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# The Pre-Retirement Job Search: A Basic Explanation of the Older Worker Employment

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# The Pre-Retirement Job Search: A Basic Explanation of the Older Worker Employment

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**Abstract**

This paper presents a theoretical foundation and empirical evidence in favor of the view that the retirement age decision impacts on the search intensity of older workers before this age. Countries with a retirement age at 60 are indeed characterized by lower employment rates for workers aged 55-59. Based on the French Labor Force Survey, we show that the likelihood of employment is significantly affected by the distance from retirement, in addition to age and other relevant variables. We then extend McCall's (1970) job search model by explicitly integrating life-cycle features and the retirement decision. Using simulations, we show that the distance effect in conjunction with the generosity of unemployment benefits for older workers explains the low rate of employment just before the eligibility retirement age. Finally, we show that implementing actuarially-fair schemes, not only extends the retirement age, but also encourages a more intensive job-search by older unemployed workers.

Keywords: Job Search, Older Workers, Retirement

JEL Codes: J22, J26, H55

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# 1 Introduction

Prolonged ageing jeopardizes the sustainability of Pay-As-You-Go (PAYG) systems. Faced with this changing demographic trend, most developed countries have chosen to encourage the elderly to delay retirement by rewarding a longer working life with more actuarially-fair pensions. However, especially in some European countries, such a strategy is weakened by the fact that a significant proportion of older workers are actually unemployed or entitled to specific assistance programs long before the current age at which benefits are first available. One often alleged reason is that technical progress makes older workers less employable[1]. Hence, trying to increase the rate of employment of older workers seems to be an unattainable goal in a context where jobs available for them are scarce.

In this paper, we put forward the idea that the existence of a retirement date intrinsically creates a decrease in the employment rate just before this age. The observed low employment rate of near-to-retirement people then cannot be considered as a reason for not postponing the age of retirement. The reasoning is completely reversed: retirement postponement is actually likely to increase the employment rate of these workers, thereby contradicting the widespread view that the low employment rate of older workers makes any extension of the retirement age pointless.

The distance effect has been already explicitly identified by Seater (1977) who theoretically stresses, in a life-cycle labor supply model, that the job search is age-dependent.[2] More recently, also using a labor supply approach, Ljunqvist & Sargent (2005) quantitatively show that the elasticity of the job search intensity to unemployment benefits is greater for older workers, leading to the view that the impact of labor market institutions can be age-dependent. But they only mention in passing the distance to retirement effect, and even less do they aim at quantifying its contribution to the low employment rate of the seniors. This paper fills this gap by identifying the contribution of the distance effect in the data and disentangling the impact of the distance effect versus unemployment benefits in a calibrated search model. We want to provide convincing evidence that the distance effect, more than a theoretical curiosity, constitutes a front-rank explanation of the observed decrease in the employment rate of older workers prior to the retirement age, challenging the prevalence of the skills obsolescence and specific assistance program effects at the end of working life. We think that it constitutes a basic explanation of the older worker employment.

This provides an original interpretation of the high differential observed across countries in terms of older worker employment before the retirement age, typically between the ages of 55 and 59. In countries with a retirement age of around 60 (Belgium, France, Italy, the Netherlands), the employment rates of 55 - 59 year-old workers are the lowest in OECD countries. In contrast, Japan, and to a lesser extent, Sweden, the US, Great Britain and Canada are characterized by the highest retirement ages and employment rates between the ages of 55-59. This suggests that the retirement age affects the employ-

[1] It is however a debated issue (Crépon et al. (2002), Hellerstein et al. (1999), Friedberg (2003), Aubert et al. (2006)).

[2] Bettendorf & Broer (2003) extend this view to a matching model *à la* Pissarides.

ment rate of older workers prior to this age. However, the existence of unemployment and disability programs for older workers in the first group of countries could dismiss this idea. These programs are often considered as an early retirement device before the official social security eligibility retirement age (Gruber & Wise (1999), Blondal & Scarpetta (1998)). They indeed correspond to an inactivity spell until retirement occurs. >From our point of view, this situation must be distinguished from retirement stricto sensu[3] and viewed as a (non-)search decision of non-employed workers. Of course, the high generosity of these programs could amplify the retirement age feedback effect by giving unemployed people the means to wait for retirement without searching for a job. This is why a low retirement age associated with a generous of old age unemployment benefits could explain the low employment rate of old workers that prevails in some European countries such as Belgium, France or Italy.

However, this interpretation must be considered with caution, in particular because there could be a reverse causation from unemployment to retirement. The status on the labor market could affect retirement choices. In order to provide a better identification of the distance effect, we focus on a country where the retirement age is quite independent of the current labor market status, because it depends only on the old age pension formula. France is a natural candidate. We then use the heterogeneity in terms of distance to full pension age at the individual level. We estimate a logit model on individual panel data (French Labor Force Survey) that measures how the distance to full pension age affects male employment probabilities. It appears that the shorter the distance to retirement, the lower the probability of being employed.

In order to highlight the economic mechanisms behind this result, we develop a modified version of McCall's (1970) model, in which unemployed workers look for a new job and choose an optimal search intensity which will influence the average length of unemployment spells. Beyond the heterogeneity arising from the wage offer distribution, life cycle features are also considered. Following Ljunqvist & Sargent (2005), agents age stochastically. In addition, retirement choice is endogenous. Our streamlined model must be considered as a first attempt to model the interaction between retirement decisions and employment issues at the end of the working life. In particular, it is clearly beyond the scope of the paper to explain the overall retirement age distribution. Especially, unlike Benitez Silva (2003), we leave aside the interaction of the job search with health and wealth considerations.[4] Our originality is to investigate how the retirement decision, mainly driven by the tax on continued activity imposed by the Social Security provisions, impacts on the search behavior. The relative value of retirement compared to employment determines the job value for unemployed older workers. Our main contribution is then to quantify the importance of this distance effect in the observed decrease in the employment rate prior to the retirement age by calibrating the model and simulating some counterfactual experiments. Surprisingly enough, it appears that the distance effect plays a key role *in conjunction with* the generosity of unemployment benefits for older workers.

[3] In the sequel, the term "retirement" will be used with this strict meaning.

[4] See Bettendorf & Broer (2003) for another search model with savings. However, with perfect insurance, they impose strong restrictions on search decisions.

We then illustrate the feedback effect by studying the impact of a social security reform, which removes the tax on continued activity by rewarding a longer working life with an actuarially-fair increase in pension. We show that such a policy does yield a double dividend: *(i)* workers are encouraged to delay retirement, which is the usual expected gain from this measure *(ii)* more unemployed older individuals are now willing to look for a job and accept job offers.

Our paper is organized as follows. We first investigate the empirical relevance of our intuition (Section 2). We then present our theoretical framework (Section 3). After a careful calibration, we propose a quantitative evaluation of the tax on continued activity and its consequences on employment for near-to-retirement workers (Section 4) along with a robustness analysis (Section 5). Finally, in Section 6, we evaluate the effect of introducing more actuarially-fair pension adjustments.

# 2 Some Empirical Evidence

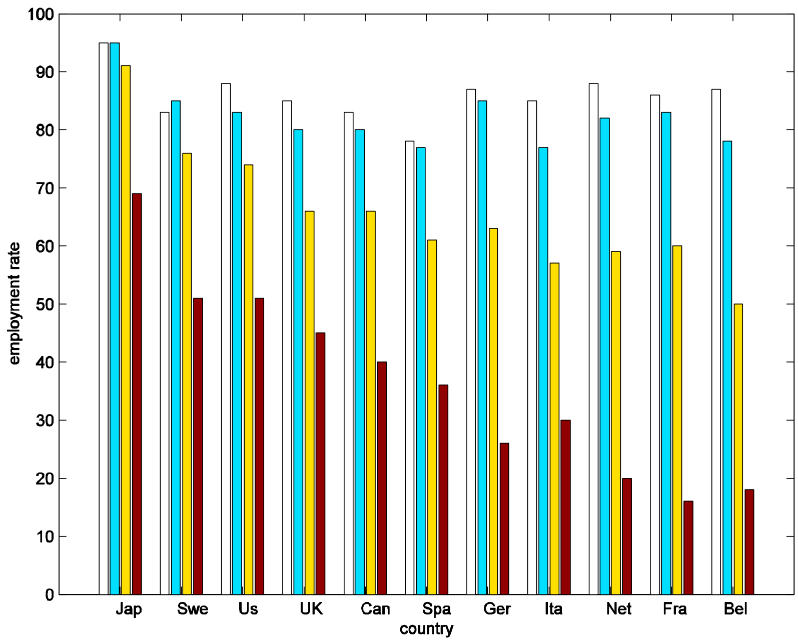
In this section, we present empirical evidence in favor of the view that there is a feedback effect of the distance to retirement on the employment rate of older workers. This is not the biological age (its absolute level) that matters for explaining the employment rate of older workers, but what can be called the social age (the age relative to the retirement age).

## 2.1 A macroeconomic overview: a preliminary step

We first rely on OECD macroeconomic data to stress the feedback effect of the retirement age on the employment rate just prior to retirement. More specifically, we consider the country panel, studied in Gruber & Wise (1999), for which homogeneous information is available on the retirement age and the social security system.

In each country, each bar refers to the employment of age groups (Figure 1): 30 - 49 (first bar on the left), 50 - 54, 55 - 59 and 60 - 64 (last bar on the right). The profile of employment rates is clearly decreasing with age. However, and more interestingly, the speed of this decrease markedly differs across countries. Two country groups emerges very clearly: those with still high employment rates for workers aged 55-59 (Canada, Great Britain, Japan, the United States and Sweden) and those which already experience a huge decrease (around 25 points) at these ages (Belgium, France, Italy and the Netherlands). The difference from the group aged 50-54 is only of ten points on average for the former, whereas it increases by up to 25 points for the latter. How can we explain this result? Should we invoke technological bias or productivity and labor cost differentials? There are no serious reasons to believe that the 55-59 year old workers in the latter countries are more particularly sensitive to these factors. Disability and unemployment programs could be more serious candidates for explaining the observed differential, but several factors seem to invalidate this explanation. First, some countries in the first group, for instance Great Britain, have also been involved in such programs. Secondly, and more fundamentally, we

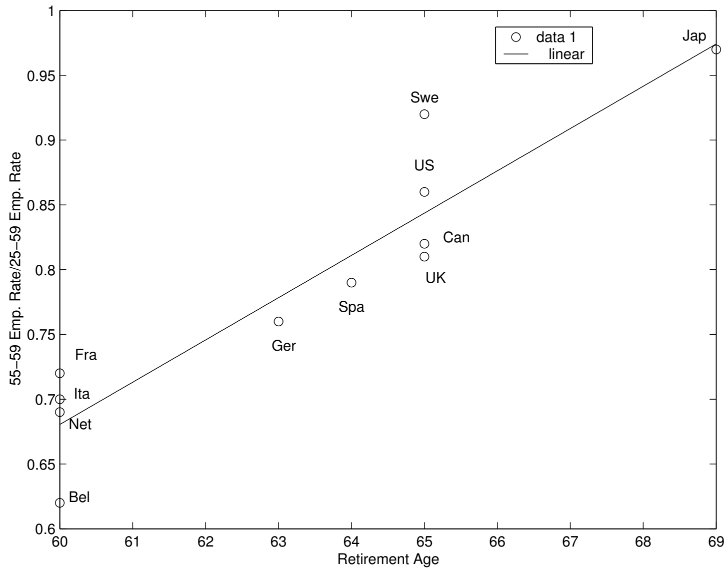
Figure 1: Employment Rate by Age (Men, OECD Labor Force Data, 1990-1995)




think that these latter and their strength are endogenous with respect to the retirement age. The participation of individuals to these programs is largely dependent on their horizon before the retirement age. This last point will be clarified by the use of individual data, but let us first consider recent French employment history that is quite illustrative. In the seventies, when the retirement age was still at 65, specific income programs were available only to people aged 60-64. These programs refer to specific allowances given to old workers until retirement (see Blanchet & Pelé (1997) for further details). The lowering of the eligibility retirement age to 60 in 1983 implies that their eligibility age has been decreased to 55. This is why it is possible to consider the retirement age as the crucial variable which explains the observed differential in the employment rate for workers aged 55-59.

