Unemployment insurance payroll tax, matching frictions and the labor market dynamics

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Abstract

This paper studies the dynamic effects of unemployment insurance experience rating systems which relates the firm payroll tax rate to its layoffs history. We build a DSGE business cycle model with matching frictions and endogenous job separations. We incorporate an experience rating of the payroll tax based on the reserve-ratio method. We evaluate the extent to which such a system affects layoffs and unemployment over the business cycles in its two central components: 1) the degree to which firms are liable for the expenditures they create through their firing decisions and 2) the minimum tax rate and the maximum tax rate known as the statutory tax rates which constrain the tax adjustment. We compare the experience rating system to a layoff tax financing unemployment compensations. The two systems reduce labor market fluctuations and are likely to reduce layoffs and unemployment but only firing taxes discourage vacancy posting. We evaluate the distortions caused by the two system and their ability to offset search externalities through a welfare analysis. The preference of a system depends on how the search externalities distort the economy.

Keywords: Unemployment insurance, non-linear dynamics, experience rating, search and matching frictions, endogenous separations, DSGE models.

JEL Classification: H29; J23; J38; J41; J64

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1 Introduction

The US unemployment insurance (UI thereafter) has often been identified as having a strong influence on the labor market dynamic. One important aspect is the "*experience-rated*" structure of the contribution rate (or UI payroll tax rate) which depends on the firm layoffs history. In order to stabilize employment and to equitably allocating the cost of unemployment, firms that cause someone to be unemployed support a higher payroll tax. However, firms do not fully bear the total cost of unemployment for two reasons 1) Adjustments of the contribution rate are sluggish, reducing the degree of liability. 2) The existence of statutory tax rates (minimum and maximum rates) constrain the tax adjustment. For example, if an employer reaches the legal maximum rate, more layoffs cannot result in higher contribution rates, which allow employers to avoid extra costs of additional dismissals.

These two characteristics are at the heart of an "imperfect experience rating " problem emphasized in the literature. The receive wisdom is that such imperfections could exacerbate the fluctuations of unemployment and layoffs in recessions. Paradoxically, they did not subject to any measurement over the business cycle while their effects lie in the dynamics of the insurance unemployment. Indeed, the smoothing of contribution rates and the statutory taxes only introduce an incentive mechanism when shocks affect the economy. The systematic use of partial equilibrium models that only look on long-run level of employment are clearly unable to assess the entire application of experience rating systems. The goal of this paper boil down to the following questions. How and to what extent does the UI affect the labor market fluctuations? Why this system it is used despite the aforementioned distortions?

To address these issues we evaluate in a dynamic and stochastic general equilibrium framework with search and matching frictions the extent to which such a system affects labor market outcomes over the business cycles. The two central components (the sluggishness of tax adjustments and the statutory tax rates) generating distortions are evaluated in term of macroeconomic performances and welfare. The originality of the present paper is to show how the nonlinear shape of the UI payroll tax impacts the sensitivity of the labor market to macroeconomic shocks. We highlight that an accurate representation of the unemployment insurance is crucial to ascertain the incentive effects for policy recommendations. This exercise is particularly important to understand how experience rating distorts firms' hiring and firing practices and why it can be desirable. We give new insights on the dynamic effects of statutory tax which have been omitted in previous theoretical studies. Finally, we tackle the commonly used assumption according to which the experience rating acts like firing taxes and show how the two systems differ.

Related literature

Experience rating systems have been of a great concern as attest several empirical and theoretical contributions. The pioneering works Feldstein (1976, 1978), Baily (1977) and Brechling (1977) have shown in labour demand models an increase of the experience rating degree may reduce substantially unemployment, layoffs and especially temporary layoffs. In this line of research, Marks (1981), Topel and Welsh (1980), Topel (1983, 1984), Anderson (1993), Card and Levine (1994), Anderson and Meyer (2000) and Woodbury (2004) argued that higher payroll tax indexation lowers the incentive for firms to lay workers off during economic downturns and to hire them during booms. They share the conventional wisdom according to which more experience rating is likely to decrease unemployment. Albrecht and Vroman (1999) and Fath and Fuest (2005) also find a positive effect on employment, wages and output and a decrease of shirking in an efficiency wage model or optimal contract model. Marceau (1993), Burdett and Wright (1989) and more recently Mongrain and Roberts (2005) reach opposite results. They show that complete experience rating is likely to raise unemployment or to be welfare detrimental for workers.

The most closely related papers to ours are the ones of Millard and Mortensen (1997), Cahuc and Malherbet (2000), L'Haridon and Malherbet (2009). All consider search and matching frictions in the labor market with endogenous job destruction. The first one highlight that a firing tax reduces firms' layoff rate but also raise unemployment duration. The two last papers outperform Millard and *al.*'s analysis by introducing a balanced budget rule of the UI trust fund and where unemployment benefits are financed through a combination of a layoff tax and a payroll tax. They study the consequences of introducing an experience rating system in a rigid labor market as in continental Europe. They show that it may reduce the unemployment rate for low-skilled workers and can improve their welfare in the presence of a high minimum wage, a stringent employment protection legislation (EPL) and a dual labor market. It also can improve the efficiency of employment protection and reduce unemployment, job creation and job destruction variability. On the other side, Stähler (2008) argues that under powerful unions, an experience rating system is likely to increase unemployment.

However, despite the remarkable attention given to experience rating systems it is highly surprising to note that previous studies have extensively used a simplified UI without investigating the dynamic effects the tax nor the effects of the statutory tax rate. Econometric studies only measure the marginal tax cost on long term unemployment. They are not able to provide a clear answer to the question: How do hirings and firings react if the tax rate reaches the minimum rate or the maximum rate? In addition, any frictions in the labor market are considered while they capture the time-consuming search process. Obviously, the interaction between job opening firms and searching workers generates congestion externalities which govern the average duration of unemployment and therefore the fiscal cost associated to a dismissal. The effects of experience rating on both hiring and firing incentives are thus not clearly evaluated. Aggregate shocks and the potential role of UI for short-run stabilization are also omitted from their analysis, leaving aside the welfare gains coming from smooth fluctuations. In addition, we demonstrate in this paper that the mechanisms of experience rating slightly depart from a layoff tax financing unemployment benefits for many reasons related to the proportionality of the tax to the payroll, the adjustment delays and the non linearities of the tax schedule.

