Optimal unemployment insurance in a life cycle model

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ABSTRACT. - We extend Hopenhayn and Nicolini’s [1997] optimal unemployment contracts by including life-cycle features. We show that it is optimal to implement an age-dependant contract. Indeed, the elderly have only a few years left on the labor market prior to retirement. The short horizon of old workers implies a more digressive replacement ratio. The introduction of a wage tax after re-employment allows to smooth the unemployment benefit profile. Nevertheless, such a tax is less efficient than in Hopenhayn and Nicolini’s [1997] paper due to the short horizon of old workers on the labor market. Consequently, we propose to adopt a global approach in our analysis by determining the optimal unemployment insurance and retirement pension. In that case, when an unemployed worker retires, the pension decreases with the length of the last unemployment spell. We then show that the integration of these two social programs (unemployment and retirement) is more efficient in increasing the employment rate and decreasing the cost of insurance programs.

Keywords: Unemployment insurance, Retirement, Recursive contracts, Moral Hazard

Classification JEL: C61, J64, J65

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1 Introduction

The aim of this paper is to characterize the optimal unemployment insurance design in a life-cycle model. The short horizon of elder workers and the non-conditional pension scheme suggest that a reform of the social security program must introduce more incentive schemes. Indeed, two types of arguments can explain the low employment rate of the elder workers in European countries: (i) the social security system and (ii) the institutions in the labor market. The generosity of these two social programs decreases the incentives of searching for a job at the end of the life-cycle (see Gruber and Wise [1998], Ljungqvist and Sargent [2002] or Hairault, Langot and Sopraseuth [2005]). In this paper, we provide some foundations for an integration of these social programs (unemployment and retirement) allowing to increase the employment rate of the elder workers.

For this purpose, we propose to study the optimal unemployment benefit/tax system for an economy where, beyond the heterogeneity arising from uninsurable shock to employment opportunities, life cycle features are also considered. We propose to develop a dynamic model of unemployment insurance with moral hazard and life-cycle features in order to find a more realistic design of the optimal unemployment insurance. As in Shavell and Weiss [1979]’s seminal work, we assume that the probability of finding a job depends on the search effort unobservable by the principal. In this type of framework, the optimal contract is such that the replacement ratio decreases with the unemployment spell. Hopenhayn and Nicolini [1997] introduce a wage tax after reemployment together with the decreasing sequence of unemployment benefits. With this tax-wage, the principal provides a better consumption smoothing with a higher replacement ratio. However, Hopenhayn and Nicolini [1997]’s model considers infinite-lived agents searching for a permanent job (the job destruction rate equals zero).

Why does the infinite-lived agents assumption lead to some important bias in the optimal unemployment insurance scheme? If we consider the life cycle of an agent the horizon becomes an important aspect of the optimal contract. Indeed, longer the length of a job, the more attractive the job search for an unemployed worker. Consequently, search intensity is less important when the agent is close to the retirement age. Hence, the principal has to provide a more incentive contract for the seniors. Moreover, the reemployment wage-tax is less effective because the principal receives the tax during a shorter period.

In this paper, we extend Hopenhayn and Nicolini [1997]’s framework by introducing life cycle features. We show that this leads to a new design of the optimal unemployment insurance. The expected time search duration difference between young and old workers leads to an age-specific optimal unemployment insurance contract. If we restrict our analysis to the instruments studied by Hopenhayn and Nicolini [1997], we show that the replacement ratio has to decrease in a much considerable way for the senior. Moreover, the wage tax
after reemployment is less effective, in particular for the agents close to retirement age. The originality of our analysis is to extend the instruments of UI agency: life-cycle features introduce an other possible future state, the retirement. Hence, incentive considerations leads us to introduce a pension-tax for unemployed workers who arrive at the age when the full pension is reached. In that case, when an unemployed worker retires, his pension decreases with the length of the last unemployment spell. This explicitly leads to an heterogeneity in pension allowing to give more incentive to elder worker to search for a job. This optimal design of the social program allows us to provide a contract where the unemployment benefit decrease is small but where the penalties applied on pension are large. As the time horizon of a retired worker is long, this tax on pension provides a better smoothing of consumption, and thus increases the efficiency of the optimal contract. We show that the integration of these two social programs (unemployment and retirement) is more efficient in increasing the employment rate and decreasing the cost of the insurance programs. As suggested by J-J. Laffont in Hopenhayn and Nicolini [1997], in our optimal unemployment insurance program, the principal acts as a bank account: workers can borrow against their future wages, if they are employed, or against their future pension, if they are retired, to finance consumption during an unemployment episode. Consistent with Stiglitz and Yun [2005]’s findings, we give some foundations to the integration of social program insurance however different framework. From a political point of view, the introduction of a tax-pension in the unemployment insurance contract allows to increase the employment value and then leads to a higher employment rate at the end of the life-cycle. Indeed, European countries are aware that the low labor participation of the elderly limits the effectiveness of recent Social Security reforms. As a result, the Stockholm European Council on Active Ageing (2002) has called for initiatives to retain workers longer in employment and sets a target of a 50% employment rate for workers between 55 and 64 by 2010. A reform of the UI that takes into account the age-specificities of the agents could be viewed as a first step to meet the Stockholm European Council objectives.

Our analysis of the economic effects of the UI is carried out in a framework of partial equilibrium analysis. Hence, we do not explore the welfare implication of the potential reduction of social cost of the UI insurance system because its financing is a complex issue, relying on the sharing between employees and firms of the taxes allowing to balance the budget of the UI system\(^1\). This paper is organized as follows: The next section reviews the literature on optimal unemployment insurance. In section 3 we describe the model. Section 4 presents the calibration and the results. Finally, section 5 concludes.

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\(^1\)See Hansen and Imrohoroglu [1992] for a general equilibrium approach.
2 Related Literature

The optimal contract of unemployment insurance was first studied by Shavell and Weiss [1979]. In their seminal paper, the probability to receive a job offer depends on the search intensity made by the agent (e.g., unemployed worker), which can not be observed by the principal (the unemployment insurance agency). However, the higher the search effort, the lower instantaneous utility. Consequently, the agent has to trade-off between increasing search costs and an increasing job offer probability. The unemployment insurance contract is a sequence of transfers between the principal and the agent. The aim of this contract is to minimize the expected discounted value of net transfers to the agent and to provide a certain ex-ante-utility for the agent. The main result of Shavell and Weiss [1979] is that an optimal contract is such that the replacement ratio has to decrease throughout the unemployment spell.

