are confined to dedicated appendices at the end of the paper.

2 Basic Stylized Facts

To analyze the evidence on the labor supply patterns of Spanish unemployed workers of advanced age we use the latest release (based on information up to the end of 2006) of the *Muestra Continua de Vidas Laborales*, MCVL06 hereafter. This is an administrative dataset based on a random draw from the Spanish Social Security archives. The database (along with some reduced-form econometric analysis) is described in detail in García Pérez and Sánchez-Martín (2008). Here we only refer to the most fundamental findings.[16]

We have explored the transitions of unemployed workers out of the labor force (ie. into retirement) or back into work (and their associated accepted wages) paying special attention to the role of age, duration in unemployment, pension rights ("Bases reguladoras", defined precisely in section 3.1) and wages in the immediately preceding job. This has resulted in a relatively small set of empirical patterns, that we summarize (and enumerate for later reference) in the next two sections.

2.1 Empirical evidence on search behavior

The most significant findings regarding the job-acceptance performance of unemployed workers can be summarized as follows:

S1 The re-employment hazard decreases with age in the range 55/60 and remains constant thereafter.

[16]The regularities reported correspond to a relatively narrow sub-sample of the MCVL06, selected to guarantee that the economic incentives of the individuals are clearly identified. We focus, then, on providing good empirical counterparts to the stylized individuals in our theoretical model rather than on generality. Consequently, we consider low skilled males of 55 years of age or older, affiliated with the General Regime of the Spanish Social Security system, who are entitled to receive Unemployment Benefits and old-age pensions upon retirement. We exclude individuals who sign Special Agreements with the Social Security, and individuals with missing information that prevent us from computing their accrued pension rights.

S2 In the age range 55/60, the re-employment hazard decreases with *duration* (the length of the unemployment spell in years, represented by h). After 60, the pattern among the few remaining unemployed is more erratic.

S3 The re-employment hazard decreases with the size of the pension rights (with one exception: before the early retirement age, 60, the unemployed with average pension rights have higher re-entry hazards that those with low pension rights).

S4 Accepted re-employment wages are roughly constant with age and clearly increasing with pension rights and previous wages.

Regularity S1 is illustrated in Figure 1: the quarterly re-employment hazard (ie. the conditional probability of making a transition from unemployment to employment) goes down from a value around 10% for workers of 55 years of age, to only 4% at 60. This small number confirms the general impression that finding jobs is a very difficult task at ages close to the "standard" retirement ages for the pension system. Regularity S2 (illustrated in the top-left panel of Figure 4) represents a negative duration dependence of the type usually described in the mainstream search literature. In our data, the reemployment hazard before 60 is clearly lower for the long-term unemployed (those that receive benefits for more than 2 years, ie $h=3$). After the early retirement age, the ranking of hazards changes and the long-term unemployed seem to reenter in larger proportion. This may be due to a composition effect: workers with lower re-employment opportunities probably retire in larger numbers at the early retirement age. The composition of this group after 60 may, then, be clearly different from that before 60. We must bear in mind, in any case, that the sample size after 60 is rather small.[17] S3 is illustrated in the top-right panel of Figure 4. For that graph we split the sample in three groups according with the percentiles 1/3 and 2/3 of the sample distribution of pension rights. At early ages, the reemployment hazard of workers with high pension rights (ie. those above the 2/3 percentile) is very low, while that of workers with intermediate pension rights is much higher, specially before 60. After the early retirement age, only the unemployed with low pension rights (below the 1/3 percentile) reenter in the labor market in significant amounts. Finally, S4 is presented in Figure 2 and in the central row of Figure 4. Average annual accepted wages by unemployed workers re-entering the labor force show little variation by age, staying within the range of 12/13 thousand Euros (of 2002). It is also possible to detect some selection effects after 60, as the general pattern turns more clearly decreasing after that important institutional age. The dependence of the accepted wages on unemployment duration, pension rights and previous wages is displayed in the central panels of Figure 4. They are lower for the long-term unemployed and higher for the unemployed with average or above average previous wages and accrued pension rights.

[17] This composition effect seems to be related to the fact that all empirical evidence in this paper is based on unemployed workers who have access to unemployment benefits throughout all their unemployment spell. The exit from unemployment is always larger for short-term unemployed when we consider both people with and without unemployment benefits.

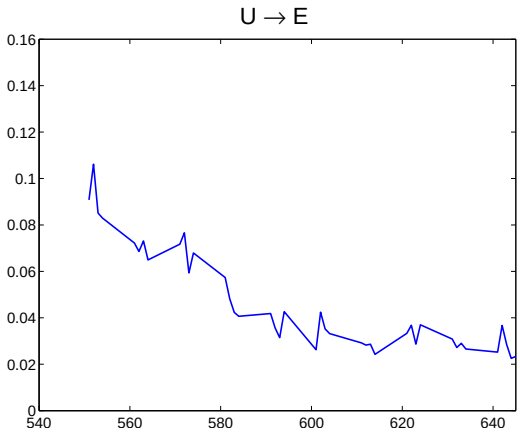

Figure 1: **Transition from Unemployment to Employment**: Quarterly re-employment hazard by age in MCVL05

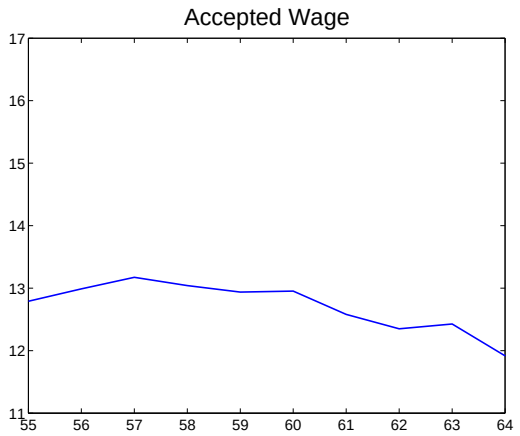

Figure 2: **Accepted wages**: Annual average accepted wage (in thousand of Euros of 2002) by unemployed workers that return to employment in MCVL05.

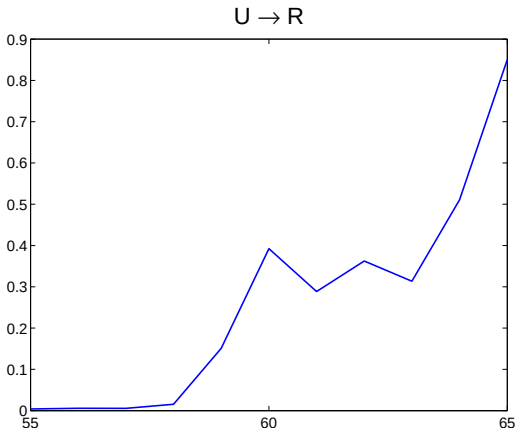

Figure 3: **Transition from Unemployment to Retirement**: Annual retirement hazard by age in MCVL05

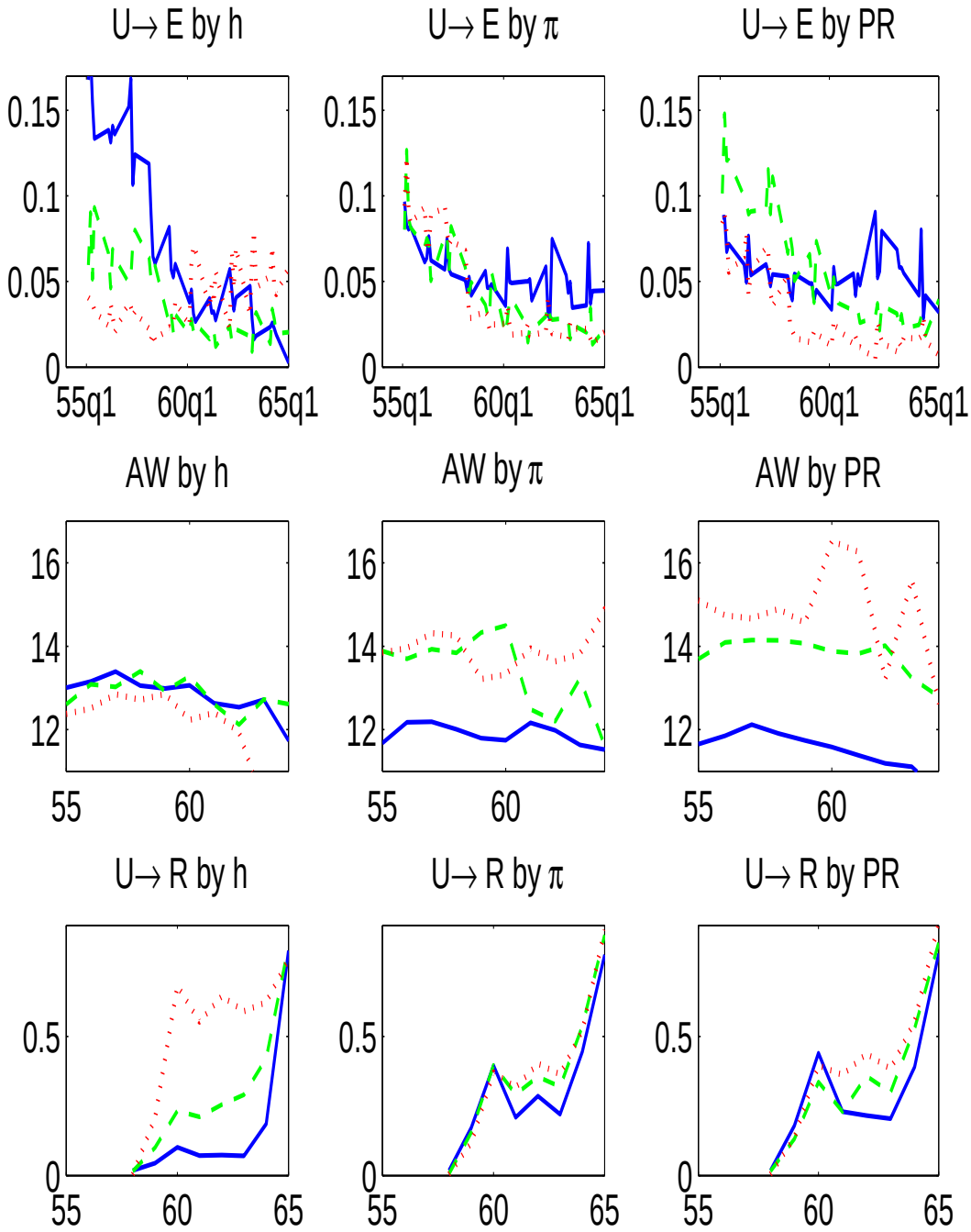

Figure 4: Quarterly reemployment hazard (top row), annual reentry wages (middle row) and retirement hazard (bottom row) by age, conditional on unemployment duration, h (left column), previous wages, π (central column), and pension rights PR, $\hat{w}$. Color code: the lower levels of each variable are represented with a blue-continuous line, average levels with a green-dashed line and higher levels with a red-dotted line.)

2.2 Empirical evidence on retirement behavior

Regarding the transition from unemployment to permanent retirement, we highlight the following empirical regularities:

R1 The retirement hazard varies strongly with age. It is higher at the early retirement age (60) and, more clearly, at the normal retirement age of 65. In the intermediate ages, the hazard remains roughly constant at a lower level.[18]

R2 The retirement hazard is strongly increasing with duration in unemployment (h).

R3 The retirement hazard is larger the higher the size of accrued pension rights and previous wages, with the exception of the early retirement age (at 60, the hazard is slightly higher for the unemployed with low pension rights).

The changing pattern of retirement hazard with age, R1, is illustrated in Figure 3. The spikes at 60 and 65 are similar to those reported in the previous literature based on the behavior of employees (See, for example Boldrin et al. (1999) for Spain and Rust and Phelan (1997) for the US). The main difference in our sample of unemployed workers is a substantially larger hazard out of the labor force observed at the intermediate ages. Regularities R2 and R3 are displayed in the bottom panels of Figure 4. The evidence regarding duration is a new and apparently very strong new stylized fact. R3 is better known from the previous literature. It is well known that minimum pensions tend to foster the early retirement of low income employees (Jiménez Martín and Sánchez Martín (2007)). This also seems to be the case in our sample of unemployed workers. After the early retirement age, however, the incidence of minimum pensions is smaller and the intensity of retirement flows is larger among the unemployed with high pension rights.

