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The influence of Unemployment Insurance rules on employment effects of pension reforms : evidence from France

Sarah Le Duigou^{*}; Pierre-Jean Messe[†]

Abstract. This paper examines how unemployment insurance rules influence the employment effects of pension reforms prior to retirement. We develop a job-search model with a finite horizon introducing age-specific unemployment insurance rules and endogenous separations. The latter result from the employer's decision to offer a mutually agreed termination after an adverse productivity shock and from the worker's choice to accept the offer. We estimate the structural parameters of the model using French data on quarterly job separation and finding rates for workers aged 55-59 years. The model fits the data at more than 99%. It allows to reproduce the observed peak in employment outflows when the distance to the legal retirement age equals the potential benefit duration of the UI system.

We demonstrate that combining an increase in the retirement age with a reduction in the generosity of the unemployment insurance scheme is an efficient policy for raising older workers' employment rates. We also put forward that the horizon effect, i.e. the positive effect of a rise in the legal retirement age on employment prior to retirement, is greater when the job-search requirements are low or when the potential benefit duration is high.

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1 Introduction

Over the last five decades, most OECD countries have experienced a significant aging of their populations. In France, the ratio of the number of persons aged 65 or over to the total working-age population was 23.7% in 2012 and is expected to reach 50% in 2050. As this demographic phenomenon puts considerable pressure on the financial balance of Pay-As-You-Go (PAYG) pension systems, retirement reforms remain a high priority on the public policy agenda.

Many European countries have chosen to extend the duration of working life by raising the legal retirement age. Recent evaluations indicate that a one-year increase in the retirement age has a positive effect on employment (Mastrobuoni, 2009; Staubli and Zweimüller, 2013; Vestad, 2013; Dubois and Koubi, 2017; Rabaté and Rochut, 2019; Cribb et al., 2019). Moreover, these reforms exhibit spillover effects, i.e. raising the retirement age encourages individuals to seek benefits from other social insurance programs such as unemployment or disability insurance (Staubli and Zweimüller, 2013; Inderbitzin et al., 2016; Rabaté and Rochut, 2019). Specifically, in European countries, unemployment insurance (UI hereafter) can serve as a pathway to retirement for older workers (Hairault et al., 2012; Lammers et al., 2013; Garcia-Perez and Sanchez-Martin, 2014). However, there is a lack of discussion regarding the influence of UI rules on employment effects of pension reforms. Another frequently overlooked aspect of pension reforms is their positive impact on employment at earlier ages. Since in most European countries the average effective exit age is substantially below the legal retirement age¹, the effect of these reforms on employment prior to retirement is a key policy issue.

This paper has two goals. First, we examine the mechanisms through which an increase in the legal retirement age affects employment prior to this age. We will refer to this effect as the horizon effect (Hairault et al., 2010). Second we investigate the influence of UI rules on this effect. We account for the replacement rate, the potential benefit duration (PBD hereafter) and the job search requirement of the UI scheme. We develop a dynamic labour supply model in which UI rules interact with pension reforms that delay the retirement age.

To build our model, we consider two categories of mechanisms through which older workers'

1. France exemplifies this phenomenon : in 2021, only 52.3% of French workers aged 60 were employed, whereas the legal retirement age is 62 years old.

employment is affected by both a change in pension and UI rules : those that pass through separation rates (employment outflows) and those that pass through job finding rates (employment inflows). Research on retirement and especially on the horizon effect puts more emphasis on the impact on employment inflows. An increase in the career horizon raises the job finding rate, since the return of job search and therefore the workers' search effort become higher (Ljungqvist and Sargent, 2008 ; Hairault et al., 2010).

Research on UI has also mainly focused on the effects of UI rules on older workers' job finding rates (Tatsiramos and Van Ours, 2014 ; Zweimüller, 2018). A bulk of empirical studies has shown that older workers' job search effort and finding rates are strongly discouraged once they become eligible for UI extended benefits (Lalive, 2008 ; Kyyrä and Ollikainen, 2008 ; Bennmarker et al., 2013 ; Inderbitzin et al., 2016) or for a specific UI regime that lowers the search requirements at older ages (Lammers et al., 2013 ; Hulleghie and Van Ours, 2014 ; Been and Knoef, 2017). Nevertheless, recent empirical evidence shows that UI rules also influence separation rates for workers close to retirement (Winter-Ebmer, 2003 ; Kyyrä and Wilke, 2007 ; Tuit and Van Ours, 2010 ; Baguelin and Remillon, 2015 ; Cahuc et al., 2016 ; Kyyrä and Pesola, 2019). In that case, UI serves as a pathway to retirement and may lead employers and employees to terminate the employment contract by mutual consent.

We choose to use a job-search model with finite horizon and endogenous search effort as in Hairault et al. (2010) that we extend in two ways. First, we carefully model age-specific UI rules for older workers. Rather than only considering the replacement rate of the UI scheme, we explicitly account for the unemployment duration to capture the individuals' responses to the UI benefits exhaustion (Marinescu and Skandalis, 2021) and for age-specific job search requirements. Second, we introduce a mechanism of endogenous job destruction. In our model, firms can offer a mutually agreed termination to their workers in the case of an adverse productivity shock. The workers can accept this offer or not. This kind of termination entails an amount of wage-dependent severance pay for the employer but strongly lower than in the case of dismissal for economic reasons (Signoretto, 2016). The interest for firms is therefore to reduce the separation cost. The interest for workers is to leave their job and to benefit from UI insurance. Even though unemployment implies a drop in income, the workers may be willing to incur this cost if the disutility of work is too high.

We estimate the structural parameters of this model through a method-of-moments estimator. The moments underlying the estimation are based on the quarterly job finding and job separation rates observed over the period 2003-2007 in France for the cohort of workers born in 1948. Then we test the predictive performances of our model exploiting the changes in French pension and UI rules that came into force over the period 2009-2012. The main reforms consisted of a rise in the legal retirement age and in stricter job-search requirements after 57.5 years old. We show that our model allows to replicate the quarterly transition and employment rates observed for the workers born in 1953, concerned by all these institutional changes.

We find that the estimated contact rate, i.e. the probability for older job-seekers to find a job at a given search effort, is very low. This result is consistent with the low job-finding rates observed in the data for workers close to retirement. In that case, a one-year increase in the legal retirement age would improve the employment rate before retirement mainly through a decrease in separations.

Our model is a useful tool of public policy evaluation especially to understand the mechanisms at work when UI rules interact with pension ones. It allows reproducing a peak in employment outflows when the distance to the legal retirement age equals the PBD of the UI system. From this age onwards, that we will refer to as the age of entry into the UI pathway, workers can leave their job and receive UI benefits until retirement without any uninsured period. Two mechanisms explain this peak. On the firms' side, the employers choose to offer a mutually agreed termination if the productivity falls below an endogenous threshold after an adverse productivity shock. This threshold depends on the distance to the legal retirement age. The shorter the workers' horizon, the higher the threshold, through a standard labour-hoarding effect (Mortensen and Pissarides, 1994; Cheron et al., 2013). In general, employers are willing to incur a loss now in anticipation of a future increase in the job's product. When workers are close to retirement, the expected job surplus is low so labour-hoarding becomes less valuable.

The workers' decision to accept or not this offer is based on the comparison between the value of being unemployed and receiving UI benefits next period and the value of remaining employed. When they reach the age of entry into the UI pathway, the value of being unemployed strongly increases because they expect to bridge the gap until retirement. Consequently, they are more

likely to accept the firms' offer ².

We could think at first sight that in this setting a one-year increase in the legal retirement age has the same effect as a one-year decrease in the PBD on the separation rates from the age of entry into the UI pathway onwards. We show that it is not the case. Indeed, mutually agreed terminations occur when the employers choose to offer this possibility to the workers and when the workers accept it. On the one hand, raising the legal retirement age has an effect on the firms' decision, because the workers' horizon lengthens, and on the workers' one because it shifts the age of entry into the UI pathway by one year. On the other hand, reducing the PBD of the UI scheme only affects the workers' choice to accept or not the mutually agreed termination but firms' incentives to offer this kind of termination remain unchanged. Consequently, a one-year increase in the legal retirement age is more efficient to reduce separations close to retirement age than a one-year reduction in the PBD of the UI system.

We also investigate the influence of job-search requirements on older workers' employment. In a setting of a very low job contact rate close to retirement, stricter search requirements could improve older workers' employment only through a reduction in employment outflows. The mechanism is the one described by Been and Knoef (2017) : since the UI pathway becomes less attractive for older workers, they are less likely to accept the mutually agreed terminations offered by their employer. We exploit the phased implementation of the reform in France to identify this effect. We show that for the cohort of workers only concerned by a rise in the legal retirement age (workers born in 1951), we observe a simple shift in the peak of separation rates, three years before the new legal retirement age. However, for the cohorts of workers concerned both by an increase in the retirement age and by stricter job-search requirements to receive UI (workers born in 1952 or in 1953), we observe a flattening of the age-profile of separation rates close to retirement. This suggests that the tightening of eligibility conditions for UI over the period 2009-2012 has reduced the value of being unemployed expected by employed older workers. As a response, they became more reluctant to accept mutually agreed terminations even after they

2. This mechanism is consistent with the French context. Cahuc et al. (2016) put forward the sharp rise in the termination rate of permanent employment contracts at 57 in 2007. Before 2010, the legal retirement age was set at 60 and the PBD of the UI system was three years for job-seekers aged 50 or more. More recently, the French national organization managing the UI scheme (UNEDIC (2023)) shows in 2023 a peak in mutually agreed terminations at 59, i.e. three years before the new legal retirement age that is 62 years old.

reach the age of entry into the UI pathway.

Our model also allows to test the effect of a taxation on the severance payment received by the workers in the case of a mutually agreed termination. This kind of policy only reduces the probability that firms offer such a termination procedure in the case of an adverse productivity shock at each workers' age close to retirement. However, it does not reduce the probability that workers will accept the offer. We find that the implementation of such a tax along with a rise in the retirement age is less efficient than combining the latter with a reduction in the duration of the UI scheme.

Last but not least, we show that UI rules strongly affect the horizon effect of a rise in the retirement age, i.e. its positive effect on employment prior to the legal retirement age. On the one hand, in a setting of generous UI benefits and long PBD (3 years) with no search requirement after 57.5 years old (e.g. the French case before the 2009-2012 reforms), increasing the legal retirement age by one year leads to an average employment gain of around +5 percentage points at 58 years old and 59 years old. On the other hand, in a UI system characterized by a lower PBD (1.5 years) and stricter job search requirements for older job-seekers, raising the legal retirement age by one year has a smaller positive employment effect at 58 (+1 percentage point), and at 59 (+3 percentage points). This may explain why the horizon effect in France is high : before and after the 2009-2012 French pension and UI reforms, employment rates among workers aged 55-59 years old increased from 55.4% to 67.5%. In the opposite, in Austria, the rise in the early retirement age in 2000 and 2003 did not significantly increase employment rates at earlier ages (Staubli and Zweimüller, 2013). In the Austrian case, the PBD ranges from 1 to 1.5 years (half of the French PBD) and the job-search requirements are stricter, so we expect a lower horizon effect.

The remainder of the paper is structured as follows. In the second section of this paper, we present the French institutional context, the changes in UI and pension rules since 2009 and the legislation regarding the terminations of open-ended contracts. In Section 3, we present the dynamic labour supply model and we explain the theoretical intuitions. In section 4, we explain our calibration method and our estimation strategy. In section 5, we test the empirical performances of our model and we simulate counterfactual policy reforms. The sixth section concludes.

2 Institutional Context

2.1 The increase in the legal retirement age and in the number of contributive quarters required to obtain full pension

The Woerth reform was voted in 2010 but came into force in 2011. Before 2011, the legal retirement age was 60 years old and the age at which workers received their full pension regardless of the number of contributive quarter was 65 years old. These two ages were gradually raised, with one additional quarter for each cohort born after 1950, reaching 62 years old for the legal retirement age in 2018 and 67 in 2023 for the full pension age. The second and third columns of Table 1 present this progression.

TABLE 1 – The evolution in the legal retirement age and the full rate duration by cohort

| Birth cohort | Full rate duration | Legal retirement age | Full pension age |
|--------------|--------------------|----------------------|------------------|
| 1948 | 160 | 60 | 65 |
| 1949 | 161 | 60 | 65 |
| 1950 | 162 | 60 | 65 |
| 1951 | 163 | 60 + 4 months | 65 + 4 months |
| 1952 | 164 | 60 + 8 months | 65 + 8 months |
| 1953 | 165 | 61 | 66 |
| 1954 | 166 | 61 + 4 months | 66 + 4 months |
| 1955 | 166 | 61 + 8 months | 66 + 8 months |
| 1956 | 166 | 62 | 67 |

Lecture : Workers born in 1953 are eligible to receive their full pension at the age of 61 if they have contributed 165 quarters to the pension system. They can receive their full pension regardless of their contribution to the pension system at the age of 66.

This reform is combined with the Fillon reform, enacted in 2003, which gradually increased the number of required contributive quarters to obtain a pension at the full replacement rate. Until 2008, 160 quarters (40 years) of contribution were required to receive a full pension. This reform, which came into force in 2009, gradually raised this duration to 164 quarters (41 years) in 2012 (for cohorts born in 1952) and then to 166 quarters for workers born in 1955 and later. The first column of Table 1 depicts this gradual change.

The early retirement scheme. The Fillon reform also introduced a long-career early retirement scheme that allows individuals who started working at 17 or earlier to retire earlier than the normal retirement age³. Initially, individuals who started working at 14 could retire at 56 if they met the eligibility criteria and had a sufficient number of contributive years.