Many important aspects are not considered in the literature previously mentioned while their effects are nontrivial for the policy analysis. We show that the incentive effects can be ascertained if the entire application of UI experience rating is taken into account rigorously. We give a particular attention on the dynamic effects of statutory tax which have been omitted in previous studies. Our framework allows large firms to form expectations about the value of a job, taking into considerations the non-linearities of the tax schedule and the dynamic of the UI. It is shown that increasing the degree at which firms are liable for the expenditures they create through their firing decisions has a large positive impact on both long-run levels and the fluctuations of labor market outcomes, especially if no legal constraints affect the tax adjustment. Once the payroll tax hits these legal constraints (statutory tax rates), sizeable deviations of the labor market can be observed when comparing to an unconstrained economy. Unemployment and separations are on average higher in recessions and in expansions. In addition, the statutory tax rate also strongly influence hirings and may lead to more vacancy posting on average. We compare the experience rating system to a layoff tax financing unemployment compensations. It is shown that the latter reduces long-run and the fluctuations of separations. But, contrary to experience rating systems, it is also likely to cut profits and discourage hirings. The distortions caused by experiences rating are negligible in term of welfare costs, especially the statutory tax rates. Firing taxes and the experience rating system can both reduce the inefficiencies of search externalities. The preference of a system depends on how the search externalities distort the economy.

The rest of the paper is organized as follows. Section 2 presents the model and the unemployment insurance system. The calibration and a quantitative evaluation of the model are presented in section 3. Section 4 is devoted to simulation exercises of experience rating. Section 5 provides a comparison with firing taxes. Section 6 investigates the desirability of the two incentive-based system by comparing the welfare cost and section 7 concludes.

2 The economic environment and the model

Our DSGE model is based on Mortensen and Pissarides (1994, 1999) framework and includes search and matching frictions, endogenous job creation and job destruction. There is a continuum of identical large firms that employ many workers. Wages are the outcome of a bilateral Nash bargaining process between the large firm and each workers. The design of UI is derived from US legislation under the *Reserve-ratio method*[1].

2.1 The labor market

The number of matches M_t is given by the following Cobb-Douglas matching function $M_t = \chi S_t^{\psi} V_t^{1-\psi}$ where V_t denotes vacancies and S_t the searching workers. χ is an efficiency parameter and ψ governs the elasticity of the matching function with respect to S_t. The labor force is constant and equal to one. A vacancy is filled with probability $q_t = M_t/V_t$ and a job seeker finds a job with probability $f_t = M_t/S_t$. $\theta_t = V_t/S_t$ is the labor market tightness. Match dissolutions occur because of idiosyncratic productivity shocks[2] *i.i.d.* drawn from a distribution $G(.)$ defined on $[0, \bar{\varepsilon}]$. If the firm specific productivity component ε falls below an endogenous threshold $\underline{\varepsilon}_t$, the job is destroyed. Endogenous separations occur at rate $G(\underline{\varepsilon}_t) = P(\varepsilon < \underline{\varepsilon}_t)$. The labor market timing is mainly derived from Den Haan *et al.* (2000). Employment in period t has two components: new and old workers, N_t^n and N_t^o respectively[3]. New employment relationships are formed through the matching process. Matches formed at period t contribute to period $t+1$ employment. The employment pool in t is determined at the beginning of period t while the number of job seekers is determined after the realization of shocks. It follows that workers who lose their job in t to have a probability of being employed within the same period. Under a firing tax system, the productivity threshold a job seeker face is different from the one in a continuing (old) employment relationship. The number of new and continuing employment relationships with specific productivity ε are defined as follows:

$$n_t^i(\varepsilon) \quad = \quad N_t^i g(\varepsilon) \qquad i = n, o \tag{1}$$

The aggregate employment law of motion is described by the following equation[4]:

$$N_{t+1}^n \quad = \quad M_t \tag{2}$$

$$N_{t+1}^o \quad = \quad \sum_{i=n,o} \int_{\underline{\varepsilon}_t^i}^{\bar{\varepsilon}} n_t^i(x)dx \tag{3}$$

The number of job seekers corresponds to $S_t = 1 - \sum_{i=n,o} \int_{\underline{\varepsilon}_t^i}^{\bar{\varepsilon}} n_t^i(x)dx$ while the number of unemployed workers $U_t = 1 - N_t$ is determined at the beginning of

[1]see Woodbury (2004) and Fougère and Margolis (2000) for a recent survey.

[2]For the sake of clarity, we assume there is no exogenous separation. Introducing exogenous separation doesn't change the results at all.

[3]Every variable related to new matches are assigned a superscript n and every variable related to old matches are assigned a superscript o.

[4]This representation allows to get explicitly the marginal value of a job.

period t. Aggregate employment is.

$$N_t = N_t^o + N_t^n \tag{4}$$

2.2 The unemployment insurance

UI states use different methods of experience rating. We will consider the most commonly used method (33 states) known as *reserve-ratio* method. Following Brechling (1977), Baily (1977), Topel (1983) and Anderson and Meyer (1994) we derive the formula for the firms' tax rate under the reserve-ratio method. The timing of events slightly differs from Topel's one to be consistent with both, the employment law of motion and the quarterly frequencies. Only employers finance the cost incurred by the unemployment benefits fund. Under the reserve ratio system, each individual firm is assigned its own account in the state UI fund. We assume the employer's account is calculated at the beginning of the period t. Each period, the account B is credited of the contributions collected and is debited of the benefits paid (by the UI) to the employer's laid off employees, defining the reserve balance. Its law of motion writes:

$$B_{t+1} = B_t + \tau_t \Upsilon_t - bS_t \tag{5}$$

Contributions collected correspond to the endogenous tax rate τ_t times the firms taxable payroll Υ_t while benefits paid are equal to the unemployment benefits b[5] job seekers receive. Dividing the employer's reserve balance by its average taxable payroll over the past three years gives the reserve ratio. To simplify we assume that the reserve ratio of a firm ($\mathcal{R}_{t+1}$) is determined just after knowing the value of B_{t+1} and is based on the taxable payroll of the current quarter. It writes as follow:

$$\mathcal{R}_{t+1} = \frac{B_{t+1}}{\Upsilon_t} \tag{6}$$

Finally, the tax rate is determined according to the tax schedule imposed by the UI state[6]. We assume it is defined at the beginning of the period. Under the

[5]For the sake of simplicity we assume that benefits b are constant.