The most popular extension of this paper is provided by Hopenhayn and Nicolini [1997]. They introduce a new instrument in the optimal contract: a wage tax after reemployment. They show that the wage tax increases with unemployment spell. The main result of this paper is that the wage tax largely improves the contract by reducing the cost to the principal. Shimer and Werning [2003] show that Hopenhayn and Nicolini [1997]'s results are robust to the assumption of the informational structure. They present a model where the moral hazard does not come from the search intensity, but from the reservation wage: the principal can not observe the reservation wage. They show that the optimal replacement ratio decreases with the length of the unemployment spell as in Hopenhayn and Nicolini [1997].

Following these seminal papers, a growing literature has studied the optimal contract of unemployment insurance. Recent contributions assume that workers are not ex-ante identical. Hagedorn, Kaul and Mennel [2002] propose to reconsider the optimal unemployment insurance when heterogeneity comes from the fact that agents face different search costs. In this model, there are two types of agents, differing in their probability of finding a job: the "good searchers" have a high probability whereas the "bad searchers" have a low reemployment probability. The principal can not observe the agents' type. The authors show that the UI agency has to offer two different contracts. A

\[\text{We limit our review of literature to papers that focus on labor supply. Cahuc and Lehmann [2000] introduce labor demand through a matching process. In Cahuc and Lehmann, the “threatpoint” of the union is the expected value of being laid off. Then, early UI payments might be kept low in order to decrease the power of the insiders, while later UI payments could be more generous so as to improve the welfare of the unemployed workers. In this case, UI payments increase with the unemployment duration. This is in contradiction with the argument developed by Shavell and Weiss [1979], where job search effort is unobserved, implying a decrease of the UI payments with the unemployment duration. Millard and Mortensen [1997] or Fredriksson and Holmlund [2001] obtain this last result in job matching models. Coles and Master [2006] show that the introduction of strategic bargaining in a simple matching model (job search effort is observable) allows to give some foundation of a UI payment decreasing with duration.} \]
contract for the good searchers which is characterized by a decreasing replacement ratio and a contract for the bad searchers which has an upward-sloping benefit profile because of an adverse selection effect.

The papers above examine the optimal contract in models where only the search behavior is unobservable. Pavoni [2003] investigates the optimal unemployment insurance when the human capital depreciates with unemployment duration. Consequently, job offers decrease during unemployment. In this framework, the optimal contract has to decrease with the length of the unemployment spell. However, he shows that unemployment insurance benefits are bounded below by a minimal "assistance" level. Werning [2002] studies the optimal design of the unemployment insurance system when the agent can save. The individual amount of savings are unobservable. If the agents can save or borrow, it is no needed to reduce unemployment insurance benefits for consumption to be decreasing. Unlike Hopenhayn and Nicolini [1997], he shows that the optimal contract can be characterized by constant benefits.

To the best of our knowledge, no papers have so far investigated the optimal unemployment insurance in a life cycle model. Interestingly, life-cycle features introduce heterogeneity and thus can allow to analyze age-specific strategies on the labor market (Seater [1977]). More precisely, the seniors expect that their average duration in the labor market is short because their age is close to the mandatory retirement age. Consequently, the expected returns of search effort is relatively low for the seniors, and thus optimal search intensity decreases with age (see Hairault, Langot and Sopraseuth [2005]). Another important point introduced by the life-cycle features is that employment can no longer be viewed as a permanent state as in Hopenhayn and Nicolini [1997]: as shown by Ljungqvist and Sargent [2002], the unemployment risk is high for young workers but also for the seniors. Hence, there is no job destructions before the transition between employment and retirement states. From the optimal UI contract this implies that the wage tax after reemployment must integrate job destruction and retirement. An interesting feature is that the introduction of a finite life-time horizon for the agents in the labor market implies that unemployed workers can leave this market before finding a job. For these workers, the wage tax incentive scheme is not efficient: this clearly suggests that social programs (unemployment benefits and pensions) must be integrated. More precisely, the unemployment insurance contract must include a pension tax if the retiree comes from unemployment. Optimal contract designs the profile of these taxes as a function of the unemployment spells. Penalties on pensions can be viewed as a way to increase the employment rate at the end of the working life via an heterogeneity the pension based on an incentive scheme (see Hairault, Langot and Sopraseuth [2005] for an alternative Social Security schemes).

Thus, this paper reconsiders the optimal unemployment insurance in a life cycle model. There are three types of agents: the young workers, the seniors
and the retirees. Our methodology follows the recursive contract literature as developed by Spear and Srivastava [1987], Phelan and Townsend [1991], Abreu, Pearce, and Staccheti [1990] and Atkeson and Lucas [1992]. The aim is to characterize the sequence of consumption and search intensity minimizing the expected discounted value of net transfers.

3 The model

In this section, we first present the agents’ behavior. In a second step, we describe the programs of the UI agency. Finally, we derive some general properties of our model.

3.1 The life-cycle

Following here Castaneda, Diaz-Gimenez and Rios-Rull [2003] and Ljungqvist and Sargent [2002] agents age stochastically. Retirement choice is exogenous. Upon death, households are replaced by other households so that the population is constant over time. We assume that the population can be divided into 3 age groups: the young workers, the seniors and the retirees. Each individual is born young. The probability for a young worker (a senior) of remaining a young worker (a senior) the next period is $1 - \lambda_{ys} \ (1 - \lambda_{sr})$. Conversely, the probability of aging for a young worker (a senior) equals $\lambda_{ys} \ (\lambda_{sr})$. Finally, we denote by $\lambda_{rr}$ the probability of death for a retiree.

An unemployed worker, each period $t$, chooses a job search intensity $a_t \geq 0$. According to probability $\pi(a_t)$, an unemployed worker receives a job offer in the next period. This offer is $w$ (there is no wage distribution). Accepting a wage offer $w$ implies that the worker earns that wage in period $t + 1$ and thereafter for each period she has not been laid off and has not retired. The probability of being laid off at the beginning of the period is $\delta \in [0, 1]$.