3 The model

We model the search, participation and retirement behavior of unemployed workers in the age range $a \in \{55, 70\}$ at one particular point in time. Time is assumed to be discrete, with one period in the model standing for one year of calendar time. All agents in the model face the same survival uncertainty, represented by the (age-conditional) survival function S_a. Labor market uncertainty depends on the state of the individual.

At the beginning of any period individuals of all ages are classified in one of three mutually exclusive labor states: employed, unemployed or retired. Retirement is a purely passive state, associated with the perception of the pension benefit, B, and with a permanent withdrawal from the labor force. Employed workers have a time invariant real wage, w, and face a constant probability δ of being fired at the end of the current period. After the Early Retirement Age, ERA, they have the option of voluntarily leaving the labor force and start collecting the pension

[18] When we refer to a peak in the hazard at 60 we are stressing the drop in the conditional retirement probability observed after that age. Note that, as we identify retirement with the collection of pension benefits, the absence of retirement before the Early Retirement Age is entirely a matter of construction. In the graphs, however, we see a non-negative hazard at earlier ages, due to measurement error -probably related to an erroneous recording as old-aged pensions of other type of pensions that can be enjoyed at earlier ages.

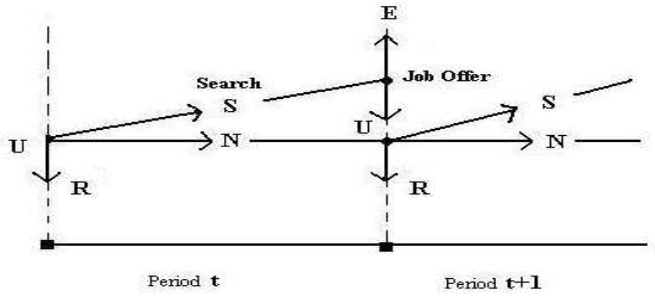

Figure 5: Timing of decisions and revelation of information in the model.

benefit.[19] In this paper we focus our attention on the behavior of the unemployed. Figure 5 summarizes in a visual way the different options opened to each of them. Immediately after the dismissal, three courses of action are possible: to retire immediately (path R in the graph), to actively search for a new job (S) or to stay inactive (N). An active search strategy involves paying some search costs upfront in exchange for getting a job offer at the beginning of the next period with probability λ_h (decreasing with the duration of the unemployment spell, h) The offer is fully characterized by the wage, which is a random draw from the invariant distribution $F(w)$. If the offer is rejected, the unemployed can either stay unemployed for another period or retire immediately (again, after ERA). Unemployed workers who opt for non-participation do not incur in any search cost in the present, but do not receive a job offer in the next period either. In theory, it should not be possible to receive the *normal* unemployment benefit without searching for a job at the same time, but we assume the public administration do not enforce this prohibition. This is in line with the empirical evidence.[20] Therefore, in both states (search and non-participation), the individual receives the same unemployment benefit, b. In section 6.3.2 we explore the consequences of granting the unemployment benefit only to the unemployed who search). Finally, we assume nobody can stay active after the age of 70.

3.1 Institutions and market arrangements

Unemployment benefits

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

[19] We do not report the optimal retirement decisions of employees in the paper, but we do take them into account in all our calculations (for example, when an unemployed decide whether to accept or reject a job offer).

[20] For example, according to the Spanish Labor Force Survey, by the end of 2006 only 13 % of the unemployed aged 45 or more who receive Unemployment Benefits declare to be searching for a new job.

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

The public employment agency (INEM) not only provides immediate income to the unemployed, but also protects their future pension income by paying their pay-roll taxes to the Social Security system. These social contributions are a fixed proportion of the individual "pensionable wage" (the labor income considered by the pension authorities when determining the pension benefit). In the current system, INEM contributes the full previous wages of those unemployed with a duration of less than two years, and the minimum contribution in case of a longer duration. The "pensionable wage" of an unemployed is, then, equivalent to a duration-dependent replacement rate of the previous wage, $\kappa_h\,\pi$, with $\kappa_h=1$ for durations of up to two years, and $\kappa<1$ for longer durations. Note, finally, that we do not consider in this paper workers covered by *Special Agreements* with the pension administration.

The pension system

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

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

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

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

The accrued pension rights ("*Base Reguladora*") is a moving average of total labor earnings in the D years immediately before retirement, $\hat{w}$:

$$\hat{w}_a=\frac{1}{D}\sum_{i=1}^{D}w_{a-i}$$

Unfortunately, implementing this formula in the model implies large computational costs. Instead, we simplify the dynamics of $\hat{w}$ by assuming that, for an individual with current labor income w, the one-year updating in the pension rights is:[21]

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

$$\hat{w}'_{a+1} = \hat{w}_a + \frac{w - \hat{w}_a}{D} \tag{4}$$

The scheme is, finally, made progressive by the inclusion of floors and ceilings in the final payment. This breaks the strict proportionality between the effective benefit $B(\hat{w}, a)$ and the pension rights:

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

The effective benefit $B(\hat{w}, a)$ is first computed when the individual retires and kept subsequently constant in real terms throughout the rest of his/her life[22].

3.2 Optimal individual behavior

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

$$e_a^* = argmax\ E\left[\sum_{i=a}^{T} \beta^{i-a}\, u(y_i, e_i)\right]$$

where e_a^* stands for the optimal sequence of present and future labor states from age a till the maximum possible age for labor participation, $\overline{N}$ (70 in the base calibration). T is the maximum longevity, β is a constant discount factor representing a pure preference for earlier consumption, and individual preferences are represented by an additively separable and age-invariant function $u(y, e)$. Period utility, then, depends on the current income flow, y, and on the labor state, e, as follows:

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

where η measures the curvature of the objective function (which, in turn, determines both the degree of risk aversion and the willingness to substitute income intertemporally) and $\nu(e)$

[22] We abstract from 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 are empirically unimportant for our sample of low-skill males. We also abstract from the effects of income taxation.

represents the variation, with the labor state, in the value of the time that is not devoted to labor-market activities. In our base specification, we normalize this value to cero for employees and assume a positive value (l) for non participants and retirees and a smaller -although still positive- one (l^s) for the unemployed that search. l^s is smaller than l to capture the costs associated to the search process, including the cost of re-training and the possible 'stigma' cost of staying unemployed.

Recursive Representation of the individual problem

As usual, we work with a recursive representation of the optimal control problem of the individual and characterize its solution via the value functions associated with each labor state. These value functions are solved by backward induction starting at $\overline{N}$. As everybody is assumed to leave the labor force at that age, we only have to compute the value of retirement:

$$R_{\overline{N}}(\hat{w}) = \sum_{i=\overline{N}}^{T} S_{\overline{N}}(i)\,\beta^{i-\overline{N}} u(\,B(\hat{w},\overline{N}),\,R\,) = \left(\frac{[B(\hat{w},\overline{N})(1+l)]^{1-\eta}}{1-\eta}\right)\cdot A_{\overline{N}}^{T} \tag{6}$$

where $S_{\overline{N}}(i)$ stands for the survival probability to age $i \geq \overline{N}$ conditional on survival to age $\overline{N}$ and A_i^j is the expected discounted value of a constant income flow of one unit starting at age i and ending at age j. To simplify the notation, from here onwards we denote the (one period ahead) effective discounting at age a, $\beta\, S_a(a+1)$, by β_a. R is simply the expected discounted value of the utility derived from the enjoyment of pension $B(\hat{w},\overline{N})$ and the full allocation of individual time to non-market activities.

At earlier ages, $a < \overline{N}$, to store all relevant information we must keep track of the value functions corresponding to the four possible labor states: $\mathcal{E}, S, N, R$ (representing, respectively, employees, unemployed who search, non-participant unemployed and retirees). We review them in turn.

3.2.1 Employed workers

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

$$\mathcal{E}_a^e(w,\hat{w}) = u(w,E) + \beta_a\left[(1-\delta)\,\mathcal{E}_{a+1}(w,\hat{w}') + \delta\, U_{a+1}(w,\hat{w}',1)\right] \tag{7}$$

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

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

The value of retirement at age $a \in [N_m, N]$ takes a completely analogous form to that in (6) for the case of retirement at age $a = \overline{N}$.

3.2.2 Unemployed workers

For the unemployed we consider three different value functions. On the one hand, we represent with $S_a(\pi, \hat{w}, h)$ the value associated with engaging in an active search process while unemployed, and with $N_a(\pi, \hat{w}, h)$ the value of avoiding search cost, at the price of giving up the chance of receiving job offers in the next period. In both cases, a vector of four state variables (age a, previous wage π, pension rights $\hat{w}$ and duration in unemployment h) is needed to fully characterize the economic situation of those workers. On the other hand, the unemployed at the beginning of the period have the option of leaving the labor force and retire, with value $R_a(\hat{w})$. Consequently, the total value attached to be unemployed at the beginning of the period, $U_a(\pi, \hat{w}, h)$, is:

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

We review each component next.

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

$$EV^S = \beta_a \{\lambda_h E_w[Max\{ U_{a+1}(\pi, \hat{w}', h+1), \mathcal{E}_{a+1}(w, \hat{w}') \} + (1-\lambda_h) U_{a+1}(\pi, \hat{w}', h+1)] \} \quad (8)$$

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

(1) If an offer of size w arrives, the individual must decide whether to accept or reject it. The optimal decision is obtained by comparing $\mathcal{E}_{a+1}(w, \hat{w}')$ to $U_{a+1}(\pi, \hat{w}', h+1)$. Of course, at t, the size of the wage offer is uncertain. Consequently, the individual operates by taking conditional expectations, which accounts for the $E_w[.]$ in (8).

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

$$\mathcal{E}_a(\overline{w}_a(\pi, \hat{w}, h), \hat{w}) = U_a(\pi, \hat{w}, h) \quad (9)$$

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

Overall, the expected future value of searching is composed of two elements: a *Stop Value* of finishing the current unemployment spell by accepting an offer immediately and an *Option*

Value derived from staying unemployed and so keeping the chances of getting an acceptable job offer in the future.

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

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

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

Note, finally, that the value of the retirement option for the unemployed is similar to what has been previously discussed and does not demand additional comments.

4 Theoretical Predictions of the model

Due to its complex dynamic and stochastic structure, it is not possible to solve the individual decision problem analytically. Instead, numerical simulations must be used to get precise quantitative predictions of individual and aggregate behavior. It is useful, in any case, to get an understanding of the basic economic forces at play in the model and how they interact with each other to generate a *qualitative* picture of the properties of the model solutions. This is the task we embark on in this section. Specifically, we review the main trade-offs involved in each decision and their dependence on the *fundamentals* of the model: (i) the institutional environment (the unemployment and pension rules); (ii) the conditions in the labor market; (iii) the individual unobservable preferences and (iv) the individual observable characteristics.

In this analysis we separately consider the three main behavioral decisions opened to any unemployed: the choice between retirement and non-participation, the acceptance of a particular wage offer and the decision to embark on the (costly) process of searching for job offers. The analysis in this section is extended in Appendix A.1, where we use a simplified version of our model to explore in a formal way the different trade-offs involved.

4.1 The choice between retirement and non-participation

In this section we review the economics behind our main claim in the paper: the strong incentives towards inactivity that the pension regulation creates on workers with a duration in unemployment of less than two years. This is exposed by revealing the main trade-offs faced by an unemployed without any job offer, who must subsequently decide on whether to retire or stay unemployed without searching in the current period. We defer the analysis of the search decision to section 4.3.