[6]Of course, the legal reserve ratio is revised each year and is divided by the average taxable payroll over the past three years. It is defined as follows:

$$\mathcal{R}_t = \frac{B_t}{\frac{1}{3}\sum_{k=0}^{2} \Upsilon_{t-k}} \quad \text{year t}$$

But, because an increase in the number of lags will generate many state variables we assume that, for the sake of simplicity, employers' accounts and reserve ratios are revised according to quarterly frequencies and based on the current taxable payroll instead of the average payroll over the past three years. However, to be consistent with the UI system we change the slope of the tax schedule. We choose a flatter slope to offset the fast tax adjustment resulting from quarterly frequencies.

reserve ratio method, the tax schedule relates τ_{t+1} to $\mathcal{R}_{t+1}$. For example, the Arizona UI payroll tax schedule in 2009 is plotted in figure 1. τ increases in

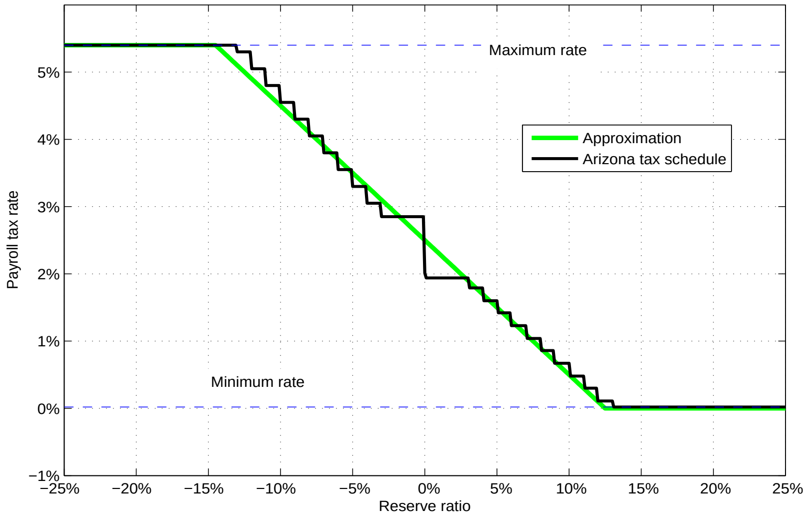

Figure 1: ***Unemployment insurance payroll tax schedule for Arizona (2009).***

step as $\mathcal{R}$ decreases. A positive reserve ratio means the employer's contributions overtake the fiscal cost of a laid off worker. It follows a low tax rate. To model the UI system, one can approximate the tax schedule. We neglect the different thresholds that give a "stair-shaped" curve and consider a linear tax schedule between the maximum rate ($\tau_{\max}$) and the minimum rate ($\tau_{\min}$). The function that we have to approximate, depicted in figure 1 (green line), is:

$$\tau(\mathcal{R}) = \max\left[\min\left(\tau_{\max}, \eta_0 - \eta_1 \mathcal{R}\right), \tau_{\min}\right] \tag{7}$$

where η_0 denotes the Y-intercept of the tax schedule for which the reserve ratio is equal to zero and η_1 is the slope of the tax schedule governing the next period amount firms have to pay to the UI if they increase their labor turnover.

2.3 The representative household

To avoid heterogeneity, we suppose there is a perfect risk sharing where incomes (labour incomes and unemployment benefits) are equally redistributed. The expected intertemporal utility of the representative household writes:

$$E_t \sum_{s=t}^{\infty} \beta^{s-t} \frac{(C_s + S_s h)^{1-\sigma}}{1-\sigma} \tag{8}$$

β is the discount factor and σ is the intertemporal elasticity of substitution. h denotes unemployed workers' home production and C_t is the market consumption goods. The dynamic optimization problem consists of choosing a set of processes $\mathcal{D}_t^H = \{C_s, \underline{\varepsilon}_t^i\}_t^\infty \quad i = n, o$ maximizing the expected intertemporal utility (8) subject to (1) (2), (3), and the following budget constraint:

$$C_t = \Upsilon_t + S_t b + \Pi_t + T_t \tag{9}$$

$\Upsilon_t = \sum_{i=n,o} \int_{\underline{\varepsilon}_t^i}^{\overline{\varepsilon}} n_t^i(x) w_t^i(x) dx$ is the total payroll, Π_t represents the instantaneous profits households receive and T_t is a lump-sum tax. The job finding rate f_t and the wage rate $w_t^i(\varepsilon)$ are taking as given. The optimality conditions of this problem write:

$$\lambda_t = (C_t + S_t h)^{-\sigma} \tag{10}$$

$$\mu_t^i(\varepsilon) = \lambda_t(w_t^i(\varepsilon) - b - h) + \mu_t^2 - \mu_t^1 f_t \tag{11}$$

$$\mu_t^i(\underline{\varepsilon}_t^i) = 0 \qquad i = n, o \tag{12}$$

(10) is the Euler condition. λ_t, $\mu_t^i(\varepsilon)$, μ_t^1 and μ_t^2 are Lagrange multipliers of the budget and the employment constraints (1), (2) and (3) respectively. $\mu_t(\varepsilon)$ gives the present and expected marginal value of a job with productivity ε. μ_t^1 corresponds to the worker net expected value from a new employment relation. Using the envelop condition, the household's marginal value of a job of type $i = n, o$ with productivity ε becomes:

$$\mu_t^i(\varepsilon) = \lambda_t(w_t^i(\varepsilon) - b - h) + \beta E_t \int_{\underline{\varepsilon}_{t+1}^o}^{\overline{\varepsilon}} \mu_{t+1}^o(x) dG(x) - f_t \int_{\underline{\varepsilon}_{t+1}^n}^{\overline{\varepsilon}} \mu_{t+1}^n(x) dG(x) \tag{13}$$