The Woerth reform raised this early retirement age from 56 to 58 but expanded access to the early retirement scheme pathway to individuals who started working at 18 and earlier. It also made eligibility criteria stricter by removing the possibility for workers of buying-back pension quarters missed to be eligible for the scheme. These measures were enacted with a delayed implementation (starting from the cohort of workers born in 1955). Last but not least, a decree voted in July 2012 that came into force in November 2012 allowed workers who started working between 18 and 20 years old to be eligible to the long-career early retirement scheme. This involved a significant increase in the number of individuals eligible to this early retirement scheme since the end of 2012.

2.2 A change in UI rules for older workers

In France, UI rules for older workers aged 50 and over are particularly generous. The level of benefits is determined by previous wages with a high replacement rate : on average unemployment insurance recipients receive 69% of their previous net salary and the maximum benefit is more than 6000 euros (UNEDIC (2013)). PBD depends on the worker's previous work history and on the age at the date of job termination. This duration is quite long compared to many other countries : the maximum benefit duration is 3 years for workers aged 50 and over.

Furthermore, job search monitoring is relatively low. Up to 2008, workers aged 57.5 and over were even granted an official exemption from active job search (*Dispense de Recherche d'Emploi* or DRE hereafter). This exemption can also apply to unemployed workers aged 55 and over who have exhausted their unemployment insurance rights and have limited resources or who have contributed at least 160 quarters to the pension system. Over the period 2009-2012, access to

3. More precisely, the eligibility to this scheme was subject to a triple condition : i) having started working at 17 or before ; ii) having validated eight quarters more than the full rate duration, while the insurance duration had to be 16 quarters higher before the introduction of this measure (the validated quarters could be made up of short unemployment spells and other types of assimilated quarters) ; and iii) having a number of quarters of contribution higher than the full rate duration or not depending on age of the first contribution.

the DRE was gradually cancelled. From 2012 onwards, older job-seekers have to register, update their situation every month and meet their caseworker. The reform was implemented gradually raising the age thresholds for entry into the DRE. For the main case, i.e. job-seekers who are entitled to UI, the thresholds were 58 years old in 2009, 59 years old in 2010 and 60 in 2011. This means that the workers born in 1952, who reach 57.5 years old in 2009 is the first cohort affected by both changes in UI and pension rules.

2.3 The French dismissal protection and the mutually agreed termination

The French labour law defines two kinds of motives for dismissal. When the separation results from the employee's behaviour, the dismissal is for personal reasons and when it results from the firms' economic situation the dismissal is economic. However, the severance payment due in cases of economic dismissal is twice as high as the amount due in cases of a dismissal for personal reasons (Signoretto and Valentin, 2019).

A cost-benefit analysis may lead employers to report a layoff for personal reasons even in the case of economic difficulties. This practice was common at the end of workers' career. For example, in 2003, 70% of layoffs of workers aged 50 and over were for "personal" reasons (Amauger-Lattes and Desbarrats, 2006). More precisely, in 2007, the share of redundancies and dismissals for personal reasons strongly increased after 57 (Cahuc et al., 2016). Another firms' motive was to circumvent the Delalande tax set since 1986 and canceled in 2008 that concerned terminations of contracts of workers aged 50 and over.

In 2008, the French labour law introduced the mutually agreed termination. This procedure is a contract termination by mutual consent between the employer and the employee. Unlike dismissals, it does not have to be justified. And unlike resignation, the employee can benefit from UI and severance pay equivalent to the amount due in the case of a dismissal for personal reasons. The introduction of this new termination procedure did not result in a strong increase in separations close to retirement. It has simply replaced the redundancies and dismissals for personal reasons already observed at these ages (Minni, 2013; Cahuc et al., 2016).

3 A dynamic labour supply model with endogenous separations

3.1 Set-up

Our theoretical framework is based on a job search model "à la" McCall (1970) in which unemployed workers choose a search effort and a reservation wage that strongly influences their job finding rate. We extend this framework in three ways. First, as in Hairault et al. (2010), we introduce a finite horizon corresponding to the legal retirement age. Second, we introduce specific UI rules for older workers regarding age-specific search requirements, replacement rate and PBD. Third, we introduce endogenous separations. These new assumptions allow us to look at the interactions between transitions into and out of jobs, and retirement or UI reforms (Baguelin and Remillon, 2015; Been and Knoef, 2017).

We depart from Hairault et al. (2010) as we focus on the end of workers' career, using 55 as a starting age⁴. In our model, $t = 1$ corresponds to the first quarter of individuals aged 55 years old. We model dynamic labour supply decisions of older workers each quarter up to the age of 59, they reach the age just before the legal retirement age set at 60 for the benchmark case. So we look at employment and transition rates among workers aged 55-59 and we assume that all workers retire at 60.

Our model is similar to a basic labour supply model in which workers' utility denoted by u is derived from their consumption and their leisure time. As we do not account for capital accumulation in our model, consumption is exactly equal to the workers' income. Once they are retired and until they die, individuals benefit from a pension depending on their previous wage w and their leisure time is equal to the total available time T . This defines our model's terminal condition.

At each age t , unemployed individuals choose an optimal search effort s^* , i.e. the time devoted to search for a job. Then, we deduce the workers' probability of receiving a wage offer. We explicitly account for the unemployment duration to capture the individuals' responses to the UI benefits exhaustion. UI replacement rate differs according to the number of quarters d spent in unemployment. As a benchmark, we adopt the PBD of the French UI system, i.e. 12 quarters.

4. It is worth noting that Hairault et al. (2010) do not find any significant horizon effect before age 55.

For $d \in [1; 12]$, UI benefits depend on the previous wage at a replacement rate b and if d exceeds 12 quarters, UI benefits strongly decrease to a lump-sum denoted by \underline{b} . This corresponds to a situation in which individuals shift from the insurance regime to the solidarity one.

If the wage offered is higher than their reservation wage, which depends on their distance to retirement, their previous wage and their unemployment duration, they accept and go back to employment. In the contrary case, they keep on searching. We introduce age-specific search requirements to account for the exemption from active job search. In our model, if $t < 10$, i.e., before workers reach 57.5 years old, a minimal job search effort \underline{s} is required to allow job-seekers to benefit from UI insurance. However, workers aged 57.5 and over are exempted from search effort and can receive UI benefits even if they do not search actively for a job.

In our model, each worker receives a wage w that is exogenous. Our economy is characterized by a cumulative distribution function of offered wages denoted by $F(w)$. The output of a worker is composed of a stochastic component ϵ and of the worker's productivity that we assume equal to her wage w . When a firm recruits a worker of age t , both the productivity ϵ and the offered wage are drawn randomly according to their respective distributions⁵. At, each period, this stochastic component of productivity ϵ is drawn following a Bernoulli distribution. We choose to consider two values of ϵ : a negative value $\underline{\epsilon}$ that occurs at a rate λ and a positive one $\bar{\epsilon}$ that occurs at a rate $(1 - \lambda)$.

Employers can decide to terminate the job by offering a mutually agreed termination and spending a severance pay, that is a fraction τ of the wage. If the employee chooses to accept the termination, she receives the severance pay and becomes unemployed with UI benefits, if she refuses it, she remains employed in the job. We also introduce job destructions for reasons that are exogenous to our model. This may correspond for instance to the end of fixed-term contracts. If this event occurs at a probability δ , the job is terminated and the worker receives UI benefits.

5. At first sight it could be surprising that a random productivity is drawn when the match is created. Since we consider a discrete-time model with a quarterly basis, we could view the elapsed time between match creation and the next period as a trial period during which the productivity of the job is revealed and the job is not protected. In the case of a low output, the employer can terminate the contract without any costs and the worker goes back to unemployment.

3.2 Value functions and job search

The value of being unemployed at age t , denoted by $U_t(w, d)$, depends on the previous wage w , on the time devoted to search for a job $s_t^*(w, d)$ chosen by the worker and on tenure in unemployment d that determines the amount of UI benefits $rr(w)$, given the following formula :

$$rr(w) = \begin{cases} bw + \tau w & \text{if } d = 1 \text{ and the separation results from a mutually agreed termination} \\ bw & \text{if } d = 1 \text{ and the separation is exogenous} \\ bw & \text{if } 2 \leq d \leq 12 \\ \underline{b} & \text{if } d > 12 \end{cases}$$

The value of unemployment $U_t(w, d)$ depends positively on the unemployment benefits $rr(w)$ and negatively on the search effort $s_t^*(w, d)$. We assume that the probability of receiving a job offer depends on the optimal time devoted to the job search $s_t^*(w, d)$ according to a function $\phi s_t^*(w, d)^\alpha$ where ϕ stands for the contact rate and α corresponds to the efficiency of this search time.

In the next period, when job-seekers receive a job offer, they decide whether to accept it or not. Given the offered wage w' , they compare the value of being employed $W_{t+1}(w')$ to the value of remaining unemployed $U_{t+1}(w, d + 1)$. If they accept the job, a new stochastic component of its productivity is drawn following a Bernoulli distribution. If ϵ falls below a threshold denoted by $R_t^0(w')$, the newly created match is not profitable for the firm and the employer terminates the contract without any costs. Let $\mathbf{1}_{\epsilon < R_t^0(w')}$ be a dummy equal to one if ϵ falls below the threshold $R_t^0(w')$ in the case of a negative productivity shock and 0 otherwise.

Job-seekers may therefore remain unemployed for several reasons. Either they did not receive any job offer at a rate $1 - \phi s_t^*(w, d)^\alpha$ or they received a job offer but either they refuse it or the newly created match is eventually not profitable for the firm.

Let β be the discount rate, $U_t(w, d)$ writes as :

$$U_t(w, d) = u(rr(w), T - s_t^*(w, d)) + \beta \phi s_t^*(w, d)^\alpha \int_{w' \geq 0}^{\bar{w}'} [\lambda(1 - \mathbf{1}_{\epsilon < R_t^0(w')}) + (1 - \lambda)] \max\{W_{t+1}(w'); U_{t+1}(w, d + 1)\} dF(w')$$

$$+\beta \left(1 - \phi s_t^*(w, d)^\alpha + \phi s_t^*(w, d)^\alpha \int_{w' \geq 0}^{\bar{w}'} \mathbf{1}_{\epsilon < R_t^0(w')} dF(w') \right) U_{t+1}(w, d + 1)$$

The optimal search effort $s_t^*(w, d)$ will depend on search requirement rules. For $t < 10$, i.e. before reaching 57.5 years old, job-seekers have to devote a minimal number of hours \underline{s} to job search to be entitled to UI benefits. However, once they are aged 57.5 and over, they benefit from a job search exemption and their search effort may be nil. So, the optimal search effort is determined as follows :

$$s_t^*(w, d) = \begin{cases} \max\{\underline{s}; \operatorname{argmax}\{U_t(w, d)\}\} & \text{if } t < 10 \\ s_t^*(w, d) = \operatorname{argmax}\{U_t(w, d)\} & \text{if } t \geq 10 \end{cases}$$

The value of being employed at age t and receiving a wage w , denoted by $W_t(w)$, depends positively on the wage received w and negatively on the exogenous number of hours worked h . In the next period, the job may be destroyed for exogenous reasons, such as the end of a fixed-term contract, at a rate δ . In that case, the employee leaves the job and enters into its first quarter of unemployment. The corresponding asset value is $U_{t+1}(w, 1)$.

If there is no exogenous job destruction, a new job productivity is drawn. If this new productivity falls below a threshold $R_t(w)$, employers offer employees a mutually agreed termination and a severance pay τw that depends on wage. Let $\mathbf{1}_{\epsilon < R_t(w)}$ be a dummy equal to one if ϵ falls below the threshold $R_t(w)$ in the case of a negative productivity shock and 0 otherwise.

If the asset value of being unemployed and receiving this severance pay exceeds the value of staying on the job, workers decide to accept the mutually agreed termination. This decision is age-dependent and depends particularly on the distance to retirement date. We could expect that the lower this distance, the higher the probability for workers to seize this opportunity to stop working before the legal retirement age.

The value of being employed at age t and receiving a wage w is expressed as :

$$W_t(w) = u(w, T - h) + \beta \left(\delta U_{t+1}(w, 1) + (1 - \delta) \lambda \mathbf{1}_{\epsilon < R_t(w)} \max\{W_{t+1}(w), U_{t+1}(w, 1)\} \right) \\ + \beta (1 - \delta) [\lambda (1 - \mathbf{1}_{\epsilon < R_t(w)}) + (1 - \lambda)] W_{t+1}(w)$$

Hereafter, we sum up the workers' decision to accept the mutually agreed termination by the

following choice variable :

$$\begin{aligned} D_t(w) &= 1 \iff W_{t+1}(w) < U_{t+1}(w, 1) \\ &= 0, \text{ otherwise} \end{aligned} \tag{1}$$

3.3 Firms' separation decision

We assume that there is free-entry in the market so that the value of a vacancy is zero. The value for a firm of employing a worker of age t , with a current output ϵ and a wage w is denoted by $J_t(\epsilon, w)$. We assume that the instantaneous output equals $\epsilon + w$. Consequently the instantaneous profit of the firm depends only on ϵ . At each period, the job can be destroyed for exogenous reasons at a rate δ without any costs for the employer. In the contrary case, a productivity is drawn following a Bernouilli distribution. If ϵ is lower than the termination threshold $R_t(w)$, the employer offers a mutually agreed termination.

Even if the instantaneous profit does not depend on wage, the intertemporal value of a job still depends on wage since it affects the retention rate of the job through workers' decision to accept the mutually agreed termination $D_t(w)$. Indeed, whatever the value of ϵ , firms continue to produce in the next period unless the job is hit by an exogenous chock δ or if workers accept the mutually agreed termination.