After a stochastic number of periods, the agents become a retiree. During this retirement period, we assume that the retirement pension is the same across agents. In an economy where there is only one level of wage, a single level of pension implies that the length of the unemployment spell does not affect the level of the pension $p$ if the agents become retiree after the employment state\textsuperscript{3}. There is three type of retiree in this economy. The first comes from employment and then have the seniority of a senior. The two others come form the unemployment: the first have became unemployed whereas they have the seniority of a senior and the second become unemployed whereas they have the seniority of a young workers. Indeed, an individual can become unemployed when she was young and have a very long unemployment duration spell: she

\textsuperscript{3}This assumption is consistent with Social Security systems in European countries where the level of the pensions does not depend on the unemployment history of the agents.
reach the retirement before to find a job. Then, one can summarizes the life-cycle sequence as follow:

For the young workers

young and employed

young and unemployed

For the seniors

senior employed or unemployed

The stochastic event $z_t$ in this economy is the age of the agent and labor market transitions: hence, the history of events at time $t$ is denoted $z^t$ and gives the age of the agent and its labor market occupation.

3.2 The agents

The agents' preferences are given by:

$$\sum_{t=0}^{\infty} \beta^t \phi(z') [u(c_t) - a_t]$$

where $\beta < 1$ denoted the intertemporal discount factor, $c_t$ consumption at time $t$, and $a_t$ the search intensity. We assume that $a_t = 0$ when the agent is an employed worker or a retiree. Thus $a_t$ is only the search intensity of the unemployed workers. The unconditional probability of $z^t$, when $z_0$ has not been realized, is denoted by $\phi(z^t)$. The instantaneous utility function $u(.)$ is increasing, twice differentiable, strictly concave with $u'(0) = \infty$ and is equal to

$$u(c_t) = \frac{c_t^{1-\sigma}}{1-\sigma}$$

where $\sigma$ is the coefficient of relative risk aversion.
The probability of receiving a job offer is given by an exponential distribution:
\[ \pi(a) = 1 - \exp(-\psi.a) \]
where \( \psi \) is a calibrated parameter. This hazard function is increasing, strictly concave, twice differentiable and satisfies the Inada conditions.

The Bellman equation for a retiree is then given by:
\[
V^{ret}(\tau^i(t)) = u(p - \tau^i(t)) + \beta(1 - \lambda_{rr})V^{ret'}(\tau^i(t)) \quad \text{for } i = y, s
\]
where \( \tau^i(t) \) denotes the tax which depends on the length of the previous unemployment spell, denoted by \( t \), and the age at which the agent become unemployed (young or senior). The Bellman equation of a retiree who comes from unemployment is the given by
\[
V^{uir}(\tau^i(t)) = u(p - \tau^i(t)) + \beta(1 - \lambda_{rr})V^{uir}(\tau^i(t)) \quad \text{for } i = y, s
\]

A young employed worker has the following Bellman equation:
\[
V^{ey}(w, \tau^y(t)) = u(w - \tau^y(t)) + \beta \left[ (1 - \lambda_{ys})[\delta V^{uy}(1) + (1 - \delta)V^{ey}(w, \tau^y(t))] + \lambda_{ys}[\delta V^{us}(1) + (1 - \delta)V^{es}(w, \tau^y(t))] \right]
\]

where \( V^{uy}(1) \) is the initial value of unemployment for a young workers and \( V^{us}(1) \) is the initial value of unemployment for a senior. Unlike Hopenhayn and Nicolini [1997]'s problem, the value of an employee is an increasing function of these values: given a strictly positive destruction rate, an increase in the promise-keeping leads to an higher level of insurance and then increases the employment value.

The value of the unemployment for a young worker is defined as follows:
\[
V^{uy}(t) = u(b^y(t)) - a^y(t) + \beta \left[ (1 - \lambda_{yr})[\pi(a^y(t))V^{ey}(w, \tau^y(t)) + (1 - \pi(a^y(t)))V^{uy}(t + 1)] + \lambda_{yr}V^{uyr}(\tau^y(t)) \right]
\]

with \( b^y(t) \) is the level of unemployment compensation after \( t \) period of unemployment and \( \lambda_{yr} \) the probability for a young unemployed worker to become a retired person.

Finally, the Bellman equations of the senior employed workers and the senior unemployed workers are given by:
\[
V^{es}(w, \tau^s(t)) = u(w - \tau^s(t)) + \beta \left[ (1 - \lambda_{sr})[\delta V^{us}(1) + (1 - \delta)V^{es}(w, \tau^s(t))] + \lambda_{sr}V^{esr}(\tau^s(t)) \right]
\]
\[ V^{us}(t) = u(b^*(t)) - a^*(t) \]
\[ + \beta \left[ (1 - \lambda_{sr})[\pi(a^*(t))V^{cs}(w, \tau^s(t)) + (1 - \pi(a^*(t)))V^{us}(t + 1)] \right. \]
\[ \left. + \lambda_{sr}V^{usr}(\tau^s(t)) \right] \]

Using these value function, one can derive the optimal search behavior. Then, we have:
\[ a^y(t) = \frac{1}{\psi} \log (\psi\beta(1 - \lambda_{jr})[V^{cy}(w, \tau^y(t)) - V^{uy}(t + 1)]) \]
\[ a^s(t) = \frac{1}{\psi} \log (\psi\beta(1 - \lambda_{sr})[V^{cs}(w, \tau^s(t)) - V^{us}(t + 1)]) \]

For the same gap between the employment and the unemployment value functions for all age, the right hand side of these equations states that, as the individual ages, the incentive to search decrease because the probability to stay in employment decrease with the age. Moreover, as if \( \lambda_{jr} = \lambda_{sr} \), if the UI agency supplies a flat sequence of \( b \), the gap between employment and the unemployment value functions narrows. This clearly show that the return on the job search effort is low when the distance from the retirement age decreases.

### 3.3 The principal

We consider a risk-neutral planner (the principal) providing an optimal unemployment compensation scheme for risk-averse workers. The principal cannot observe the search intensity \( a(t) \), but knows the economic environment, in particular the hazard function \( \pi(a) \). On the other hand, the principal observes and controls perfectly the consumption of the workers: the consumption of the employed workers and of the retirees thought the tax, and the unemployed worker consumption thought the unemployment compensation.

At the beginning of his life, the agent is considered by the principal as a young worker. After several years she is considered as a senior. The major difference between young and old workers is their life-time expected durations in the labor market. For the young, the employment value relatively to the one of retirement is high, whereas for the old workers, this relative value is lower. The incentives to find a job are lower for old workers. Moreover, from a financial point of view, it is more easy to recoup the unemployment benefits via a tax for the young workers. Hence, age-specific contracts must be compute by the principal.