2.4 The large firm program

The expected discount sum of instantaneous profits of the large firm writes:

$$E_t \sum_{s=t}^{\infty} \beta^{s-t} \frac{\lambda_s}{\lambda_t} \left[z_s \sum_{i=n,o} \int_{\underline{\varepsilon}_s^i}^{\overline{\varepsilon}} x n_s^i(\varepsilon) d\varepsilon - (1 + \tau_s)\Upsilon_s - \Gamma(V_s; q_s) - \mathcal{F}_s N_s^o G(\underline{\varepsilon}_s^o) \right] \tag{14}$$

For the sake of simplicity we assume that total wages and taxable wages are equivalent. $\Gamma(V_t; q_t)$ denote the hiring cost function. It depends on the number of vacancies and matching costs that occurs when the match goes on (with probability q_t). $\mathcal{F}_t$ is a firing tax the firm has to pay when a separation occurs in old matches. The dynamic optimization problem consists of choosing a sequence of processes $\mathcal{D}_t^F = \{V_t, \underline{\varepsilon}_t^i\}, i = n, o$ maximizing the expected discount sum of instantaneous profits (14) subject to the employment motion ((1), (2) and (3)) and the unemployment insurance system ((5), (6) and (7)). We assume the large firm takes both the probability of filling vacancies and wages as given. For the sake of clarity we define $\tilde{\beta}_{t+1} = \beta \frac{\lambda_{t+1}}{\lambda_t}$ as the stochastic discount factor. The state vector is given by $\Omega_t^F = (N_t, \tau_t, B_t, \mathcal{R}_t; z_t)$. The associated optimality conditions of the above problem are given by:

$$\begin{aligned} \frac{\Gamma'(V_t)}{q_t} &= \Lambda_t^1 && (15) \\ \Lambda_t^i(\underline{\varepsilon}_t^i) &= 0 && (16) \\ \Lambda_t^i(\varepsilon) &= z_t\varepsilon - w_t^i(\varepsilon)\Psi_t + \Lambda_t^2 + \Lambda_t^3 b + \mathcal{F}_t \mathbb{1}_{i=o} && (17) \\ \text{with} \quad \Psi_t &= 1 + \tau_t(1-\Lambda_t^3) + \Lambda_t^4 \frac{\mathcal{R}_{t+1}}{\Upsilon_t} && (18) \end{aligned}$$

where $\mathbb{1}_{i=o}$ is a variable taking the value 1 if $i = o$ (old jobs) and 0 otherwise. $\Lambda_t^i(\varepsilon_t)$, Λ_t^1, Λ_t^2, Λ_t^3 and Λ_t^4 denote the Lagrange multipliers associated to the dynamics of employment ((1), (2) and (3)), the reserve balance (5) and the reserve ratio (6) respectively. Equation (15) provides the employment creation condition. It implies that the expected cost of search $\Gamma'(V_t)/q_t$ must be equal to the benefits of hiring a new worker (with Λ_t^1 being the firm's net expected value from a new job). (16) is the job separation condition. It shows that the firm present value of a job with productivity $\underline{\varepsilon}_t^i$ is equal to zero. Equation (17) defines the firm marginal surplus from employment with productivity level $z_t\varepsilon$. Because of the legal constraints, the tax dynamics is restricted to be below $\tau_{\max}$ and above $\tau_{\min}$. Between the two statutory rates, the tax adjustment is linear, consistent with equation (7). The Lagrange multiplier associated to the reserve ratio (Λ_t^4) takes the following values:

$$\Lambda_t^4 = \begin{cases} -\eta_1 \Phi_t^1 & \text{if} \quad \tau_{\min} < \tau_{t+1} < \tau_{\max} \\ 0 & \text{otherwise} \end{cases} \qquad (19)$$

where Φ_t^1 is the Lagrange multiplier associated to (7). When the tax hits a statutory rate, the shadow cost of the tax (Λ_t^4) is zero as shown in the above condition. Otherwise it is governed by the backward looking dynamic of the firm tax rate. Using envelop conditions we have:

$$\begin{aligned} \frac{\Gamma'(V_t)}{q_t} &= E_t\tilde{\beta}_{t+1} \int_{\underline{\varepsilon}_{t+1}^n}^{\bar{\varepsilon}} \Lambda_{t+1}^n(x) dG(x) && (20) \\ \Lambda_t^i(\varepsilon) &= z_t\varepsilon - w_t^i(\varepsilon)\Psi_t + \Lambda_t^3 b + E_t\tilde{\beta}_{t+1} \int_{\underline{\varepsilon}_{t+1}^o}^{\bar{\varepsilon}} \Lambda_{t+1}^o(x) dG(x) \\ &\quad + \mathcal{F}_t \mathbb{1}_{i=o} - E_t\tilde{\beta}_{t+1}\mathcal{F}_{t+1} \qquad i = n, o && (21) \\ \Phi_t^1 &= E_t\tilde{\beta}_{t+1}\Upsilon_{t+1}(\Lambda_{t+1}^3 - 1) && (22) \\ \Lambda_t^3 &= \frac{\Lambda_t^4}{\Upsilon_t} + E_t\tilde{\beta}_{t+1}\Lambda_{t+1}^3 && (23) \end{aligned}$$

2.5 Wage setting mechanism

We have to distinguish two wages, the wage of a new job and the wage of a continuing job. The two wages are determined through an individual Nash bargaining process between a worker and the large firm who share the total surplus. As it is standard, the bargaining process provides optimal rules for surplus sharing:

$$(1-\xi)\Lambda_t^i(\varepsilon) \quad = \quad \xi \frac{\mu_t^i(\varepsilon)}{\lambda_t}\Psi_t \qquad i=n,o \tag{24}$$

where $\xi \in]0,1[$ and $1-\xi$ denote the firms and workers bargaining power respectively. This condition slightly differs from the one in standard matching models since the UI system now makes the payroll tax rate endogenous. Using (13), (20) and (21), the wage expression of a job with idiosyncratic productivity ε is given, after some calculus, by:

$$\begin{aligned} w_t^i(\varepsilon) &= \frac{(1-\xi)}{\Psi_t}\left(z_t\varepsilon + \Lambda_t^3 b + \mathcal{F}_t \mathbb{1}_{i=o} - E_t\beta_{t+1}\mathcal{F}_{t+1}\right) + \xi(b+h) \\ &\quad +(1-\xi)E_t\tilde{\beta}_{t+1}\frac{1}{\Psi_{t+1}}\left[\int_{\underline{\varepsilon}_{t+1}^o}^{\bar{\varepsilon}} \Lambda_{t+1}^o(x)dG(x)\frac{\Psi_{t+1}-\Psi_t}{\Psi_t}\right. \\ &\quad \left. +f_t\int_{\underline{\varepsilon}_{t+1}^n}^{\bar{\varepsilon}} \Lambda_{t+1}^n(x)dG(x)\right] \qquad i=n,o \end{aligned} \tag{25}$$