The value of a job $J_t(\epsilon, w)$ is written as follows :

$$\begin{aligned} J_t(\epsilon, w) &= \epsilon + \beta(1 - \delta)(1 - \lambda)J_{t+1}(\bar{\epsilon}, w) \\ &+ \beta(1 - \delta)\lambda([1 - \mathbf{1}_{\epsilon < R_t(w)}]J_{t+1}(\underline{\epsilon}, w) + \mathbf{1}_{\epsilon < R_t(w)}([1 - D_t(w)]J_{t+1}(\underline{\epsilon}, w) - D_t(w)\tau w)) \end{aligned}$$

The productivity and termination thresholds of firms are defined in the following way :

$$\begin{aligned} J_t(R_t^0(w), w) &= 0 \\ J_t(R_t(w), w) &= -\tau w \end{aligned}$$

Note that the severance payment in the case of mutually agreed termination increases with the wage w . Consequently, the higher the wage, the lower $R_t(w)$ and hence the lower the probability that the employer offers a mutually agreed termination after an adverse productivity shock ⁶.

6. This is consistent with stylized facts regarding mutually agreed terminations in France (Minni, 2013). Over the period 2008-2012, 70% of mutually agreed terminations concerned low-paid occupations like blue-collar workers or clerks while only 20% of such terminations concerned managers and executives.

3.4 Backward model solving

The model is solved recursively from a terminal condition that corresponds to the discounted sum of income flows that individuals receive during retirement. Let $N_R(w)$ be this sum, we have :

$$N_R(w) = \sum_{t=1}^L \beta^{t-1} u(Pe(w), T)$$

where L stands for the death time and $Pe(w)$ corresponds to the quarterly amount of pension ⁷.

At $t = 20$, just before the retirement date, the value of being employed denoted by $W_{t=20}(w)$ depends on the wage w , the disutility of working hours h in the present period and the expected discounted flows of income from retirement.

$$W_{t=20}(w) = u(w, T - h) + \beta N_R(w)$$

The value of being unemployed at $t = 20$ denoted by $U_{t=20}(w, d)$ depends on the previous wage w and on the number of quarters spent at unemployment d that determine the amount of UI benefits. There is no incentive to search for a job as unemployed expect to retire at the next period and are exempted from job search effort. So, the optimal search effort for $t = 20$ is equal to 0. Consequently, $U_{t=20}(w, d)$ is written as :

$$U_{t=20}(w, d) = u(rr(w), T) + \beta N_R(w)$$

3.5 Labour market stocks and flows

We compute the separation rates recursively from our theoretical model for each period and at a given wage level w . $EN_t(w)$ corresponds to the proportion of individuals who were employed, at a wage w at $t - 1$ and entered unemployment at t . This transition may result either from exogenous job destruction at a rate δ or from individuals' endogenous decisions to seize the opportunity of a mutually agreed termination of contract. We determine $EN_t(w)$ in the following way :

7. One can argue that the way the pensions are computed in the paper makes them fully dependent on the last wage. To avoid this particularly strong dependence, we can add a fixed component in the pension calculation. In France, in the private sector, pensions are indexed on the mean wage of the 25 best years. In our framework, we model only 5 years of the individuals' working life. Note that generally, these 5 years are also the 5 best years in terms of wage over the working life. An alternative way of modelling would be therefore to index the pension at 5/25 % on the last wage and at 20/25% on the mean wage of workers at 55 that we observe in the data. We can show that this does not change qualitatively the results of our simulations.

$$EN_t(w) = \delta + (1 - \delta)\lambda \mathbf{1}_{\underline{\epsilon} < R_t(w)} D_t(w)$$

These separation rates at each age t and for each wage value w allow us to determine the dynamics of the number of new unemployed individuals.

We also compute job-finding rates at each age t , for each previous wage w and for each unemployment duration d . These rates denoted by $NE_t(w, d)$ are determined by three key variables : the optimal search effort $s_t^*(w, d)$, the probability that a new job is profitable for the firm equal to $(1 - P(R_t^0(w)))$ and the job-seeker's decision to accept this new job.

These behaviours are expected to vary according to the distance to retirement but also according to the amount of unemployment benefits and to the unemployment duration. $NE_t(w, d)$ is written as :

$$NE_t(w, d) = \phi s_t^*(w, d)^\alpha \int_{w' \geq w'^R(w, d)}^{\bar{w}} [\lambda(1 - \mathbf{1}_{\underline{\epsilon} < R_t^0(w')}) + (1 - \lambda)] dF(w')$$

where w'^R stands for the reservation wage depending on the previous wage w and the unemployment tenure d , i.e. the minimal wage offered such that the value of being employed is higher than the value of remaining unemployed.

This enables us to characterize the dynamics of the number of unemployed individuals for each amount of unemployment benefits depending on the previous wage w and each unemployment duration d . Using job separation and finding rates at each age t , it is straightforward to estimate the number of employed individuals at next period aged $t+1$ and receiving w . Next, by summing up the number of employed individuals leaving their job the next period and dividing it by the number of employed individuals of age t , we obtain job separation rates at each age t . Finally, we compute job-finding rates at each age by summing up the number of unemployed individuals who find a job in the next period over all the values of previous wages w and all the unemployment durations d and by dividing it by the total number of unemployed at age t .

4 Model, calibration and estimation strategy

4.1 The data

To estimate the structural parameters of our model, we use a simulated moments method that consists in replacing the computations of analytic moments with simulations. The moments used in the estimation are based on quarterly job finding and separation rates computed at each age t . We calculate these worker flows using the French Labour Force Surveys (FLFS hereafter) from 2003 to 2012. Since 2003, each individual in the FLFS is surveyed every quarter for six consecutive quarters. However, in our study, we calculate transition rates for individuals surveyed in two consecutive quarters rather than six. This allows us to have a larger sample at each age and for each cohort studied. Unlike Choi et al. (2015) we measure quarterly labour force transitions instead of monthly ones. While Hairault et al. (2015) consider monthly flows from the FLFS using the retrospective survey, we depart from their approach, considering that infra-quarterly transitions are less frequent towards the end of one's career. Besides, this choice is convenient since the unit of time considered for retirement policies is the quarter. As we do not use retrospective data, we do not need to correct for a potential recall bias.

We impose several restrictions to define our sample. First we focus on individuals whose current or last job was in the private sector. Transition rates of civil servants have specific features beyond the scope of this paper. We also exclude individuals who left the schooling system and started working before the age of 18, as they are potentially eligible to the long-career early retirement scheme introduced in France in 2004, allowing them to retire before the legal retirement age. As we do not know precisely whether the respondents are effectively eligible to this early retirement scheme, we prefer to exclude individuals who started working early.

To make our sample as homogeneous as possible, we also exclude those who started working at 21 or later, focusing on a sub-sample of individuals who started working between 18 and 20 years old. This category of workers is not eligible to the long-career early retirement scheme and is expected to have a sufficient insurance duration to the pension scheme to draw a pension at the full rate once they reach the legal retirement age. Consequently, they are particularly concerned by a change in this age⁸. We restrict our period of study to 2012 because since 2013, a large

8. In our sample, the quarterly separation rate at 60 is 14.16%. It means that more than half of people still

fraction of individuals in our sample become eligible to the long-career early retirement scheme.

As the frontier line between unemployment and inactivity is somewhat blurred for older workers, as they could benefit from job search exemption once they reach 57.5 years old at least before 2009, we could abstract from inactivity and focus only on job finding/separation rates. So we merge unemployment and inactivity into a non-employment state. One could argue that in the FLFS, individuals are asked whether they are unemployed and actively looking for a job. We also know whether they are registered with the National Public Employment Service, which seems a good proxy for job search requirements. Indeed, individuals are asked whether they are registered and not exempted from job search, registered and exempted from job search (until 2012) or not registered.

However, if we consider that an inactive individual is someone who answers that she is not registered, we find that around 71.65% of respondents who are not employed are inactive among those born in 1948 in our sample. This would mean that more than two thirds of people out of employment do not receive any unemployment benefits which is not really plausible. Consequently, we prefer merging unemployment and inactivity into a non-employment state to avoid misclassification errors.

4.2 Descriptive statistics on employment and transition rates before and after reforms

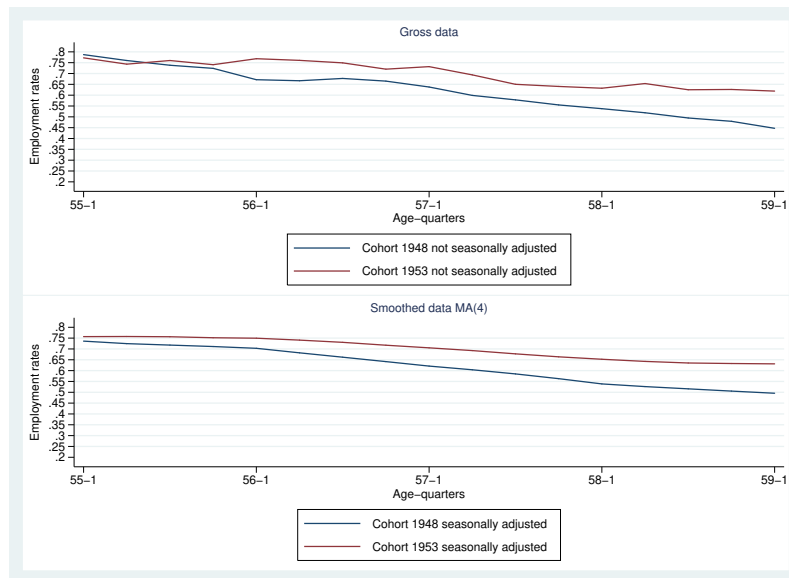
We compare two cohorts of individuals : those born in 1948 not concerned by UI and pension reforms and those born in 1953, affected by UI and pension reforms. Our sample contains 3919 individuals born in 1948 and 6270 individuals born in 1953. Descriptive statistics of the sample for these two cohorts are presented in Table 3 in Appendix A.

Figure 1 shows age profiles of employment rates for workers aged 55-59 by birth cohort. As we use quarterly rates, each age is divided by 4 quarters. For example, for the cohort of workers employed at 59 are not employed once they reach 60. Note that if we had included in our sample individuals who started working after the age of 20, this separation rate at 60 would be only 3.94%. This justifies our sample restrictions.

born in 1948, 55-1 corresponds to the first quarter of the year 2003, i.e. when these workers are 55 years old. To remove the seasonality linked to the quarterly data on employment rates, we use a 4-quarter centered moving-average smoothing method.

We observe a similar evolution between both 1948 and 1953 cohorts for workers aged 55-56 but then the decrease in employment rates is less steep for the 1953 cohort. This suggests that a higher fraction of workers aged 57-59 stay in employment after the changes in UI and pension rules enacted since 2009. The increase in employment rates among workers aged 59 before and after the reforms is quite substantial. For the workers born in 1948 that are not concerned by the French pension and UI reforms enacted over the period 2009-2012, the employment rate at the age of 59 years is only 49.6% while it amounts to 63.1% for workers born in 1953 that are fully affected by these changes in UI and pension rules.

FIGURE 1 – Gross and seasonally adjusted series of employment rates among workers aged 55-59 years old for the 1948 and 1953 cohorts



Note : The sample includes only individuals working or having worked in the private sector aged 55-59 of the cohorts 1948 and 1953 and who started working between 18 and 20 years old. The series have been seasonally adjusted by a 4-quarter centered moving-average smoothing method. We present quarterly rates, dividing each year (age) in 4 quarters. For example, for the 1948 cohort 55-1 corresponds to the first quarter of the year 2003 i.e. when these workers are 55 years old. Source : French Labour Force Surveys (2003-2012)

In Appendix B, we demonstrate that this strong positive horizon effect does not result from a

selection bias on observables. When we regress a dummy indicating whether the individual is employed or not on a dummy equal to one if the individual is born in 1953 (the cohort treated by the reforms) controlling for observable characteristics, age and time dummies, we find that employment rates among the workers born in 1953 is 11.1 points higher than the employment rates among workers born in 1948. This effect is strongly significant.

In addition, to ensure that this effect does not result from a pure cohort effect, we also compare in Appendix B the employment rates among workers born in 1948 and in 1953 who started working at 23 or later. We expect that the labour-supply behaviour of these workers is rather affected by the eligibility age for full pension benefits than by the legal retirement age. We fail to find any significant positive effect of the reforms on employment among workers born in 1953. The coefficient associated with the cohort 1953 is only 0.015, which is almost ten times lower than the one estimated in our baseline model. This placebo test shows that the positive horizon effect can be attributed to the policy and not to specific characteristics of workers born in 1953.