For each unemployed worker, the profile of unemployment insurance benefits depends on the age of the agent when he became an unemployed worker. Hence, a contract is four vectors of consumption \( B^i = \{(b^i(1), b^i(2), ..., b^i(T))\} \) and \( T^i = \{\tau^i(1), \tau^i(2), ..., \tau^i(T)\} \) for \( i = y, s \) where \( b^i(t) \) and \( \tau^i(1) \) are respectively
the benefit level and tax after $t$ periods of unemployment. Given this vector of consumption, the agent maximizes his intertemporal utility by choosing a vector of search intensity \( A^i = \{ (a^i(1), a^i(2), \ldots, a^i(T)) \} \) for \( i = y, s \) where \( a^i(t) \) is the search intensity after \( t \) periods of unemployment.

The objective of the principal is to minimize the total expenditure of the UI agency, under two constraints: (i) a given expected utility \( V^{uy}(1) \) for a new unemployed young worker, and (ii) a given expected utility \( V^{us}(1) \) pour for a new unemployed senior. This program is given by:

\[
\min C = \sum_{t=1}^{\infty} CT(t)
\]

where \( CT(t) \) is the costs associated to the unemployed workers with a length of the unemployment spell equal to \( t \) periods. This cost is given by:

\[
CT(t) = U^y(t)b^y(t) + U^s(t)b^s(t) + \beta \left[ CT(t+1) + \sum_{i=ey}^{rs} G_i(t+1) \right]
\] (1)

where \( U^y(t) \) (\( U^s(t) \)) is the number of young (old) unemployed workers with a length of the unemployment spell equal to \( t \) periods, and \( G_i(t+1) \) is the actualized sum of taxes paid by an agent after his unemployment spell. These taxes can be paid by employed or by retirees\(^4\). The dynamics of these numbers of agents are given by:

\[
U^y(t+1) = U^y(t)[1 - \pi(a^y)](1 - \lambda_{yr})
\] (2)

\[
U^s(t+1) = U^s(t)[1 - \pi(a^s)](1 - \lambda_{sr})
\] (3)

\[
E^y(t+1) = U^y(t)\pi(a^y)(1 - \lambda_{yr})
\] (4)

\[
E^s(t+1) = U^s(t)\pi(a^s)(1 - \lambda_{sr})
\] (5)

\[
R^y(t+1) = U^y(t)\lambda_{yr}
\] (6)

\[
R^s(t+1) = U^s(t)\lambda_{sr}
\] (7)

where \( E^y(t+1) \) (\( E^s(t+1) \)) is the number of young (old) unemployed workers who find a job for the next period, and \( R^y(t+1) \) (\( R^s(t+1) \)) the number of young (old) unemployed who becomes retired without any employment spell since his last unemployed episode when he was young (old). If the number of unemployed agents gives the size of the agency expenditures, the number of employees and retirees gives the size of the agency receipts.

The envelop condition of this cost function \( C \) verifies:

\[
\frac{\partial C}{\partial U^y(t)} = \frac{\partial CT(t)}{\partial U^y(t)}
\]

\[
\frac{\partial C}{\partial U^s(t)} = \frac{\partial CT(t)}{\partial U^s(t)}
\]

\(^4\)After an unemployment spell, the agent is denoted by \( ey \) if he is employed and young, \( es \) if he is employed and senior, \( ry \) if he becomes retired without any employment spell since his last unemployed episode when he was young, and \( rs \) if he becomes retired without any employment spell since his last unemployed episode when he was a senior.
Let denote $\frac{\partial C_T(t)}{\partial U_i(t)} = C_i(V^{ui}(t))$, for $i = y, s$, using equations 1 and (2)-(7), we obtain, for $i = j, s$:

$$
C_i(V^{ui}(t)) = b^j(t) + \beta(1 - \lambda_{ir})(1 - \pi(a^j(t)))C_i(V^{ui}(t + 1))
$$

$$
+ \beta(1 - \lambda_{ir})\pi(a^j(t)) \frac{\partial G_{ei}(t + 1)}{\partial E^i(t + 1)}
$$

$$
+ \beta\lambda_{ir} \frac{\partial G_{ri}(t + 1)}{\partial R^i(t + 1)}
$$

where $\frac{\partial G_{ee}(t + 1)}{\partial E^e(t + 1)} \frac{\partial G_{ee}(t + 1)}{\partial R^e(t + 1)}$ represents the discounted sum of the taxes paid by an individual if she finds a job. These discounted sum of taxes are defined as follows:

$$
\frac{\partial G_{ey}(t + 1)}{\partial E^y(t + 1)} = -\tau^y(t) + \beta(1 - s)\lambda_{yr} \frac{-\tau^y(t)}{1 - \beta(1 - \lambda_{rr})} + \beta\lambda_{yr} \frac{-\tau^y(t)}{1 - \beta(1 - \delta)(1 - \lambda_{rr})}
$$

$$
\frac{\partial G_{es}(t + 1)}{\partial E^s(t + 1)} = -\tau^s(t) + \beta(1 - s)\lambda_{sr} \frac{-\tau^s(t)}{1 - \beta(1 - \lambda_{rr})} + \beta\lambda_{sr} \frac{-\tau^s(t)}{1 - \beta(1 - \delta)(1 - \lambda_{rr})}
$$

$$
\frac{\partial G_{ry}(t + 1)}{\partial R^y(t + 1)} = -\tau^y(t) + \beta(1 - s)\lambda_{yr} \frac{-\tau^y(t)}{1 - \beta(1 - \lambda_{rr})} + \beta\lambda_{yr} \frac{-\tau^y(t)}{1 - \beta(1 - \delta)(1 - \lambda_{rr})}
$$

$$
\frac{\partial G_{rs}(t + 1)}{\partial R^s(t + 1)} = -\tau^s(t) + \beta(1 - s)\lambda_{sr} \frac{-\tau^s(t)}{1 - \beta(1 - \lambda_{rr})} + \beta\lambda_{sr} \frac{-\tau^s(t)}{1 - \beta(1 - \delta)(1 - \lambda_{rr})}
$$