2.6 Job creation and job destruction condition

The job creation and job destruction condition are governed by (20) and (16) respectively. We can deduce that $\Lambda_t^i(\varepsilon) - \Lambda_t^i(\underline{\varepsilon}_t^i) = \Lambda_t^i(\varepsilon)$. Using equation (21) and (25), one can easily deduce that:

$$\Lambda_t^i(x) = \xi z_t(x - \underline{\varepsilon}_t^i) \qquad \forall\ x,\ i=n,o \tag{26}$$

We can now evaluate the surplus $\Lambda_t^i(x)$ in $t+1$ thanks to (26) and replace it in (20) and (21). Using (16), the wage expression in (25), the job creation and the job destruction conditions can be defined as:

$$\frac{\Gamma'(V_t)}{q_t} \quad = \quad \xi E_t\tilde{\beta}_{t+1}z_{t+1}\int_{\underline{\varepsilon}_{t+1}^n}^{\bar{\varepsilon}}(x-\underline{\varepsilon}_{t+1}^n)dG(x) \tag{27}$$

$$\begin{aligned} 0 &= z_t\underline{\varepsilon}_t^i + \Lambda_t^3 b + \mathcal{F}_t\mathbb{1}_{i=o} - E_t\beta_{t+1}\mathcal{F}_{t+1} - (b+h)\Psi_t \\ &+ E_t\tilde{\beta}_{t+1}z_{t+1}\left[\int_{\underline{\varepsilon}_{t+1}^o}^{\bar{\varepsilon}}(x-\underline{\varepsilon}_{t+1}^o)dG(x)\left(1-(1-\xi)\frac{\Psi_{t+1}-\Psi_t}{\Psi_{t+1}}\right)\right. \\ &- \left.(1-\xi)\frac{\Psi_t}{\Psi_{t+1}}f_t\int_{\underline{\varepsilon}_{t+1}^n}^{\bar{\varepsilon}}(x-\underline{\varepsilon}_{t+1}^n)dG(x)\right] \quad i=n,o \end{aligned} \tag{28}$$

It results:

$$\mathcal{F}_t \quad = \quad z_t(\underline{\varepsilon}_t^n - \underline{\varepsilon}_t^o) \tag{29}$$

2.7 Closing the model

The aggregate output Y_t is obtained through the sum of individual productions :

$$Y_t = \sum_{i=n,o} N_t^i z_t \int_{\underline{\varepsilon}_t^i}^{\overline{\varepsilon}} x dG(x) \tag{30}$$

The aggregation of the individual profits Π_t is :

$$\Pi_t = Y_t - \Upsilon_t(1+\tau_t) - \Gamma(V_t) - \mathcal{F}_t G(\underline{\varepsilon}_t^o) N_t^o \tag{31}$$

where Υ_t can be defined as a function of the average wage $\overline{w}_t^i$ of each type of jobs

$$\Upsilon_t = \sum_{i=n,o} \overline{w}_t^i N_t^i (1 - G(\underline{\varepsilon}_t^i)) \tag{32}$$

$$\bar{w}_t^i = \int_{\underline{\varepsilon}_t}^{\overline{\varepsilon}} w_t^i(x) \frac{dG(x)}{1 - G(\underline{\varepsilon}_t^i)} \tag{33}$$

As τ_t obeys to the rule described by (7), the UI budget is not balanced every periods. To avoid additional distortions we assume the UI is balanced through a lump-sum tax T_t. It doesn't offset the dynamic effects of the payroll tax since the firm account B_t record the entire imbalance history. In addition, such a rule avoid problem of multiple equilibria or indeterminacy because τ_t is not a residual variable used to balance the UI budget (see Rocheteau, 1999). The unemployment insurance budget rule satisfies[7]:

$$T_t = \tau_t \Upsilon_t - bS_t \tag{34}$$

The above equation together with (30), the budget constraint (9) and the profit (31) gives the aggregate resource constraint :

$$Y_t = C_t + \Gamma(V_t) \tag{35}$$

We assume, in line of Yashiv (2006) the adjustment cost function takes the form:

$$\Gamma(V_t; q_t) = \frac{\phi_V}{1+\gamma} \left(V_t(\kappa + Qq_t)\right)^{1+\gamma} \tag{36}$$

where κ stands for the cost of posting a vacancy. It is paid by the firm as long as the job remains unfilled. Q stands for the cost of screening and training workers. It is only paid at the time of hiring.

[7]The budget constraint including a firing tax will be studied later. In order to isolate the impact of experience rating the firing tax is equal to zero and doesn't vary at this stage.