As documented by Gruber & Wise (1999), the second group of countries is indeed characterized by an effective retirement age of 60 (versus 65 in the first group). The significant decrease in the employment rate would occur when the retirement age gets sufficiently close. Figure 2 plots the scattered employment rate of older workers aged (55 - 59) relative to the overall employment rate for those aged 25 - 59 against the retirement age, calculated for our country panel in Gruber & Wise (1999), in 1995. This linear regression suggests in another way that the later the retirement age, the higher the employment of older workers before 60: the employment rate of workers aged 55-59 is particularly low in countries where retirement occurs as early as 60. The retirement age heterogeneity across countries could help explain the observed employment rate profiles

Figure 2: Older Worker Employment Rate and Retirement Age (Men, OECD, 1990-1995)




by age. Where does this heterogeneity come from? Gruber & Wise (1999) stressed the differences in early retirement ages and especially, in implicit taxes on continued activity after the age. Early retirements occur when social security wealth accrual significantly gets negative implying a high tax on continued activity after a given age: this is mostly due to the fact that the pension does not reward additional working years. In the US, the tax is essentially zero at the eligibility retirement age, whereas it is close to 70% in France and about 40% in Germany (Gruber & Wise (1999)). This explains why in France and Germany the departure rate at the social security eligibility retirement age is approximately 80% whereas it is only about 25% in the US.

## 2.2 Microdata on French workers

In this section, we measure the feedback effect of the retirement age on employment odds using individual data. Our intuition is that as individuals get closer to their pension age, they are less likely to be employed. The use of individual data enables us to control for the potential influence of specific income programs, which was not allowed by macroeconomic data. The distance to retirement is captured by the difference between the current age and the expected retirement age.

We investigate the magnitude of the distance effect by looking at French Data. Indeed, the French pension system allows to define a retirement age that can be considered as exogenous to the individuals' labor market status. The expected retirement age primarily depends on the number of contributive quarters. Unemployment spells are included in the number of contributive quarters. Moreover, the huge tax on continued activity that prevailed in the French pension system prior to the 2003 reform gave individuals strong incentives to retire as soon as they accumulated the required number of contributive years. Then, we protect ourselves against the risk of misinterpreting a reverse causation from unemployment to retirement.

### 2.2.1 Data and Empirical Strategy

The retirement age is computed by adding to the age at the first job the required number of contributive years to draw full pension. As stressed by Blanchet & Pelé (1997), in France there are no incentives to delay retirement after the full pension age as no pension adjustments are made for any additional working year[5]. However, if a person enters the job market at a very young age, she cannot retire before the eligibility retirement age (60 years old) even though she has accumulated the required number of contributive quarters before this age. In this case, the expected retirement age is then set to 60. Finally, we take into account the fact that individuals aged 65 are forced to retire whatever their number of contributive years.

As people start working at different ages, the retirement age is an heterogenous individual characteristic, even though a large number of workers have already reached their full pension eligibility at the age of 60. Obviously, our proxy for the retirement age does not take into account incomplete careers. However, we believe that our proxy remains relevant as, in the French system, unemployment episodes are included in the number of contributive quarters. In addition, non-continuous careers due to maternity leaves and family matters could indeed make our proxy less accurate. To avoid this bias, we measure the impact of the retirement age only on *male* employment.

We estimate a logit model that measures how the distance to retirement age affects the chance of being employed. Estimating an unemployment duration model could be judged more appropriate. But focusing only on unemployed people is too restrictive as non-employed older people are mainly outside the labor force, entitled to specific income programs. The dependent variable is the male probability of employment. It is coded as 1 when working, 0 otherwise, meaning unemployed or inactive (but not yet retired). The estimate is based on 8 successive waves of the LFS (from 1995 through 2002). The Balladur reform in 1993 gradually increased the required number of contributive quarters to reach the full rate. The required number of contributive quarters before retirement amounts to 150 quarters for individuals born in 1933 or earlier, while the 1934 generation needs to contribute 151 quarters to Social Security, the 1935 generation 152 quarters , ... and individuals born in 1943 or later 160 quarters. This transition is taken into account when computing the retirement age. Considering data in the post reform era allows to include in our sample individuals with heterogeneous distances to retirement. It ensures a robust identification of the distance effect.

A third of the LFS sample is replaced each year. As a consequence, the LFS allows us to follow the same individual for only 3 consecutive years. Our sample is an unbalanced panel, which allows us to check the robustness of our results against events that are specific to each year, such as macroeconomic fluctuations. We implement a random effect

[5] This is why the expression "full pension" is used.

logit model which takes advantage of the multi-period nature of the data and controls for unobserved individual heterogeneity. Error terms then consist of random individual specific effects and unobserved individual characteristics that vary with time. A Hausman test confirms that a random effect logit is preferable to a fixed effect model.

Tables 10 - 13 in Appendix A display the descriptive statistics of our sample. We consider variables that are widely used as key determinants in the understanding of employment probabilities: age, age squared, marital status, number of children, size of city, sector, citizenship and occupational group. We add to these standard characteristics the number of years left before retirement. In the descriptive statistics, to summarize the impact of expected retirement on employment probabilities, distance to retirement is presented in dummies (more than 11 years, 6 to 10 years, 3 to 5 years and less than 2 years).

Table 10 displays the expected number of years before retirement as a function of age for individuals of age 50 and older. Obviously, the vast majority of individuals of 58 and 59 (of 55-57) have to wait for less than two years (between 3 and 5 years) before retiring. These statistics are consistent with the fact that the vast majority of French workers retire at the age of 60 (see Blanchet & Pelé (1997)), but, due to the 1993 reform, which has increased the required number of contributive quarters, they show some heterogeneity. The first lines of Table 11 suggest that the number of years before retirement does affect employment probabilities: employment odds shorten as the individual gets closer to retirement. 63% of individuals who have to wait for less 3 - 5 years before drawing full pension are still working while this proportion goes down to 35% for those who are 2 years away from retirement.

### 2.2.2 Estimation results

We adopt a two-step approach. We measure the effect of conventional explanatory variables (age, education, sector, ...) on male employment probability before adding the distance to retirement in the estimated equation.

The estimated coefficients of the model including only traditional variables without distance are displayed in Table 1. The reference individual is a French, blue-collar individual working in the industry, living with his spouse in the Paris area. He has no children. As far as standard characteristics are concerned, the estimates yield significant and expected results: higher skills (captured by the occupational group) and living in the Paris area increase employment probabilities. Activities in the service sector and French citizenship also improve employment odds. Family characteristics affect employment status: compared with the reference individual, not having a spouse (respectively having 6 children or more) tends to reduce employment odds by roughly 60% [6] (respectively by 32%). Notice that the coefficients on age is positive and negative on the quadratic term, thereby capturing the positive effect of age (as a proxy for experience) and the negative impact of human capital depreciation with age (quadratic term) on employment odds.

[6] $1 - e^{-0.923}$

We added to the standard explanatory variables specific dummies on age (from the age of 50 to 59). $age = k$ means that the dummy equals 1 if the individual is $k$ years old, 0 otherwise. These variables capture the eligibility to programs specific to old workers, allowing them to withdraw from the labor force before the age of 60. From the age of 54 to 59, dummy variables appear negative and significant, which could be interpreted as the effect of the declining human capital (specific to workers in their 50s) and especially, given the age thresholds, the old worker specific programs.

Table 2 reports estimation results when we introduce an additional explanatory variable that is distance to retirement. In order to save space, estimates on control variables are displayed in another table (Table 14 in Appendix A). Estimates on standard control variables are barely affected by the introduction of distance to retirement, which allows us to be confident that there is little multicollinearity problem.

We introduce distance to retirement in a non linear way. Two elements prompt us to adopt a non linear specification. First, for individuals who are far away from retirement, an additional year away from the retirement age is unlikely to influence their employment status. Another source of nonlinearity could arise from the existence of specific programs for workers over 50 years old.

We then define the variable $dist * age = k$ as the distance to retirement (in years) for individual of age $k$, with $k = \{50, 51, ..., 59\}$, 0 otherwise. Distance to retirement could affect employment odds differently at each age $k$. This will be shown by the difference in the coefficients of the interaction terms. We keep age dummies (after 50 years) in order to control for old age specific programs. First, notice in column "Logit 2" that the distance to retirement appears significant with the correct sign: this confirms the view that old individuals' employment rate is affected by their expected retirement age. However, this is true only after the age of 57. 57 appears as the threshold age at which the distance to retirement begins to matter. It is interesting to note that this is the age at which generous income schemes are available to all old workers[7], thereby suggesting a strong interaction between generous income plans and the expected retirement effect. Interestingly, age variables (age, age squared and age dummies from 50 to 59) remain negative (Table 14 in Appendix A) and significant, suggesting that distance to retirement negatively affects employment odds beyond the specific effect of age.

Secondly, the coefficient value on the distance variable increases from 0.103 at age 57 to 0.198 at age 59. As reported in Table 10, at 55 (59), the heterogeneity of the distance to retirement ranges from 5 (1) to 10 (5) years. The noticeable increase in the coefficient associated with the distance and age interaction variable indicates that the distance effect is particularly significant when individuals are sufficiently close to retirement. For instance, for a worker aged 59, if the distance to the age of retirement is increased by one year, this raises the employment odds by 21.9% - but only by 10.9% for a worker aged 57.

In addition, distance to retirement appears as a heterogeneous characteristic across individuals because of different expected retirement ages (due to the gradual implemen-

[7] Conditional on having already contributed the required number of quarters to Social Security, workers aged 55 and 56 are also eligible for specific older worker programs.

Table 1: Logit 1 - Male employment probability

| | Logit 1 |
|---|---|
| Age variables | |
| Age | 0.143*** |
| Age squared | -0.002*** |
| age=50 | 0.007 |
| age=51 | 0.007 |
| age=52 | -0.057 |
| age=53 | -0.100* |
| age=54 | -0.197*** |
| age=55 | -0.376*** |
| age=56 | -0.808*** |
| age=57 | -1.105*** |
| age=57 | -1.610*** |
| age=59 | -2.207*** |
| Education (Reference: Low education) | |
| High education | 0.326*** |
| Marital status (Reference: live with a spouse) | |
| Lives alone | -0.923*** |
| Number of children (Reference: no children) | |
| 1-2 children | 0.157*** |
| 3-5 children | 0.001 |
| +6 children | -0.385*** |
| Size of city (Reference: Parisian Area) | |
| +200000 inhabitants | -0.270*** |
| 20000 to 200000 inhabitants | -0.159*** |
| - 20000 inhabitants | 0.067** |
| Rural area | 0.170*** |
| Occupational group (Reference: Blue collar) | |
| Clerks | -0.259*** |
| Middle White collars | 0.251*** |
| Executives | 0.422*** |
| Sector (Reference: Industry) | |
| Agriculture | -0.401*** |
| Construction | -0.449*** |
| Services | 0.170*** |
| Citizenship (Reference: French) | |
| Non french | -0.491*** |
| Time dummies | yes |
| Constant | -0.279* |
| Observations | 211507 |

* significant at 10%; ** significant at 5%; *** significant at 1%

tation of the Balladur reform) and various ages of first job. One might then argue that the age of first job actually captures the individual's education, thereby introducing a bias in our estimates. An agent close to retirement is also less educated and entered the job market at a very young age, so a short distance to retirement is associated with low employment odds. We argue that the distance to retirement still plays a role in determining employment odds, beyond the effect of education, since we control for educational attainment with a dummy variable. Individuals are either in the Low Education group (no degree to degrees obtained below the completion of High School, before Baccalauréat) or the High Education group (Baccalauréat and beyond). Table 14 in Appendix A shows that this variable is significant and correctly signed in all our estimations.

Finally, we allow the distance effect to differ across educational groups by defining $dist * age = k$ for each educational level: $dist * age = k * High\ Education$ ($dist * age = k * Low\ Education$ respectively) captures the distance to retirement of an individual of age $k$ with High Education (Low Education respectively). Our intuition is that the impact of the distance effect might be larger for individuals in the Low Education group. A shorter distance to retirement lowers the employment odds, all the more so as the investment in training or job search is costly, which is the case for low-educated workers. Estimates in column "Logit 3" of Table 2 confirm this intuition.

For educated workers (for unskilled workers respectively), distance to retirement appears significant at age 57 (56 respectively) onwards at the 1% level. At the 10% level, the first age at which the distance effect appears significant is 56 for the High educated workers and 55 for the Low Educated workers. This suggests again a strong interaction between distance to retirement and eligibility to old worker specific programs, as the Low Educated workers are likely to satisfy eligibility conditions to specific old workers' programs at younger ages than the High Educated workers.

As in "Logit 2", estimated coefficients on distance to retirement increase with age, confirming the view that distance to retirement affects more employment odds when individuals are close to retirement, all the more so as they are in the Low Education group: a Low Educated individual of age 58 bears a fall in its employment odds of 46% for each year that brings him closer to retirement versus 22% in the High Education group.