The objective of the principal is reached if he finds the solution of this following joint problem:

$$
\begin{align*}
C_y(V^{uj}(t)) &= \min_{a^y(t)} \left\{ b^y(t) + \beta(1 - \lambda_{yr}) \left[ (1 - \pi(a^y(t)))C_y(V^{uy}(t + 1)) + \pi(a^y(t)) \frac{-\tau^y(t)}{1 - \beta(1 - \lambda_{rr})} + \beta\lambda_{yr} \frac{-\tau^y(t)}{1 - \beta(1 - \delta)(1 - \lambda_{rr})} \right] \right. \\
&\left. + \beta\lambda_{yr} \frac{-\tau^y(t)}{1 - \beta(1 - \lambda_{rr})} \right\}
\end{align*}
$$

subject to

$$
\begin{align*}
V^{uj}(t) &= u(b^j(t)) - a^j(t) \\
&\quad + \beta \left[ (1 - \lambda_{jr})\pi(a^j(t))V^{ej}(w, \tau^j(t)) + (1 - \pi(a^j(t)))V^{uj}(t + 1) \right] \\
&\quad + \lambda_{jr} V^{ujr}(\tau^j(t)) \\
1 &= \beta\pi^l(a^j(t))(1 - \lambda_{jr})[V^{ej}(w, \tau^j(t)) - V^{uj}(t + 1)]
\end{align*}
$$
\begin{equation}
\left\{ \begin{array}{l}
C_s(V^{us}(t)) = \min \{ b^s(t) + \beta(1 - \lambda_{sr}) \left[ (1 - \pi(a^s(t)))C_s(V^{us}(t + 1)) \right. \\
+ \pi(a^s(t)) \left[ \frac{-\tau_s(t) + \beta(1 - \lambda_{sr})}{1 - \beta(1 - \delta)(1 - \lambda_{sr})} \right] \\
\left. + \beta \lambda_{sr} \frac{-\tau_s(t)}{1 - \beta(1 - \lambda_{sr})} \right\} \\
\text{subject to} \\
V^{us}(t) = u(b^s(t)) - a^s(t) \\
+ \beta \left[ (1 - \lambda_{sr})[\pi(a^s(t))V^{es}(w, \tau^s(t)) + (1 - \pi(a^s(t)))V^{us}(t + 1)] \right. \\
\left. + \lambda_{sr}V^{us}(\tau^s(t)) \right\} \\
\text{and} \\
1 = \beta \pi'(a^s(t))(1 - \lambda_{sr})[V^{es}(w, \tau^s(t)) - V^{us}(t + 1)]
\end{array} \right. (Ps)
\end{equation}

where \( C^i \equiv \{ b^i(t), a^i(t), V^{ui}(t + 1), \tau^i(t) \} \), for \( i = y, s \). The fist constraints of the \((Py)\) and \((Ps)\) programs are the promise-keeping constraints, whereas the seconds are the incentive-compatibility constraints.

For any unemployment spells \( t \), an expected discounted utility \( V^{ui}(t) \) and an expected discounted cost of unemployment benefit \( C^i(V^{ui}(t)) \) are associated with each contract. \( V^{ui}(t) \) and \( C^i(V^{ui}(t)) \) are estimated with the same intertemporal discount factor. Moreover, the agent chooses the search intensity that maximizes the intertemporal utility. Thus different contracts \( \{B^i, T^i\} \) can provide the same initial utility \( V^{ui}(1) \) to the agent, but with different costs \( C^i(V^{ui}(1)) \) to the principal. The optimal contract minimizes the cost of the unemployment insurance and guarantees an ex-ante lifetime utility \( V^{ui}(1) = V^{ui} \).

Concerning the taxes, we assume that the taxes paid by an employed worker are the same than the ones paid by a retiree.

### 4 Quantitative analysis

In this section we characterize the optimal contract of unemployment insurance in a life-cycle model. In order to compare the young worker’s contract with the senior worker’s contract, we chooses \( U^y \) and \( U^s \) assuming that the unemployment insurance profile is flat \( b_1 = b_2 = \ldots = b_T = \bar{b} \). Then the principal minimizes the cost of the unemployment insurance which ensures the same ex-ante utilities \( U^y \) and \( U^s \).

#### 4.1 Calibration

In this model, we choose a monthly period. Following Hopenhayn and Nicolini [1997], we set the discount factor \( \beta \) to 0.995, which implies an annual discount rate of 0.95, and the coefficient of relative risk aversion\(^5\) to \( \sigma = 0.5 \). We

\(^5\) This calibration is usual in the literature. See for example Hagedorn, Kaul, and Mennel [2002].
normalize the wage $w$ to 100, so that the unemployment benefit equals the replacement rate. We set the job destruction rate $\delta$ to 0.01. Consequently, the average employment duration equals 100 months.

On average an agent participates to the labor market during 40 years and receives a pension during 20 years before he dies. In European countries, the benefit duration is longer for the unemployed workers of more than 50 years old. Consequently, we assume that a young employed worker works 30 years before becoming a senior and then is entitled to the unemployment insurance provided to the seniors. A senior becomes a retiree after 10 years. Consequently, the probability for a young employed worker to become a senior is $\lambda_{JS} = 0.0028$. A young unemployed worker has a probability $\lambda_{JR} = 0.0021$ to become retired whereas a senior retires with probability $\lambda_{SR} = 0.0083$. Finally, a retired person dies with probability $\lambda_{RR} = 0.0042$.

The parameter $\phi$ is chosen in order to replicate an unemployment rate of 8.7%. We set $\phi$ to 0.0046. Thus the average unemployment duration equals 7.4 months for the young and 16.6 months for the elderly with $b = 50$. Finally, the lower bound to the unemployment value corresponds to the expected discounting value of an agent who receives $b = 0$ forever and does not pay taxes if he gets a job. Concerning the pension, we set the replacement rate at its observed average rate in European countries, i.e. $p = 70$.

4.2 The design of the optimal UI contract

In this section, we discuss the quantitative properties of the model. We then compare the optimal contract without taxes on pension with the contract with taxes on pension.

The main point is show how the life cycle features lead to a new design of the optimal contract. Indeed, the life cycle have two characteristics: (i) the time horizon is finite and (ii) agents do not work during the retirement period. The first point implies that the returns of the search decrease when the agent age is close to the end of her life on the labor market. The second point implies that the gross earnings the agent are lower at the end of the life cycle relatively to the gross wage ($p < w$), but higher than the unemployment benefits ($p > b$). These two points have important implications on the optimal contract: (i) a shorter life-time horizon leads the principal to introduce more incentives for the seniors (the agents having the shorter horizon), (ii) the gains provided by the taxes on pensions are positive but lower than those provided by the taxes on wages because the marginal utility of the pension is higher than the marginal utility of the wage.