2.8 Equilibrium and the optimal allocations

Definition 1 (competitive equilibrium) *For a given exogenous stochastic process* z_t*, the competitive equilibrium is a sequence of prices and quantities* N_t^i*,* τ_t*,* B_t*,* $\mathcal{R}_t$*,* λ_t*,* V_t*,* $\underline{\varepsilon}_t^i$*,* Υ_t*,* Λ_t^3*,* Λ_t^4*,* Φ_t^1*,* T_t *(*$i = n, o$*) satisfying equations* (2), (3) , (7), (5), (6), (10), (19), (22), (27), (28), (29), (32), (34) *and* (35) *and using the definition of* f_t*,* q_t*,* θ_t*,* S_t*,* Y_t*,* $\overline{w}_t^i$ *and* Ψ_t*.*

Definition 2 (The Pareto allocation) *For a given exogenous stochastic process* z_t*, the Pareto allocation is a sequence of quantities* N_t*,* Δ_t^2*,* θ_t*,* $\underline{\varepsilon}_t$ *satisfying equations* (41), (**??**), (**??**) *and* (**??**) *using the definition of* f_t*,* q_t*,* S_t *and* Y_t*.*

Definition 3 (The laissez-faire allocation) *The laissez-faire allocation is given by definition 1 and assuming there is no unemployment insurance:* $b = 0$*,* $\tau_t = 0$*,* $B_t = 0$*,* $\mathcal{R}_t = 0$*,* $T_t = 0$*,* $\Lambda_t^3 = 0$*,* $\Lambda_t^4 = 0$ *and* $\Phi_t^1 = 0$*.*

The equilibrium allocation (definition 1) is defined conditionally to the unemployment benefits financing scheme. The tax schedule is set by the authorities. There is no reason it is optimal. We define a second-best allocation where the policy instrument is chosen to maximize the conditional welfare. To make the analysis tractable, we assume that b is fixed and the authorities focus on the optimal value of η_1. Furthermore, we assume the authorities are able to revise the Y-intercept if the steady state level of the payroll tax change so as to ensure a zero reserve ratio condition ($\eta_0 = \tau(0)$)[8]. Assuming $\tilde{C}$ and $\tilde{S}$ denote the consumption and the number of job seekers in the equilibrium allocation, an optimal values for η_1^* is obtained (given initial conditions on job seekers and given the parameter η_1) by solving the following problem[9]:

$$\{\eta_1^*\} \quad = \quad \arg\max_{\eta_1} E_0 \sum_{t=0}^{\infty} \beta^t \frac{(\widetilde{C}_t + \widetilde{S}_t h)^{1-\sigma}}{1-\sigma} \tag{37}$$

Definition 4 (The second-best allocation) *The second-best allocation is given by definition 1, knowing that* $\eta_1 = \eta_1^*$*.*

The standard Hosios condition is often analyzed as a starting point to measure inefficiencies coming from search externalities. Usually, efficiency is reached if the the firms' (resp. workers') bargaining power is equal to the elasticity of the matching function with respect to vacancies (resp. unemployment). Here, $\xi = 1 - \psi$. However, in our benchmark setup the existence of matching costs

[8]This assumption simplify the determination of the second-best allocation because we only optimize the conditional welfare w.r.t one parameter (η_1) or $\mathcal{F}$. In addition, we concentrate this section on the slope effect and remove the statutory tax rates.

[9]The second-best allocation under a firing tax system is obtained by maximizing the welfare with respect to $\mathcal{F}$ assuming the firing tax is a parameter. Then, $\mathcal{F} = \mathcal{F}^*$

creates an additional channel for search externalities because a firm takes the probability of filling a vacancy q_t as given (see (36)). Then, comparing the laissez-faire allocation to the Pareto allocation leads to the following statement:

Proposition 1 *When the hiring cost function takes the form* (36), *the standard Hosios condition* $\xi = 1 - \psi$ *no longer achieve efficiency. The condition that ensure efficiency at the steady state is:*

$$\xi = (1-\psi)\frac{\kappa + qQ}{\kappa + (1-\psi)qQ}$$

Proof See appendix.

In the absence of matching costs Q, the standard Hosios condition applied $\xi = 1-\psi$. A greater number of vacancies increases the probability an unemployed worker finds a job and reduces the probability a firm fills a vacancy. Additional search externalities arise from matching costs. To offset the negative externalities coming from q_t, the firm bargaining power have to be higher than the elasticity of the matching function w.r.t. unemployment.

$$\begin{aligned} &\kappa + q_t Q > \kappa + (1-\psi)q_t Q \quad \forall Q > 0,\ \psi \in]0,1[\\ &\xi > (1-\psi) \quad \forall Q > 0 \end{aligned}$$

3 Model solution and calibration

We follow Den Haan and *al.* (2000), Andolfatto (1996) and Shimer (2005) to set the US labor market parameters according to quarterly frequencies (see table 1).

Productivity and preferences We set the discount factor to 0.99, which gives an annual steady state interest rate close to 4%. The risk aversion coefficient σ is set to 2. The aggregate productivity shock follows a first-order autoregressive process: $\log z_{t+1} = \rho_z \log z_t + \varepsilon^z_{t+1}$ where the autocorrelation coefficient ρ_z is equal to 0.95. $\varepsilon^z_{t+1} \sim iid\mathcal{N}(0, \sigma^2_z)$. The standard deviation σ_z is chosen to match the standard deviation of output as close as possible. The distribution G(.) of idiosyncratic productivity shocks is Uniform over the range [0;1][10]. Then, $G(\underline{\varepsilon}) = \underline{\varepsilon}$.

Labor market: stocks and flows The steady state of stocks and flows can be summarized through the variables $M, \varepsilon^n, \varepsilon^o, N, U, q, f$ and V. There are no firing taxes in the benchmark. We can deduce from (28) that $\underline{\varepsilon}^n = \underline{\varepsilon}^o = \underline{\varepsilon}$. We impose the equilibrium unemployment rate U of 5.64% and the probability of being unemployed $G(\underline{\varepsilon}) = 4\%$, which corresponds to their empirical counterpart

[10]Results remain unchanged using a log-normal distribution. But, the log-normal distribution is more time and resource-consuming since it requires numerical integration over a sparse grid.