The trade-off faced by such an individual is essentially intertemporal, involving the substitution of current for future income. Typically, the unemployed gets a smaller current income by staying inactive rather than retiring, but this can be compensated by gains in future pensions (derived from a reduction in the early retirement penalties and from the further accumulation of pension rights that follows when the Unemployment authority pays pay-roll taxes on behalf

of the unemployed).[23] Staying inactive avoiding search is a rational strategy if the unemployment program provides sufficient income support (ie, if b_h and κ are large enough), and if the annual pension penalty for early retirement is substantial.[24] Only very impatient or very intertemporally-inelastic individuals (ie, workers with very low β and high η respectively) will prefer to take pension benefits immediately. Note, in particular, that workers with a larger valuation of leisure will not choose to retire earlier, as they can enjoy the same amount of leisure time in the alternative of inactivity. Among the observable individual characteristics favoring inactivity, duration in unemployment and age seem of paramount importance. For short-duration unemployed in the years immediately preceding the Early Retirement Age, the unemployment insurance provides enough income support to "comfortably" wait to the ERA without searching. More disturbingly, short-duration unemployed older than the ERA may avoid the early retirement penalties for up to two years by pretending to stay active while avoiding search. High previous wages π and low levels of accrued pension rights are also associated with a stronger preference for inactivity.

The simulation of the model in section 5.2.1 (with the specific parameters of our benchmark calibration) provides clear illustration of these qualitative patterns. The associated optimal policy functions are displayed in Appendix A.2.

4.2 The decision to accept a particular wage offer

The decision of whether to accept or turn down a wage offer has been extensively studied in standard search models, typically in the context of the job search decision of young individuals[25] A realized offer can be rejected in the expectation that a better offer may materialize in the future, relying in unemployment benefits to survive in the meantime. In our context, things are more complex. First, the alternative of retirement (both outright or delayed through an inactivity spell), can be dominant, specially for the workers of more advanced age. Second, current unemployment income is still important, but deferred payment as pension rights is normally even more determinant. And last, but not least, the importance of the *option value* of waiting for future offers is, for a majority of workers, smaller than for young workers (and decreasing with age).

Overall, the age of the individual has a strong impact in the pattern of variation of reservation wages with individual characteristics. While the pattern is very standard (ie. similar to that described in the previous literature) at earlier ages, it becomes increasingly dominated by the role of pensions for older individuals. More precisely, at the younger aged considered (55), the reservation wages are substantially smaller for the long-term unemployed and are slightly increasing with the previous wage, reflecting the details of the provision of unemployment insur-

[23] This point is formally illustrated by equation (9) in Appendix A.1.1.

[24] Large annual early retirement penalties are intended to discourage employees to leave the labor force early. The paradox is that, while they provide the right incentives for the employees, they create perverse incentives for the unemployed. They have a similar retention impact, which makes very convenient to stay inactive without searching. As explored in section 6.3.2, this unfortunate side-effect would disappear if the provision of Unemployment Benefits were link to an active search effort.

[25] More precisely, in models where the non-stationarity created by age in the search problem was ignored: a constant future awaited the individual after his/her return to work.

ance. The size of accrual pension rights is, in contrast, irrelevant. Figures 14 to 16 in appendix A.2 provide a graphical illustration of these patterns in our benchmark case. Things are dramatically different for older individuals: the reservation wages become more and more dependent on pension rights and less and less sensitive to previous wages and duration[26]. Eventually, only the determinants of the size of the pension matters. Furthermore, age is also very important for the sensitivity to the labor market conditions: as the individuals approach the normal retirement age, reservation wages cease to respond to changes in both λ and $F(\cdot)$. Finally, it is interesting to note that high annual early retirement penalties (a very steep profile of μ with age) do reduce reservation wages around the ERA, making workers more willing to return to the labor force. This is in sharp contrast with our discussion of the disincentive effect of early retirement penalties in the previous section.

4.3 The decision to search

Getting involved in a search process implies accepting an immediate cost (that we represent as a drop in the utility value of income) in the *hope* of larger labor and pension income in the future. The main trade-off is therefore intertemporal, but it also strongly depends on the uncertainty about future wage offers and the risk attitude of the individual.

The most crucial determinant for job search is the prospect of future employment conditions. Equation (8) in section 3.2.2 (or equation (A.1.3) in Appendix A.1.2) illustrates how larger arrival rates or the expectation of more generous wage offers increase the expected return to searching, making it a more attractive option.[27] Individual preferences and institutional details are also very relevant. Intuitively, search is more attractive to individuals with a low degree of risk-aversion, a low degree of time discounting and, obviously, low search cost (eg. better skills to recycle to a new position). On the other hand, a reasonably generous unemployment benefit is also essential to keep the individual in the labor force. This raises the standard questions about the moral-hazard implications of unemployment insurance, that we explore in an experiment in section 6.3.1. In our case, however, the disincentive effects of pensions seem to be more important in most cases. The influence of pensions is felt both directly (as an outright alternative option to search) and more indirectly as creating higher reservation wages and reinforcing the value of staying unemployed without searching.

The value of search is also strongly dependent on the individual characteristics. To start with, age is very important due to the interaction with the pension rules. For young workers, an aceptable offer typically represents high labor income for several years and sizable improvements in the size of accrual pension rights at retirement. These gains are much smaller for workers very close to their optimal retirement age, making them more reluctant to engage in the search process. After the ERA, the increase with age in the size of the available pension acts as a

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

[27] Note, however, that higher reservation wages reduce the expected return to searching, meaning that improved labor market conditions also make individuals more selective when accepting particular job offers. In our simulations, however, we find this effect to be of second order of importance.

direct deterrent to the search process. Duration is also particularly important, even before the normal retirement age. When the job offer arrival rate is negatively dependent on duration, it may be optimal for the long-term unemployed to avoid searching (despite the low reservation wages) and retire at the earliest possible age. Finally, searching is specially advantageous in our model for workers with low pension rights (and, consequently, low opportunity cost of the foregone pension)[28]. This follows from our assumption that the process generating the size and arrival rate of wage offers is independent of the previous income of the individual. The variation in optimal behaviour with age, duration, pension rights and previous wages in our benchmark simulation can be appreciated in Appendix A.2.

5 Calibration

After having explored the qualitative properties of the model in the previous section, this section is devoted to analyze its quantitative performance. We start in section 5.1 by discussing our strategy to select the parameters that will constitute our benchmark case in the rest of the paper. The chosen parameters and their associated model performance are then reviewed in section 5.2. We pay special attention to check to what extent the model can reproduce the empirical stylized facts of section 2.

5.1 Calibration strategy

The model parameters can be classified in two broad categories depending on the availability of directly observable empirical counterparts. The parameters controlling the human survival and the institutional parameters of the pension and unemployment schemes are among the observable ones. Individual preferences and the parameters that control the demand side of the labor market (with the exception of the dismissal rate) belong to the alternative group without direct observable counterparts.[29]

We assign specific values to the parameters in the unobservable group by following a calibration strategy: we choose a set of empirical properties and search for the parameters that make the model reproduce them as closely as possible. Among the many dimensions of the model predictions, in this work we target the aggregate performance by age: we try to reproduce the conditional probabilities of retirement and reemployment by age in the range 55/65 and the reentry wages in the same age range (a total of 30 empirical moments). To find our benchmark parameter vector we combine a pure evaluation of the quantitative error generated by the simulation of the model with some qualitative consideration. In a nutshell, we create a grid of potential values for the unobservable parameters, solve the model at each node of the grid, compute the prediction errors and select the set of values that provide the best combined quantitative and qualitative adjustment. The details of this informal "method of simulated moments" are presented in Appendix C.1, while the robustness of our main findings to the particular set

[28] Again, this observation apply to workers who are close enough to the NRA. As with the reservation wages, differences in $\hat{w}$ are irrelevant at early ages.

[29] Note that we can observe the wages of the unemployed that reenter the labor force, but we cannot directly observe the properties of the offered wages (because the rejected ones are unobservable).

of parameters chosen is reviewed in Appendix C.2. All in all, we fall wide short of claiming that our benchmark case is *the best* possible empirical model. Such a claim would demand a proper estimation of the model. We think that it should be understood as a highly significant example, whose qualitative properties are largely robust to the particular parameter combination selected.

5.2 Benchmark parameter values and the model empirical performance

The set of parameter values resulting from our calibration procedure are shown in table **??**. In this section we briefly review the selected values (both in cases with and without direct observable counterparts) and discuss the individual and aggregate behaviour implied (subsection 5.2.1).

The parameters describing the pension and unemployment schemes are set to reproduce their direct empirical counterparts as of 2002. Retirement pensions are, then, first available at the age of 60, with an annual early-retirement penalty of 7.5% of the accrued pension rights. $\hat{w}$ is computed to approximate a moving average of the 15 years immediately before retirement (according to equation (4)). The full pension is granted at the normal retirement age of 65. The value of the minimum and maximum pensions are, respectively 5.7 and 23.8 (thousand of 2002 Euros, per annum). Unemployed workers receive 65% of their previous wages as benefits during the first year out of work (an average of the 70% being provided in the first six months, and the 60% provided thereafter, till a maximum of two years). This value is then reduced to 60% in the second year and just 75% of the minimum contribution (6.2 thousand Euros) in subsequent years. The general proportionality of benefits and wages (for durations of less than two years), then, is broken by the minimum subsidy and a ceiling of two times the minimum contribution (12.4 thousand Euros)[30]. Finally, we calibrate the dismissal rate, δ, to 6.7%, the average annual value observed in the entire MCVL sample for workers in the age range 50-65. This is coherent with our treatment of transitions from employment into unemployment as an exogenous process.

Unobservable preferences are chosen as follows. The individual annual discount factor is set to 7.5%, which is a bit larger than the values most frequently observed in the literature. In our model we need relatively impatient individuals to rationalize the early retirement flows (particularly the peak at the age of 60).[31] A moderately high degree of risk aversion (η=4) also contributes to this end, by reducing the willingness of individuals to accept low unemployment income in exchange for high future pension income. This is also important to help to capture the low reemployment hazard in the data. The two parameters determining the value of time (roughly, the relative value of leisure in retirement, l, and while searching, l^s) are more difficult to assign due to their contradictory effects on the reemployment hazard and on accepted wages. To replicate observed reentry wages, individuals should attach high value to leisure in retirement and low value to leisure while searching (and be offered relatively small wages, as described

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

[31] In reality the discount factor is most certainly heterogeneously distributed across the population. Previous studies (eg. Gustman and Steinmeier (2005)) find that early retirement is largely due to a relatively small group of highly impatient individuals. In our framework with homogeneous preferences this feature leads to a high average discount factor. There is some substitutability with the value of η (higher risk aversion implies a lower degree of intertemporal substitution, which tends to foster earlier retirement). However, very large values of η create implausibly high reentry wages at advanced ages.

Preferences			**Labor Market parameters**		
r	0.075	Annual discount factor	λ_1	0.6	Job offer arrival rate h=1
η	4	Risk aversion	λ_2, λ_3	0.7	arrival rate for h=2,3
l	0.3	Extra value of income (inactive)	μ	8	Average wage offer
l^s	0.1	Extra value of income (search)	σ	4.5	Std. of wage offers
			δ	0.067	Probability of dismissal
Pensions			**Unemployment**		
N	65	Normal Retirement age	b_1, b_2	0.65;0.6	Benefit coverage if h=1,2
N_m	65	Early Retirement age	κ_1, κ_2	1	Payment to Soc. Security
B_{max}	27.34	Maximum pensions	b_{max}	$2\underline{\varsigma}$	Maximum benefit
B_{min}	5.79	Minimum pensions	b_{min}	6.32	Minimum benefit
D	15	Num. lags in pension formula	b_{min}	$0.75\underline{\varsigma}$	Unemployment subsidy
μ_1	0.075	Annual early retirement penalty			
Social Contributions					
ς	0.275	Pay-roll rate	$\underline{\varsigma}$	6.19	Minimum contribution
$\overline{\varsigma}$	36.05	Maximum contribution			

Table 1: Parameter values in the benchmark economy (all monetary quantities are expressed in thousands of Euros of 2002).

below). Otherwise, their reentry wages will be strongly increasing with age. However, the reemployment hazard would be implausible low if we selected the more extreme leisure values considered. The model needs smaller values of l and, specially, larger values of l^s to make the unemployed more willing to search and so replicate the observed size of the reentry flows. The selected values (30% extra value of income at retirement and 10% while searching) represent a compromised between these two opposing forces.