To summarize, the distance to retirement helps explain the employment probability of not-yet-retired workers. The effect appears strongly nonlinear: employment odds are affected only when the distance is sufficiently close to the retirement age and only for workers between 55 and 59 years old, who are eligible to specific income programs. The structural model developed in the next section helps identify the economic mechanisms behind this result.

# 3 A Structural Model

The job search model appears as a natural candidate to a global approach of older workers employment, provided life cycle features are taken into account. We choose to present a simple model in order to make the key mechanisms more transparent. This model must

Table 2: Logits 2 and 3 - Male employment probability controlling for age and education

| | Logit 2 | Logit 3 |
|---|---|---|
| Distance to retirement | | |
| Interaction with age | | |
| dist*age=50 | -0.041 | |
| dist*age=51 | -0.027 | |
| dist*age=52 | 0.054 | |
| dist*age=53 | -0.023 | |
| dist*age=54 | 0.009 | |
| dist*age=55 | 0.009 | |
| dist*age=56 | 0.013 | |
| dist*age=57 | 0.103*** | |
| dist*age=58 | 0.141*** | |
| dist*age=59 | 0.198*** | |
| Interaction with age and education | | |
| dist*age=50*High education | | -0.007 |
| dist*age=51*High education | | -0.048 |
| dist*age=52*High education | | 0.047 |
| dist*age=53*High education | | 0.003 |
| dist*age=54*High education | | 0.049 |
| dist*age=55*High education | | 0.056 |
| dist*age=56*High education | | 0.075* |
| dist*age=57*High education | | 0.196*** |
| dist*age=58*High education | | 0.197*** |
| dist*age=59*High education | | 0.248*** |
| | | |
| dist*age=50*Low education | | 0.011 |
| dist*age=51*Low education | | -0.055 |
| dist*age=52*Low education | | 0.049 |
| dist*age=53*Low education | | 0.028 |
| dist*age=54*Low education | | 0.090 |
| dist*age=55*Low education | | 0.116* |
| dist*age=56*Low education | | 0.168*** |
| dist*age=57*Low education | | 0.370*** |
| dist*age=58*Low education | | 0.377*** |
| dist*age=59*Low education | | 0.588*** |

Control variables include age, age squared, age dummies, education, marital status, number of children, time dummies, citizenship, sector, occupational group, size of city
* significant at 10%; ** significant at 5%; *** significant at 1%

be considered as a first step to improve our understanding of the interaction between retirement and the employment rate of older workers.

The model is a modified version of McCall's (1970) model, in which unemployed workers look for a job and choose a search intensity which will influence the average length of unemployment spells. Beyond the heterogeneity arising from wage offer distribution, life cycle features are also considered. Following here Castañeda et al. (2003) and Ljunqvist & Sargent (2005), agents age stochastically. In addition, retirement choice is endogenous. Upon death, households are replaced by other households so that the population is constant over time. Finally, we discard saving decisions in order to keep the model tractable. For each period, consumption equals income.

## 3.1 Population dynamics and employment opportunities

In this section, we define the exogenous stochastic variables of the model, namely the age of the households and their employment opportunities. These two stochastic processes are independent. A worker observes his new wage at the beginning of the period before deciding to accept a new wage offer, quit a job or choose a search intensity.

### 3.1.1 Population dynamics

In each period, some households are born and some die. We assume that the measure of the newly-born is constant over time. They are born as unemployed workers. Retirement is endogenous.

We assume that the population can be divided into 6 age groups[8], denoted $C_i$ for $i = 1, ..., 6$. These age groups are a stylized representation of the following life-cycle: if a worker enters the labor market at 20, his expected time in the labor market is 40 years, and his expected time as a retiree is 20 years. In order to take into account typical age-specific unemployment rates, we consider the following age groups. 20 - 34 year old individuals, in $C_1$, start working. Experienced individuals of age 35 - 49, in $C_2$, expect to be employed for a long time. People of age 50 - 54 and 55 - 59, in $C_3$ and $C_4$, expect that the duration of the job is short before retirement. Individuals in age group 60 - 64, in $C_5$, can choose to retire. Finally, people aged 65 and more, in $C_6$, are all retirees as 65 is the mandatory retirement age. Retirement occur at age 60 (end of $C_4$) and 65 (end of $C_5$). In our policy experiments, we will then be able to measure individuals' willingness to delay retirement following changes in pension schemes.

Each individual is born young. The probability for a worker of remaining in $C_i$ (for $i = 1, .., 6$) the next period is $\pi_i$. Conversely, the probability of aging equals $1 - \pi_i$. The matrix governing the age Markov-process is given by:

[8] More motivations are given in the calibration (section 4.1).

|  |  | $t+1$ |  |  |  |  |  |
|---|---|---|---|---|---|---|---|
|  |  | $C_1$ | $C_2$ | $C_3$ | $C_4$ | $C_5$ | $C_6$ |
| $t$ | $C_1$ | $\pi_1$ | $1-\pi_1$ | 0 | 0 | 0 | 0 |
|  | $C_2$ | 0 | $\pi_2$ | $1-\pi_2$ | 0 | 0 | 0 |
|  | $C_3$ | 0 | 0 | $\pi_3$ | $1-\pi_3$ | 0 | 0 |
|  | $C_4$ | 0 | 0 | 0 | $\pi_4$ | $1-\pi_4$ | 0 |
|  | $C_5$ | 0 | 0 | 0 | 0 | $\pi_5$ | $1-\pi_5$ |
|  | $C_6$ | $1-\pi_6$ | 0 | 0 | 0 | 0 | $\pi_6$ |

This matrix yields the stationary distribution of workers conditionally on their age group. In each period, a fraction $1-\pi_6$ of new workers is born. They replace an equal number of dead workers, so that the measure of the population is constant.

### 3.1.2 Employment opportunities

An unemployed worker, each period $t$, chooses a job search intensity $s_t \geq 0$. We assume that individuals derive utility from consumption and leisure. Leisure refers to the time not spent on labor or the job search. Consequently, the utility of an unemployed worker at time $t$ can be expressed as $u(b, T-s_t)$, where function $u$ satisfies the usual Inada conditions, $b$ denotes unemployment benefits and $T$ the total time endowment. The incentive to increase the job search intensity is linked to the probability of getting a job offer. This probability $\phi(s_t)$ is an increasing function of $s_t$, and we assume that $\phi(s_t) \in [0,1]$, for $s_t \in [0, \infty[$.

According to probability $\phi(s_t)$, an unemployed worker receives a job offer in the next period. This offer is drawn from the wage offer distribution $F(w)$, which denotes the probability of receiving a wage offer between the lower wage of the distribution $\underline{w}$ and $w_t$ ($F(w) = \text{Prob}(w_t \leq w)$). Accepting a wage offer $w_t$ implies that the worker earns that wage in period $t$ and thereafter for each period she has not been laid off and has not retired. The probability of being laid off at the beginning of the period is $\lambda \in [0,1]$.

## 3.2 Behavioral assumptions and optimal solution

An unemployed worker observes his new age at the beginning of a period before deciding to accept or reject a new wage offer and chooses a job search intensity. The preferences are given by:

$$E_0 \sum_{t=0}^{\infty} \beta^t u(y_t, T-z_t) \quad \text{where } z_t \equiv I^p(As_t - (1-A)h)$$

where $E_0$ is the expectation operator conditional at time 0, $\beta \in [0,1]$ the subjective discount factor and $y_t$ the after-tax income from employment, unemployment compensation or pension. If $I^p = 0$, then the agent is retired, otherwise the agent participates in the labor market. In the latter case, if $A = 0$, then the worker is at work and has a constant disutility of labor denoted by $h$, whereas if $A = 1$ the worker is unemployed and has an endogenous disutility of job search.

Let $V_i^e(w)$ be the value of the optimization problem for a worker of age $C_i$ and paid $w$, $V_i^u$ the value of the optimization problem for an unemployed worker of age $C_i$, and $V^r$ the value of a retiree. Let $V_i(w)$ be the value of the optimization problem for a worker of age $i$ who was employed in the previous period and today has the option to work at the wage $w$

$$V_i(w) = \max\{V_i^e(w), V_i^u\} \quad \text{for } i = 1,..,5$$

Bellman equations can be written as:

for $i = 1,2,3$

$$\begin{aligned} V_i^e(w) &= u((1-\tau_p-\tau_b)w_i, T-h) + \beta\{\pi_i[(1-\lambda)V_i(w) + \lambda V_i^u] \\ &\quad +(1-\pi_i)[(1-\lambda)V_{i+1}(w) + \lambda V_{i+1}^u]\} \end{aligned} \tag{1}$$

$$\begin{aligned} V_i^u &= u((1-\tau_p)b_i, T-s_i) \\ &\quad +\beta\left\{\pi_i\left[\phi(s_i)\int V_i(w)dF(w) + (1-\phi(s_i))V_i^u\right]\right. \\ &\quad \left.+(1-\pi_i)\left[\phi(s_{i+1})\int V_{i+1}(w)dF(w) + (1-\phi(s_{i+1}))V_{i+1}^u\right]\right\} \end{aligned} \tag{2}$$

The agent ages with probability $1-\pi_i$. When the agent is employed, she pays taxes $\{\tau_p, \tau_b\}$ to finance non-employment incomes and retirement pensions[9]. She can lose her job with a probability $\lambda$. When the agent is non-employed, she can find a job opportunity with a probability $\phi(s)$. Each job offer is associated with a wage offer drawn from the wage distribution $F(w)$. The non-employed agent accepts a job if and only if its associated value is larger that the non-employment value.

for $i = 4$

$$\begin{aligned} V_4^e(w) &= u((1-\tau_p-\tau_b)w_4, T-h) + \beta\{\pi_4[(1-\lambda)V_4(w) + \lambda V_4^u] \\ &\quad +(1-\pi_4)[(1-\lambda)\max\{V_5(w), V_5^r\} + \lambda\max\{V_5^u, V_5^r\}]\} \end{aligned} \tag{3}$$

$$\begin{aligned} V_4^u &= u((1-\tau_p)b_4, T-s_4) \\ &\quad +\beta\left\{\pi_4\left[\phi(s_4)\int V_4(w)dF(w) + (1-\phi(s_4))V_4^u\right]\right. \\ &\quad \left.+(1-\pi_4)\left[\phi(s_5)\int \max\{V_5(w), V_5^r\}dF(w) + (1-\phi(s_5))\max\{V_5^u, V_5^r\}\right]\right\} \end{aligned} \tag{4}$$

At age 4, workers expect with a probability $(1-\pi_4)$ to have the right to get retired: age 5 constitutes the eligibility retirement age. Given the age of first job, age 5 is also the age of full pension. Finally, these equations highlight an important feature of the French social security system: the pension is not lowered by an unemployment spell. The value $V_5^r$ of

[9] Payroll taxes endogenously adjust to balance the social security budget.

getting retired in $C_5$ is the same for employed or non-employed workers. However, two retiree value functions must be distinguished in $C_6$, namely the already (in $C_5$) retired workers value $V_6^{r5}$ and the newly (in $C_6$) retired workers value $V_6^{r6}$.

for $i = 5$

$$\begin{aligned} V_5^e(w) &= u((1-\tau_p-\tau_b)w_5, T-h) \\ &\quad +\beta\left\{\pi_5[(1-\lambda)\max\{V_5(w), V_5^r\} + \lambda\max\{V_5^u, V_5^r\}]\right. \\ &\quad \left.+(1-\pi_5)V_6^{r6}\right\} \qquad (5) \\ V_5^u &= u((1-\tau_p)b_5, T-s_5) \\ &\quad +\beta\left\{\pi_5\left[\phi(s_5)\int\max\{V_5(w), V_5^r\}dF(w)\right.\right. \qquad (6) \\ &\quad \left.\left.+(1-\phi(s_5))\max\{V_5^u, V_5^r\}\right] + (1-\pi_5)V_6^{r6}\right\} \qquad (7) \\ V_5^r &= u(p_5, T) + \beta\left\{\pi_5 V_5^r + (1-\pi_5)V_6^{r5}\right\} \qquad (8) \end{aligned}$$

where $p_5$ denotes the retiree's pension at age 5.

for $i = 6$

$$V_6^{r5} = u(p_5, T) + \beta\left\{\pi_6 V_6^{r5}\right\} \qquad (9)$$

$$V_6^{r6} = u(p_6, T) + \beta\left\{\pi_6 V_6^{r6}\right\} \qquad (10)$$

In the benchmark case, we assume that the pension is not increased by additional years of working beyond the full pension rate: $p_6 = p_5$. This implies that the employment value does not increase if the agent decides to postpone retirement, leading to impose implicitly a huge tax on continued activity. In contrast, an increase in pension ($p_6 > p_5$) would lead the value of employment to increase relatively to being unemployed in the age group ($C_4$) before the eligibility retirement age.