To define transition rates, we match individuals across two consecutive quarters based on the interview identification number. In each quarter t , individuals are employed (E) or not employed (N). We define a dummy D_{it}^{XZ} equal to one if the individual i has transitioned from status $X \in \{E, N\}$ in $t - 1$ to $Z \in \{E, N\}$ in t . We average these indicator variables for each quarter t for each age $a \in \{55; 59\}$ and for each cohort $c \in \{1948; 1953\}$. Let $\Upsilon_i(a, t, c)$ be a dummy variable that indicates whether the individual is observed in quarter t , belongs to cohort c and is a years old. We define the corresponding worker flows in the following way :

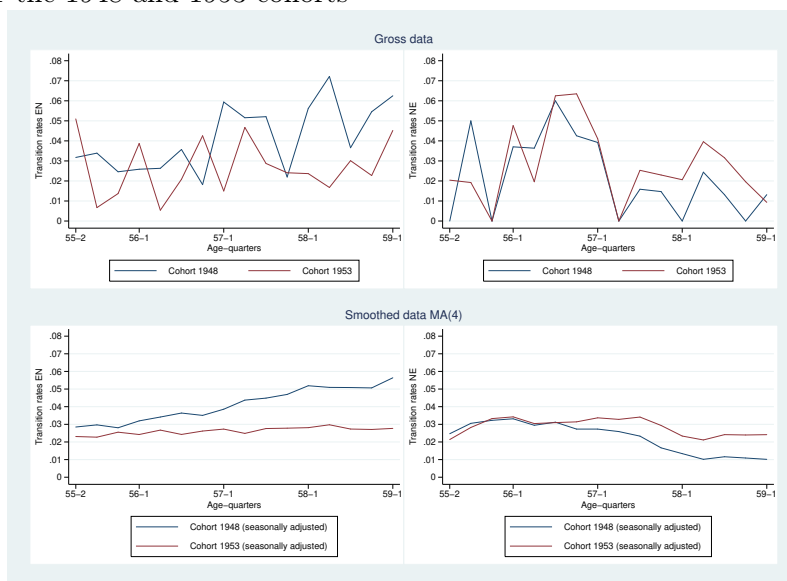
$$f_{atc}^{XZ} = \frac{\sum_{i=1}^n D_{it}^{XZ} \Upsilon_i(a, t, c)}{\sum_{i=1}^N D_{it}^X \Upsilon_i(a, t, c)}$$

where D_{it}^X equals 1 if the individual was in state X in $t - 1$. For expositional reasons, for a given cohort c , for a given age a and a given quarter t , we denote XZ_t , with $X \in \{E, N\}$ and $Z \in \{E, N\}$, the quarterly transition rates from state X to state Z between $t - 1$ and t .

Figure 2 depicts the quarterly transition rates by age (divided by quarters) and by cohort (1948 and 1953). As for the employment rates, we show the gross and seasonally adjusted data of these worker flows. We see that the increase in employment is explained by both a decrease in the employment outflows (EN) and an increase in the employment inflows (NE). Employment

outflows sharply increase between 55 and 59 years old for the workers born in 1948 while this profile is much flatter for the cohort of workers born in 1953, i.e. affected by the changes in UI and pension rules. In addition, employment inflows have a similar profile before and after the reforms until the age of 57 years but they exhibit a stronger decline after 57 years old for the cohort of workers born in 1948 not concerned by the reforms.

FIGURE 2 – Gross and seasonally adjusted series of transition rates among workers aged 55-59 years old for the 1948 and 1953 cohorts



Note : The sample includes only individuals working or having worked in the private sector aged 55-59 of the cohorts 1948 and 1953 and who started working between 18 and 20 years old. The series have been seasonally adjusted by a 4-quarters centered moving-average smoothing method. We present quarterly rates, dividing each year (age) in 4 quarters. For example, for the 1948 cohort, 55-1 corresponds to the first quarter of the year 2003 i.e. when these workers are 55 years old. Source : French Labour Force Surveys (2003-2012)

In appendix C, using a Markov-chain analysis (Choi et al., 2015), we measure the contribution of each transition rates to the observed employment rate evolution between the two cohorts. This exercise shows that the evolution in employment rate is mainly driven by the reduction in separation rates over the two cohorts.

4.3 Calibration of baseline economy

We group all the parameters of our model into three categories. The first category, defined by the vector $\Omega = \{\beta, \nu, \sigma, \rho, b, \underline{b}, T, h\}$, is fixed on the basis of external information. The discount factor β is set at 0.99, yielding an annual interest rate of 4% (Hairault et al. (2010)). As in Hairault et al. (2010), the utility function is defined as :

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

where c stands for the individuals' consumption equal to their income, $T - z$ represents their leisure time, ν is the consumption share in utility function and σ is the relative risk aversion. As in the standard literature we set $\nu = 0.33$ and $\sigma = 2$ (Hairault et al., 2010).

ρ is the replacement rate of the French retirement system. On average, for the general regime, it amounts to 0.7 (DREES (2004)). b is the replacement rate of the French unemployment insurance regime, set at 0.7 (UNEDIC (2016)) and \underline{b} stands for the solidarity allowance received by unemployed workers who have exhausted their rights. According to the French unemployment insurance scheme, we set $\underline{b} = 500$. T is the total available time to share between leisure time and z , which can be either working hours h or job-search effort s_t when the worker is unemployed⁹. Here, we assume that the number of working hours h is exogenous and corresponds to a full-time job on the basis of 35 hours a week. We allow the search effort to range from 0 to a number of hours equal to h . We consider a grid of 100 values of s_t and we define the value of s_t by the rank in the grid. For example, a rank of 50 corresponds to a value of $s_t = \frac{h}{2}$. In that case, the utility cost of job search requirements would amount to that of a part-time job.

A second category of parameters will help us to define the initial condition of our model, i.e. the number of employed individuals who received a wage w and the number of unemployed for each amount of unemployment benefits and each unemployment duration at $t = 1$. Indeed, to simulate the evolution of job finding and separation rates between 55 and 59 years old, we need to know the initial distribution of wages, wage offers, unemployment benefits and duration. We directly import this information from the data based on the FLFS collected over the period 2003-2007, i.e. before the change in unemployment insurance and pension rules.

9. On a yearly basis, $T = 8736$, $h = 1820$ and s_t ranges from 0 to $h = 1820$

The cumulative distribution of wages received by employed workers corresponds to the empirical one observed in the FLFS for workers aged 55 in 2003. For the cumulative distribution of wage offers, we consider only wages corresponding to job tenures of less than one year. As we have too few observations, we consider this distribution for workers aged 55-59 over the period 2003-2007. The FLFS also provides information on the amount of unemployment benefits and unemployment duration of unemployed respondents, even though this information is self-reported. We look at the distribution of unemployment benefits for each unemployment duration for workers aged 55 over the period 2003-2007.

The fraction τ of wage that has to be paid by employers in the case of mutually agreed terminations is set at $\tau = 0.25$. Given the wage distribution, it allows to reproduce a median amount of severance payment of around 1500 euros that corresponds to the one observed in France over the period 2008-2012.

A third category of parameters corresponds to a vector of unknown structural parameters that we have to estimate. Among these parameters, we have to characterize the cumulative distribution of the stochastic component of the job's productivity ϵ . We choose to consider two values of ϵ . Recall that the job's productivity is composed of this stochastic component ϵ and of the worker's productivity that we assume equal to her wage w . The low value $\underline{\epsilon}$ that occurs at a rate λ is set such that the lowest value of instantaneous output $\epsilon + w$ equals 0. In other words, the low value of epsilon is set to $-\underline{w}$, where \underline{w} denotes the minimum wage observed for workers aged 55 in 2003 in our data. In the case of an adverse productivity shock, a firm employing a worker who receives this minimum wage has an output equals to 0 but a firm employing a more productive worker still gets a positive output. The high value $\bar{\epsilon}$ is estimated. Given the wage distribution is directly imported from the data, we simulate a continuous distribution of the output.

In this setting, 6 unknown parameters have to be estimated through the method-of-moments estimator : the exogenous job destruction rate δ , the efficiency of job search effort α , the rate ϕ at which job-seekers have a wage offer given their search effort, the probability for a firm to draw a low productivity level λ , the minimal job search effort \underline{s} required to be entitled to UI benefits at least until job-seekers reach 57.5 years old in the benchmark case, and the high value of the stochastic component of the productivity $\bar{\epsilon}$.

Note that as mentioned previously, search effort is defined by a rank in a grid. Consequently, the value of \underline{s} is discrete and its estimation leads us to conduct our estimation strategy in two steps. In step 1, we define a vector Θ of structural parameters for each value of \underline{s} , with $\dim(\Theta) = 5$ by :

$$\Theta = \{\delta, \alpha, \phi, \lambda, \bar{\epsilon}\}$$

Let ψ be a vector of empirical moments defined as quarterly job separation and finding rates denoted respectively by EN_t and NE_t where $t \in [2; 17]$. The vector ψ writes as :

$$\psi = \begin{pmatrix} NE_2 & EN_2 \\ NE_3 & EN_3 \\ \vdots & \vdots \\ NE_{17} & EN_{17} \end{pmatrix}$$

$\psi(\Theta)$ denotes the vector of quarterly transition rates predicted by the model as a function of parameters Θ . An estimate $\hat{\Theta}$ of Θ minimizes the quadratic form : $(\psi - \psi(\Theta))'W(\psi - \psi(\Theta))$, where W is a weighting matrix¹⁰. W is the identity matrix in which we have assigned greater weight to particularly well-identified moments. In our analysis, we have chosen to emphasize key moments of our model, such as the first and last moments of transitions into and out of employment, as well as moments corresponding to the observed jumps in separations and in job-finding rates around respectively 57 and 57.5 years old. We have chosen this weighting matrix to make sure that our fitted model generates these jumps. The variance covariance matrix for parameter estimates is given by $Q_s(W) = (1 + \frac{1}{S})[\frac{\partial\psi(\Theta_0)'}{\partial\Theta} W * \frac{\partial\psi(\Theta_0)}{\partial\Theta}]^{-1}$, where $\frac{\partial\psi(\Theta_0)}{\partial\Theta}$ is the derivative of the vector of moments with respect to the parameter vector and S is the number of simulations. Step 2 consists in estimating the last structural parameter \underline{s} by choosing the value of this parameter that minimizes the criterion function.

4.4 Identification strategy

In this subsection, we clarify our identification strategy and provide theoretical intuitions regarding the effect of parameters on employment and transition rates. First, the arrival rate δ of the

10. The minimization of the simulated criterion function is carried out using the Nelder-Mead method provided in the Matlab numerical optimization toolbox.

exogenous termination shock determines the lowest separation rate observed at 55 years old in the data. Indeed, when workers are too far from their retirement age, so that UI can not bridge the gap until retirement, they always reject the offer of mutually agreed termination. In that case, job terminations are only exogenous. In the data, for the individuals born in 1948, the lowest separation rate observed at 55 years old equals 3.1%. This would correspond to the estimated value of δ .

In addition, our set of moments allows us to identify the four remaining parameters. Indeed, age profiles of transition rates are characterized by a minimum and a maximum, a trend over the workers' age or jumps at specific ages. The estimated parameters must be able to replicate these features. For instance, the highest value of ϵ determines the magnitude of the labour-hoarding effect at each age (Mortensen and Pissarides, 1994; Cheron et al., 2013) in the case of a negative shock. Employers are willing to incur a loss now in anticipation of a future increase in the job's product. If $\bar{\epsilon}$ is high, employers will be less likely to offer a mutually agreed termination in the case of an adverse productivity shock. However, the shorter the worker's remaining horizon, the lower the expected job surplus so labour-hoarding becomes less valuable. Consequently, the parameter $\bar{\epsilon}$ influences a threshold worker's age at which firms would like to terminate the job.

The arrival rate λ of an adverse productivity shock affects the number of firms who experienced such a shock and who offer a mutually agreed termination after the threshold age. We expect that workers close to their retirement age will be more willing to accept the offer, so that λ rules the highest value of separation rates, i.e., when older workers always accept the termination. In the data, this highest value equals 5.4%. This would correspond to a value of λ equal to $5.4 - 3.1 = 2.3\%$, where 3.1% is the lowest value of separation rates defined by δ .

The last two parameters, i.e. the efficiency of job search effort α and the rate ϕ at which job-seekers have a wage offer given their search effort are identified using the age profile of job finding rates. The efficiency of search affects the shape of this profile. The shorter the remaining horizon, the lower this return. This induces that, in the model and in the literature, the search effort is decreasing with age. If $\alpha = 0$, the contact rate would not depend on search effort and would be only equal to ϕ , constant over age. If α is high, the contact rate strongly depends on this effort and the decreasing age-profile of job finding rate is expected to be steeper.

The rate ϕ rather rules the highest value of the job finding rate, that would correspond to the age at which the search effort is the highest.

5 Results

5.1 Empirical performances of the model

Table 2 reports estimates of structural parameters and their associated standard errors. Thanks to our upweighting procedure, the first four parameters are precisely estimated. Note that the minimal job-search requirement estimated suggests that the utility cost of this requirement for unemployed equals the utility cost of a job with 19 hours and 15 minutes a week (55% of a full-time job on a basis of 35 hours a week).

We check whether the simulated moments match their empirical counterparts. The figure 3 depicts the observed and simulated profiles of separation, job finding and employment rates between 55 and 59 years old of workers born in 1948. Our model allows to reproduce quite well the empirical moments. Regarding job finding rates, our model replicates a quite flat profile until 57.5 years old (57 years and 2 quarters) and then a declining one observed in the data. Indeed, once workers reach 57.5 years old, they are entitled to job-search exemption, which discouraged them to search actively for a job. Note that the estimated value of the job contact rate may seem low, nevertheless, it allows to replicate the average quarterly job finding rates observed close to retirement that range from 1 to 3%.

Regarding separation rates, our theoretical model generates a jump at 57 that corresponds to the age of entry into the UI pathway. In the data, this jump is less sharp but we observe a change in the trend after 57. This is consistent with the previous findings of Hairault et al. (2016).