Things are similar regarding the labor market parameters: a compromise must be reached among opposing tendencies in wages and entry flows. A combination of relatively high wage offers (μ around 10 thousand euros per annum) and low rates of arrival (λ rates around 50%) generates the best match with the empirical reemployment patterns. However, a mean value of offers of that size would generate average accepted wages significantly bigger than those observed in the data. Actually, the model can almost exactly replicate the observed reentry wages with a much smaller μ value (around 6 thousand euros). A good balance between these two forces can be achieved combining a slightly larger rate of arrival, 60%, with an implied persistence factor in λ_2 and λ_3 of 70% (implying arrival rates of 42% for durations of more than one year) and an annual mean offer of 8 thousand euros. The dispersion of the offers is set to 4.5 thousand euros.

5.2.1 The empirical performance of the model

Once equipped with a fully specified set of parameter values, we can compute the optimal individual and aggregate behavior (the latter by aggregation assuming the same distribution of observable characteristics as in our sample of Section 2). The optimal individual decisions in

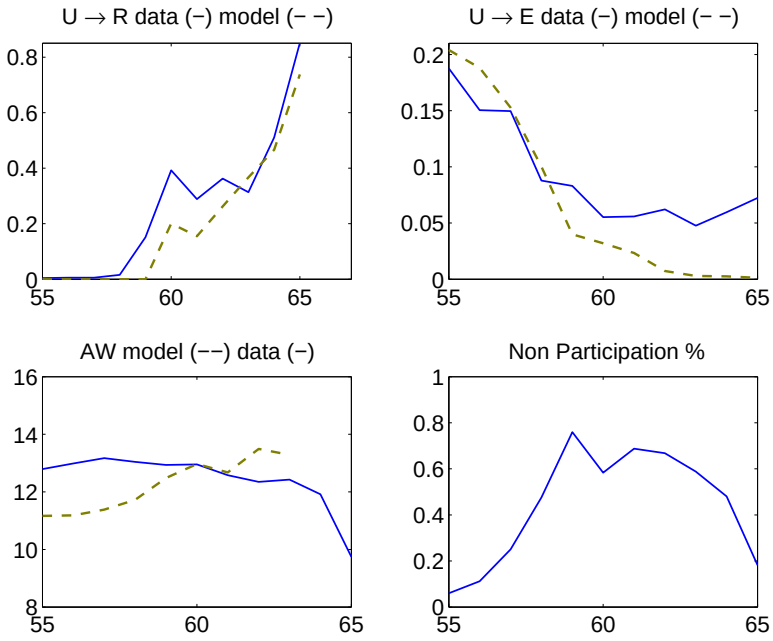

Figure 6: Benchmark theoretical predictions (green, dashed line) vs. empirical data (blue, continuous line): retirement and reemployment hazards (top panels), reemployment wages (bottom left panel) and predicted incidence of non-participation by age (bottom right panel).

our benchmark case are reproduced in Appendix A.2, along with some illustrative reservation wages in Figures 14 to 16. They constitute a concrete illustration of the economic forces discussed in detail in Section 4. The aggregate quantitative performance of the benchmark model is represented in Figure 6 and, in more detail, in Figures 7 (patterns by age conditional on unemployment duration), 8 (patterns by age conditional on the size of accrued pension rights) and 9 (patterns by age conditional on the size of previous wages).

The comparison of the predicted reemployment and retirement hazards and accepted wages by age in Figure 6 makes clear that our highly stylized model does a very reasonable work in reproducing the broad empirical patterns simultaneously in the three dimensions. Overall, the model successfully reproduces the decreasing reemployment hazard by age (stylized fact S1); the increasing pattern of retirement by age, including the large spikes at 60 and 65 (fact R1) and the average level of accepted wages (fact S4). It also very accurately replicates the dramatic increase in retirement for the unemployed with more than two years of duration (R2, illustrated in the top row of Figure 7) and -with less precision- the increase in retirement hazard with the size of the pension rights and the corresponding decreases in the reemployment hazard (top and middle row of Figure 8). It is particularly striking the ability of the model to reproduce the levels of retirement, reemployment and accepted wages conditional on previous wages (Figure 9).

Obviously, some discrepancies do reveal themselves. In particular we find that the model: (1) does not generate enough early-retirement; (2) underpredicts reemployment after the age of 60 and (3) tends to generate a profile of accepted wages that increases with age. The difficulties

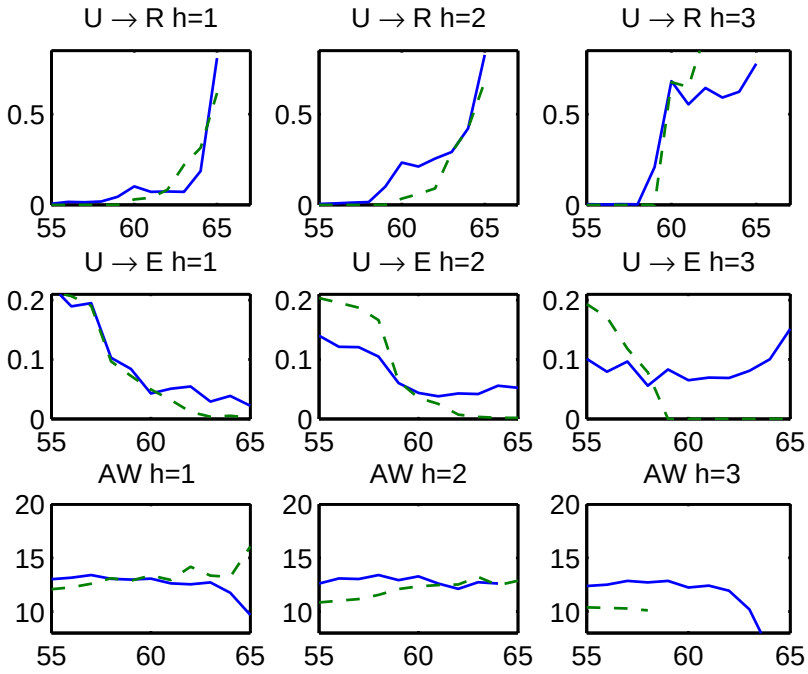

Figure 7: Comparison of the data (-) and the theoretical predictions of the model (- -). Retirement and reemployment hazards and accepted wages by age and duration in unemployment, h.

are essentially due to the behaviour of the long-term unemployed and/or of individuals with above average pension rights. After 60, the model does not generate reemployment for the long-term unemployed while (surprisingly) high flows are observed in the data. Similarly, the model predicts very small reentry flows of unemployed with average and above average pension rights, which, again, is at odds with the observations.[32] These difficulties may suggest the need for some additional unobserved heterogeneity in the model.[33]

[32] As the model fails to generate significant amounts of reemployment after the age of 60, we have difficulties in evaluating the predicted accepted wages after that age. This may contribute to the counterfactually high reentry wages predicted at advanced ages: the model fails to generate transitions into employment of unemployed whose predicted accepted wage is small (those with high duration and high pension rights).

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

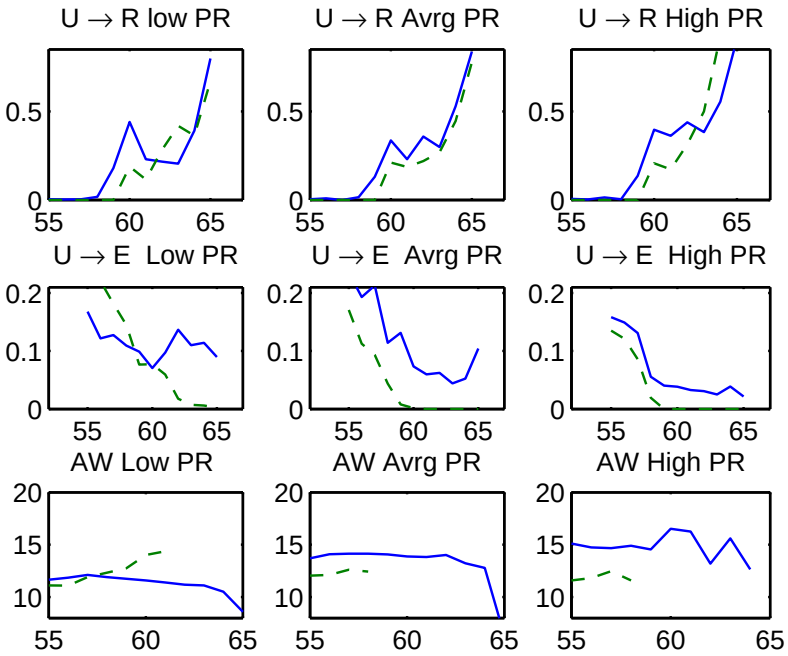

Figure 8: Comparison of the data (-) and the theoretical predictions of the model (- -). Retirement and reemployment hazards and accepted wages by age and accrued pension righs. Low (high) PR are below (above) the 1/3 (2/3) percentage of the empirical distribution.

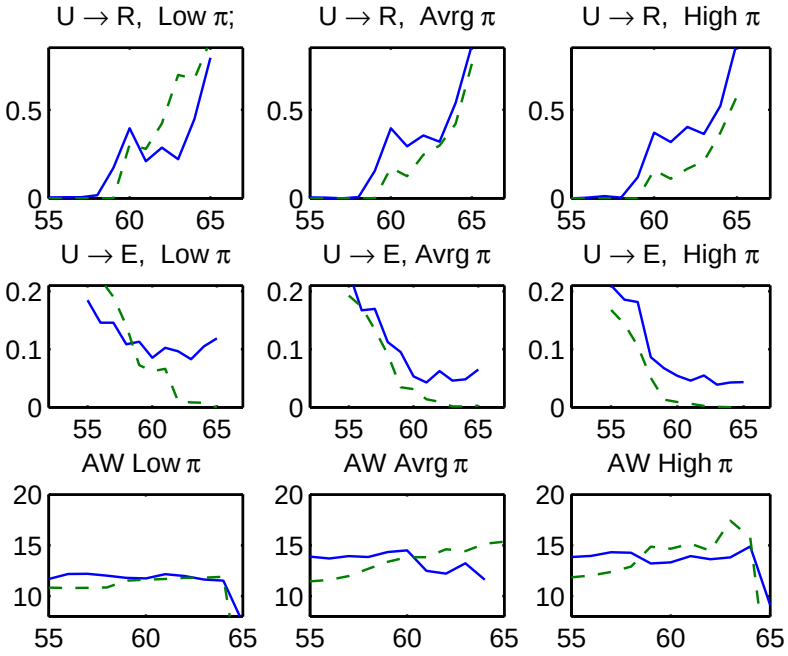

Figure 9: Comparison of the data (-) and the theoretical predictions of the model (- -). Retirement and reemployment hazards and accepted wages by age and previous wage, π. Low (high) π are below (above) the 1/3 (2/3) percentage of the empirical distribution.

6 Policy Experiments

After having successfully tested the ability of the model to reproduce the most relevant empirical evidence, we can proceed to use our economic model for policy analysis. We proceed in two steps: First, we explore the extension of non-participation in the benchmark case (Section 6.1). The rest of the section is devoted to explore its main determinants along with its financial and welfare consequences. We do so by analyzing the optimal individual behaviour predicted by the model (and its aggregate consequences) in some alternative economic environments. We address two broad issues here: first, we try to establish the role played by the institutional design in inducing a low search effort by a large number of senior individuals, with independence of the opportunities offered by the labor market. This is explored in Section 6.2. Next, in Section 6.3 we consider some alternative designs of the public institutions, aimed at fostering labor participation. We explore the optimal labor supply in these new institutional frameworks, along with the associated costs for the Public Insurance System and the welfare gains/losses inflicted on different individuals in comparison to the *status quo*.