(Shimer and BLS figures). The steady state number of matches must be equal to the number of separations: $M = G(\underline{\varepsilon})N$ with $N = 1 - U$. We also deduce the number of job seekers from the definition $S = 1 - (1 - (\underline{\varepsilon}))N$ and the job finding rate $f = M/S$. Following Andolfatto (1996), the rate at which a firm fills a vacancy is 0.9. We can deduce the aggregate number of vacancies $V = M/q$. χ is calculated in such a way that $M = \chi S^{\psi} V^{1-\psi}$. From (27) we get a value for $\Gamma'(V)$ with two unknowns κ and Q. We assume $\phi_V = 1$ and $\gamma = 1$. Following Chéron and Langot (2006) and Pissarides (2009) the cost of training and screening is higher than advertising costs. We assume Q is two times higher than κ. Due to the presence of matching cost, the standard Hosios condition no longer achieve efficiency. The "*New Hosios condition*" that ensure efficiency at the steady state for a conventional workers bargaining power of 0.5 and $q = 0.9$ is an elasticity of the matching function with respect to unemployment of around 0.7. This is similar to what Shimer (2005) fund. Then, if we compare the benchmark allocation to the Pareto allocation (with $\xi = 0.5$ and $\psi = 0.7$), most of the welfare cost comes from the UI at the steady state. We come back later on this assumption in section 5.2.1. For a given tax rate τ define later, the remaining parameters are h and b. The remaining equations to satisfy[11] at the steady state are: (28) and (32). We impose b to be consistent to the average net replacement rate of 43% ($b/\bar{w} = 0.43$) according to DOLETA[12] over the period 1988-2011 and let $\bar{w}$ to satisfy (33). Then, h is determined from (28).

Variables	Symbol	Value
Discount factor	β	0.99
Autocorrelation coefficient	ρ_z	0.95
Std. dev. of aggregate shock	σ_z	0.0079
Risk aversion coefficient	σ	2
Matching elasticity	ψ	0.7
Worker bargaining power	ξ	0.5
Replacement rate	ρ^R	0.43
Home production	h	0.36
Vacancy posting costs	κ	0.79
Matching cost	Q	1.58

Table 1: **Baseline parameters.**

Unemployment insurance The UI parameters are more complex to calibrate since some variables are only available at annual frequencies and each state has its own tax schedule[13]. In addition, it seems not really relevant to choose the

[11] The lagrange multiplier Λ^3 and Φ^1 are residual.

[12] Department Of Labor, Employment and Training Administration

[13] All but three states use either a reserve-ratio method or a benefit-ratio method to set the tax. Each state chooses the tax schedule, involving different value of τmin, τmax, the slope

same slope and the statutory tax rates of the tax schedule presented in figure 1 because most of the variables related to the UI (wages and unemployment benefits) are standardized and non informative. To parameterize the tax schedule we choose instead to match as close as possible the proportion of employers at the minimum and the maximum rate[14]. It seems the most suited calibration for the purpose of this papers since we try to evaluate the deviation of aggregate variables when the tax hits $\tau_{\min}$ or $\tau_{\max}$. In order to compare a constrained economy (benchmark) to an unconstrained economy (no $\tau_{\min}$ and no $\tau_{\max}$), we need to reproduce the realistic proportion over time a firm is rated $\tau_{\min}$ or $\tau_{\max}$.

We employ a broad variety of studies to compare our results. In the annual report compiled by DOLETA "*Significant measures of state UI tax systems*" they are statistics on the number of employers at the minimum and the maximum tax rate over 2005-2010. Furthermore we also report the results of Anderson and Meyers (1993) who have estimated the marginal tax cost (MTC) for six states in 1981 and computed the proportion of employment at the minimum and maximum rate where the MTC is equal to zero. To our knowledge, the paper of Marks (1984) is the only study providing estimations on the probability to switch from one tax category to another. He uses a random sample of more than 17000 New Jersey employers. Despite the oldness of the figures it gives interesting priors to make a comparison. All these statistics are reported in table 2. Regarding the statistics, the tax schedule parameters are set in the following manner:

(i) The payroll tax is set to solve the UI budget constraint without any lump-sum transfer. Contributions collected ($\tau\Upsilon$) are equal to benefits paid (bS). The firm's account (B), the reserve ratio ($\mathcal{R}$) and the lump-sum tax (T) are all equal to zero at the steady state. The dynamics of the firms account is balanced at the steady state. The resulting payroll tax corresponds to the *Y-intercept* of the tax schedule: $\tau(0) = \eta_0$. η_0 is calibrated to be consistent with the average net replacement rate of 43% ($b/\bar{w} = 0.43$) according to DOLETA over the period 1988-2011. We get $\eta_0 = 0.045$.

(ii) On average, we can see that the observed proportion of employers rated at the minimum level is twice higher than that at the maximum tax rate. We set initial values for η_1, $\tau_{\min}$ and $\tau_{\max}$. We simulate the model, get the proportion over time the large firm is rated at the minimum, the maximum and the experience rating tax. We update the value of η_1, $\tau_{\min}$ and $\tau_{\max}$ and repeat the procedure until matching our targets. It results the following value : $\tau_{\min} = 3.3\%$, $\tau_{\max} = 6.8\%$, and $\eta_1 = 0.08$. As explained Brechling (1977), the slope of the tax schedule is typically 0.3 for a tax that is annually revised. For Arizona (figure 3), it is equal to 0.2. A slope of about 0.08 seems to be a reasonable value and prevents fast changes of the firm account due to quarterly frequencies.

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and the level of unemployment benefits.

[14] which will be here computed as the proportion the representative large firm is rated at the minimum, the maximum and the experience rating tax.

Period-to-Period transition probabilities			
Initial status	Status next period		
	$\tau_{\min}$	mid-rate	$\tau_{\max}$
$\tau_{\min}$	0.91 (0.62)	0.09 (0.36)	0.0 (0.02)
mid-rate	0.03 (0.21)	0.95 (.66)	0.02 (0.13)
$\tau_{\max}$	0.0 (0.001)	0.09 (0.175)	0.91 (0.825)
Proportion of tax rate			
Marks (1975-78)	35.75	51.7	12.65
AM (1981)	13.02	82.1	4.88
DOLETA (2005-10)	20.2	74.4	5.4
Model	20.6	67.7	11.7

Table 2: **Transition matrix of UI tax categories.** *Annual transition probabilities are equal to an average of quarterly rates (computed by simulating the model 10^5 times). Results are compared to Marks' study (in parentheses). The proportion of employers at the minimum and the maximum rate in past studies is reported in average over the sample periods and over the different states of the US considered. AM stands for Anderson and Meyers (1993).*