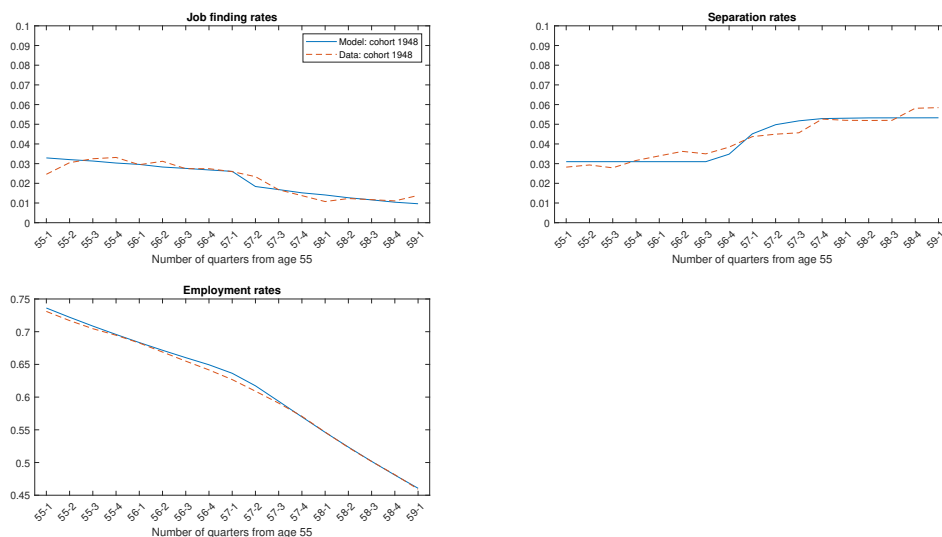
The share of the employment rate variance for workers aged 55 to 59 explained by the model is given by :

$$\frac{V(E_t) - \frac{\sum_t (E_t - \hat{E}_t)^2}{T}}{V(E_t)}$$

TABLE 2 – Parameter estimates

| Parameters | Estimated value | Standard errors |
|--|-----------------|-----------------|
| Exogenous destruction rate δ | 0.031 | 0.0003 |
| Probability of drawing a low productivity λ | 0.023 | 0.0005 |
| Efficiency of job search α | 0.4284 | 0.1511 |
| Contact rate ϕ | 0.002 | 0.0003 |
| High level of output | 8928.1 | 0.3748 |
| Minimal job search requirement (in Full-Time Equivalent hours) \underline{s} | 0.55 | – |

FIGURE 3 – Observed and simulated transition and employment rates for workers aged 55-59 before the reforms

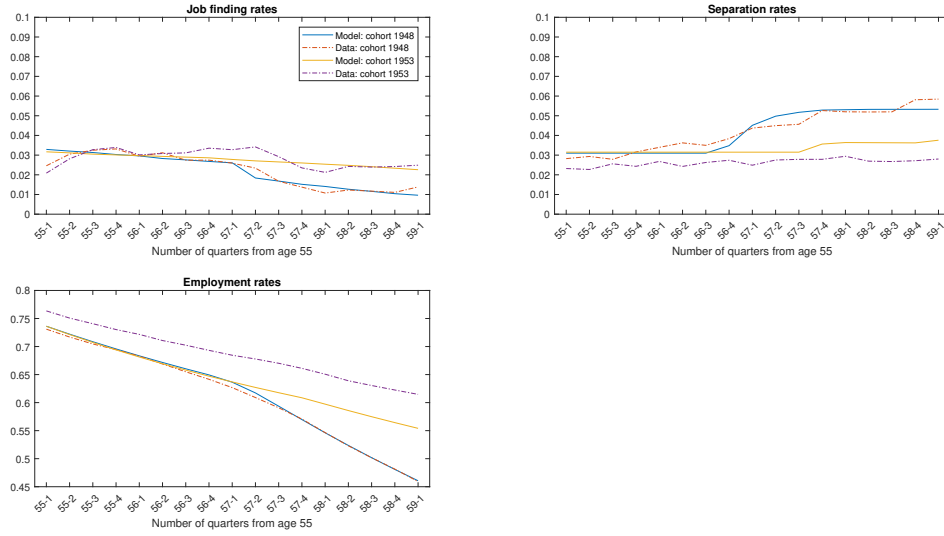


with E_t the employment rate serie and \hat{E}_t the estimated one. This share reaches 99%.

We also test the ability of our model to reproduce the evolution in separations, job finding and employment rates before and after the French reforms that occurred over the period 2009-2012. As mentioned previously, these reforms consisted of a gradual increase in the legal retirement age for workers born after 1950 and the cancellation of job-search exemption after 57.5 years old. Starting from our benchmark case that corresponds to the cohort of workers born in 1948, we simulate the change in transition and employment rates that would result in a tightening of job-search requirements after 57.5 years old and an increase in the legal retirement age by 4 quarters. Figure 4 shows the profiles of transition and employment rates among workers aged

55-59 estimated from the model before and after these changes and their empirical counterparts for workers born in 1948 and those born in 1953.

FIGURE 4 – Observed and simulated transition and employment rates among workers aged 55-59 before and after the French pension and UI reforms



The model matches the evolution in transition and employment rates between the 1948 and the 1953 cohorts of workers quite well. For instance, in the data, we observe a rise in the employment rate at age 59 between these two cohorts of workers by 15.5 percentage points while the model predicts an increase by 9.75 percentage points. The share of the observed employment rate evolution for workers aged 55-59 between the two cohorts explained by the model is :

$$\frac{V(\Delta E_t) - \frac{\sum_t (\Delta E_t - \hat{\Delta E}_t)^2}{T}}{V(\Delta E_t)}$$

with $\Delta E_t = E_t^{48} - E_t^{53}$, the employment rate difference between the two cohorts before and after the reforms and $\hat{\Delta E}_t = \hat{E}_t^{48} - \hat{E}_t^{53}$, the estimated one. This share reaches 72%. Note that if we simulate transition and employment rates for the cohort 1953, starting from observed initial conditions on employment for this cohort, the model explains more than 84% of the variation in employment rates observed between the two periods. So, our model allows to reproduce quite well the effect of these two reforms on employment among workers aged 55-59. One may think that part of the effect of the reforms on employment can also go through the evolution of the wage distribution, that is exogenous in our model. To assess the importance of this effect, we import the distribution of wage offers from the data for the 1953 cohort. Doing so, the model

explains 83% of the variation in employment rates. This shows that given the age of the workers and the type of reforms we study, the effects that pass through wages are negligible.

5.2 The effect of UI and pension reforms on employment and transition rates among workers aged 55-59

To better understand how UI and pension rules interact between each other, we simulate first different UI rules and we look at their impact on job finding, separation and employment rates in the five years before the legal retirement age (set initially at 60 in France). We choose as a benchmark, UI rules close to the French UI scheme for the 1948 cohort. The potential benefit duration is 3 years, the replacement rate is 70% and there is no job-search requirement after 57.5 years old. Then we simulate two UI reforms. The reform 1 consists of reducing the PBD from 3 to 2 years. The reform 2 corresponds to the cancellation of the job search exemption after 57.5 years old. At last, we compare these effects to those obtained through a one-year increase in the legal retirement age.

5.2.1 The effects of UI and pension reforms on separations

We first examine the effect of these institutional changes on the main key variables of our model. Regarding job destruction, we first look at the firms' and workers' decision to terminate the contract after an adverse productivity shock, according to their age and to different UI or pension rules. Figure 5 depicts in these four situations (Baseline, UI Reform 1, UI Reform 2 and One-year-increase in retirement age), the firms' decision to offer a mutually agreed termination of the job (i.e. the threshold productivity) and the workers' decision to accept this offer (i.e. the wage threshold) given the age. We see that the age-profile of the productivity threshold is increasing, which aligns with the labour-hoarding effect (Mortensen and Pissarides, 1994; Cheron et al., 2013). Employers are willing to incur a loss now in anticipation of a future increase in the job's product. The shorter the worker's remaining horizon, the lower the expected job surplus so labour-hoarding becomes less valuable.

In the baseline case, we see a strong jump in this wage threshold just before 57 years old i.e. the age of entry into the UI pathway. From this age onwards, the workers would always accept

the mutually agreed termination. In that case, the separation rates only depend on the firms' decision. This explains the gradual increase in the separation rates observed after 57 years old in the data and simulated by our model.

We observe that lowering the UI potential benefit duration by one year (reform 1) shifts this jump by one year (58 years old). If workers expect that they can receive UI benefits only during two years, they are willing to accept to leave their job and to enter into the UI pathway only when they reach 58 years old. Before this age, separation rates are very low even if firms offer mutually agreed terminations. From 58 years old onwards, separation rates will follow the same pattern as the firms' productivity threshold. Note that this firms' decision curve is not affected by a change in UI rules. UI reforms only affect the worker's choice to accept the employer's offer.

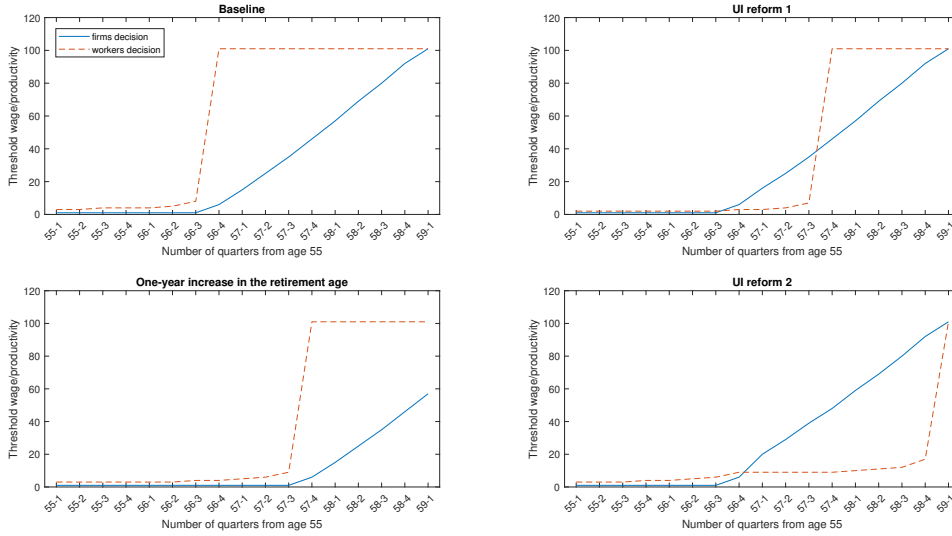
We see that a one-year increase in the legal retirement age is more efficient to reduce separations than a reduction in the PBD of the UI system by one year. Such a pension reform shifts the age of entry into the UI pathway by one year but it also reduces incentives for employers to offer a mutually agreed termination at a given age. Since the workers' horizon is longer, the labour hoarding-effect is stronger. Consequently, the firms' decision curve shifts to the right after an increase in the retirement age, with respect to the baseline case.

Interestingly, the jump in separation rates is smoothed when job-search requirements become stricter (reform 2). In that case, UI pathway is no longer attractive for workers so they are reluctant to accept the mutually agreed termination offered by their employer, even when they reach the age of entry into the UI pathway.

5.2.2 The effects of UI and pension reforms on older job-seekers' behaviour

As for job finding rates, we investigate the age-profile of optimal and effective job-seekers' search effort and their reservation wage, i.e. the minimal wage demanded by the unemployed. Figure 6 presents the result of this investigation according to the presented reforms. First, we can see in the top left panel of Figure 6 that the reservation wage is increasing. In the baseline case, the workers become pickier as they approach the retirement age. The reservation wage is the highest from 57 years old, onwards. This is the age of entry into the UI pathway. A one-year

FIGURE 5 – Simulated firms’ and workers’ decision to terminate the contract according to the workers’ age and to different UI scenarii



Note : We choose as a benchmark, UI rules close to the French UI scheme for the 1948 cohort. The potential benefit duration is 3 years, the replacement rate is 70% and there is no job-search requirement after 57.5 years old. Then we simulate two reforms. The UI reform 1 consists in reducing the PBD from 3 to 2 years. The UI reform 2 corresponds to the cancellation of the job search exemption after 57.5 years old.

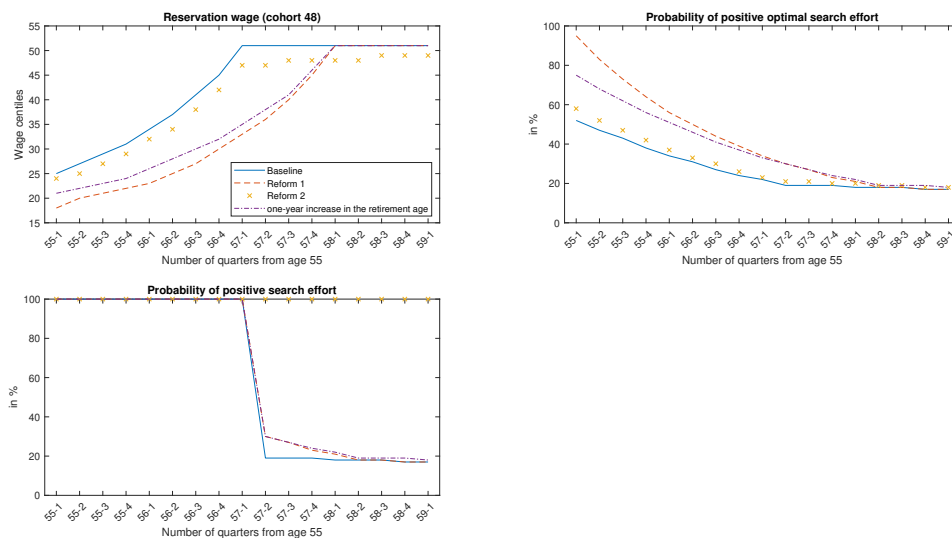
decrease in the PBD of the UI system (UI reform 1) or a one-year increase in the retirement age shift the age-profile of reservation wages to the right. At a given age, the reservation wage is smaller, because the job-seekers are either closer to the UI benefit exhaustion or further from the retirement age. From 58 years old, the new age of entry into the UI pathway, onwards, the reservation wage is the highest. Note that the cancellation of the job-search exemption (UI reform 2) also reduces the reservation wage at a given age but to a smaller extent than the two other reforms.