6.1 Non-participation in the benchmark case

The performance of the benchmark model along the observable dimensions was discussed in the previous section. The key question addressed in this work, however, is the enquiry about the use of the unemployment insurance without searching. This is unobservable, but can be inferred from the solution of our theoretical model. We compute the extension of this practice in our empirical sample simply by adding up the proportion of individuals who find this behaviour optimal. The aggregate value is reported in the sixth column of Table 2 (under the heading NP), and the results by age are shown in the right-bottom graph of Figure 6. The figures speak by themselves: it is optimal to avoid searching for almost 2 out of 5 of the unemployed of less than 60 and a staggering 2 out of 3 after that age. This practice becomes widespread as individuals approach the early retirement age, and remains so until the normal retirement age. This finding suggests that the strategic use of the unemployment insurance, far from a theoretical possibility, may be a prevalent practice among Spanish unemployed of advanced age.

The non-participation decision of the unemployed may have important consequences for the financial balance of the public insurance mechanisms. To check this issue, we have calculated the average per capita financial cost for the combined "pension + unemployment" systems of the individuals in our empirical sample. We have computed the expected present discounted valued of the flow of future pension and unemployment payments net of any social contributions that the individual may pay to the system. The formal definition of this Net Pension Cost (NPC) is provided in Appendix B.3. The calculation reflects the optimal behaviour of the individual in each labor state and is a function of his/her observable characteristics. The average figure found in the benchmark case is close to 145 thousand euros. This value will provide the base to measure the potential financial gains of alternative institutional environments in the following sections.

Eco	Age range	Labor Supply			NPC	Welfare
		Ret	Search (Reenter)	NP		
BASE	55/59	0	0.6162 (0.1249)	0.3838		
	60/65	0.2509	0.0856 (0.0155)	0.6635	144.9	
λ=1	55/59	0	0.7969 (0.2439)	0.2031		
	60/65	0.3002	0.1718 (0.0415)	0.5280	130.3	
b rep 50%	55/59	0	0.5935 (0.1247)	0.4065		
	60/65	0.3923	0.0781 (0.0133)	0.5296	143.9	0.79
Law	55/59	0	0.7456 (0.1340)	0.2544		
Enforc.	60/65	0.4167	0.5511 (0.0475)	0.0322	138.9	0.55
Separate	55/59	0	0.6607 (0.1485)	0.3393		
μ	60/65	0.5800	0.2786 (0.0526)	0.1413	137.5	1.86

Table 2: Simulation Results: labor supply, financial cost and welfare change associated with each institutional environment. The labor supply columns report the proportion of workers whose optimal decision is to retire (*Ret*), *Search* or stay inactive (*NP*). It also reports the reemployment hazard (*Reenter* value in brackets). The Net Pension Cost (NPC) is in thousand of Euros per person. The Welfare measure is an Equivalent Variation versus the benchmark situation (also in thousand of euros).

6.2 Non-participation under improved labor market conditions

A popular explanation for the small number of transitions back into employment observed among the more senior Spanish unemployed is the unfavorable labor market conditions faced by this group. The idea is simply that the Spanish labor market offers very few opportunities of reemployment for this particular population group. Under these circumnstances, the effort of engaging in costly training to improve one's re-employment chances is probably not worthwhile. In our view, there is little doubt that labor demand considerations play a big role on the observed low reemployment hazards. However, we conjecture that there is also a voluntary component in this outcome, resulting from the (perverse) incentive structure emerging from the public insurance mechanism. Our conjecture is that the reemploment hazard at the ages sorrounding retirement would be small even in presence of more favorable labor market conditions.

In this section we test our conjecture with a simple counterfactual experiment: we compute the optimal decisions of the unemployed in an environment with the same institutions as in the benchmark but with significantly improved labor market conditions. Specifically, we assume that the initial rate of arrival of job offers is much larger that the 60% rate that best rationalized the observed empirical flows. We solved our model assuming a 100 % rate of arrival for the unemployed with less than one year of duration (and left the 30% *histeresis* reduction for unemployed of longer duration unchanged). The aggregate results in this new environment are reproduced in rows 3 and 4 of Table 2 (economy λ=1) and illustrated in Figure 10.[34]

The option of searching becomes more attractive in presence of better future wage prospects, specially when the chance of collecting the old-age pension is not available until a (relatively)

[34]To keep the length of the work within reasonable limits we do not reproduce the new individual policy functions here. They are available from the authors upon requests.

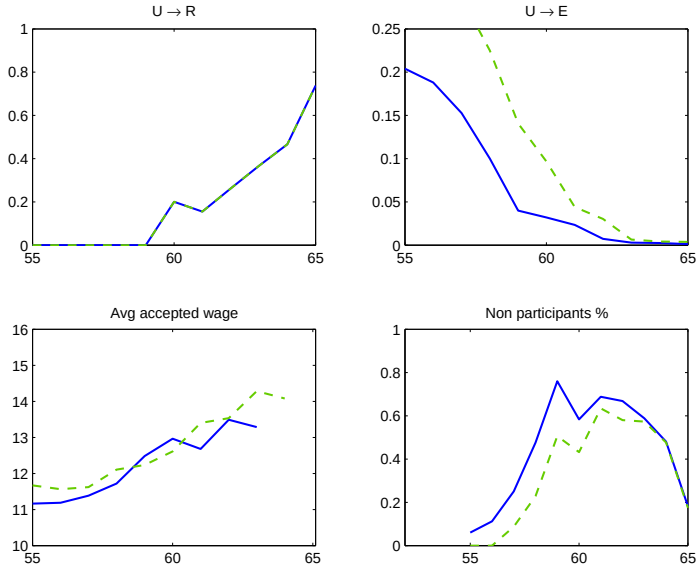

Figure 10: **Improved Labor Market conditions**: Model prediction in the benchmark case (-) (λ=60%) and with secure arrival of job offers. λ=100% (- -)

distant future. This changes the predicted behaviour of large groups of long-term unemployed (whose previous optimal response was to stay inactive). For workers below the Early Retirement Age the predicted reemployment hazard doubles, and the share of non-participants roughly halves. This generates a very substantial reduction in the cost posed by the unemployed to the overall public insurance system: on average, the life-cycle transfers for the individuals in the sample goes down by more than 10%. However, we observe rather small gains in the reemployment rates once the individual becomes elegible for old-age pensions. The reemployment hazard in the age range 60/65 more than doubles, but the absolute figures are still very small, with an average value of just 4.2%. This is so because staying inactive remains the most popular choice after 60, being selected by 60% of the unemployed (down from 67% in the benchmark). Overall, our simulations indicate that poor labor market conditions are very important for the incidence of inactivity before the ERA, but only a relatively minor factor after the age of 60. The advantages of the "inactivity path" into retirement are simply too strong to be compensated by improvements in potential wage offers. The disincentive effects of the current institutional framework, then, seems to play a large role in the low reemployment observed after 60.

6.3 Institutional reforms: incentives, costs and welfare changes

After having checked in the previous section the importance of the institutional design for the extent of non-participation, it is natural to consider alternative institutional mechanisms capable of providing better incentives to labor participation. The general principle is to modify the existent framework in such a way that the unemployment insurance were only used by workers with an active search strategy and not as an early-retirement device. In this section we consider three of such reforms. Our first experiment (Section 6.3.1) explores a traditional recipe against the moral-hazard present in our situation: a reduction in the generosity of the

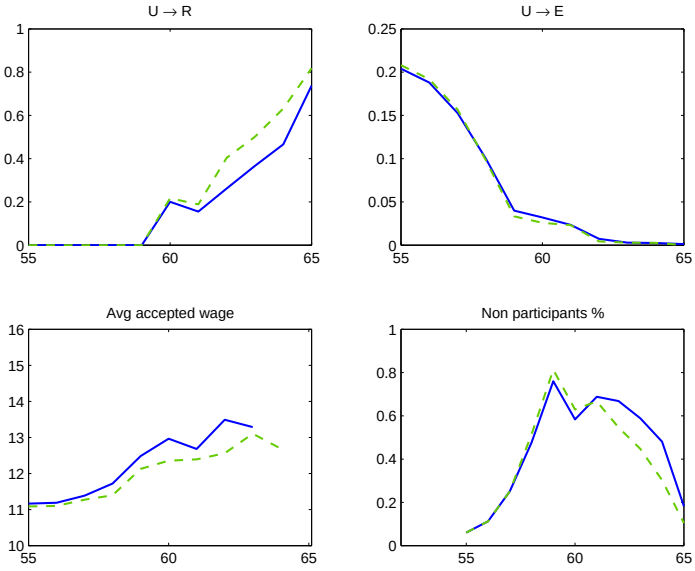

Figure 11: **Unemployment Benefit reform**: Model prediction in the benchmark case (-) and with unemployment benefits equal to 50% of previous wages (- -)

unemployment benefit. We then explore (Section 6.3.2) the consequences of a strict enforcement of the unemployment law (which implies that contributory benefits should only be paid to workers actively engaged in the search of a future job). Finally, in Section 6.3.3 we consider a change in the pension rules, linking the size of the early retirement penalty with the age of effective withdrawal from the labor force (rather than the age of claiming the benefit). In all cases we compute the changes in labor supply and in the cost that each worker represents for the Social Security system. We also assess the welfare impact of the reforms, by computing the Equivalent Variation (EV) associated with each institutional change in relation to the initial benchmark. For each individual, the EV is defined as the income he/she would be willing to forego in terms of an outright payment to avoid the introduction of the reform under study. A formal definition is presented in Appendix B.4.

6.3.1 Change in unemployment benefits

Our first simulation explores the most straightforward strategy in the context of a moral-hazard problem. We simply reduce the protection provided in the contingency of unemployment, hoping this will induce a proper self-selection of workers and make the option of staying unemployed without searching less attractive. For "*good risks*", ie. workers with good chances of re-employment, this institutional change should push them back to active work. For "*bad risks*" ie. workers whose skills are in low demand, making them very hard to re-employ, this should push them into early retirement (paying the price of a penalized pension). The reform is implemented by reducing the size of the unemployment benefit to 50% of the previous wage (down from the current 65/60% for workers with 1/2 years duration). The minimum benefit is left untouched, providing a lower threshold on the welfare of the unemployed.

Rows 5 and 6 of Table 2 and Figure 11 display the results obtained. We find a very different

outcome from the standard in stationary models: Non-participation does go down (from 66.4 to 53%), but only as a result of the self-selection of the "*bad risks*" into retirement rather than from an increase in the re-entry hazard. Actually, the proportion of searching unemployed goes down slightly. The logic behind these findings is clear: by making the life of the unemployed harder we have reduced the value of both searching and staying unemployed without search. In contrast, the value of retirement is left unchanged, making it relatively more attractive than in the benchmark. The reform is also rather unsatisfactory from a purely financial perspective. The average cost for the combined Social Security system of an unemployed in our sample is reduced by, roughly, one thousand euros (144 thousand euros vs 145 in the benchmark). At the same time, the estimated compensation needed to maintain the initial welfare is around 800 euros in average, but this EV can reach much larger figures for particular workers.[35] This leaves little room for a welfare improving role of this reform.

6.3.2 Perfect enforcement of unemployment law

According with the current Spanish law, the perception of the contributory unemployment benefit as described in equation (1) of Section 3.1 is conditional of being actively involved in the search for a new job. However, this requirement is hardly ever implemented in practice.[36] In this section we explore the consequences of a perfect enforcement of this rule. We assume that all the unemployed who decide to stay inactive will only receive the minimum unemployment benefit, b_{min}, rather than the contributive benefit corresponding to their individual characteristics. This amounts to assume that the System can observe the decisions of the individual which, obviously, is a very extreme assumption. The value of the experiment is, then, essentially theoretical.

The results of the experiment are reproduced in rows 7 and 8 of Table 2 and in Figure 12. They make clear that the alternative of inactivity largely disappears in a context of perfect observability. Only long-term unemployed (ie. those with h=3) in the age range 55/60 still find it optimal to avoid searching while unemployed. After 60, most individuals who preferred to stay inactive in the benchmark now find searching more convenient, while a sizable part of them shift decision to immediate retirement. None of them stick to the labor market without searching. Quite surprisingly, we also find that the reemployment hazard increases only moderately despite a very large jump in the proportion of the unemployed actively searching. There is a threefold increase with respect to the value in the benchmark in the age range 60/65, but still fails to reach an average annual value of 5%. The reason for this lies in the strong opportunity cost generated by the availability of pensions. It means that the reservation wages of the unemployed remain very high at advanced ages, implying that only those workers who get very high job offers do effectively reenter the labor force. This can be appreciated in the much larger average reemployment wages predicted for this environment.