Associated with equations (2), (4) and (6) are 5 optimal policy rules $\overline{s}_i$, and 5 reservation wages $\overline{w}_i$ for $i = 1, ..., 5$. The optimal decision for search intensity is given by

for $i = 1, 2, 3, 4$

$$u_2'((1-\tau_p)b_i, T-s_i) = \phi'(s_i)\beta\pi_i\left(\left[\int V_i(w)dF(w)\right] - V_i^u\right) \qquad (11)$$

for $i = 5$

$$u_2'((1-\tau_p)b_5, T-s_5) = \phi'(s_5)\beta\pi_5\left(\begin{array}{c}\left[\int\max[V_5(w), V_5^r]dF(w)\right] \\ -\max[V_5^u, V_5^r]\end{array}\right) \qquad (12)$$

The marginal disutility of job search activity equals its expected return, which is captured by the increase in the probability of getting a wage offer times the expected surplus of employment. The right hand side of equation (11) states that, as the individual ages, the gap between discounted earnings ($V_i^e$) and unemployment benefits ($V_i^u$) narrows. This remains true in equation (12) whatever the value of discounted pensions ($V_5^r$). *A fortiori,* in a social security system paying the same pension to employed and unemployed workers, the return on the job search effort is low when the distance to retirement decreases.

If $\max\{V_5(w), V_5^r\} = V_5^r$, then employed and unemployed people in $C_4$ have the same expected value $V_5^r$. Decreasing the unemployment benefit is then a traditional solution to foster job search by creating an instantaneous gap between employment and non-employment value. In contrast, if $\max\{V_5(w), V_5^r\} = V_5^e(w)$, then the relative value to be employed goes up. By inspecting equation (5), it appears that this result can be reached by increasing the relative value of $p_6$ to $p_5$. This incentive policy is implemented in Section 6. Aggregate equilibrium and wage distributions are detailed in Appendix B.

# 4 Investigating the feedback effect of retirement age on the job search

This section aims at investigating the interplay between the endogenous distance to retirement and individual job search decisions on the labor market. At this stage, we have two options: either to consider a theoretical setting that we could solve analytically at the expense of the robustness of our results or to calibrate a more general specification of the utility function and the wage distribution. We chose to follow the second route in order to quantify the economic mechanisms in a more general setting, even though we do not claim to encompass all dimensions of employment and retirement decisions.

## 4.1 Calibration

We base our calibration on the French Labor Surveys prior to the 1993 Balladur Reform (4 waves from 1990 to 1993). Indeed, given the simplicity of our model, we cannot pretend to be able to generate heterogenous retirement ages. When computing the key elements to calibrate our model (unemployment duration, employment rates, destruction rate, ...) on the French micro data, we restrict our sample to low and middle wage workers, namely all workers except executives. Indeed, these workers enter the job market at very young ages. Therefore, before the 1993 reform, they have accumulated the required number of contributive years before 60 years old which allows them to retire at 60. This fact encourages us to calibrate the model on pre-1993 data and on low and middle wage workers, which constitutes 85% of the labor force, because our stylized model can only capture this homogeneous retirement behavior[10].

We aim at replicating the main feature of the labor market along the life cycle. We first discretize the working life cycle by choosing quite homogenous age groups. We have already provided some empirical or institutional arguments in favor of the discretization in the model exposition. In France, 60 is the eligibility retirement age and 65 the maximum age. Between 60 and 65, agents have the choice to withdraw or not their pension. It is then particularly important to distinguish the 60-65 and the 65-and-more age groups. The expected age of death is set at 80. The working life cycle before the eligibility retirement age is split into four age groups. The first one from 20 to 30 aims at taking into account

[10]In contrast, in our empirical investigation based on micro data, we needed heterogeneous distances to retirement to robustly identify our feedbak effect. We thus chose to use Labor Force Surveys after 1993.

the labor market entry process. We consider that all workers are first unemployed at 20. The employment rate is then growing with age as long as this entry process carries on. On French data, the employment rate becomes stationary from 30 on. Until 50, the employment rate exhibits a strong stationarity. From 50 on, the employment rate starts declining. It would have been useful to finely discretize these ages between 50 and 60. In order to keep the model within tractable bounds, we only consider two age groups, 50-54 and 55-59. The dividing age of 55 is natural as special income programs exists from this age to the eligibility retirement age. In the pre and post 1993 periods, eligibility to old age specific programs is 55 years old for workers who have already contributed the required number of years to Social Security, which is the case for low skilled individuals. In contrast, eligibility to old workers specific schemes is unconditional for workers older than 57. Our estimation results validate our choice to isolate workers aged 55-59. In Table 2, for workers of the low education group, the distance effect appears significant in the interval 55-59.

To sum up, the four age groups prior to the retirement periods are such that each individual has an expected duration of 10 years in the first class $C_1$ $(\pi_1 = 1 - \frac{1}{10})$, 20 years in $C_2$ $\left(\pi_2 = 1 - \frac{1}{20}\right)$, 5 years in $C_3$ $\left(\pi_3 = 1 - \frac{1}{5}\right)$ and 5 years in $C_4$ $\left(\pi_4 = 1 - \frac{1}{5}\right)$: this leads to an expected duration of 40 years in the labor market. We assume that the expected duration is 5 years for $C_5$ $\left(\pi_5 = 1 - \frac{1}{5}\right)$ and 15 years for $C_6$ $\left(\pi_6 = 1 - \frac{1}{15}\right)$.

All parameters, except one ($\gamma$), are fixed according to external information. We set the model period to a month. The discount factor $\beta$ equals 0.9967, which yields an annual interest rate of 4%.

The utility function is:

$$u(c, T - z) = \frac{(c^{\nu}(T - z)^{1-\nu})^{1-\sigma}}{1 - \sigma}$$

We opt for this utility function as it makes the search intensity depend on the level of unemployment benefit. Dwelling on our empirical analysis on individual data, we cannot actually rule out that the generosity of unemployment benefit scheme interacts with the distance effect. In addition, this function is compatible with a balanced growth path and the parameters needed for the calibration have been extensively studied in the literature relying on calibration (Prescott (1986), Cooley & Prescott (1995), Hansen & Imrogoroglu (1992), Rios Rull (1996), Huggett & Ventura (1999)). $\nu$ is set to the traditional value of 0.33, $\sigma$ to 2. This implies that the value of the relative risk aversion $\widetilde{\sigma} = 1 - \nu(1 - \sigma)$ is equal to 1.33. This is close to the estimates provided by Attanasio et al. (1999).

The unemployment benefits are calibrated on the basis of their empirical counterparts. As a consequence, our results on employment rates by age will be consistent with a realistic calibration of unemployment benefits [11]. The replacement rate is set to 37% according to

[11] Our model is not able to capture the specific problems of entry of young people on the labor market (high turnover, learning, ...). As a result, we calibrate the unemployment benefits $b_1$ so as to reproduce the employment rate of workers aged 20-30. This generates a consistent initial condition to avoid distorting the employment rate of subsequent age groups. Our paper focuses on the distance effect that does not by definition affect this age group. A better understanding of the job entry is left for future research.

Table 3: Wage Offer Distribution over the Life Cycle in French Francs

| Age groups | $C_1$ | $C_2$ | $C_3$ | $C_4$ | $C_5$ |
|---|---|---|---|---|---|
| Age in years | 20-29 | 30-49 | 50-54 | 55-59 | 60-64 |
| Mean | 6817 | 7538 | 7600 | 8081 | 8081 |
| Standard deviation | 0.1723 | 0.2095 | 0.2046 | 0.2596 | 0.2596 |

Blanchard & Wolfers (2000) for workers aged 30 to 55. Non-employed workers aged 55-59 who are in specific programs are characterized by a lower decrease of their benefits with the unemployment spell. Given the legislation in the early nineties in France, we thus add a premium of 11.5% on the unemployment benefit for workers older than 55 ($C_4$ and $C_5$).

We now turn to the pension system calibration. We calibrate the pension level in order to match the observed replacement rate which equals 85% (Hairault et al. (2005)) of the last wage for the workers in our sample. Moreover, in our benchmark calibration, we consider an actuarially-unfair social security scheme as it was the case until the 2003 reform in France[12]. We impose the pensions to be the same whatever the retirement age between 60 and 65: $p_6 = p_5$. No pension adjustment is taken into account in case of delayed retirement.

We assume that the exogenous wage offer distribution $F(w)$ is a log-normal distribution. In order to replicate the wage increase with age, the wage offer distribution is assumed to depend on the age of the worker. We then potentially take care of some general human capital accumulation in our setup. From the French Labor Surveys, we compute the mean and the standard deviation of the wage offer distribution over each age group. We only consider wages corresponding to job tenures of less than one year. In Table 3, we indeed observe a shift to the right of the wage offer distribution along the life cycle. As we have only few observations after 60, we consider the same distribution as between 55 and 59.

Using the French Labor Survey data set, we calibrate the job destruction rate, which corresponds to the average probabilities of being fired for employed workers: $\lambda$ is set to 0.0055 at all ages. The model is simulated as if labor demand for all age groups were similar, which allows us to highlight how individual responses to social security pension schemes generate differential unemployment rates by age. The results are then not biased by an exogenous differential in labor demands across age groups.

Finally, the function that maps the job search intensity onto the probabilities of obtaining a wage offer is defined as follows:

$$\phi(s) = \gamma s \quad \text{where } s \in [0; 1]$$

In the literature (Mortensen (2003), Postel-Vinay & Robin (2004)), the search effort is a concave function of employment surplus. This simple linear rate of the offer arrival function combined with our utility function ensures that this standard property holds.

[12] The 2003 reform introduced an actuarial flavor in the French pension scheme by giving a 3% increase in pension for any additional working year beyond the required number of contributive years.

Table 4: Employment rates

| Age groups | $C_1$ | $C_2$ | $C_3$ | $C_4$ | $C_5$ |
|---|---|---|---|---|---|
| Age in years | 20-29 | 30-49 | 50-54 | 55-59 | 60-64 |
| data | 0.830 | 0.883 | 0.847 | 0.559 | 0.024 |
| Benchmark model | 0.837 | 0.844 | 0.864 | 0.534 | 0 |

As the parameter $\gamma$ has no empirical counterpart, we choose to calibrate it in order to replicate the observed unemployment duration for the workers aged 30-55. Based on the French Labor Survey, the unemployment duration amounts to 13.5 months, which leads to $\gamma = 0.93$.

## 4.2 Model Assessment

We replicate quite well the decrease in the employment rate as the retirement age stands out (Table 4). Especially, the dramatic decrease in the employment rate for workers aged 55 to 59 is quite well reproduced. This age group mainly differs by a 11.5 percent higher unemployment benefit and a weaker distance to the retirement age. It is enough to strongly decrease their employment rate in a way which is consistent with the data. It must be acknowledged that the levels are not perfectly reproduced, in particular the one relative to the 50-54 age group. Yet, we consider that this simple model works surprisingly well to capture the decline in the employment rates at the end of the working life cycle.

We aim at replicating the fact that French workers retire when they reach the full record of contributive years, as documented by Blanchet & Pelé (1997)[13]. Given the lack of heterogeneity in terms of careers, assumed for sake of simplicity, it implies that all individuals must be retired at age 60 in our model. Given the calibrated preferences, the model is able to generate a 100% rate of retirement at 60. It turns out that no workers choose to delay retirement in the case of no actuarial adjustments (column $C_5$ in Table 4).

Given the levels of non-employment incomes and pensions, the equilibrium tax rates are $\tau_b = 7.46\%$ and $\tau_p = 31.14\%$. Notice that these values are close to their empirical counterparts, respectively 6.4% and 26% in France despite the highly stylized model we consider.

## 4.3 The feedback effect of retirement on job search

In Table 4, the fall in the employment rate of older workers results from the combination of two mechanisms: a traditional one due to the upward sloping profile of unemployment benefits and the distance effect, that is specific to the life cycle framework. This section aims at illustrating and quantifying the respective role of each element.

[13] 97.6% of men retire at the full pension age.

Young workers are by definition not affected by the distance effect. Furthermore, in the benchmark calibration, workers aged 60 and beyond are retirees. So, in this section, we will focus on the behavior of age groups 2 to 4.

### 4.3.1 The distance effect

How is the job search behavior altered when individuals get closer to their expected retirement age? In order to make the mechanisms at work more transparent, we first examine labor participation when non-employed incomes do not differ across ages. We can fix all non-employed incomes at the low median age level or at the higher level of older workers.