The top-right panel of Figure 6 shows the probability that the optimal search effort is positive. This probability is decreasing when the worker gets close to the retirement date. This is the main point of Hairault et al. (2010) : since search is an investment, optimal search effort decreases with age since the return on job search becomes lower. In the baseline case, this probability is the lowest at 57.5 years old when the worker becomes eligible to the job-search exemption. A one-year reduction in the PBD of the UI system (UI reform 1) or a one-year increase in the retirement age shift the age-profile of this probability to the right. At a given age, the optimal search effort is more likely to be positive. The tightening of job-search requirements (UI reform

2) has smaller effects on this curve.

However, the bottom-left panel of the same figure shows the probability that a job-seeker will provide effectively a positive effort given the regulation. In this panel, there is a strong jump at 57.5 years old, when workers can be exempted from job search without losing UI benefits in the baseline scenario. As long as job-seekers must devote a minimal time to search, they prefer doing so rather than losing UI benefits. As soon as they can be exempted, a large fraction of unemployed stops searching and waits for their retirement. When lowering PBD or raising the retirement age by one year, we observe that this fraction is slightly smaller between 57.5 and 58.5 years old but then converges to the one that prevails in the baseline scenario. Indeed, for a retirement age set at 60, if the new benefit duration is only two years, those who stop searching at 57.5 years old can not receive UI benefits until they reach 60. In this respect, the cancellation of job-search exemption (reform 2) is more likely to stimulate job-search. In this scenario, the probability of effectively searching is always 100%.

FIGURE 6 – Simulated job-seekers’ optimal search effort and decision to accept the job offer according to their age and to different UI and pension reforms



Note : We choose as a benchmark, UI rules close to the French UI scheme for the 1948 cohort. The potential benefit duration is 3 years, the replacement rate is 70% and there is no job-search requirement after 57.5 years old. Then we simulate two reforms. The reform 1 consists in reducing the PBD of the UI system from 3 to 2 years. The reform 2 corresponds to the cancellation of the job search exemption after 57.5 years old.

5.2.3 The effects of UI and pension reforms on older workers' transition and employment rates

After presenting the main mechanisms at work, we look at the counterfactual effects of the changes in UI or pension rules on older workers' transition rates and employment rates. Results are shown in Figure 7. First, looking at job finding rates, the decline observed at 57.5 that corresponds to the eligibility age to the job search exemption fades away only when this exemption is cancelled. This suggests that the only way to stimulate search effort before the legal retirement age is the implementation of job search requirements. This is consistent with previous empirical findings (Benmarker et al., 2013; Been et al., 2017).

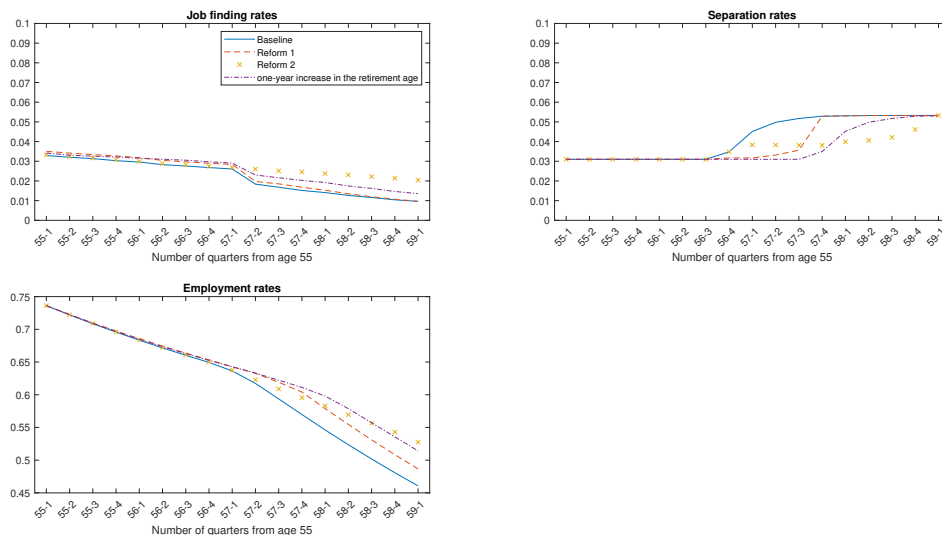
Regarding separation rates, the jump observed at 57 in the baseline case is smoothed when job-search requirements are tightened. This suggests that UI is an attractive pathway to retirement only when the job search requirements are low. In addition, lowering the UI potential benefit duration by one year reduces separation rates at 57 but generates a new jump in these rates at 58, i.e. the new age at which workers can leave their job and receive UI benefits until the legal retirement age without any uninsured period. As mentioned previously, a one-year increase in the legal retirement age is more efficient than a one-year reduction in the PBD to reduce separations.

The effect of all these reforms on employment rates is almost negligible until 57 years old and then becomes positive. The UI reform 2, i.e. the cancellation of the job-search exemption turns out to be the most efficient in increasing employment at 59. It allows to raise the employment rate from 46% to 52.7% at 59 years old. Conversely, the reduction in the PBD by one year is a less efficient tool for raising older workers' employment rates. Indeed, we have seen that the main effect is a shift of the jump in the separation rates by one year. However from 58 years old onwards, the separation rates converge to the ones in the baseline case. This reform would raise the employment rate from 46% to 48.7% at 59 years old.

A one-year increase in the retirement age also implies a shift of the jump in the separation rates but this jump is less pronounced than in the case of a reduction of the PBD. Consequently, the effect of older workers' employment rates is higher than in the case of this UI reform. However, since this jump is not definitely smoothed, this pension reform is less efficient than a tightening of job-search requirements. After this reform, the employment rate at 59 years old would rise

from 46% to 51.4%.

FIGURE 7 – Simulated transition and employment rates among workers aged 55-59 after changes in the UI or in pension rules



Note : We choose as a benchmark, UI rules close to the French UI scheme for the 1948 cohort. The potential benefit duration is 3 years, the replacement rate is 70% and there is no job-search requirement after 57.5 years old. Then we simulate two reforms. The reform 1 consists in reducing the PBD of the UI system from 3 to 2 years. The reform 2 corresponds to the cancellation of the job search exemption after 57.5 years old.

5.3 The impact of job-search requirements on separation rates

Our results suggest that the cancellation of the job-search exemption that came into force over the period 2009-2012 has strongly reduced separation rates among workers aged 57-59 years old. We also show that without this UI reform, the one-year increase in the legal retirement age would have a lower positive effect on employment close to retirement. Indeed, when we simulate with our model the effect of the combination of the two reforms on employment rates among workers born in 1953 in subsection 5.1, we find an increase in the employment rate at 59 years old by 9.75 percentage points, whereas, when we simulate the effect of a simple increase in the retirement age by one year, leaving UI rules unchanged, as in subsection 5.2, the employment rate at 59 increases only by 5.4 percentage points.

As shown previously, a pure rise in the retirement age fails to smooth the jump in separation

rates as in the case of the cancellation of job-search requirements that make UI pathway less attractive. To disentangle the effect of a rise in the retirement age from the one due to the cancellation of the job-search exemption, we exploit the phased implementation of the latter. We have mentioned in section 2 that the age thresholds for entry into the DRE have been gradually raised. In this setting, workers born in 1951 have been only affected by the increase in the legal retirement age¹¹ while workers born in 1952 have been concerned by this pension reform and the cancellation of the job-search exemption¹². In Appendix D, we provide some descriptive statistics regarding these two cohorts of workers. We show that these two cohorts are similar in terms of observable characteristics.

We check first whether the simulated effect of a two-quarter increase in the legal retirement age, without change in UI rule, on older workers' separation rates can reproduce the observed variation in these rates between the cohorts 1948 and 1951. In the top left panel of Figure 8, we observe in the data that the separation rates for the cohort 1948 start increasing from 57 years old, onwards as predicted by our model. For the cohort 1951, these rates start increasing from 57.5, i.e. two quarters later, which is also consistent with our model. Without any change in UI rules, raising retirement age simply shifts to the right the jump in separation rates.

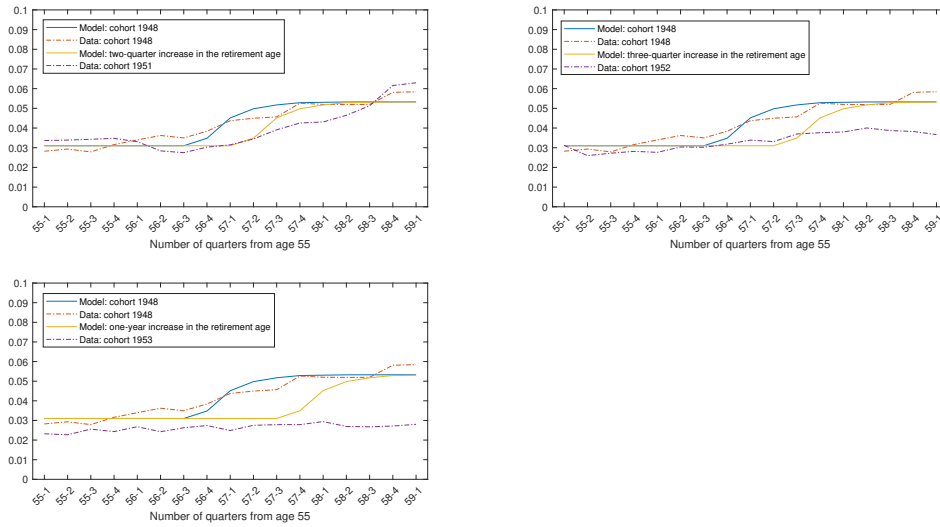
However, in the top-right panel of Figure 8, we see that the empirical age-profile of separation rates for the cohort 1952 has flattened. For this cohort the cancellation of the job-search exemption has discouraged workers to accept mutually agreed terminations even after the age of entry into the UI pathway. If we only simulate a three-quarter increase in the legal retirement age, we fail to reproduce the age-profile of separation rates for these workers. This is the same story for the cohort 1953 : a one-year increase in the legal retirement age only leads to a shift by one year of the jump in separation rates, which is not consistent with the flat curve observed in the data.

These findings suggest that the substantial rise in older workers' employment rates observed between the cohorts 1948 and 1953 result from both the one-year increase in the retirement age and the cancellation of the job-search exemption. To discuss the effect of the cancellation of the DRE, we could compare this reform to the Dutch UI reform enacted in January 2004, which consisted

11. For this cohort, the retirement age has increased by 4 months.

12. These workers are aged 58 years old in 2010, 59 years old in 2011 so they cannot benefit from the DRE. In addition, for this cohort, the retirement age has increased by 8 months.

FIGURE 8 – Simulated and observed older workers’ separation rates for the cohorts 1948, 1951, 1952 and 1953



in making search requirements stricter for job-seekers aged 57.5 years old and over. In the Dutch UI system, search requirements involve job-seekers meeting their caseworkers, accepting suitable job offers, making a sufficient number of applications and participating in active labour market programs (Been and Knoef, 2017).

Regarding the French UI system, the cancellation of the DRE could hardly be seen as a change of regime for job-seekers aged 57.5 years old and over. Indeed, since this reform, they have to register and update their situation every month, attend meetings at the unemployment office but they do not have to accept suitable job offers or enter into training or job-search assistance programs. In this setting, this reform is expected to have a low effect on their job-finding rates.

However, we can consider that the anticipation of stricter job-search requirements may have discouraged employed older workers to accept mutually agreed terminations offered by their employers¹³. This would explain the flat age-profile of separation rates observed for the cohorts 1952 and 1953. In this context, the minimal job search effort announced by the reform would

13. In articles published in various newspapers in 2011, union representatives emphasized that the psychological cost should not be underestimated. For instance they argued that waiting for retirement without any pressure is not the same thing as waiting for retirement knowing that the Public Employment Service will force older workers to search for jobs that do not exist.

act as a psychological cost that would make the UI pathway less attractive. We could expect that a couple of years after the cancellation of the DRE, older workers have learned that it has not changed anything regarding search requirements. In that case, this UI reform would be no longer efficient to reduce unemployment inflows. This can explain why a recent study of the French national organisation managing the UI scheme (UNEDIC (2023)) shows in 2023 a peak in mutually agreed terminations at 59, i.e. three years before the new legal retirement age, which is 62 years old.

5.4 The impact of a taxation of severance payments in the case of mutually agreed terminations

In this paper, we argue that a one-year increase in the retirement age combined with a reduction in the generosity of the UI system for older job-seekers would be more efficient to raise older workers' employment rates. In that case, the burden of the reforms would be only borne by workers. Since the main effect results from a reduction in separations, we can consider an alternative reform : taxing the severance payment in the case of a mutually agreed termination. In contrast to the previous Delalande contribution, this tax could not be circumvented because it would concern all separations by mutual consent.

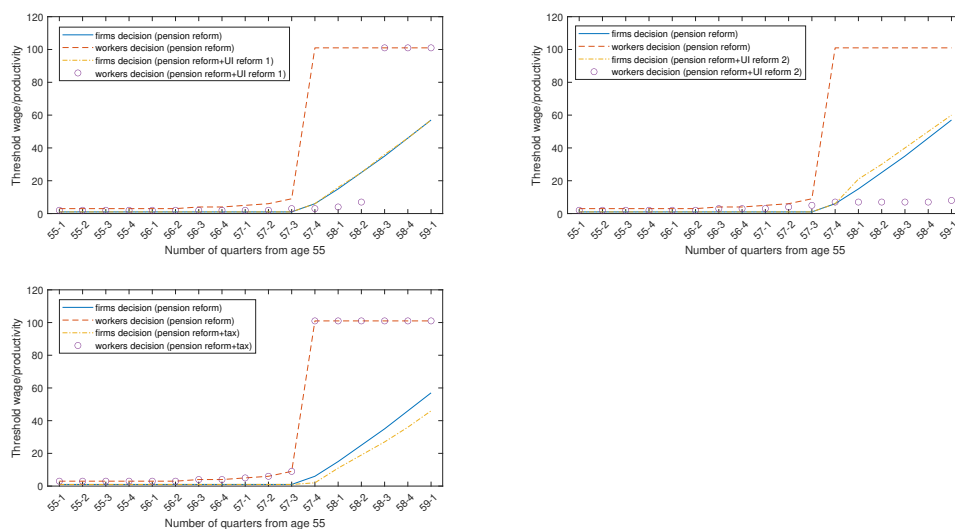
Our model can simulate the effect of a one-year increase in the legal retirement age combined with such a tax. We compare these effects to those obtained by combining the same pension reform with different changes in the UI system (as in the previous sections). Note that since 2013, severance payments due in case of mutually agreed termination have already been taxed at a rate of 20%. We apply this tax rate and we look first at the effects of such a tax on the two mechanisms that drive separations, i.e. the firms' and workers' decision to terminate the contract after an adverse productivity shock.