In this case, the average cost for the combined Social Security system of the individuals in our sample is 139 thousand euros, ie. 9.6% less than in the benchmark case. The financial condition

[35] The compensation for short-term unemployed at early ages can be as high as 3.5 thousand Euros.

[36] In most cases, individuals are simply required to periodically report to their respective Unemployment Offices. They may also be required to attend specific job offers, but this involves nothing more than interviewing with the prospective employer. Taking part in recycling courses, for instance, is entirely voluntary.

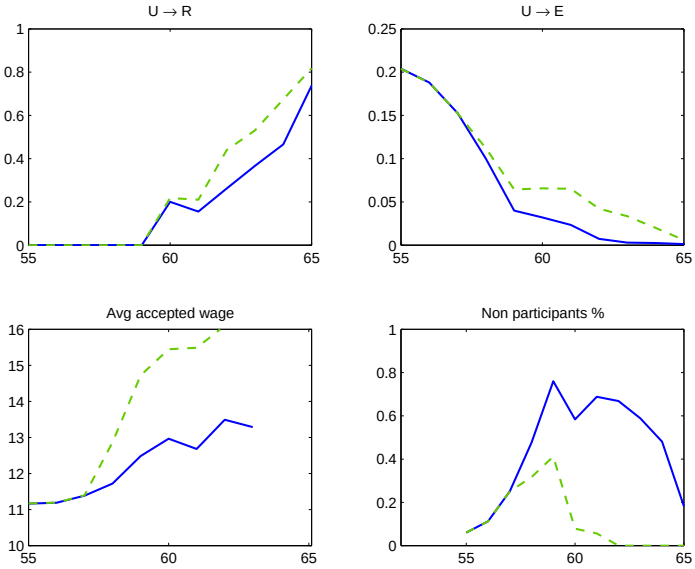

Figure 12: **Perfect enforcement of the Unemployment Law**: Model prediction in the benchmark case (-) and with contributive benefits confined to actively searching unemployed (- -)

of the system would, then, be much reinforced in this environment. However, this value should be interpreted bearing in mind that we have not taking into account the implementation costs of the institutional change. In any case, the calculation of the EV generated leaves ample room for a welfare enhancing role of this environment: in average, it would suffice to pay 550 Euro per unemployed to compensate for the change. This value varies depending on the characteristics of the individuals, but the financial gains for the system seems to compensate the welfare losses even in the worst-hit cases.[37] All in all, this simulation shows that avoiding the misusage of the unemployment benefit scheme can reduce the financial costs of the Social Security system without imposing large welfare cost on the unemployed. It is not enough, however, to guarantee much larger inflows into the labor force.

6.3.3 Pension formula reform for the unemployed

A perfect enforcement of the unemployment law largely succeeds in eliminating the inactivity of the unemployed, but is difficult to implement in reality. In this section we propose an alternative way of correcting the incentives for inactivity, which is easier to put into practice.

A key aspect for the attractiveness of inactivity is the automatic increase of the pension while the unemployed stays out of job, (at least in the age range 60/65, as a result of the reduction in the early retirement penalties). Therefore, a straightforward way to prevent inactivity is by severing this link. This can be achieved by making the early retirement penalty depends on the age of exit from employment, rather than the age when the individual claims the pension benefit. It would amount to changing the replacement rate $\mu(a)$ in equation (3) to $\mu(a-h)$. So if somebody is made redundant at the end of the year when he/she is 59, the corresponding

[37] The EV reach almost 3000 Euros for short-term unemployed around the Early Retirement Age.

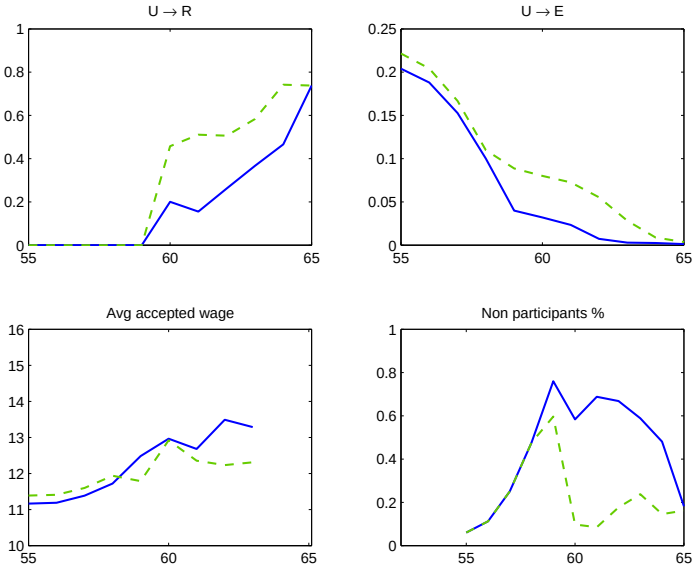

Figure 13: **Pension benefit reform**: Model prediction in the benchmark case (-), and with early retirement penalties fixed at the effective age of exit from employment (- -)

pension rights, $\hat{w}$, will be equally punished if he retires immediately (a=60, h=0) or if he/she waits for one year (a=61, h=1) or longer. This change eliminates the incentives to stay idle while enjoying the unemployment benefit.[38] The idea is to provide the incentives for the voluntary, immediate retirement of the unemployed who do not search (in line with -although not quite as straightforward- the recent reform in the German regulations discussed in Section 1).

Figure 13 and the bottom rows of Table 2 reports the results of this reform. It is very successful in fostering re-employment after 60: the hazard of those workers is almost four times larger than in the base simulation. This is the result of both a larger search effort of the unemployed and a drop in their reservation wages driven by the depreciation of the retirement alternative. This latter remark, easily traceable in the reductions in the accepted re-entry wages in Figure 13, is in sharp contrast with the results in the *perfect enforcement* reform. The change in the pension formula also pushes a sizable part of the non-participant unemployed older than 60 into retirement. All these changes are essentially concentrated among the unemployed with shorter durations and average or above-average previous wages and acrrued pension rights. All in all, non-participation after 60 is very substantially reduced under this reform.

The financial savings for the combined Social Security system are also rather substantial. On average, each worker on our sample costs to the system 137.5 thousand euros, which represents a 5% reduction from the 145 thousand estimated in the benchmark. This savings came at the expense of some welfare losses. On average, we would need to pay 1.9 thousand euros to maintain the utility of the unemployed as in the benchmark. As usual, the figures are larger for the worst-hit individuals.[39] Overall, the reform seems attractive, as the simulated financial

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

[39]The larger EV computed is slightly larger than 4 thousand euros. The biggest figures are observed at more

savings more than compensate for the welfare losses generated.

7 Conclusions

Both labor market conditions and institutional incentives are important to rationalize the reemployment and retirement patterns observed in the Spanish data. Our analysis clearly shows that the weak demand for workers of advance age is not the only force behind the small reemployment hazard of the unemployed of 55 years of age or more. This result is also a direct consequence of an institutional design that favors the non-participation of the unemployed over the costly alternative of job searching. The combination of generous Unemployment Benefits (for durations of up to two years), and substantial penalties for early retirement make staying unemployed without searching an optimal strategy for roughly one out of two of the unemployed in the age range 55/65.

Our simulation analysis suggests that a more satisfactory social outcome can be obtained by changing the pension rules applied to the unemployed. If their early retirement penalties were fixed according to the age when the individual effectively withdraws from the labor force (rather than when he/she claims the pension for the first time), the incentives to stay idle would be much smaller. That would be very effective in reducing non-participation and increasing labor supply, specially after the early retirement age. Furthermore, the combination of some extra contributions and some less pension/unemployment payments generate a relevant improvement in the financial condition of the Social Security. Our simulations indicates that this financial gain is more than enough to compensate for the welfare loss of those that suffer as a result of the reform. Therefore, a proper redistribution of the extra output generated by the reform will lead to an overall welfare improvement.

Needless to say, our conclusions are only strictly valid in the context of the specific model employed in our simulations. It is important, then, to bear in mind the limitations of our analysis and the dimensions for future potential improvements. Our partial equilibrium analysis, for instance, abstracts from the impact on prices of relatively large institutional reforms. 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 empirical performance of the model. In particular, the inclusion of more unobservable heterogeneity and the consideration of a process of wage offers whose mean will depend on the observable life-cycle wealth of the individual (ie. the pension rights) are specially interesting. We leave those improvements for future research.

advanced ages for workers with short or average duration in unemployment.

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APPENDIX

A Theoretical predictions of the model

In this section we review explore the theoretical predictions of the model in detail. In section A.1 we consider a simplified environment where illustrative analytical expressions can be derived for some particular ages. In section A.2 we reproduce the optimal decisions for the individuals in our benchmark case.

A.1 Optimal behaviour in a simplified environment

In this section we explore the optimal individual behaviour in the environment described in Section 3, but with the following additional assumptions: (1) the period utility is linear and additive $u = w+l$; (2) it is not possible to continue working after 65; (3) there are no floor/ceilings in the public regulations (like minimum pensions or maximum unemployment benefits) and (4) employees face no risk of being fired. In this setting the value functions are linear, which allows for a very illustrative discussion of the main forces involved.

A.1.1 Retirement vs. Non-participation at the age of 64

Consider first the options available to an unemployed worker of 64 years of age. Given our assumption of retirement with certainty at 65, it is clear that the only relevant alternatives are immediate retirement or staying in the labor force for one more year without searching (ie, to non-participate). The value of the latter option, is:

$$N_{64} = (b_{64} + l) + \beta_{64}\, A_{65}\, (B_{65} + l) = (b_h\, \pi + l) \; + \beta_{64}\, A_{65} \left(\hat{w} + \frac{\kappa_h\, \pi - \hat{w}}{D} + l \right) \tag{9}$$

with β_{64} standing for the one-period discount factor at age 64; b_{64} is the unemployment benefit currently available to the individual, B_{65} is the pension available in one year time when retiring at 65 (updated according to equation (2)); A_{65} is a short for A^T_{65} in Section 3.2, ie the expected present discounted value of one unit of income at every period after 65: $A_{65} = \sum_{i=65}^{T} \beta^{i-65}\, S(i \,|\, 65)$. In case of immediate retirement, the value function takes the form:

$$R_{64} = (B_{64} + l) + \beta_{64}\, A_{65}\, (B_{64} + l) = (\mu_{64}\, \hat{w} + l) + \beta_{64}\, A_{65}\, (\mu_{64}\, \hat{w} + l) \tag{9}$$

The two expressions above make clear that the non-participation decision is based on purely financial considerations (the value of leisure is similar in both pathways). By comparing them we get to:

$$\begin{aligned} N_{64} > R_{64} \quad &\Leftrightarrow \quad \beta_{64}\, A_{65}\, (B_{65} - B_{64}) > B_{64} - b_{64} \\ &\Leftrightarrow \quad \beta_{64}\, A_{65} \left(\hat{w} + \frac{\kappa_h\, \pi - \hat{w}}{D} - \mu_{64} \hat{w} \right) > \mu_{64}\, \hat{w} - b_h \pi \end{aligned} \tag{9}$$

Expression (9) makes apparent the rationality of choosing to non-participate by a large part of the Spanish unemployed of advanced age. In the most common situations, current pension

payments would exceed the unemployment benefits (the difference is the RHS of (9)) while the opposite would be true of future pensions (the term in brackets in the LHS of (9)). This is so because the gain from lower early-retirement penalties is normally larger than the loss implied by the dynamic updating inside $\hat{w}$. If that is the case, postponing retirement can lead to significant utility gains, as that the pension increase is enjoyed during the whole remaining lifespan of the individual (reflected by the factor A_{64} in the LHS). Overall, equation (9) rationalizes the optimality of staying in the labor force without searching if the discounted value of the future gains from a larger pension exceeds the associated losses in current income.[40] With the current Unemployment Benefit rules, only the long-term unemployed ($h \geq 3$) suffer significant reductions in current income and future pension rights. Consequently, it seems clear that (for moderate values of the discount factor), delaying retirement at 64 may be optimal for a majority of the unemployed with a duration of less than two years. $5(\beta_{64}\, A_{65}\, \kappa_h/D) > b_h$ (which guarantees

A second important insight from expression (9) is the essential role played by the pension rules in fostering non-participation. In particular, delaying retirement is more favorable in utility terms the *smaller* the value of μ_{64}, ie. the higher the early retirement penalty.[41] Large early retirement penalties make sense to stop the employees from leaving the labor force early. The fact that, precisely because they discourage retirement, they also push the unemployed into non-participation is an important unintended consequence of the design of this policy.