Figure 1 gives a quantitative illustration of the first point. Indeed, this figure describes the unemployment compensation profile for the young workers and for the seniors when pensions are not taxed. These contracts correspond to those studied by Hopenhayn and Nicolini [1997], but in a model where
the life-time horizon is finite. The replacement ratio decreases throughout the unemployment spell for the two UI contracts. As shown in figure 1, the replacement ratio of the seniors decreases more than for the young workers. The intuition for this result is straightforward. In order to give unemployed workers the right incentive to search for a job, agency must punish those who do not find a job. The incentive to search for a job increases with the gap between the value functions of the employed and the unemployed workers. Then, by increasing the relative value of employment, the replacement rate decrease leads to an increase in the search intensity. Nevertheless, there is some heterogeneity among workers: seniors are close to the retirement age. As a result, they will remain employed during a shorter period than the young. Consequently, the job search is less attractive for the seniors and the principal has to give more incentives in order to induce the seniors to search for a job. This explains why the principal provides an unemployment insurance system where the decrease in the replacement is larger for the seniors.

Figure 1: Optimal replacement ratio with tax on wages

![Figure 1](image1)

The solid line refers to seniors whereas the dashed line presents the optimal contract for young workers.

Figure 2: Optimal tax on wages

![Figure 2](image2)

At it is shown in Hopenhayn and Nicolini [1997], if UI agency can control
the consumption spending during both the unemployment and employment spells, a better consumption smoothing could be achieved. The important point is not the introduction of a wage tax, but rather that this tax depends on the duration of the preceding unemployment spell. If the tax depends on the duration of the preceding unemployment spell, then the same level of incentive could be attained with smaller distortions of the consumption stream. Hence, a same level of expected utility of the worker can be obtained at a lower cost to the insurer. The high level of unemployment benefit (see figure 1) is compatible with the incentive scheme because, for the first two months, the optimal contracts of the young workers and the seniors are characterized by a negative tax. Indeed, figure 2 shows that the agents receive a subsidy if they quickly find a job. When an agent finds a job after two months, the subsidy is higher for the seniors than for the young workers. The principal pays subsidy as long as the agent remains employed. However, the seniors leave more often employment because of retirement. Consequently, the principal can provide a more generous subsidy. After these two months of unemployment, the tax becomes positive and increases with the length of the unemployment spell.

Beyond the ability of the optimal contract to smooth consumption spending during the life cycle, this unemployment insurance system has another advantage for the principal: when the unemployed worker does not find a job quickly, the tax finances the unemployment compensations. In other words, the agent refunds the principal with higher taxes. However, the efficiency of the wage-tax is lower for the seniors than for the young workers for two reasons. First, the employment spell is shorter for the seniors than for the young workers because the tax smoothing effect is less efficient. Second, the probability that an unemployed worker becomes a retiree is higher for the senior. In this case, the wage tax is also less efficient. Consequently, in order to give more incentive to seniors, the principal provides a contract where (i) the decrease in the replacement ratio is higher, and (ii) the wage tax increases in a higher proportion with the duration of unemployment.
In order to improve the contract, we propose to integrate unemployment and retirement insurance. Indeed, as suggested by Stiglitz and Yung [2005], one can smooth the agents’ consumption by shifting some resources from the retirement to the unemployment period of an individual. Figures 3, 4 and 5 present the results of the optimal UI contract for an integrated system. With this system, the replacement ratio profile of the elders decreases more slowly than without pension tax. On the one hand, the unemployed elders search more in order to have the full rate retirement pension. On the other, UI agency can always receive taxes once the agents are retired. Consequently, agents refund the principal once retired.

As shown in figure 5, the optimal retirement pension level decreases with the length of the unemployment spell: this gives the optimal penalties on pensions conditional to the duration of the preceding unemployment spell. Then for the principal, the same level of incentive could be attained by simultaneously
reducing the expected retirement pension level and lowering the decrease of the replacement rate.

![Figure 5: Optimal pension](image)

The solid line refers to seniors whereas the dashed line presents the optimal contract for young workers.

In other words, for a given expected utility for the first period of unemployment, it is possible for UI agency to increase the incentive to find a job by increasing the gap between the value of unemployment and the value of employment through a decrease in the retirement value for a worker who becomes unemployed. These penalties on pensions are some taxes that UI agency uses to smooth the consumption of unemployed workers. Hence, as shown in the theoretical analysis, the optimal contract is characterized by the integration of unemployment insurance and retirement pension system. The quantitative results show that the seniors are more sensitive two the introduction of the pension tax: the comparison of the figures 1 and 3 shows that the level and the decrease of the unemployment compensations are approximatively the same for the young workers. Hence, when the time horizon is long, our result are close to Hopenhayn and Nicolini [1997]'s one.

4.3 The gains from the optimal contracts

How large are the social gains from the optimal UI contracts? Tables 1 and 2 report the expected cost of the unemployment insurance systems and the social gains for each contract, relatively to the flat profile system. In this paper, we are particularly interested in the quantitative impact of taxes on pensions. Thus, in a first simulation, we assume that there is no retirement period, but we keep a finite life-time horizon$^6$. Hence, as in Hopenhayn and Nicolini [1997],

$^6$In order to easily compare the simulation results, we assume that a worker become a senior 10 years before the end of his life. Hence the length of horizon is the same in all the
workers can search for a job during all their life. In this case, the returns of the tax after an unemployment spell are at the maximum because the wages are higher than the pensions (the marginal cost of the tax is lower for the employed worker than for the retirees). Nevertheless, contrary to Hopenhayn and Nicolini [1997], these returns are not over-estimated by an infinite life-time horizon. The results of these simulations are reported in the second line of the tables 1 and 2.

When the principal provides a flat replacement ratio \( \bar{b} = 50 \) throughout the unemployment spell, for the agency the costs are equal to 352.92 for the young workers and 687.44 for the elders\(^7\). The second line gives the upper bound of the gains provided by the optimal contract: if a worker can be employed during all his life, the costs of the insurance decrease by 33.53\% for the young workers and 51.73\% for the elders. The larger impact of the optimal contract is due to the horizon effect: when the horizon is short, the incentive to search is low if the unemployment compensations are constants. With the optimal contract, the incentive scheme partially compensate this horizon effect, as if the cost of UI system remains higher for the elders than for the young workers.