Given our assumptions on preferences, the optimal search intensity before retirement is given by: for $i = 1, ..., 5$

$$s_i = T - \left\{ \frac{\gamma\beta\mathcal{S}}{(1-\nu)((1-\tau_p)b)^{\nu(1-\sigma)}} \right\}^{\frac{1}{(1-\nu)(1-\sigma)-1}}$$

$$\text{where: } \mathcal{S} = \begin{cases} \pi_i \left[\int V_i(w)dF(w) - V_i^u\right] & \text{if } i = 1, ..., 4 \\ \pi_i \left[\int \max[V_i(w), V_5^r]dF(w) - \max[V_i^u, V_5^r]\right] & \text{if } i = 5 \end{cases}$$

As equation (13) shows, high unemployment benefits increase the elasticity of the job search effort to a variation in $\mathcal{S}$: with this utility function, given the calibration of $\sigma$, a high non-employment income implies a decrease in the marginal utility of leisure. As a result, we choose to examine the two cases[14]: $b$ high (the benefit level received by 55-59 year old individuals) and $b$ low (the benefit level paid to individuals aged 30-49).

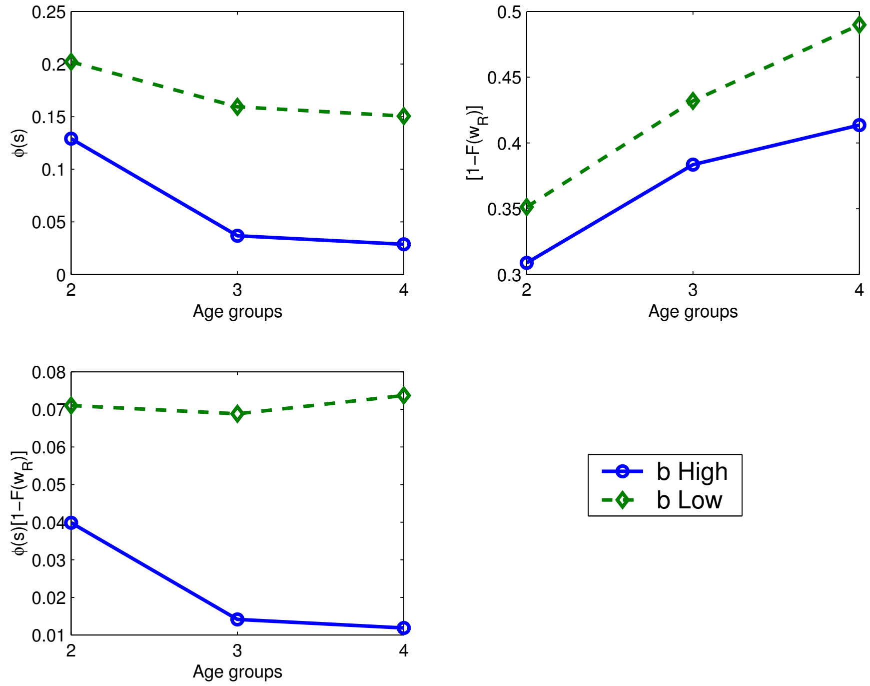
Figure 3 illustrates the two main forces at work in the model at the end of the working life.

- First, older workers will accept lower wages because impatience increases with age: the shorter the distance to retirement, the smaller the benefit of waiting to see if a higher job offer becomes available, as the benefits of employment cannot be enjoyed for a long period. As a result, accepting a job becomes more attractive: a larger number of job offers becomes acceptable. This is directly measured by the increasing probability of accepting a job offer, $[1 - F(w_R)]$, where $w_R$ denotes the reservation wage by age (Figure 3). Therefore, this first effect cannot account for the low employment rate of old workers in countries such as France.

- The second effect makes the model more consistent with French data. Even if old unemployed workers accept lower wage offers, their incentives to search more intensively for job offer decline. After age 55, their job search intensity falls and so does the probability of getting a job offer, measured by $\phi(s)$. Equation (13) shows that, as the individual ages, the gap between the values of an employed and an non-employed worker narrows whatever the reservation wage. The non-employed worker

[14] Both experiments were carried out using the payroll tax rates computed in the benchmark scenario.

Figure 3: Search behavior over the life-cycle ($b$ flat over the life cycle)



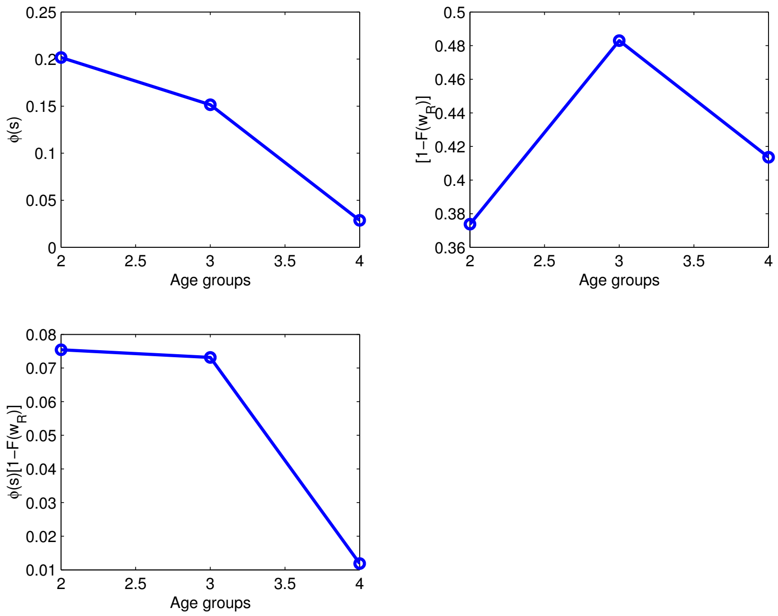

and the employed worker become retirees and receive the same pension: the value of employment converges to the one of non-employment. These effects are measured by $\mathcal{S}$. As the non-employment income is constant ($b_i = b$, $\forall i$), the expression of the optimal job search intensity by age implies that $s_i$ decreases with age only because of the fall in $\mathcal{S}$ (equation (13)). This effect is magnified when non-employed income $b$ is high: the higher $b$, the lower the search effort. It suggests that the generosity of the non-employment benefit system strongly interacts with the distance effect.

These two economic forces move in opposite directions during the life-cycle. The decrease in the reservation wage leads to an increase in employment at the end of the life-cycle, while the decline in job search intensity, capturing the distance effect, implies that the transition rate from unemployment-to-employment, $\phi(s)[1 - F(w_R)]$, goes down at the end of the life-cycle. Our numerical example measures the combination of these two effects and shows that the distance effect gets the upper hand ($\phi(s)[1 - F(w_R)]$ declines) when the unemployment benefits are high.

#### 4.3.2 Adding upward sloping unemployment benefits

Line 4 in Table 5 shows that the combination of the distance effect and the rise in the non-employment income at the end of the life cycle leads to a dramatic fall in the employment rate. Figure 4 provides the intuition behind this result.

Figure 4: Search behavior over the life-cycle when $b$ increases with age (Benchmark calibration)




- Age groups 2 and 3 are characterized by the same non-employment income. However, workers aged 50-54 are affected by the impatience effect that makes them less reluctant to accept a wage offer. On Figure 4, the probability of accepting a job offer $[1 - F(w_R)]$ is higher for this age group than for younger individuals, which results in a higher employment rate in the benchmark calibration (Table 4).

- Finally, at the end of the life-cycle, the rise in non-employment income accounts for the evolution of the reservation wage. Both the distance effect and the generosity of unemployment benefit schemes then contribute to the decline in employment rate.

### 4.3.3 Disentangling the distance effect and the unemployment benefit profile

At this stage, one could argue that the decline in older workers' labor force participation results more from high unemployment benefits than from the expected retirement effect. In order to measure the role of both elements, Table 5 displays the employment rates predicted by the model with a constant and high unemployment benefit (the benefit level received by 55-59 year old individuals), and the ones with a constant and low unemployment benefit (set to the level of benefits paid to individuals aged 30-55).

Let us consider line 2 of Table 5: employment rates before retirement remain quite stable. With low unemployment benefits, individuals at all ages are encouraged to work, as the impatience effect dominates the decrease in the search intensity. Comparing with line 3 yields interesting results. Employment rates are weaker at all ages, but, more

Table 5: Employment rates

| Age groups | $C_2$ | $C_3$ | $C_4$ |
|---|---|---|---|
| Age in years | 30-49 | 50-54 | 55-59 |
| 1 . Data | 0.883 | 0.847 | 0.559 |
| 2. Model with $b$ constant and low | 0.835 | 0.857 | 0.857 |
| 3. Model with $b$ constant and high | 0.738 | 0.629 | 0.516 |
| 4. Benchmark model | 0.844 | 0.864 | 0.534 |

importantly, much more for older workers. There is now a huge difference across ages. The distance effect alters the employment rate for older workers *only in conjunction with* generous unemployment benefits.

The joint effect of high unemployment benefits and the distance mechanism supports our interpretation of the estimated logit model reported in Table 2. The theoretical model suggests that the distance from retirement discourages activity as a result of generous non-employment benefits *and* the distance effect.

Therefore, it could be interesting to have a quantitative measure of the respective role of both elements in the decline in older workers' labor participation. First, at ages when the distance effect does not affect search behavior (before the age of 50), the employment rate is about 10% lower on line 3 than on line 2. Secondly, a high $b$ in conjunction with the distance effect yields a 31% decline in employment rate at ages just prior to retirement (a fall in labor participation from 84% at age $C_2$ to 53% at age $C_4$, line 4 of Table 5). This suggests that the generosity of non-employment income accounts approximately for a third of the decline in the labor participation and the distance effect alone corresponds to a two-thirds decline in the employment rate for older workers. When the unemployment benefit is high for the 50-54 age group, the distance effect exists at these ages, but to a lesser extent.

This result sheds light on the empirical results we obtain in Section 2. In the context of high unemployment benefits, the distance effect may be very significant, and tends to eclipse the role of unemployment benefits. The number of years prior to retirement is crucial, since only workers close to retirement age modify their job search behavior. But this occurs only when unemployment benefits are high enough: the generosity of these programs amplifies the retirement age effect by giving unemployed people the means to wait for retirement without searching a job.

As expected, there are two options to deal with the lower employment rate at the end of the working life. On the one hand, decreasing the generosity of the unemployment benefit would be efficient, in particular, and unexpectedly, by dampening the distance effect. On the other hand, delaying the retirement age could be another strategy if a high unemployment benefit for older workers is maintained: this argument reinforces the case for more actuarially-fair adjustments in social security provisions. We evaluate this policy in the Section 6

# 5 Robustness

In this section, we check that the distance effect we reveal in the preceding section is robust to changes in the value of some parameters. In this sensitivity analysis, we compare the employment rate gap between the 30-49 and 55-59 age groups in order to evaluate the robustness of the distance effect.

We want to measure the robustness of the distance effect to alternative labor market institutions. The parameter $\gamma$ is then worth considering. Countries differ in their degree of efficiency of the search process. Low value of $\gamma$ could explain why older workers do not search intensively when the distance to retirement is short, thereby dampening the quantitative importance of the distance effect.

We also check that the distance effect remains quantitatively significant for alternative calibrations of preference parameters. As shown by equation (13), search behavior is sensitive to the discount factor. Discounting less the future could increase the desire to search for another job. The sensitivity to the risk aversion coefficient also deserves to be treated in this section since it affects the trade-off between job search and retirement.

In each case, we report employment rates predicted by the model under the benchmark calibration for all parameters except the one under investigation[15]

- with upward sloping unemployment benefits (columns (1) and (2))
- with flat and high unemployment benefits (columns (4) and (5))

## 5.1 The search efficiency

Alternative calibrations of the search efficiency lead to the employment rates displayed in Table 6. As in the previous section, the combined effect of generous unemployment benefits and the distance effect yields a significant decline in the employment rate at age 55-59 (measured by the difference between columns (1) and (2), reported in column (3)). In order to isolate the magnitude of the distance effect alone (column (7)), one has to subtract from the joint effect in column (3) the specific impact of generous unemployment benefits (column (6)). The latter can be computed as the drop in the employment rate observed at ages that are far from retirement, namely the 30-49 age group, for the two profiles of unemployment benefits (column (1) minus column (4)).

We first verify that decreasing the efficiency of the search process amplifies the distance effect. It is indeed the case: when $\gamma = 0.89$, the distance effect amounts to 32 points of the decrease in the employment rate of the workers aged between 55 and 59 versus 20 points with $\gamma = 0.93$.