A.1.2 The job-acceptance decision of unemployed workers at 64

Unemployment rules and, more interestingly, pension regulations are also crucial for the job-acceptance decisions of the unemployed that intend to return to employment. To illustrate this point we explore the reservation wages of the unemployed in the simplified environment. Firstly, it is clear that the value of accepting a wage w at the age of 64, $\mathcal{E}_{64}$, is simply:

$$\mathcal{E}_{64} = w + \beta_{64}\, A_{65} \left(\hat{w} + \frac{w - \hat{w}}{D} + l \right)$$

The value of working at this age is linear in the wage and in the accrued pension rights. Direct comparison with the value functions of non-participant (A.1.1) and retirees (A.1.1) lead to the corresponding reservation wages (recall the definition in equation (9)):

$$\overline{w}_{64} = \frac{[b_h + \beta_{64}\, A_{65}\, \kappa_h/D]\pi + l}{1 + \beta_{64}\, A_{65}/D} \quad \text{if Non-Participation is optimal} \tag{10}$$

$$\overline{w}_{64} = \frac{\left[\, \mu_{64} + \beta_{64}\, A_{65} (\, \mu_{64} - (1 - \frac{1}{D})\,)\,\right]\hat{w} + l}{1 + \beta_{64}\, A_{65}/D} \quad \text{if Retirement is optimal} \tag{11}$$

The impact of public regulations is clear. When the opportunity cost of accepting a job offer is given by the value of non-participation, the willingness to take offers clearly depends on the

[40] With a non linear utility, elasticity/risk aversion considerations also play a role in the decision. Individuals with higher intertemporal elasticity of substitution (or a smaller degree of relative risk aversion) would not mind temporary drops in income in exchange for larger income gains in the future. Therefore, those workers would tend to non-participate rather than to early retire. Minimum/maximum pensions will also have a clear (and well known) impact, fostering earlier retirement.

[41] Conditional on a fixed replacement rate at the normal retirement age of 65.

generosity of Unemployment Benefits. This generosity manifests in two forms; as current income (controlled by b_h) or as differed income materialized in bigger future pensions (controlled by κ). When the best alternative to re-employment is immediate retirement (as in equation (11)), pension rules take over as the relevant public institutions. In both cases, more generous rules will make unemployed workers more selective when accepting re-employment offers.

A.1.3 Optimal Search behaviour at the age of 63

At the age of 63, unemployed workers may search during one period to be entitled to the option of receiving a job offer in the next period. The value function in this case reflects a trade-off between the immediate cost of searching and the value derived from the chances of getting a good job offer in the next period:

$$S_{63} = b_h\pi + l^s + \beta_{63}\left[U_{64}(\hat{w}', h)(1 - \lambda_{h'}\overline{F}_{\overline{w}_{64}}) + \lambda_h \int_{\overline{w}_{64}}^{\infty} W_{64}(w, \hat{w}')\, dF_w\right] \tag{11}$$

where $\hat{w}'$ is updated as in equation (4) and $\overline{F}(x)$ stands for $1 - F(x)$.

Note that this expression is a particular case of the value of searching discussed in Section 3.2.2. The alternatives to search are either staying in the labor force without searching or outright retirement. We review them in turn, starting with the former. The value of staying in the labor force without searching is:

$$N_{63} = (b_h\pi + l) \; + \beta_{63}\, U_{64}(\hat{w}', h)$$

With a little algebra, we can characterize the optimal searching behavior (vis a vis the alternative of non-participation) by the following condition:

$$S_{63} - N_{63} > 0 \Leftrightarrow \beta_{63}\,\lambda_{h'}\left[1 + \beta_{63}\,A_{65}\frac{1}{D}\right]\int_{\overline{w}_{64}}^{\infty}(w - \overline{w}_{64})\, dF_w > l - l^s \tag{11}$$

In words, it is optimal to search when the expected benefits (LHS) exceed the immediate costs (RHS) , materialized in the different enjoyment of time in both situations. The (potential) future benefits of returning to work also include two aspects: an improvement in immediate income at 64 and, through its effect on the pension rights, a boosts to future pension income. These two effects can be easily identified in the two terms inside the brackets of the expression in the left hand side of $(A.1.3)$.

Condition $(A.1.3)$ highlights the importance of labor market conditions on the self-selection of the unemployed into non-participation: it is rational not to engage in a search process for those unemployed workers with weak re-employment prospects (ie. with low probability of receiving an acceptable offer). It also makes clear that the design of both the Unemployment Benefits and the Pension System can help to keep the unemployed away of the labor market, through its impact on the value of search. Note that this value is decreasing in the future reservation wage which, in turn, is increasing in the generosity of the public institutions (as documented in Section A.1.2 above).

If the alternative of outright retirement is more valuable than non-participation the trade-off faced by the individual is roughly similar to that discussed in Section A.1.1: a choice between the immediate income/leisure gains of retirement versus the prospect of better future income of searching. Formally, the difference in value between retiring and searching at the age of 63 is:

$$R_{63}-S_{63}>0 \Leftrightarrow \mu_{63}\,\hat{w}+l-b_h\,\pi-l^s+\beta[\,\mu_{63}\,\hat{w}+l-E(I_{64})-E(l_{64})\,]+\beta^2\,A_{65}\,[\,B_{63}-E\,(B_{65}(\hat{w}_{65}))\,]>0$$

with expected future income, $E(I_{64})$, leisure, $E(l_{64})$, and pensions, $E(B_{65}(\hat{w}_{65}))$:

$$\begin{array}{ll} E(I_{64})= & (1-\lambda_h\,\overline{F}_{\overline{w}_4})(b_{h+1}\,\pi)+\lambda_h\int_{\overline{w}_{64}}^{\infty} w\,dF_w \\ E(l_{64})= & (1-\lambda_h\,\overline{F}_{\overline{w}_4})\,l \\ E(B_{65}(\hat{w}_{65}))= & \hat{w}+\frac{\kappa_h\,\pi-\hat{w}}{D}(1-\frac{1}{D})+ \\ & (1-\lambda_{h+1}\,\overline{F}_{\overline{w}_4})\frac{\kappa_{h+1}\,\pi-\hat{w}}{D}+\lambda_{h+1}\int_{\overline{w}_{64}}^{\infty}\frac{w-\hat{w}}{D}\,dF \end{array}$$

Here the higher future income comes from two sources: from the reduction in early retirement penalties and (in contrast with the situation at 64) from the possibility of receiving a good job offer, which would increase future labor income and pensions. The current costs of staying active, however, are increased by the need of incurring the search cost. Overall, better market conditions would again make searching more attractive and would foster later retirement.

A.1.4 The job-acceptance decision of unemployed workers at 63

To conclude the review of the impact of the labor market conditions on individual behavior we must mention its effect on the job-acceptance decisions of the unemployed who opted for searching at the age of 63. Note that the more general environment faced at the age of 63 adds nothing of substance to the discussion of Non-Participation versus Retirement in Section A.1.1 and to the discussion of reservation wages against the alternatives of retirement or non-participation in Section A.1.2. The value of reentering the labor force with wage w at 63 is:

$$W_{63}=w+\beta_{63}\,w+\beta_{64}\,A_{65}\left[\hat{w}\,\left(\frac{D-1}{D}\right)^2+\frac{w}{D}\left(1+\frac{D-1}{D}\right)+l\right]$$

where we can appreciate the impact of the two extra working years (63 and 64) in the final value of pension rights. It is easy to obtain an expression for the reservation wage when combined with the value of S_{63} in expression (A.1.3):

$$\overline{w}_{63}=\left[1+\beta_{63}+\beta_{64}\,A_{65}\,\frac{1}{D}\,\left(1+\frac{D-1}{D}\right)\right]^{-1}\,\left[S_{63}-\beta_{64}\,A_{65}\,\left(\hat{w}\,\left(\frac{D-1}{D}\right)^2-l\right)\right]$$

As one may expect, good prospects of future job-offers (summarized in a high value of searching S_{63}) may lead workers to turn down a low wage offer currently available. Of course, the empirical importance of this possibility at such advanced ages may be rather small.

A.2 Optimal policy functions and reservation wages in the full model

In this section we reproduce the optimal individual decisions in the benchmark calibration and some selected properties of the associated reservation wages. Each array below 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:

$$\Pi = \{3.9, 6.7, 10.1, 13.7, 17.9, 22.2, 25.7, 30.2\} \quad \hat{W} = \{5.9, 8.6, 11.4, 14.4, 17.6, 20.2, 23.2, 26.1\}$$

All values are in thousand of Euros of 2002. The decision displayed in the cell defined by the i-row and j-column, $d_{i,j}$, is the optimal behaviour for the individual whose previous wage is the i-th element of Π and whose pension rights is 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.

The properties of the reservation wages (figures 14 to 16) are discussed in section 4.2.

```
h =      1
            56          58          60          62          64        65
        11111111|111NNNNN|11N00000|1N000000|1N000000|10000000
        11111111|111NNNNN|11N00000|1N000000|1N000000|10000000
        11111111|111NNNNN|11NN0000|1NN00000|1N000000|N0000000
        11111111|1111NNNN|111NNN00|11NN0000|1NN00000|1N000000
        11111111|1111NNNN|111NNNNN|11NNNN00|1NNNN000|1NN00000
        11111111|1111NNNN|111NNNNN|11NNNNN0|1NNNN000|1NNN0000
        11111111|1111NNNN|111NNNNN|1NNNNNN0|1NNNN000|NNNN0000
        11111111|1111NNNN|11NNNNNN|1NNNNNN0|NNNNN000|NNNN0000

h =      2

            56          58          60          62          64        65
        11111111|1111NNNN|11N00000|1N000000|1N000000|N0000000
        11111111|1111NNNN|11N00000|1N000000|1N000000|N0000000
        11111111|1111NNNN|11NN0000|1NN00000|1N000000|N0000000
        11111111|11111111|111NN000|11NN0000|1NN00000|1N000000
        11111111|11111111|111NNNN0|11NNN000|1NNN0000|1NN00000
        11111111|11111111|1111NNNN|11NNNNN0|1NNNN000|1NNN0000
        11111111|11111111|111NNNNN|11NNNNN0|1NNNN000|1NNN0000
        11111111|11111111|111NNNNN|11NNNNN0|1NNNN000|1NNN0000

h =      3

            56          58          60          62          64        65
        111NNNNN|N1NNNNNN|0N000000|00000000|00000000|00000000
        111NNNNN|N1NNNNNN|0N000000|00000000|00000000|00000000
        111NNNNN|N1NNNNNN|0N000000|00000000|00000000|00000000
        111NNNNN|N1NNNNNN|0N000000|00000000|00000000|00000000
        111NNNNN|N1NNNNNN|0N000000|00000000|00000000|00000000
        111NNNNN|N1NNNNNN|0N000000|00000000|00000000|00000000
        111NNNNN|N1NNNNNN|0N000000|00000000|00000000|00000000
        111NNNNN|N1NNNNNN|0N000000|00000000|00000000|00000000
```

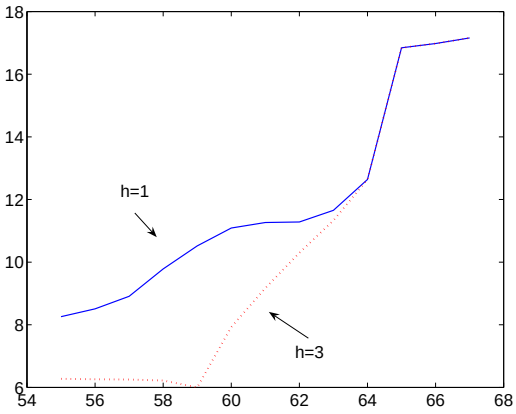

Figure 14: Reservation wage by age conditional on duration (for average π and $\hat{w}$).