Table 1: The costs of the unemployment insurance for the young workers

<table>
<thead>
<tr>
<th>The unemployment insurance contracts</th>
<th>( \bar{b} = 45 )</th>
<th>( \bar{b} = 50 )</th>
<th>( \bar{b} = 55 )</th>
</tr>
</thead>
<tbody>
<tr>
<td>The flat profile</td>
<td>287.26</td>
<td>352.92</td>
<td>438.19</td>
</tr>
<tr>
<td>The optimal contract with no retirement</td>
<td>234.6</td>
<td></td>
<td>(-33.53%)</td>
</tr>
<tr>
<td>Decreasing UB with wage tax</td>
<td>222.78</td>
<td>266.3</td>
<td>311.68</td>
</tr>
<tr>
<td>(-22.45%)</td>
<td>(-24.54%)</td>
<td>(-28.87%)</td>
<td></td>
</tr>
<tr>
<td>Decreasing UB with wage and pension taxes</td>
<td>220.78</td>
<td>264.41</td>
<td>309.52</td>
</tr>
<tr>
<td>(-23.14%)</td>
<td>(-25.08%)</td>
<td>(-29.36%%)</td>
<td></td>
</tr>
</tbody>
</table>

Table 2: The costs of the unemployment insurance for the seniors

<table>
<thead>
<tr>
<th>The unemployment insurance contracts</th>
<th>( \bar{b} = 45 )</th>
<th>( \bar{b} = 50 )</th>
<th>( \bar{b} = 55 )</th>
</tr>
</thead>
<tbody>
<tr>
<td>The flat profile</td>
<td>443.8</td>
<td>687.4</td>
<td>2338.5</td>
</tr>
<tr>
<td>The optimal contract with no retirement</td>
<td>331.8</td>
<td></td>
<td>(-%)</td>
</tr>
<tr>
<td>Decreasing UB with wage tax</td>
<td>287.4</td>
<td>363.4</td>
<td>487.6</td>
</tr>
<tr>
<td>(-35.24%)</td>
<td>(-47.14%)</td>
<td>(-79.15%)</td>
<td></td>
</tr>
<tr>
<td>Decreasing UB with wage and pension taxes</td>
<td>273.8</td>
<td>350.9</td>
<td>471.1</td>
</tr>
<tr>
<td>(-38.31%)</td>
<td>(-49.97%)</td>
<td>(-79.85%)</td>
<td></td>
</tr>
</tbody>
</table>

\(^7\)This corresponds to 5 (10) months of unemployment benefits for a young worker (an elder).
The third lines of tables 1 and 2 show that the introduction of a retirement state decreases the efficiency of the contract. Indeed, this third state is not used by the principal to smooth the consumption of the workers. Moreover, this state insure an earning: if the pensions are generous, they can prevent for the punishment of the contract.

As shown in the last lines of tables 1 and 2, the introduction of a pension-tax improves the contract. The potential gains are larger for the elders (49.07%) than for the young workers (25.08%). Beyond the levels, one can notice that the marginal gains are higher for the senior contracts: 49.07% for the contract with decreasing UB and wage and pension taxes, versus 47.14% for the contract with decreasing UB and only wage tax. For the contract of the young workers, the marginal gains correspond to the difference between 25.08% (the contract with decreasing UB and wage and pension taxes) and 24.54% (the contract with decreasing UB and only wage tax). This is due to the difference between the horizon of young workers and that of the elders. For the seniors, the probability to become a retiree is high: the punishment through a decrease in the pension gives more incentives to the elders. Moreover, the tax on pensions gives more funds to the agency of the elders.

Our results show that the wage-tax after reemployment allows the principal to find funds only if the employment spell is long. This could be the case for young workers only. In this case, the wage-tax after reemployment is an efficient tool. At the opposite, for the elders, the pension tax is gives higher incentives.

These results clearly show that the social cost unemployment can be largely decreasing for all types of workers if unemployment insurance is integrated with retirement insurance. Finally, tables 1 and 2 show that the potential gains increase with the ex-ante utility. The higher is $b$, the larger are the gains. Unemployed workers reduce their search intensity when the principal proposes high UB in a flat system. Consequently, this leaves the optimal UI contract with larger possibilities to give incentives to find a job.

Finally, we report in the appendix (see table 5) an experiment where the destruction rate is reduced to 0.005. For all workers, a lower value of the exogenous destruction decreases the cost of the UI contract: this is due to the lower value of the equilibrium rate of unemployment. In order to compare the benchmark results with the experience where $\delta/2$, we focus on the decrease expressed in percentage. Hence, the quantitative results show clearly that the marginal impact of the introduction of wage-tax after reemployment is higher when the destruction rate is low: approximatively 10% (9%) for the young workers (the elders) when $\delta$ is low, whereas we obtain 7% (4%) with the benchmark calibration. The gains are lower for the elders because a large fraction of these workers leave the labor market as they become retiree, a transition which is independent of the destruction rate. We find similar results to Hopenhayn and Nicolini [1997]. The lower is the destruction rate, the more efficient is the optimal UI contract with wage-tax after reemployment.
4.4 The impact on unemployment

Beyond the social cost of the insurance program measured by the expected cost of the UI contract, another measure of the efficiency is the unemployment rate. Indeed, since we introduce an exogenous job destruction rate, there is an equilibrium unemployment rate at the stationary equilibrium, unlike the Hopenhayn and Nicolini [1997] framework.

Tables 3 and 4 report unemployment rates in each system. When the UI agency provides a flat replacement ratio $\tilde{b} = 50$ throughout the unemployment spell, the unemployment rates of 6.87% for the young workers and 14.24% for the seniors. For this level of replacement rate, the percentage of unemployment with a duration spell higher than six months is respectively 41.73% for young workers and 68.88% for seniors (see the tables 6 and 7 in the appendix). The longer unemployment spell duration for the elder workers is a stylized fact in European countries (see Ljungqvist and Sargent [2002]).

The second lines of tables 3 and 4 show that the transition from the flat profile to the optimal contract with only tax on wages leads to unemployment rates of 4.43% for the young and 5.40% for the elders. The magnitude of the decrease the unemployment rates of the elder is larger, emphasizing that any incentive scheme largely increases the search effort of this type of workers, which is close to zero in the benchmark case (flat replacement ratio). The higher level of the UB in the flat system, the higher the efficiency of the optimal UI contract. Indeed, an high and flat replacement rate gives lower incentives to seniors than to young workers: the shorter the horizon of the agent, the lower the incentive to find a job if the UI agency supplies a flat replacement rate. Then, the optimal contract à la Hopenhayn and Nicolini [1997], allows to largely increase the employment rate of this type of workers.