On the other hand, considering higher values of $\gamma$ leads to a dampening of the distance effect. For $\gamma = 1.05$, we see that both higher unemployment benefits and the proximity to retirement implies a 17% lower employment rate of the 55-59 age group. 8 points of this

[15] As in the previous section, all experiments in the robustness analysis are implemented using the payroll tax rates computed in the benchmark scenario.

Table 6: Sensitivity of employment rates to search efficiency

| | Benchmark | | Distance and b high | b constant and high | | b high only | Distance only |
|---|---|---|---|---|---|---|---|
| | 30-49 (1) | 55-59 (2) | (3)=(1)-(2) | 30-49 (4) | 55-59 (5) | (6)=(1)-(4) | (7)=(3)-(6) |
| $\gamma = 0.89$ | 0.836 | 0.412 | 0.424 | 0.734 | 0.356 | 0.102 | 0.322 |
| $\boldsymbol{\gamma} = \mathbf{0.93}$ | **0.844** | **0.534** | **0.31** | **0.738** | **0.516** | **0.106** | **0.204** |
| $\gamma = 1.05$ | 0.856 | 0.683 | 0.173 | 0.766 | 0.687 | 0.09 | 0.083 |
| $\gamma = 1.15$ | 0.862 | 0.732 | 0.13 | 0.793 | 0.739 | 0.069 | 0.061 |
| $\gamma = 1.25$ | 0.866 | 0.78 | 0.086 | 0.803 | 0.78 | 0.063 | 0.023 |

in **bold**: benchmark calibration ($\gamma = 0.93$)

decrease can be interpreted in terms of a distance effect. The duration of unemployment decreases by 1.5 months for $\gamma = 1.05$. Considering now the case $\gamma = 1.15$, the employment rate gap between the age groups decreases again. There is only a difference of 13 points between the 30-49 group and the 55-59 one. 7 points appears to be due to the higher unemployment benefits. But in this case the unemployment duration is lower by 2 months than the observed one. Finally, for $\gamma = 1.25$, the employment gap must be interpreted completely in terms of an unemployment benefit differential. However, in this case, the unemployment duration is only 10.9 months.

In view of the results displayed in Table 6, we feel confident of the empirical relevance of the distance effect. This analysis indeed shows that the benchmark calibration is not a borderline case. There exists a significant distance effect for a large range of values, and it disappears for values leading to unrealistic durations of unemployment.

This sensitivity analysis on $\gamma$ reveals that the efficiency of the search process is a key parameter for the quantitative importance of the distance effect. This result confirms the presence of a strong complementarity between labor market institutions, namely the generosity of unemployment benefits, the profile of pension schemes and the search efficiency, which suggests that the magnitude of the distance effect can be heterogeneous across countries.

## 5.2 The discount rate

Table 7 shows that the discount rate modifies the importance of the distance effect. Lowering the discount factor increases the job value before the retirement age. This explains why the lower the discount rate, the lower the distance effect. For an annual rate of 2%, both higher unemployment benefits and the proximity to retirement explain a 24 percentage point lower employment rate for the 55-59 age group workers, to be compared with the 31 percentage points obtained with the benchmark calibration. On the other hand, if $r = 5\%$, the employment gap amounts to 37 percentage points of which 27 points could be considered as reflecting the distance effect. Even for a very low annual rate of 1%, the distance effect still explains an 11 percentage point decrease in the employment

Table 7: Sensitivity of employment rates to the discount rate

| | Benchmark | | Distance and b high | b constant and high | | b high only | Distance only |
|---|---|---|---|---|---|---|---|
| | 30-49 | 55-59 | | 30-49 | 55-59 | | |
| | (1) | (2) | (3)=(1)-(2) | (4) | (5) | (6)=(1)-(4) | (7)=(3)-(6) |
| $r = 1\%$ | 0.833 | 0.637 | 0.196 | 0.751 | 0.634 | 0.082 | 0.114 |
| $r = 2\%$ | 0.84 | 0.601 | 0.239 | 0.756 | 0.593 | 0.084 | 0.155 |
| $r = 3\%$ | 0.837 | 0.589 | 0.248 | 0.747 | 0.572 | 0.09 | 0.158 |
| $\mathbf{r = 4\%}$ | **0.844** | **0.534** | **0.31** | **0.738** | **0.516** | **0.106** | **0.204** |
| $r = 5\%$ | 0.842 | 0.471 | 0.371 | 0.74 | 0.425 | 0.102 | 0.269 |

in **bold**: benchmark calibration ($r = 4\%$)

Table 8: Sensitivity of employment rates to the risk aversion

| | Benchmark | | Distance and b high | b constant and high | | b high only | Distance only |
|---|---|---|---|---|---|---|---|
| | 30-49 | 55-59 | | 30-49 | 55-59 | | |
| | (1) | (2) | (3)=(1)-(2) | (4) | (5) | (6)=(1)-(4) | (7)=(3)-(6) |
| $\sigma = 1.1$ | 0.862 | 0.659 | 0.203 | 0.759 | 0.643 | 0.103 | 0.1 |
| $\sigma = 1.3$ | 0.862 | 0.642 | 0.22 | 0.781 | 0.632 | 0.081 | 0.139 |
| $\sigma = 1.6$ | 0.85 | 0.601 | 0.249 | 0.762 | 0.582 | 0.088 | 0.161 |
| $\boldsymbol{\sigma = 2}$ | **0.844** | **0.534** | **0.31** | **0.738** | **0.516** | **0.106** | **0.204** |
| $\sigma = 2.4$ | 0.83 | 0.477 | 0.353 | 0.728 | 0.438 | 0.102 | 0.251 |

in **bold**: benchmark calibration ($\sigma = 2$)

rate of the older workers. Even if its magnitude appears sensitive to the discount rate, the existence of a distance effect shows up robust to different values of $r$.

## 5.3 The risk aversion

As can be seen in Table 8, the magnitude of the distance effect increases with the value of $\sigma$. It appears that the distance effect would explain a 25 percentage point decrease in the employment rate of older workers for $\sigma = 2.4$, whereas the decrease is of only 10 percentage points for $\sigma = 1.1$. This is to be compared with the 20 points obtained in the benchmark case. Even for low values of risk aversion, the distance effect appears important. Note that we could have obtained a higher distance effect for higher, but still realistic, values of the risk aversion parameter.

The higher the risk aversion, the larger the distance effect. Indeed, for a non employed worker, the risky choice is the decision to keep looking for a job while the non search behavior yields a steady income. For workers who are close to retirement, the choice to remain on the labor market appears all the more risky as the gain from employment cannot be enjoyed for very long.

# 6 The Double Dividend of Actuarially-Fair Pension Adjustments

Over the last decade, several pension reforms have been implemented in OECD countries to increase the labor-market participation of older people. Along the lines of the US Social Security system, the actuarially fair adjustment was introduced in the 1990s in Italy and Sweden which have adopted a so-called "notional defined contribution" model, thereby providing flexible retirement choices. Public pensions have been made more neutral vis-à-vis work-retirement decisions. Pension entitlements depend among other things on the number of years worked, the size of lifetime earnings and remaining life expectancy at the age of withdrawal.

In this section, we show that, beyond the incentive to delay retirement, the decrease in the tax on continued work has sufficiently large effects to encourage unemployed older workers to find a job. This is an additional point in favor of this policy, usually left aside by neglecting the impact of social security arrangements on job search behavior in an economy with full employment.

In the previous sections, pension schemes were characterized by an extreme tax on continued activity: the pension was constant whether individuals retired at 60 or 65 years old. In this section, the tax on continued work is lowered by increasing the pension for workers who choose to retire at age 65 rather than 60: an actuarially-fair policy amounts to a 46% increase in pension in the case of delayed retirement by 5 years. Let us recall that it remunerates five additional working years, and not only one. This value is consistent with Hairault, Langot and Sopraseuth's (2005) computations on French data as well as the US 1983 old age pension reform. As we want to analyze pension reforms only, unemployment benefits are left unchanged.[16]

Actuarially-fair pension schemes should greatly increase the value of being employed before retirement. For unemployed workers aged 55 or more, the incentives to look for a job go up. Is this uncertain return on the job search, anticipated today, large enough to reduce the distance effect which dominated the labor choices of older workers?

In light of Figure 5, the answer to this question is a qualified *yes*.

- First, with incentive schemes, the implicit tax on continued activity is removed. Thus, more individuals remain at work until the maximum retirement age. 23.4% of workers choose to delay retirement until the age of 65 (line 2 in Table 9). All workers unemployed from 60 on choose to retire.

- The first effect is the standard expected gain from the introduction of actuarially-fair schemes. The job search model actually helps uncover an additional gain from this policy: incentive schemes not only encourage individuals to keep their jobs, but

[16] This section aims at illustrating how the distance effect could magnify the impact of a common Social Security reform implemented in some European countries. It is beyond the scope of the paper to assess the optimality of such a policy compared with alternative measures such as decreasing unemployment benefits.

Figure 5: Job search behavior over the life-cycle with incentive schemes

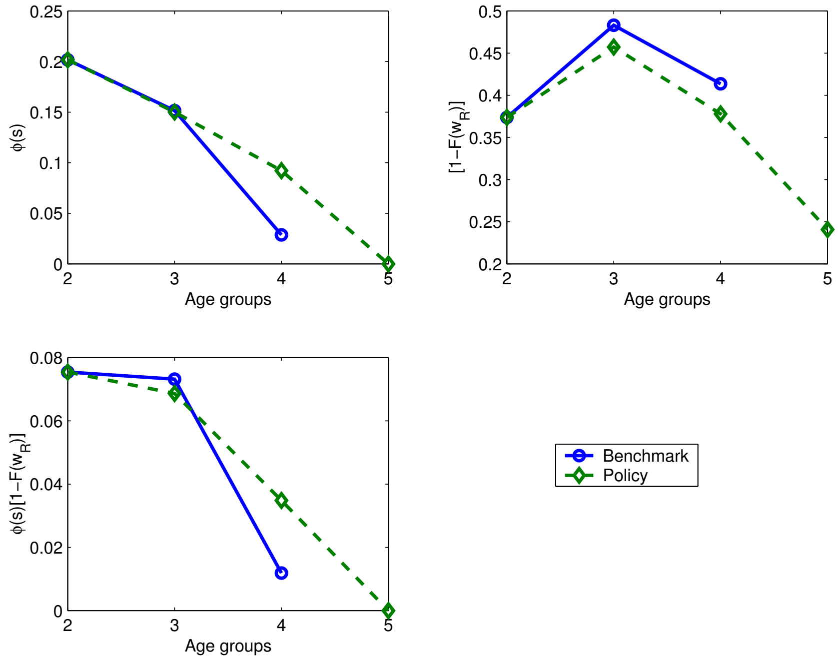



Table 9: Incentive schemes and employment rates

| Age groups | $C_1$ | $C_2$ | $C_3$ | $C_4$ | $C_5$ |
|---|---|---|---|---|---|
| Age in years | 20-29 | 30-49 | 50-54 | 55-59 | 60-64 |
| 1. Benchmark | 0.837 | 0.844 | 0.864 | **0.534** | 0.024 |
| 2. Retirement Policy | 0.837 | 0.844 | 0.858 | **0.686** | **0.234** |

also make job offers more attractive to unemployed people because the distance to retirement increases. In age group $C_4$, a more intensive job search effort, relative to the benchmark case, reduces the fall in the transition rate to employment (Figure 5). The employment rate of age group $C_4$ goes up from 53% to 68% (lines 1 and 2 in Table 9), despite the high non-employment benefits.

Incentives to work longer generate a double dividend: the increase in pension because of continued activity not only encourages some employed workers to delay retirement but also gives incentives to non-employed workers below the age at which they are eligible to retire to search more intensively. Incentive schemes globally increase the employment rate for older workers.

# 7 Conclusion

This paper aimed at quantifying the effect of the retirement age decision on the job search prior to retirement. Both on macro and micro data, the time horizon before retirement seems to account for a large part of the low employment rate of older workers in conjunction with high unemployment benefits at these ages. We extend McCall's (1970) search model to allow for life cycle features and endogenous retirement. This gives theoretical grounds for the mechanisms at work on the labor market when the retirement age gets closer, in particular the strong interactions between the distance effect and generous unemployment benefits at the end of the working life. Calibration on the French economy confirms the major effects uncovered by the micro-econometric analysis of French panel data. The model predicts that a decrease in the tax on continued activity not only makes more older workers delay retirement, but also encourages more unemployed people to find a job, yielding a double dividend of incentive schemes. It provides strong support in favor of policies that reward continued activity on an actuarially-fair basis.

Overall, we think that integrating the retirement deadline into labor market analysis is a promising approach which could be undertaken to revisit other important issues such as training, labor demand and wage bargaining. This is left for further research.