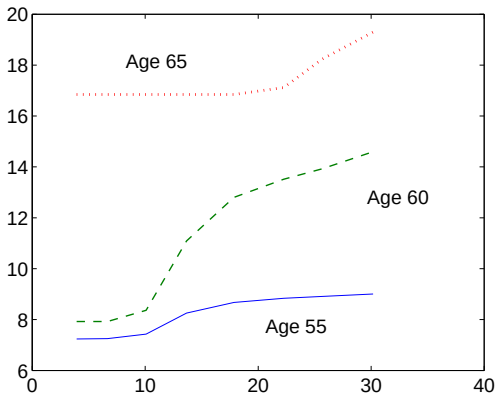

Figure 15: Reservation wage by π conditional on age (for h=1 and average $\hat{w}$).

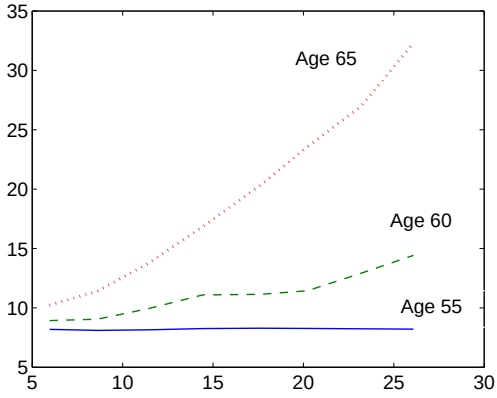

Figure 16: Reservation wage by $\hat{w}$ conditional on age (for h=1 and average π).

B Numerical methods and procedures

B.1 Numerical representation of the Value Functions

There are no analytical solutions to the functional equations characterizing the optimal individual behaviour. Consequently, we employ numerical methods to compute the optimal retirement and search decisions, to calculate the value functions and to explore the basic properties of the solutions.

Including two continuous states, the value functions are infinite dimensional objects and can only be reproduced in the computer approximately. The use of some numerical approximation method is, then, unavoidable. In particular, we:

- Discretize the continuos state variables when computing the value functions.

  Thus, we build an uniform grid in the State Space $\Pi \times \hat{W}$ (see Appendix A.2). N is the number of nodes in the grid. In each iteration $a = \{55, \ldots, 65\}$ we compute:

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

- We use linear interpolation whenever a value function is evaluated outside the grid. For example, to compute the reservation wage of an unemployed worker in state $(\pi, \hat{w}, h, a)$ we have to evaluate $W_a(w, \hat{w})$ for any value of w (and not just $w \in \Pi$. We also have to repeatedly evaluate the future value of staying unemployed with pension rights that do not exactly match the values in the grid.

  We use linear interpolation because, despite being more time consuming than other higher order approximation schemes, it guarantees that the shape of the value function is preserved.

B.2 Design of the aggregate simulations

The basic idea is simply to compare the model predictions in term of the generated transition *flows* across labor states with their empirical counterparts, taking the *stocks* (ie. the initial distribution across labor states) as given.[42] To implement this simple concept we undertake a simplified Monte-Carlo experiment involving the following steps:

1. Create a large sample of individuals reproducing the empirical distribution of labor states by $\{a, \pi, \hat{w}, h\}$:

$$\mu(\pi, \hat{w}, a, h) \quad a \in \{50, \ldots, 65\} \quad h \in \{1, \ldots, 3\} \quad \pi \in \Pi \quad \hat{w} \in \hat{W}$$

2. Simulate the arrival of job offers and the size of the wage proposed, according with the parametric functions included in our model.

3. Let the individual in the simulated sample react to the job offers (and to the alternative of retiring from the labor force) in accordance with the model policy functions. Keep records of the job acceptances and retirement decisions.

4. Aggregate the decisions, compute the implicit re-employment and retirement hazards and compare with empirical counterparts.

[42] Note that the model also generates predictions in terms of stocks, but we abstract from them at this stage.

B.3 Pension financial cost

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

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

$$PC_N^R(\hat{w}) = \sum_{i=t}^{T} \left(\frac{1}{1+d}\right)^{i-60} S_t(i)\, B(\hat{w}, N) = B(\hat{w}, t)\, A_{N,\,60}^T \tag{11}$$

  We use the same notation as in Section 3.1. In particular, $A_{N,\,60}^T$ is a special case of A_i^j in Section 3.2, ie. the expected present discounted value of one unit of income received in every period of the age range $\{i, \ldots, j\}$. The difference here is that we discount to age 60 rather than to age i.

- For individuals observed at the age N-1, the cost associated with retirement, $PC_{N-1}^R(\hat{w})$ responds to a expression entirely similar to (B.3). For individuals who stay employed at that age, the implicit cost reflects the contributions paid throughout the year and the change in the accrued pension rights:

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

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

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

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

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

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

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

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

$$
\begin{array}{rcc}
PC_t^U(x) = & b(\pi,h)\,A_t^t + & \text{U benefit in t} \\
& +S_t(t+1)\,I_{t+1}(S|x)\,P_t^E(x)\,E_w[PC_{t+1}^E(w,\hat{w}')] + & \text{Successful search} \\
& +S_t(t+1)\,I_{t+1}(S|x)\,(1-P_t^E(x))\,C_{t+1}^U(x') + & \text{Unsuccesful search} \\
& +S_t(t+1)\,I_{t+1}(NS|x)\,C_{t+1}^U(x') & \text{Inactivity}
\end{array}
$$

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

$$
C_{t+1}^U(x') = I_{t+1}(R|\pi,\hat{w}',h+1)\,PC_{t+1}^R(\hat{w}') + I_{t+1}(U|\pi,\hat{w}',h+1)\,PC_{t+1}^U(\pi,\hat{w}',h+1)
$$

which includes the impact of the retirement option.

B.4 Equivalent Variation

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

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

We follow the same notation as in section 3.2. Alternatively, if searching is the optimal decision, the implicit definition is:

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

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

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

C Calibration and Sensitivity Analysis

C.1 Calibration

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

1. We define a range of variation for each unobservable parameter:

   Preferences: $r \in [0.05, 0.1]$, $\eta \in [2,4]$, $l \in [0.1, 0.5]$, $l^s \in [0.0, 0.3]$.

   Labor Market: $\lambda \in [0.5, 0.8]$, $h \in [0.6, 0.8]$, $\mu \in [6, 10]$, $\sigma \in [4, 5]$

We create a "central" grid made of all the possible combinations of the parameters (r, l, l^s, λ, h) and the central values of the other three parameters (η, μ, σ). We then generate grids with all possible extreme values of the latter three parameters. For example, we consider a "low μ" grid with the same variation in r, l, l^s, λ and h as in the "central", the same central values of η, σ and the lowest possible value of μ. (These grids coincides with the different economies presented in Table 3).

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

3. We compute the prediction error in each node: the differences between the observed hazards and reentry wages by age and the theoretical predictions.[43] We get one overall error number by averaging (with equal weights) the errors by age in the three empirical dimensions.

4. We find several groups of economies that can approximate the overall empirical performance relatively well. Among those economies, we choose as our benchmark the one that we find more illustrative according with two criteria: (1) we avoid economies which produce systematic errors (ie those that, despite having good *average* properties, systematically under/over predict in at least one dimension); and (2) we avoid economies whose parameters are in open disagreement with the estimations available in the literature.

C.2 Sensitivity

In our benchmark case, it is possible to reduce the extend of voluntary non-participation by changing the early retirement penalties of the unemployed (Section 6.3.3). This change reduces the average pension liabilities (Net Pension Cost, NPC, of the individuals in our sample) by 6.8 thousand euros, making it possible to compensate the welfare losses of the workers affected (evaluated at 1.78 thousand euros in average). Therefore, the difference between the average financial savings generated by the reform and the average transfer needed to keep welfare constant adds up to a comforting cushion of 5.0 thousand euros. In this section we explore whether this positive evaluation of the main reform proposal of the paper is robust to the particular parameter values used in our numerical experiment. To test this robustness we proceed in two steps. First, we select among all the economies simulated for the calibration of the paper (Appendix C.1), those that are "empirically relevant". By this we mean that the average differences between the predicted reemployment hazard, retirement hazard and average wages and their empirical counterparts (ie, the *err* defined in equation (12)) are within certain bounds.[44] We limit our exploration of the impact of the reform to those empirically relevant economies. In the second step, we repeat our main experiment in each of the selected alternative economies. The results obtained are presented in Table 3.

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

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

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

$$err = \left[\sum_a err_a^2\right]^{1/2} \tag{12}$$

[44] The thresholds implemented for the results presented in Table 3 are 0.22, 0.15 and 0.3 in, respectively, retirement hazard, reemployment hazard and average accepted wages.

Name of Experiment	Num. Ecos	Empirically relevant	NPC	NPC_R	Financial savings	EV	Slack
Base			144.9	137.5	7.4	1.86	5.5
Central	324	29	145.4	138.6	6.8	1.78	5.0
			(4.1)	(4.1)	(.68)	(.10)	(.64)
"Low μ"	324	14	151.1	145.2	5.9	1.84	4.1
			(1.1)	(1.2)	(.38)	(.11)	(.31)
"Low μ"	324	20	144.3	137.2	7.1	1.70	5.4
			(2.7)	(2.7)	(.66)	(.10)	(.61)
"High η"	324	17	146.2	142.1	4.1	1.96	2.2
			(1.3)	(1.1)	(.50)	(.14)	(.47)
"Low σ"	324	29	144.9	138.3	6.6	1.79	4.8
			(3.7)	(3.4)	(.80)	(.10)	(.77)
"Low σ"	324	28	146.2	139.2	7.0	1.77	5.2
			(3.2)	(3.5)	(.65)	(.10)	(.63)

Table 3: Sensitivity analysis. NPC=Net Pension Cost; NPC_R=Net Pension Cost in the reformed economy; Financial savings= NPC_R-NPC; EV=Welfare cost measured by the Equivalent variation generated by the reform; Slack=Financial savings-EV. The definition of the *empirically relevant* economies is provided in the text. Values in brackets are the standard deviations in each particular experiment.

To present the results, we assemble the simulations in seven groups.[45] The group labeled "Central" consists of 324 economies in which r, l, l^s, λ and h vary within the limits indicated in Appendix C.1 above, while η, μ, and σ are fixed at the same (central) values used in the benchmark. The other groups are obtained by changing the latter parameters, one at a time. For example, the group of economies labeled "low μ" feature the lowest posible valued considered for μ in Appendix C.1, together with the same variation in r, l, l^s, λ and h and the same fixed values for η and σ. The table provides the number of economies simulated in each group, the number of empirically relevant economies found and the mean and standard deviation (in brackets) of the main statistics in our experiment: the Net Pension Cost in the Status Quo (NPC) and after the reform (NPC_R); the difference between the two (ie, the financial savings generated by the reform); the Equivalent Variation associated with the reform and, finally, the difference between the financial savings and the EV (called the "slack" generated by the reform). This slack represents the buffer stock of extra financial savings generated by the reform even after workers are compensated to the point that none of the unemployed in our sample suffers a welfare loss. The results strongly confirms our findings in the benchmark case. The reform generates a positive "slack" in all our empirically relevant simulations. The minimum "slack" observed is above one thousand euros, and the average values are only slightly below the 5.5 thousands in the benchmark case. This result reflects similar estimations of both the financial savings and the EV generated by the reform across the simulations. The group of economies with a higher level of risk aversion ("High η") presents the behavior that is more at odds with that in our benchmark. In this group, the compensation needed after the reform is larger (almost 2 thousand euros versus 1.78 in the benchmark) and the savings in financial liabilities smaller (as individuals are more reluctant to reenter the labor force after the reform than in the other environments). Still, the average slack is well above two thousand euros.

[45] Only 6 groups are reported in Table 3 because we cannot find any empirically plausible economy when we assume a low value of η.