Table 3: The unemployment rate for the young workers

<table>
<thead>
<tr>
<th>The unemployment insurance regimes</th>
<th>$\tilde{b} = 45$</th>
<th>$\tilde{b} = 50$</th>
<th>$\tilde{b} = 55$</th>
</tr>
</thead>
<tbody>
<tr>
<td>The flat profile</td>
<td>6.23%</td>
<td>6.87%</td>
<td>7.73%</td>
</tr>
<tr>
<td>Decreasing UB with wage tax</td>
<td>4.43%</td>
<td>4.43%</td>
<td>4.40%</td>
</tr>
<tr>
<td>with wage tax</td>
<td>(-28.89%)</td>
<td>(-35.52%)</td>
<td>(-43.08%)</td>
</tr>
<tr>
<td>Decreasing UB with wage and pension taxes</td>
<td>4.41%</td>
<td>4.43%</td>
<td>4.40%</td>
</tr>
<tr>
<td></td>
<td>(-29.21%)</td>
<td>(-35.52%)</td>
<td>(-43.08%)</td>
</tr>
</tbody>
</table>

The third lines of tables 3 and 4 show that the introduction of a decreasing UB improves the performances of the optimal UI contract only for the older workers. For the young workers, we obtain the same results as with the contract where UB decrease and with only wage-tax after reemployment. Hence, the impact of this sophistication of the optimal UI contract is negligible on unemployment rate. Indeed, the probability of becoming a retiree after more than ten years of unemployment is very low. Thus, the weight of the tax on
Table 4: The unemployment rate for the elders

<table>
<thead>
<tr>
<th>The unemployment insurance regimes</th>
<th>$b = 45$</th>
<th>$b = 50$</th>
<th>$b = 55$</th>
</tr>
</thead>
<tbody>
<tr>
<td>The flat profile</td>
<td>10.07%</td>
<td>14.24%</td>
<td>49.10%</td>
</tr>
<tr>
<td>Decreasing UB with wage tax</td>
<td>5.37%</td>
<td>5.40%</td>
<td>5.41%</td>
</tr>
<tr>
<td></td>
<td>(-46.67%)</td>
<td>(-62.08%)</td>
<td>(-88.98%)</td>
</tr>
<tr>
<td>Decreasing UB with wage and pension taxes</td>
<td>5.32%</td>
<td>5.34%</td>
<td>5.35%</td>
</tr>
<tr>
<td></td>
<td>(-47.17%)</td>
<td>(-62.50%)</td>
<td>(-89.10%)</td>
</tr>
</tbody>
</table>

Pensions is small in the expectations of the young workers. In contrast, for the elder workers, the introduction of a pension tax leads to a significant decrease in the unemployment rate. Moreover, this largely decreases the fraction of long run unemployed workers (see in tables 6 and 7 in the appendix). Indeed, for this type of agents, the punishment has a higher probability: the financial resources perceived through taxation allow to increase significantly the incentives, relatively to the case where only wage are taxed. Hence, this leads the seniors to increase their search intensity: the employment rate of the seniors is at its maximum.

5 Conclusion

In a principal-agent model, Hopenhayn and Nicolini [1997] show that (i) the optimal contract is such that the replacement ratio has to decrease throughout the unemployment spell, and (ii) the introduction of a wage tax after reemployment improves the contract by reducing the cost to the principal. In addition, if a wage tax is introduced, the replacement ratio decreases less dramatically.

In this paper, we extend these previous results in a framework where we introduce exogenous job destruction and workers’ heterogeneity, namely young and old workers. These new features allow us to take into account the impact of the expected employment spell on the incentive to find a job. Indeed, the longer the length of a job, the more intensive the job search for an unemployed worker. Consequently, when the agent is close to retirement age, search effort is less intense.

Accordingly, we show that the principal has to provide a more incentive contract. The short employment duration for the seniors reduces the effectiveness of the introduction of a wage tax. We show that the integration of unemployment and retirement insurances is more efficient to increase the employment rate, in particular for the employment rate of the seniors. The integration reduces the costs for the principal and allows to provide the same utility to the unemployed workers during the first period of unemployment.

In this paper, we focus on the economic analysis on UI insurance programs in a partial equilibrium framework. The study of the distortions introduced by
these different UI programs is likely to become an important policy research agenda. Indeed, future research using quantitative dynamic general equilibrium models can estimate the impact of these incentive programs by taking into account endogenous retirement decisions as well as the financing of Social Security.


Appendix

A  The impact of the destruction rate on UI contract

Table 5: The costs of the unemployment insurance regimes when $\bar{b} = 50$ and $\delta = 0.005$

<table>
<thead>
<tr>
<th>The unemployment insurance contracts</th>
<th>For the young</th>
<th>For the elders</th>
</tr>
</thead>
<tbody>
<tr>
<td>The flat profile</td>
<td>295.11</td>
<td>429.26</td>
</tr>
<tr>
<td>Decreasing UB</td>
<td>255.41</td>
<td>311.72</td>
</tr>
<tr>
<td>with wage tax</td>
<td>(-13.45%)</td>
<td>(-27.38%)</td>
</tr>
<tr>
<td>Decreasing UB</td>
<td>224.84</td>
<td>271.05</td>
</tr>
<tr>
<td>with wage and pension taxes</td>
<td>(-23.81%)</td>
<td>(-36.86%)</td>
</tr>
</tbody>
</table>

B  UI contract and long term unemployment

Table 6: Percentage of young unemployed workers with spells so far $\geq 6$ months

<table>
<thead>
<tr>
<th>The unemployment insurance regimes</th>
<th>$\bar{b} = 45$</th>
<th>$\bar{b} = 50$</th>
<th>$\bar{b} = 55$</th>
</tr>
</thead>
<tbody>
<tr>
<td>The flat profile</td>
<td>37.54%</td>
<td>41.73%</td>
<td>46.67%</td>
</tr>
<tr>
<td>Decreasing UB</td>
<td>23.04%</td>
<td>23.00%</td>
<td>22.77%</td>
</tr>
<tr>
<td>with wage tax</td>
<td>22.70%</td>
<td>22.84%</td>
<td>22.73%</td>
</tr>
<tr>
<td>Decreasing UB</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>with wage and pension taxes</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 7: Percentage of old unemployed workers with spells so far $\geq 6$ months

<table>
<thead>
<tr>
<th>The unemployment insurance regimes</th>
<th>$\bar{b} = 45$</th>
<th>$\bar{b} = 50$</th>
<th>$\bar{b} = 55$</th>
</tr>
</thead>
<tbody>
<tr>
<td>The flat profile</td>
<td>57.06%</td>
<td>68.88%</td>
<td>93.94%</td>
</tr>
<tr>
<td>Decreasing UB</td>
<td>30.16%</td>
<td>30.79%</td>
<td>30.80%</td>
</tr>
<tr>
<td>with wage tax</td>
<td>30.10%</td>
<td>30.17%</td>
<td>30.27%</td>
</tr>
<tr>
<td>Decreasing UB</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>with wage and pension taxes</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>