In Figure 9, we depict in all panels the firm's and worker's decision to terminate the contract after a pension reform, i.e. a one-year increase in the retirement age. The top-left panel shows the evolution of these curves after the combination of the pension reform with a reduction in the PBD by one year, the top right panel represents their evolution after the combination with the tightening of search requirements after 57.5 years old and the bottom left panel depicts their

evolution after the combination with taxing severance payments due in the case of mutually agreed termination.

Let us focus on this latter panel. Contrarily to UI reforms, such a tax affects only the firms' choice to offer a mutually agreed termination after an adverse productivity shock, shifting the firms' decision curve to the right. This is standard in the literature regarding employment protection. A higher tax on separations reinforces the labour-hoarding behaviour and reduces separations. However, it does not affect the workers' choice to accept the firm's offer. This tax implies therefore a reduction in separation rates but smaller than the one obtained after either the UI reform 1 or 2.

FIGURE 9 – Simulated firms' and workers' decision to terminate the contract according to the workers' age after pension reforms combined with UI reforms or a tax on separations

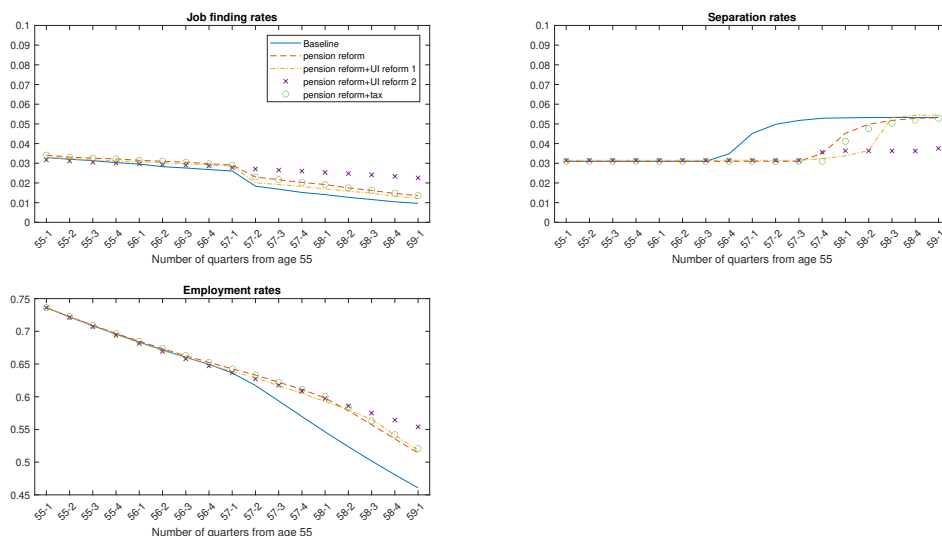


Note : The pension reform consists in a one-year increase in the legal retirement age. We choose as a benchmark, UI rules close to the French UI scheme for the 1948 cohort. The potential benefit duration is 3 years, the replacement rate is 70% and there is no job-search requirement after 57.5 years old. Then we simulate two UI reforms. The UI reform 1 consists in reducing the PBD from 3 to 2 years. The UI reform 2 corresponds to the cancellation of the job search exemption after 57.5 years old. We compare the effect of these changes to the effect of a tax on severance payments due in the case of mutually agreed termination.

Consequently, we expect that combining a one-year increase in the retirement age with a tax on mutually agreed terminations is less efficient in raising older workers' employment rates than combining the same pension reform with a reduction in the generosity of the UI scheme. We

can clearly see in Figure 10 that the rise in employment rates among workers aged 55-59 after the pension reform is almost the same even after implementing a tax on severance payments due in the case of mutually agreed terminations. In this context, the figure demonstrates that a combination of a rise in the retirement age and a reduction in the generosity of the UI system is the best strategy to increase older workers' employment rates.

FIGURE 10 – Simulated transition and employment rates among workers aged 55-59 after combining a one-year increase in the retirement age with UI reforms or a tax regarding mutually agreed terminations



Note : We choose as a benchmark, UI rules close to the French UI scheme for the 1948 cohort. The potential benefit duration is 3 years, the replacement rate is 70% and there is no job-search requirement after 57.5 years old. Then we simulate two UI reforms. The reform 1 consists in reducing the PBD of the UI system from 3 to 2 years. The reform 2 corresponds to the cancellation of the job search exemption after 57.5 years old. We compare the effect of these changes to the effect of a tax on severance payments due in the case of mutually agreed termination.

5.5 A differentiated horizon effect according to UI rules

In this last subsection, we explain why the horizon effect, i.e. the effect of an increase in the retirement age on employment at earlier ages, may differ across UI systems. Hairault et al. (2010) wrote (p. 1062) : "the distance effect alters the employment rates of older workers only in conjunction with generous unemployment benefits and high separation rates". They already had the intuition that UI rules strongly affect the magnitude of the horizon effect. However, in their model, separation rates are exogenous, while we have shown that it is a key driver of the

horizon effect.

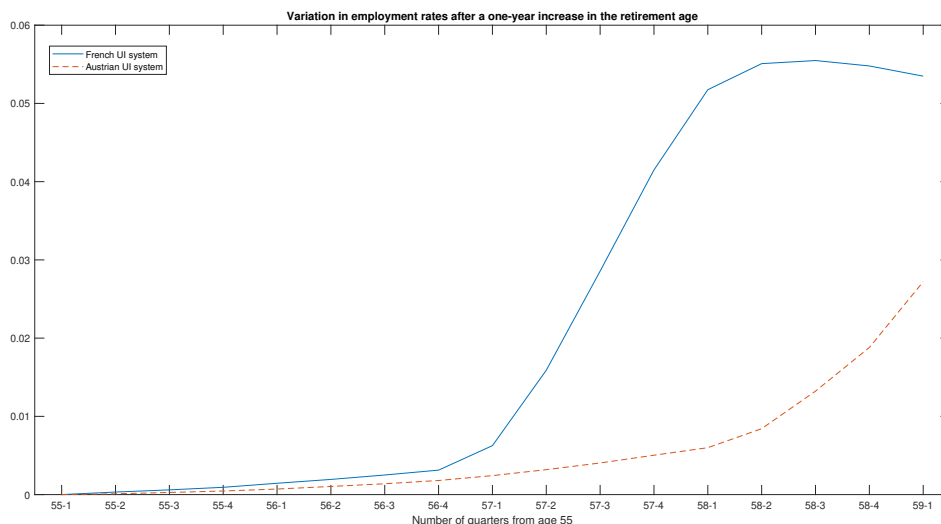
We simulate the effect of an increase in the legal retirement age by one year for two UI scenarii. The first corresponds to the French one before the reforms enacted over the period 2009-2012 : a generous replacement rate, a PBD equal to 3 years and no job-search requirements after 57.5 years old. The second scenario would correspond to a less generous UI system, like the Austrian one for instance. In this system, the PBD is around 1.5 years and the search requirements are stricter even after 57.5 years old (Staubli and Zweimüller, 2013).

As mentioned previously, in the second UI system, the UI pathway is not attractive for older workers so an increase in the retirement age would lead to a very small reduction in separations and only one year before the initial retirement age. We expect therefore a very small positive effect on employment one year before the initial retirement age and no effect two or three years before this age.

Figure 11 depicts the difference between older workers' employment rates before and after the increase in the retirement age for each UI scenario. In the generous UI system (The French one), as mentioned previously, it is quite negligible until the age of 57 years, and then is about 5 percentage points at the age of 58 and 59. This occurs mainly through a decrease in separation rates between ages 57 and 58.

However, in a less generous UI system (the Austrian one), a rise in the legal retirement age by one year has a small additional positive effect on employment before retirement, lower than +1 p.p. at 58 years old and lower than 3 p.p. at 59 years old. In other words, in the first UI scheme, the horizon effect is around twice as high as the one in the second UI scheme. This is consistent with Staubli and Zweimüller (2013)'s findings when they show that employment rates at ages before the retirement age did not change significantly after the 2000 Austrian reform that has increased the early retirement age by 1.5 years.

FIGURE 11 – Difference in employment rates among workers aged 55-59 after a pension reform that consists in an increase in the legal retirement age by one year under different UI scenarii



6 Conclusion

This paper analyses the impact of pension and UI reforms on older workers’ employment rates prior to retirement. We develop a job-search model with finite horizon accounting for age-specific UI rules and introducing a mechanism of endogenous job destruction. Using French data, we estimate the structural parameters of our model through a method-of-moments.

Our model fits the data at more than 99% and has a strong predictive power. Interestingly, it allows to replicate a peak in separation rates at the age of entry into the UI pathway, i.e. when the distance to retirement equals the PBD of the UI system. This phenomenon is a salient fact regarding the older workers’ situation in the French labour market. It also allows to replicate the strong increase in employment rates observed among workers close to the legal retirement age after the French pension and UI reforms enacted over the period 2009-2012. In our sample, the employment rate of workers aged 59 has risen by 15.5 percentage points while the model predicts an increase by 9.75 points.

This increase is mainly due to a strong reduction in separations through two mechanisms. First, postponing retirement reinforces the labour-hoarding effect, that reduces firms’ propensity to

offer a mutually agreed termination in the case of an adverse productivity shock. Second, the age of entry into the UI pathway rises and the attractiveness of the UI system is lower, which discourages workers from accepting the separation.

The interest of the structural approach is to disentangle the effects that pass through the pension reform and the ones that pass through a change in UI rules. We show that a simple one-year increase in the legal retirement age, leaving UI rules unchanged, would have increased the employment rates at age 59 only by 5.4 percentage point. This suggests that the cancellation of the job-search exemption strongly contributed to the increase in employment rates for workers close to retirement. The minimal job-search effort announced by the reform would have acted as a psychological cost that has made the UI pathway less attractive. This is an important result in terms of public policy recommendation. Making job search requirements more credible improves the seniors' employment rates through a strong reduction in employment outflows.

This study shows that pension reforms may have substantial positive effects on employment prior to retirement yet only under specific UI rules. These effects have to be accounted for when evaluating the fiscal implications of delaying retirement age. In a generous UI system like the French one (PBD of 3 years and no job search requirement as before 2009), these effects would be twice as large as in a less generous UI system such as the Austrian one (PBD of 1.5 years and strict job search requirements). This allows us to reconcile the findings of Staubli and Zweimüller (2013), that find no significant horizon effect after Austrian pension reforms with those of Hairault et al. (2010) that put forward a strong horizon effect in the French case.

One limitation of our study is that it puts aside the spillover effects of pension reforms into other social insurance programs such as the disability insurance. We have assumed that all workers have the same disutility of work constant over time. However, we could also introduce heterogeneity in this disutility and allow it to increase with age. Doing so, we would also model endogenous separations that would result from a strong deterioration in older workers' health. We leave this issue for further investigation.

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Appendix A- Descriptive statistics

At the individual-level, the data include the gender, the educational and occupational level, the marital status and the number of dependent children. Descriptive statistics of the sample for the two cohorts (1948 and 1953) are presented in Table 3. This table shows strong differences in characteristics between the two cohorts. First, the share of individuals born in 1953 with a high-school/college diploma is 36.8%, significantly higher than its counterpart for the cohort 1948 (32.4%). However, the individuals born in 1948 are on average employed in more skilled occupations than those born in 1953. This may result from a diploma inflation phenomenon after

the rise in the minimum school-leaving age in 1959.

TABLE 3 – Descriptive statistics of the sample

| VARIABLES | Cohort 1948 | Cohort 1953 |
|---|-------------|-------------|
| Male | 0.496 | 0.496 |
| Education | | |
| High-school/College | 0.324 | 0.368*** |
| Secondary/vocational | 0.410 | 0.416 |
| No diploma | 0.266 | 0.216*** |
| Occupation | | |
| Managers | 0.166 | 0.146*** |
| Intermediate | 0.330 | 0.297*** |
| Employee | 0.326 | 0.360*** |
| Blue-collar workers | 0.178 | 0.197** |
| At least one child aged 17 or under still living at home | 0.063 | 0.062 |
| Single | 0.239 | 0.253 |
| Observations | 3919 | 6270 |

Note : The sample includes only individuals working or having worked in the private sector aged 55-59 of the cohorts 1948 and 1953 and who started working between 18 and 20 years old.