# References


Attanasio, O. P., Banks, J., Meghir, C., & Weber, G. (1999). Humps and bumps in lifetime consumption. *Journal of Business and Economic Statistics*, 17.

Aubert, P., Caroli, E., & Roger, M. (2006). New technologies, workplace organisation and the age structure of the workforce: Firm-level evidence. *Economic Journal*, 116(509), F73–F93.

Benitez Silva, H. (2003). *Job Search Behavior of Older Americans.* Mimeo, Yale University.

Bettendorf, L. & Broer, D. (2003). *Lifetime Labor Supply in a Search Model of Unemployment.* Mimeo.

Blanchard, O. & Wolfers, J. (2000). The role of shocks and institutions in the rise of european unemployment : The aggregate evidence. *Economic Journal*, 110, C1–C33.

Blanchet, D. & Pelé, G. (1997). *Social Security and Retirement in France.* NBER Working Paper 6214, NBER.

Blondal, S. & Scarpetta, S. (1998). *The Retirement Decision in OECD Countries.* OECD Economics Department Working Paper 202, OECD.

Castañeda, A., Diaz-Gimenez, J., & Rios-Rull, V. (2003). Accounting for the u.s. earnings and wealth inequality. *Journal of Political Economy*, 111(4), 818–857.

Cooley, T. & Prescott, E. (1995). Economic growth and business cycles. In T. Cooley (Ed.), *Frontiers of Business Cycle Research* (pp. 1–38).: Princeton University Press.

Crépon, B., Deniau, N., & Perrez-Duarte, S. (2002). *Wages, Productivity, and Workers Characteristics: A French Perspective*. Mimeo, INSEE.

Friedberg, L. (2003). The impact of technological change on OlderWorkers: Evidence from data on computer use. *Industrial and Labor Relations Review*, 56(3), 511–529.

Gruber, J. & Wise, D. (1999). *Social Security Around the World*. National Bureau of Economic Research Conference Report.

Hairault, J., Langot, F., & Sopraseuth, T. (2005). *A Quantitative Investigation of the Laffer Curve on the Continued Work Tax : The French Case*. IZA Discussion Paper DP 1499, IZA.

Hansen, G. & Imrogoroglu, A. (1992). The role of unemplyment insurance in an economy with liquidity constraints and moral hazard. *Journal of Political Economy*, 100, 118–142.

Hellerstein, J. K., Neumark, D., & Troske, K. R. (1999). Wages, productivity, and worker characteristics: Evidence from plant-level production functions and wage equations. *Journal of Labor Economics*, 17, 409–446.

Huggett, M. & Ventura, G. (1999). On the distributional effects of social security reform. *Review of Economic Dynamics*, 2(3), 498–531.

Ljunqvist, L. & Sargent, T. (2005). *Obsolescence, Uncertainty and Heterogeneity : The European Employment Experience*. Mimeo.

McCall, J. (1970). Economics of information and job search. *Quarterly Journal of Economics*, 84, 113–126.

Mortensen, D. (2003). *Wage Dispersion : Why are Similar People Paid Differently?* Cambridge: MIT Press.

Postel-Vinay, F. & Robin, J. (2004). To match or not to match? optimal wage policy with endegenous worker search intensity. *Review of Economic Dynamics*, 7(2), 297–333.

Prescott, E. (1986). Theory ahead of business cycle measurement. *Federal Reserve Bank of Minneapolis Quarterly Review*, (pp. 9–22).

Rios Rull, V. (1996). Life-cycle economies and aggregate fluctuations. *Review of Economic Studies*, 63, 465–490.

Seater, J. (1977). A unified model of consumption, labor supply, and job search. *Journal of Economic Theory*, 14, 349–372.

APPENDIX

# A Empirical evidence

Table 10: Age and expected retirement age

| Age | More than 11 years | 6 - 10 years | 3 - 5 years | Less than 2 years | Total |
|---|---|---|---|---|---|
| 50 | 759 | 4 525 | 0 | 0 | 5 284 |
| 51 | 536 | 4 472 | 0 | 0 | 5 008 |
| 52 | 410 | 4 374 | 0 | 0 | 4 784 |
| 53 | 265 | 4 208 | 0 | 0 | 4 473 |
| 54 | 154 | 4 001 | 0 | 0 | 4 155 |
| 55 | 0 | 433 | 3 433 | 0 | 3 866 |
| 56 | 0 | 314 | 3 505 | 0 | 3 819 |
| 57 | 0 | 233 | 3 619 | 0 | 3 852 |
| 58 | 0 | 119 | 193 | 3 440 | 3 752 |
| 59 | 0 | 61 | 165 | 3 584 | 3 810 |
| Total | 2 124 | 22 740 | 10 915 | 7 024 | 42 803 |

Table 11: Descriptive Statistics - Men (I)

| | Not employed | Employed | Total |
|---|---|---|---|
| Total | 36 039 | 175 468 | 211 507 |
| | 17 | 83 | 100 |
| Number of years before retirement (distance to retirement) | | | |
| More than 10 years | 23 071 | 147 757 | 170 828 |
| | 13.5 | 86.5 | 100 |
| 6 - 10 years | 4 343 | 18 397 | 22 740 |
| | 19.1 | 80.9 | 100 |
| 3 - 5 years | 4 047 | 6 868 | 10 915 |
| | 37.1 | **62.9** | 100 |
| Less than 2 years | 4 578 | 2 446 | 7 024 |
| | 65.2 | **34.8** | 100 |
| Education | | | |
| Low (no degree - high school dropout) | 29 430 | 123 883 | 153 313 |
| | 19.2 | 80.8 | 100 |
| High (Completed high school, university) | 6 609 | 51 585 | 58 194 |
| | 11.4 | 88.6 | 100 |
| Marital Status | | | |
| Live with a spouse | 21 307 | 133 099 | 154 406 |
| | 13.8 | 86.2 | 100 |
| Live alone | 14 732 | 42369 | 57 101 |
| | 25.8 | 74.2 | 100 |
| Number of children | | | |
| Nno child | 16 354 | 55 302 | 71 656 |
| | 22.8 | 77.2 | 100 |
| 1-2 children | 14 632 | 94 289 | 108 921 |
| | 13.4 | 86.6 | 100 |
| 3-5 children | 4 628 | 25 063 | 29 691 |
| | 15.6 | 84.4 | 100 |
| 6 and more | 425 | 814 | 1 239 |
| | 34.3 | 65.7 | 100 |
| Size of city | | | |
| Parisean area | 4 827 | 26 187 | 31 014 |
| | 15.6 | 84.4 | 100 |
| More than 200000 inhabitants | 8 178 | 3 285 | 41 028 |
| | 19.9 | 80.1 | 100 |
| 20000 to 200000 inhabitants | 8 227 | 35 071 | 43 298 |
| | 19 | 81 | 100 |
| Less than 20000 inhabitants | 6 113 | 31 120 | 37 233 |
| | 16.4 | 83.6 | 100 |
| Rural town | 8 694 | 50 240 | 58 934 |
| | 14.75 | 85.25 | 100 |

Table 12: Descriptive Statistics - Men (II)

| | Not employed | Employed | Total |
|---|---|---|---|
| Occupational group | | | |
| Blue Collars | 21 879 | 92 437 | 114 316 |
| | 19.1 | 80.9 | 100 |
| Clerk | 5 482 | 18 409 | 23 891 |
| | 22.95 | 77.05 | 100 |
| Middle skilled worker | 5 859 | 39 753 | 45 612 |
| | 12.85 | 87.15 | 100 |
| Executive | 2 819 | 24 869 | 27 688 |
| | 10.2 | 89.8 | 100 |
| Sector | | | |
| Industry | 10 356 | 58 843 | 69 199 |
| | 15 | 85 | 100 |
| Agriculture | 1 239 | 4 157 | 5 396 |
| | 23 | 77 | 100 |
| Construction | 6 090 | 19 731 | 25 821 |
| | 23.6 | 76.4 | 100 |
| Services | 18 354 | 92 737 | 111 091 |
| | 16.5 | 83.5 | 100 |
| Citizenship | | | |
| French | 32 346 | 16 447 | 196 816 |
| | 16.4 | 83.6 | 100 |
| Non French | 3 693 | 10 998 | 14691 |
| | 25.1 | 74.9 | 100 |

Table 13: Descriptive Statistics - Men (III)

| | Not employed | Employed | Total |
|---|---|---|---|
| Age dummies | | | |
| Less than 50 years old | 22 817 | 145 887 | 196 291 |
| | 13.5 | 86.5 | 100 |
| 50 | 792 | 4 492 | 168 704 |
| | 15 | 85 | 100 |
| 51 | 816 | 4 192 | 5 008 |
| | 16.3 | 83.7 | 100 |
| 52 | 888 | 3 896 | 4 784 |
| | 18.6 | 81.4 | 100 |
| 53 | 901 | 3 572 | 4 473 |
| | 20.1 | 79.9 | 100 |
| 54 | 923 | 3 232 | 4 155 |
| | 22.2 | 77.8 | 100 |
| 55 | 1 022 | 2 844 | 3 866 |
| | 26.4 | 73.6 | 100 |
| 56 | 1 374 | 2 445 | 3 819 |
| | 36 | 64 | 100 |
| 57 | 1 709 | 2 143 | 3 852 |
| | 44.4 | 55.6 | 100 |
| 58 | 2 112 | 1 640 | 3 752 |
| | 56.3 | 43.7 | 100 |
| 59 | 2 685 | 1 125 | 381 |
| | 70.5 | 29.5 | 100 |
| Time dummy | | | |
| 1995 | 5 416 | 25 519 | 30 935 |
| | 17.5 | 82.5 | 100 |
| 1996 | 5 484 | 25 723 | 31 207 |
| | 17.6 | 82.4 | 100 |
| 1997 | 5 521 | 25 139 | 30 660 |
| | 18 | 82 | 100 |
| 1998 | 5 340 | 25 212 | 30 552 |
| | 17.5 | 82.5 | 100 |
| 1999 | 5 528 | 25 414 | 30 942 |
| | 17.9 | 82.1 | 100 |
| 2000 | 4 015 | 21 929 | 25 944 |
| | 15.5 | 84.5 | 100 |
| 2001 | 4 736 | 26 533 | 31 269 |
| | 15.1 | 84.9 | 100 |
| 2002 | 4 952 | 26 569 | 31 521 |
| | 15.7 | 84.3 | 100 |

Table 14: Logit 1, 2 and 3 : Estimates on control variables

| | Logit 1 | Logit 2 | Logit 3 |
|---|---|---|---|
| Age variables | | | |
| Age | 0.143*** | 0.143*** | 0.142*** |
| Age squared | -0.002*** | -0.002*** | -0.002*** |
| age=50 | 0.007 | 0.430 | -0.071 |
| age=51 | 0.007 | 0.262 | 0.504 |
| age=52 | -0.057 | -0.507* | -0.463 |
| age=53 | -0.100* | 0.068 | -0.273 |
| age=54 | -0.197*** | -0.259 | -0.719** |
| age=55 | -0.376*** | -0.425** | -0.926*** |
| age=56 | -0.808*** | -0.865*** | -1.438*** |
| age=57 | -1.105*** | -1.442*** | -2.175*** |
| age=57 | -1.610*** | -1.928*** | -2.352*** |
| age=59 | -2.207*** | -2.458*** | -2.806*** |
| Education (Reference: Low education) | | | |
| High education | 0.326*** | 0.314*** | 0.357*** |
| Marital status (Reference: live with a spouse) | | | |
| Lives alone | -0.923*** | -0.924*** | -0.923*** |
| Number of children (Reference: no children) | | | |
| 1-2 children | 0.157*** | 0.157*** | 0.159*** |
| 3-5 children | 0.001 | 0.000 | 0.004 |
| +6 children | -0.385*** | -0.385*** | -0.382*** |
| Size of city (Reference: Parisian Area) | | | |
| +200000 inhabitants | -0.270*** | -0.271*** | -0.268*** |
| 20000 to 200000 inhabitants | -0.159*** | -0.160*** | -0.159*** |
| - 20000 inhabitants | 0.067** | 0.065** | 0.069** |
| Rural area | 0.170*** | 0.168*** | 0.173*** |
| Occupational group (Reference: Blue collar) | | | |
| Clerks | -0.259*** | -0.259*** | -0.262*** |
| Middle White collars | 0.251*** | 0.253*** | 0.251*** |
| Executives | 0.422*** | 0.412*** | 0.414*** |
| Sector (Reference: Industry) | | | |
| Agriculture | -0.401*** | -0.402*** | -0.404*** |
| Construction | -0.449*** | -0.449*** | -0.450*** |
| Services | 0.170*** | 0.170*** | 0.170*** |
| Citizenship (Reference: French) | | | |
| Non French | -0.491*** | -0.492*** | -0.494*** |
| Time dummies | yes | yes | yes |
| Constant | -0.279* | -0.276* | -0.271* |
| Observations | 211507 | 211507 | 211507 |