Significance levels for difference in means are *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Source : French Labour Force Surveys (2003-2012)

Appendix B - Empirical evidence of a horizon effect

We look at the effect of the reforms on employment, controlling for the difference in characteristics between the two cohorts. We estimate the following regression :

$$y_{it} = \alpha + \beta X_{it} + \sum_{a=56}^{59} \theta^a Age_{it}^a + \delta T_i + \epsilon_{it}$$

where y_{it} is a dummy indicating whether the individual i is employed at time t . X_{it} are individual characteristics to control for any observable differences that might confound the analysis. The set of individual characteristics includes the gender, the marital status, the educational level, the skill level of the job occupied or previously occupied and a dummy indicating whether the respondents have still at least one child aged 17 or under at home. Age_{it}^a are age dummies equal to one if the individual i is aged a at time t . These variables control for age specific trends in labour market behavior. T_i is a dummy that takes the value of one for the period 2008-2012 (post-reform period) and 0 for the period 2003-2007 (pre-reform period). This dummy captures the effect of the reforms on the employment among the workers aged 55-59 born in 1953.

The results of these estimates are presented in Panel A of Table 4. After controlling for differences in observable characteristics between the two cohorts, the employment rates among the workers born in 1953 (the cohort treated by the reforms) is 11.1 points higher than the employment rates

among workers born in 1948. This effect is strongly significant. However, one could argue that the periods considered, i.e. 2003-2007 and 2008-2012 strongly differ in terms of business cycle. Indeed, the Great Recession has affected the labour market and it seems difficult to disentangle these effects from the impact of pension reforms. In addition, the positive effect found may be driven by some unobservable characteristics between the two cohorts.

To confort our interpretation of results, we use a different sample to perform a placebo test. We compare employment rates among workers born in 1948 and in 1953 and who started working at 23 or later. We expect that the labour-supply behaviour of these workers are rather affected by the eligibility age for full pension benefits than by the legal retirement age. Assuming that these workers have a continuous career, their expected retirement age before 2009 pension reform was 63 years old. Even though the reform has changed this eligibility age, it should not affect their labour supply decisions before 60. Indeed, Hairault et al. (2010) show that the horizon effect is significant only at three years or less from the retirement age. Consequently, when restricting our sample to workers who started working at 23 or later, we ensure that both cohorts face the same retirement environment. We estimate the same model for this subsample of workers and we present estimates in Panel B of Table 4.

Once controlling for the differences in observable characteristics between both cohorts, we fail to find any significant positive effect of the reforms on employment among workers born in 1953. The coefficient associated to the cohort 1953 is only 0.015, almost ten times lower than the one estimated in our baseline model. This placebo test shows that the positive horizon effect can be attributed to the policy and not to specific characteristics of workers born in 1953.

Appendix C - A Markov Chain Analysis of older workers' flows

We follow Choi et al. (2015) to measure the contribution of each transition rates to the explanation of the observed increase in employment rates before and after the reforms. We construct age- and cohort-specific Markov transition matrices denoted by Γ_a^c . Let S_{55-1}^c be the matrix corresponding to initial conditions on the distribution of workers among labour market statuses

TABLE 4 – Estimation of a potential horizon effect of the French pension reforms

| VARIABLES | Effect on quarterly employment rate |
|--|--|
| Panel A | |
| Age dummies (Ref. Age ₅₅) | |
| Age ₅₆ | -0.042*** (0.015) |
| Age ₅₇ | -0.108*** (0.015) |
| Age ₅₈ | -0.170*** (0.015) |
| Age ₅₉ | -0.198*** (0.015) |
| Cohort 1953 | 0.111*** (0.009) |
| Individual characteristics | YES |
| Constant | 0.568*** (0.199) |
| Observations | 10189 |
| R-squared | 0.059 |
| Panel B | |
| Age dummies (Ref. Age ₅₅) | |
| Age ₅₆ | -0.018 (0.022) |
| Age ₅₇ | -0.038* (0.022) |
| Age ₅₈ | -0.043*** (0.022) |
| Age ₅₉ | -0.060** (0.022) |
| Cohort 1953 | 0.015 (0.013) |
| Individual characteristics | YES |
| Constant | 0.517*** (0.028) |
| Observations | 3758 |
| R-squared | 0.109 |

Note : The sample in Panel A includes only individuals working or having worked in the private sector aged 55-59 of the cohorts 1948 and 1953 who started working between 18 and 20 years old.

The sample in Panel B includes only individuals working or having worked in the private sector aged 55-59 of the cohorts 1948 and 1953 who started working at 23 or later.

The set of individual characteristics includes the gender, the marital status, the educational level, the skill level of the job occupied or previously occupied and a dummy indicating whether the respondents have still at least one child aged 17 or under at home.

Standard errors are in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Source : French Labour Force Surveys (2003-2012)

at 55 for each cohort c , with $c \in \{1948; 1953\}$.

$$S_{55-1}^c = \begin{pmatrix} E_{55-1}^c \\ N_{55-1}^c \end{pmatrix}$$

Then we compute the predicted labour market states one quarter after as

$$S_{55-2}^c = \Gamma_{55-1}^c \times S_{55-1}^c \quad \text{with} \quad \Gamma_{55-1}^c = \begin{pmatrix} EE_{55-1}^c & EN_{55-1}^c \\ NE_{55-1}^c & NN_{55-1}^c \end{pmatrix}$$

And one year after as

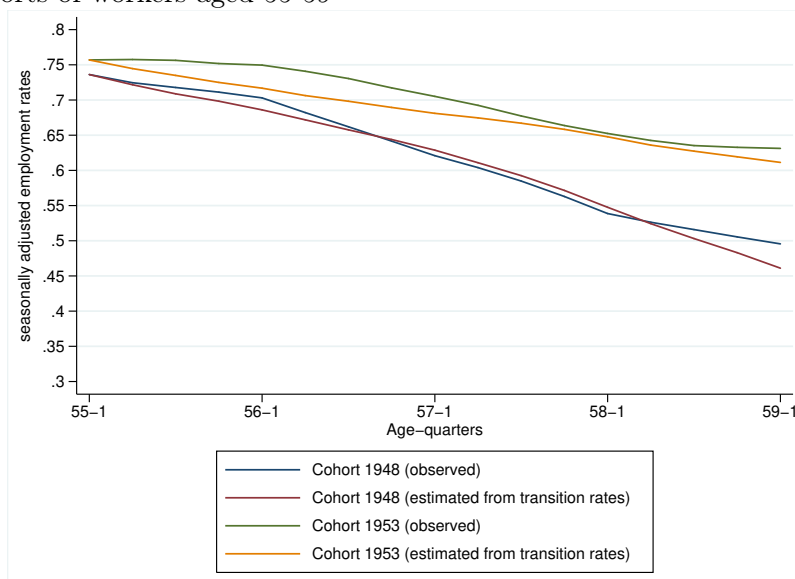
$$S_{56-1}^c = \Gamma_{55-4}^c \times \Gamma_{55-3}^c \times \Gamma_{55-2}^c \times \Gamma_{55-1}^c \times S_{55-1}^c$$

This method allows us to compute employment rates denoted by e_a^c from observed transition rates at each age a and for each cohort c of workers in the following way : $e_a^c = \frac{E_a^c}{E_a^c + N_a^c}$. This quarterly employment rate is computed among workers whose labour market state is known in the next period. So, using the distribution of workers among labour markets states in the previous quarter and the quarterly transition rates, we can not exactly replicate the observed employment rate. Nevertheless, we see in figure 12 that this approach allows us to fit quite well the employment profiles at older ages for each cohort.

We can perform a decomposition analysis "à la" Choi et al. (2015) to examine the relative contribution of separation and job finding rates to the difference in employment rates between older workers born in 1948 and those born in 1953. Here, we have two types of transition rates : separation and job finding rates. We simulate first the difference in employment rates by age between the two cohorts of workers if only the separation rates had changed before and after the reforms. And we reconduct this estimation but considering that only the job finding rates had changed before and after the reforms. For each case, we adjust the staying flows for the cohort of workers born in 1953 at each age a (EE_a^{1953} or NN_a^{1953}) so that the quarterly transition matrices are well defined for this cohort¹⁴. We consider that the "varying" transition probability is important in generating the difference in employment rates between both cohorts if the counterfactual estimated difference is close to the observed employment rate gap by age across cohorts.

14. Suppose we fix separation rates at their values for the cohort of workers born in 1948, we define $EE_a^{1953} = 1 - EN_a^{1948}$.

FIGURE 12 – Comparison of observed and simulated seasonally adjusted employment rates by age and cohorts of workers aged 55-59



Note : The sample includes only individuals working or having worked in the private sector aged 55-59 of the cohorts 1948 and 1953 and who started working between 18 and 20 years old. The series of observed employment rates have been seasonally adjusted by a 4-quarters centered moving-average smoothing method. Their simulated counterparts have been computed using seasonally adjusted job separation and job finding rates at each age for each cohort.

We present quarterly rates, dividing each year (age) in 4 quarters. For example, for the 1948 cohort, 55-1 corresponds to the first quarter of the year 2003 i.e. when these workers are 55 years old.

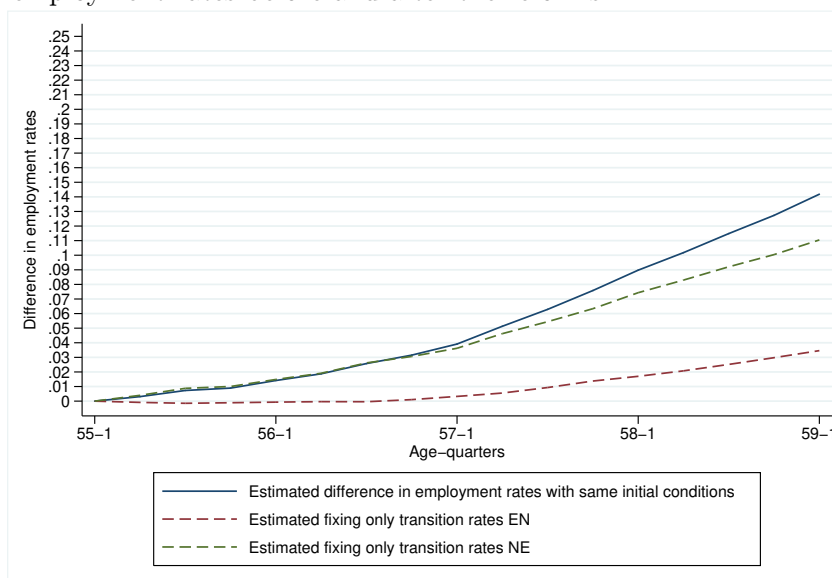
Source : French Labour Force Surveys (2003-2012)

With respect to the study of Choi et al. (2015), we encounter a supplementary issue given that initial conditions, i.e. employment rates at 55, differ across the 1948 and the 1953 cohorts of workers. To overcome this issue, we consider the difference in employment rates leaving initial conditions unchanged between both cohorts and we conduct our decomposition analysis to simulate this difference.

We present in figure 13 the results of this decomposition method. The blue curve corresponds to the employment rates gap between both cohorts at each age leaving initial conditions unchanged (so it starts from 0 and then becomes positive as employment rates among workers aged 55-59 increased before and after the reforms). The green curve is its estimated counterpart if job finding rate had remained unchanged before and after the reforms and the red curve is its estimated counterpart if separation rates had remained invariant. We see that the green curve fits remarkably well the blue curve at least until age 57, with an R^2 equal to 0.996. It means that regarding workers aged 55-57 of our sample, the increase in employment rates observed before and after

the changes in UI and pension rules is entirely driven by a decrease in separation rates¹⁵. The same conclusion holds for workers aged 57-59 even though the relative contribution of job finding rates is much higher at these ages.

FIGURE 13 – Analysis of the relative contribution of separation and job finding rates to the difference in employment rates before and after the reforms



Note : The sample includes only individuals working or having worked in the private sector aged 55-59 of the cohorts 1948 and 1953 and who started working between 18 and 20 years old. The blue curve corresponds to the employment rates gap between both cohorts at each age leaving initial conditions unchanged (so it starts from 0 and then becomes positive as employment rates among workers aged 55-59 increased before and after the reforms). The green curve is its estimated counterpart if job finding rate had remained unchanged before and after the reforms and the red curve is its estimated counterpart if separation rates had remained invariant. Their simulated counterparts have been computed using seasonally adjusted job separation and job finding rates at each age for each cohort.

Lecture : Before and after the reforms, the employment rate among workers aged 59 would have increased by approximately 14 percentage points had employment rates at 55 remained invariant between the 1948 and the 1953 cohorts of workers. This increase would have been of 11 percentage points if job finding rates had not changed before and after the reforms and of only 3 percentage points if separation rates had remained unchanged before and after the reforms. Source : French Labour Force Surveys (2003-2012)

Appendix D - Descriptive statistics for workers born in 1951 and 1952

Descriptive statistics of the sample for the two cohorts (1951 and 1952) are presented in Table 5. We see that the two cohorts are strongly similar in terms of observable characteristics. Indeed, we fail to find any significant difference in means for all the variables considered.

15. In other words, the relative contribution of job finding rates to explain the rise in employment rates among workers aged 55-57 before and after the reforms is almost 0.

TABLE 5 – Descriptive statistics of the sample

| VARIABLES | Cohort 1951 | Cohort 1952 |
|---|-------------|-------------|
| Male | 0.476 | 0.481 |
| Education | | |
| High-school/College | 0.342 | 0.345 |
| Secondary/vocational | 0.409 | 0.410 |
| No diploma | 0.249 | 0.245 |
| Occupation | | |
| Managers | 0.163 | 0.165 |
| Intermediate | 0.295 | 0.294 |
| Employee | 0.342 | 0.345 |
| Blue-collar workers | 0.200 | 0.196 |
| At least one child aged 17 or under still living at home | 0.059 | 0.062 |
| Single | 0.237 | 0.236 |
| Observations | 4579 | 5424 |

Note : The sample includes only individuals working or having worked in the private sector aged 55-59 of the cohorts 1951 and 1952 and who started working between 18 and 20 years old.

Significance levels for difference in means are *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Source : French Labour Force Surveys (2003-2012)