* significant at 10%; ** significant at 5%; *** significant at 1%

# B Equilibrium

## B.1 Equilibrium unemployment rates

Let $U_{t,i}$, $N_{t,i}$, $R_{i,t}$and $P_{t,i}$ denote respectively the number of unemployed workers of age $i$ at the beginning of period $t$, the number of employed workers, the number of retirees, and the total labor force (note that $P_{t,i} = N_{t,i} + U_{t,i} + R_{t,i}$, $\forall t, i$). Unemployment rates at each age obey the following laws of motion:

$$U_{t,1} = \underbrace{(1-\pi_6)P_{t-1,6} + \pi_1 \lambda N_{t-1,1}}_{\text{newly unemployed workers}} + \underbrace{\pi_1[\phi(\overline{s}_1)F_1(\overline{w}_1) + (1-\phi(\overline{s}_1))]U_{t-1,1}}_{\text{surviving unemployed workers}}$$

and, for $i = 2, 3, 4, 5$

$$\begin{aligned} U_{t,i} = & \underbrace{(1-\pi_{i-1})[\phi(\overline{s}_i)F_i(\overline{w}_i) + (1-\phi(\overline{s}_i))]U_{t-1,i-1}}_{\text{newly unemployed workers coming from age } i-1} \\ & + \underbrace{(1-\pi_{i-1})N_{t-1,i-1}[\lambda + (1-\lambda)\max\{0, G_{i-1}(\overline{w}_i) - G_{i-1}(\overline{w}_i)\}]}_{\text{newly unemployed workers coming from age } i-1} \\ & + \underbrace{\pi_i \lambda N_{t-1,i}}_{\text{newly unemployed workers}} + \underbrace{\pi_i[\phi(\overline{s}_i)F_i(\overline{w}_i) + (1-\phi(\overline{s}_i))]U_{t-1,i}}_{\text{surviving unemployed workers}} \end{aligned}$$

where $G_i(w)$ denotes the fraction of age $i$ employed workers at wage $w$ or less. The right hand side of these equations is the sum of newly unemployed workers of age $i$ and the survivors at age $i$ of workers who were unemployed at the end of the period, which correspond to the workers who reject offers that are less than the optimal reservation wage $(\overline{w}_i)$.

Given that the size of the population is a constant, denoted $P$, one can define stationary equilibrium unemployment rates by age. These constant levels of unemployment rates, denoted $u_i = U_i/P$, are defined by:

$$u_1 = \frac{(1-\pi_6)p_6 + \pi_1 \lambda p_1}{1 - \pi_1[\phi(\overline{s}_1)F_1(\overline{w}_1) + (1-\phi(\overline{s}_1))] + \lambda \pi_1}$$

and for $i = 2, 3, 4, 5$,

$$\begin{aligned} & (1 - \pi_i[\phi(\overline{s}_i)F_i(\overline{w}_i) + (1-\phi(\overline{s}_i))] + \pi_i \lambda)u_i \\ = \; & (1-\pi_{i-1})[\phi(\overline{s}_i)F_i(\overline{w}_i) + (1-\phi(\overline{s}_i))]u_{i-1} \\ & -[\lambda + (1-\lambda)\max\{0, G_{i-1}(\overline{w}_i) - G_{i-1}(\overline{w}_{i-1})\}]u_{i-1} \\ & +(1-\pi_{i-1})[\lambda + (1-\lambda)\max\{0, G_{i-1}(\overline{w}_i) - G_{i-1}(\overline{w}_{i-1})\}]p_{i-1} + \pi_i \lambda p_i \end{aligned}$$

where $p_i$ denotes the fraction of population of age $i$ in the total population. Finally, the equilibrium rates of retired workers are given by:

$$\begin{aligned}
& \text{if } V_5^r < V_5^u \Longrightarrow U_{5,t} > 0 \text{ and,} \\
R_{5,t} &= 0 \\
& \text{if } V_5^r < V_5^u \Longrightarrow U_{5,t} = 0 \text{ and,} \\
R_{5,t} &= \pi_5[R_{5,t-1} + \lambda N_{5,t-1} \\
&\quad +(1-\pi_4)[\lambda + (1-\lambda)\max\{0, G_4(\overline{w}_5) - G_4(\overline{w}_4)\}]N_{4,t-1} \\
&\quad +(1-\pi_4)[\phi(\overline{s}_5)F_5(\overline{w}_5) + 1 - \phi(\overline{s}_5)]U_{4,t-1} \\
R_{6,t} &= \pi_6 R_{6,t-1} + (1-\pi_5)P_5
\end{aligned}$$

At steady state, these equations imply that the rate of retired workers ($R_i/P$) is given by:

$$\begin{aligned}
& \text{if } V_5^r < V_5^u \\
r_5 &= 0 \\
& \text{if } V_5^r > V_5^u \\
r_5 &= \frac{(1-\pi_4)[\phi(\overline{s}_5)F_5(\overline{w}_5) + (1-\phi(\overline{s}_5)) - \lambda - (1-\lambda)\max\{0, G_4(\overline{w}_5) - G_4(\overline{w}_4)\}]}{1-\pi_5(1-\lambda)} u_4 \\
&\quad + \frac{\lambda\pi_5 p_5 + (1-\pi_4)[\lambda + (1-\lambda)\max\{0, G_4(\overline{w}_5) - G_4(\overline{w}_4)\}]p_4}{1-\pi_5(1-\lambda)} \\
r_6 &= \frac{(1-\pi_5)p_5}{1-\pi_6}
\end{aligned}$$

After solving this system of equations, one can deduce the aggregate equilibrium unemployment rates: $u = \sum_i u_i/(1-\sum_i r_i)$ and the equilibrium rate of retirees $r = \sum_i r_i$. Equilibrium unemployment rates by age are defined as $\widetilde{u}_i = u_i/p_i$.

## B.2 Equilibrium wage distributions

As the demographic structure leads to a non stationary reservation wage, in order to determine equilibrium unemployment rate, we compute $G_{i,t}(w)$ the fraction at time $t$ of workers of age $i$ employed at wage $w$ or less. These functions are derived from the following equilibrium flows:

$$(p_1 - u_{1,t})G_{1,t}(w) = \pi_1\left[(1-\lambda)(p_1 - u_{1,t-1})G_{1,t-1}(w) + \phi_{1,t-1}\max\{0, F_1(w) - F_1(\overline{w}_1)\}u_{1,t-1}\right]$$

where $\phi_{1,t-1} \equiv \phi(\overline{s}_{1,t-1})$. At steady state, this equation implies:

$$[1-\pi_1(1-\lambda)](p_1 - u_1)G_1(w) = \phi_1 \max\{0, F_1(w) - F_1(\overline{w}_1)\}u_1$$

$$\Leftrightarrow G_1(w) = \frac{\phi_1 u_1}{[1-\pi_1(1-\lambda)](p_1-u_1)}\max\{0, F_1(w) - F_1(\overline{w}_1)\}$$

For age $i = 2,3,4,5$ the dynamics of the fraction of age $i$ employed workers at wage $w$ or less at time $t$ is given by:

$$\begin{aligned} & (p_i - u_{i,t})G_{i,t}(w) \\ = \ & \pi_i \left[(1-\lambda)(p_i - u_{i,t-1})G_{i,t-1}(w) + \phi_{i,t-1}\max\{0, F_i(w) - F_i(\overline{w}_i)\}u_{i,t-1}\right] \\ & +(1-\pi_{i-1})\left[\phi_{i,t-1}\max\{0, F_i(w) - F_i(\overline{w}_i)\}u_{i-1,t-1}\right. \\ & \left. +(p_{i-1} - u_{i-1,t-1})(1-\lambda)(1-\max\{0, G_{i-1}(\overline{w}_i) - G_{i-1}(\overline{w}_i)\})\right] \end{aligned}$$

For employees, the transition between age $i-1$ and age $i$ could lead to a voluntary quit if the wage accepted at age $i-1$ is lower than the reservation age at age $i$. This fraction of voluntary quits is measured by $(1-\pi_{i-1})(p_{i-1} - u_{i-1,t-1})(1-\lambda)\max\{0, G_{i-1}(\overline{w}_i) - G_{i-1}(\overline{w}_{i-1})\}$. At steady state, we then obtain:

$$\begin{aligned} & [1-\pi_i(1-\lambda)](p_i - u_i)G_i(w) \\ = \ & (1-\pi_{i-1})(1-\lambda)(1-\max\{0, G_{i-1}(\overline{w}_i) - G_{i-1}(\overline{w}_{i-1})\})(p_{i-1} - u_{i-1}) \\ & +u_i\pi_i\phi_i(F_i(w) - F_i(\overline{w}_i)) + u_{i-1}(1-\pi_{i-1})\phi_i(F_i(w) - F_i(\overline{w}_i)) \end{aligned}$$

For age $i = 5$, if $V_5^r > V_5^u$, then the dynamics of the fraction of age $i$ employed workers at wage $w$ or less at time $t$ is given by:

$$\begin{aligned} & (p_i - r_{i,t})G_{i,t}(w) \\ = \ & \pi_i(1-\lambda)(p_i - r_{i,t})G_{i,t}(w) + (1-\pi_{i-1})\left[\phi_{i,t-1}(F_i(w) - F_i(\overline{w}_i))u_{i-1,t-1}\right. \\ & +(p_{i-1} - u_{i-1,t-1})(1-\lambda)(1-\max\{0, G_{i-1}(\overline{w}_i) - G_{i-1}(\overline{w}_{i-1})\}) \end{aligned}$$

At steady state, we then obtain:

$$\begin{aligned} & (1-\pi_{i-1}(1-\lambda))(p_i - r_{i,t})G_{i,t}(w) \\ = \ & (1-\pi_{i-1})\left[\phi_i(F_i(w) - F_i(\overline{w}_i))u_{i-1}\right. \\ & +(p_{i-1} - u_{i-1})(1-\lambda)(1-\max\{0, G_{i-1}(\overline{w}_i) - G_{i-1}(\overline{w}_{i-1})\}) \end{aligned}$$

Notice that the equilibrium rates of unemployment by age depend on the equilibrium wage distributions, because some workers decide to quit their jobs. Moreover, the equilibrium wage distribution for a worker of age $i$ is a function of the equilibrium wage distribution of workers of age $i-1$. Finally, one can define the aggregate equilibrium wage distribution as follows:

$$(p-u)G(w) = \sum_i (p_i - u_i)G_i(w)$$

where the the aggregate participation rate $p$ is defined by $p = 1-r$, with $r$ the rate of retired workers.

## B.3 Government budget constraints

Social security is financed by a proportional tax on labor income levied on all working people. For the sake of simplicity, we assume that pensions and non-employment incomes are not linked to individuals' earning histories. For each period, the social security budget is balanced. Then non-employment incomes are financed by levying taxes on workers:

$$\tau_b \sum_{i=1}^{5} (p_i - u_i - r_i) \sum_j w_{i,j} dG_{i,j}(w_{i,j}) = \sum_{i=1}^{5} u_i b_i$$

Similarly, for pensions, we have:

$$\tau_p \sum_{i=1}^{5} (p_i - u_i - r_i) \sum_j w_{i,j} dG_{i,j}(w_{i,j}) + \tau_p \sum_{i=1}^{5} u_i b_i = r_6^6 p_6 + \sum_{i=5}^{6} r_i^5 p_5$$

where $r_5^5$ and $r_6^5$ denote respectively the rate of retirees at age 5 and 6 who have decided to retire at age 5, and $r_6^6$ the newly retired workers at age 6. These rate are defined by

$$\begin{aligned}
R_{5,t}^5 &= R_{5,t} \\
R_{6,t}^5 &= \pi_6 R_{6,t-1}^5 + (1-\pi_5) R_{5,t-1}^5 \\
R_{6,t}^6 &= \pi_6 R_{6,t-1}^6 + (1-\pi_5)(P_5 - R_{5,t-1}^5)
\end{aligned}$$

At steady state, these equations imply:

$$\begin{aligned}
r_5^5 &= r_5 \\
r_6^5 &= \frac{(1-\pi_5) r_5^5}{1-\pi_6} \\
r_6^6 &= \frac{(1-\pi_5)(p_5 - r_5^5)}{1-\pi_6}
\end{aligned}$$

The computation of the equilibrium allows us to find the tax rates $\tau_b$ and $\tau_p$ that balance both budgets.