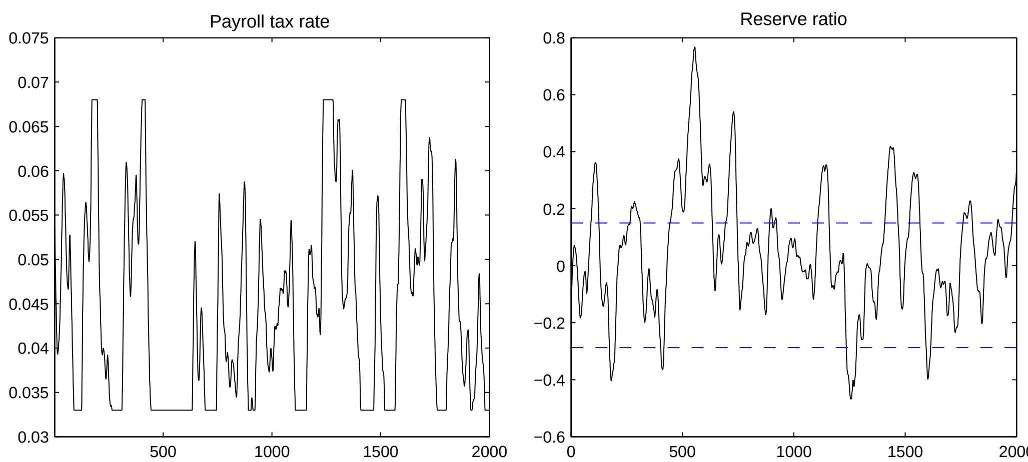

Figure 2: ***Simulated reserve ratio and payroll tax rate.*** *On the right panel, the tax is experience rated when it lies between the two dashed lines. The upper bound is the threshold above which the implied tax rate is $\tau_{\min}$. The lower bound is the threshold below which the implied tax rate is $\tau_{\max}$.*

The model succeeds to mimic this stylized fact and reproduces the observed proportion of employers at $\tau_{\min}$ which is about 21% and at $\tau_{\max}$ (11%). Our results capture reasonably well the observed very low probability of moving from one statutory tax rate to the mid-rate category[15]. A simulated path of the reserve ratio and the payroll tax rate is depicted in figure 2.

How well does the model matches the data?

The ability of DSGE models in reproducing simultaneously the volatility of wages, unemployment, vacancies and the job finding rate has been of a great concern as attests a broad variety of studies: Shimer (2005), Hall(2005), Krause and Lubik (2007), Mortensen and Nagypal (2007), Hagedorn and Manovskii (2008), Pissarides (2009), Rotemberg (2008) and the list is far from being exhaustive[16]. To evaluate whether the model succeeds in reproducing key business cycle facts we simulate mean levels, standard deviations, correlation and first-order auto-correlation of selected macroeconomic variables. The simulations are reported in table 6. The model performs pretty well in reproducing the volatility of output, employment, unemployment, wages without relying on the real wage rigidity assumption. However, the model generates only 52% of the job finding rate volatility and overestimates the separation rate volatility. Due to the low standard deviation of vacancies the model only generates 65% of the tightness volatility. On the other side, the model produces a very realistic persistence of the series and a negative correlation between unemployment and vacancies needed to mimic the Beveridge curve. Our results comes from the use of convex hiring costs with matching costs (Q). It allows to reproduce 1) the negative correlation between unemployment and vacancies found in the data 2) the hump-shaped response of vacancies following an aggregate productivity shock. Calibrated according to the definition of the unemployment rate (about 5%), the matching model with endogenous job separations lead to more volatility of unemployment than without endogenous job separations[17]. It allows to reproduce more than 75% of the observed unemployment volatility but only half of the vacancies volatility.

4 Policy experiments

4.1 How the slope of the tax schedule affects the labor market?

Obviously, the underlying question is: to what extent an increase in the payroll tax rate can creates an incentive for firms to reduce layoffs? What stabilization

[15] The mid-rate corresponds to the case where employers are assigned a tax rate between the minimum and the maximum rate *i.e.* $\tau_{\min} < \tau_t < \tau_{\max}$.

[16] Although this debate is still highly interesting, it is beyond the scope of this paper. We then do not discuss the macroeconomic implications of models in papers previously mentioned and we advise readers to refer to these papers instead.

[17] See Albertini (2011) *a note on Endogenous job separations, hiring costs and the cyclical behavior of unemployment and vacancies*

gains can we expect if we vary the slope of the tax schedule? We explore the consequences of a lower and a higher slope (from less 25% to more 100%). We first discuss the steady state effects.

4.1.1 Steady state effects

In order to isolate the steady state effects of the slope (η_1), we use different strategies. In partial equilibrium, increasing the slope of the tax schedule will make the probability to reach a statutory tax rate higher, which is likely to influence the slope effect. Therefore, we can either keep the statutory tax rates constant or keep constant the probability to reach a statutory tax. The two assumptions allow to eliminate either the levels effects ($\tau_{\min}$ and $\tau_{\max}$ constant) or the probabilities effects ($\tau_{\min}$ and $\tau_{\max}$ recalculated). In the latter case, we denote by $\underline{\mathcal{R}}$ (resp. $\overline{\mathcal{R}}$), the threshold below (resp. above) which the reserve ratio implies the maximum (resp. minimum) tax rate. Secondly, we have assumed the Y-intercept of the tax schedule η_0 is constant. In this case, changing the slope of the tax schedule is be likely to affect the steady state level of the firm account B and the reserve ratio $\mathcal{R}$. Firms may have an incentive to keep a reserve ratio sufficiently high or low to avoid potential variations of the payroll tax. To avoid this drawback and to ensure that $B = \mathcal{R} = 0$ we assume that $\eta_0 = \tau(0)$ which is the steady state of τ. In that case[18], the steady state payroll tax is adjusted to ensure a zero reserve ratio. Then, for a complete treatment of the slope, all assumptions will be tested. The different assumptions are represented in figure 3[19].

As reported in table 5, a twice-higher slope of the tax schedule ($\eta_1 = 0.16$) reduces the long-run level of unemployment by 1.2 percentage points and reduces the separation rate by 27% in the first case (Panel A figure 3). Employers post more vacancies (up to 5% more), enhancing the job finding rate by around 20% and reducing the average unemployment duration by 18%. The reason why separations decrease and vacancies increase is that firms anticipate potential rapid variations of the payroll tax. The shadow value of the firm account (Λ_t^3) being higher, a steeper slope is likely to engender fast increases of the payroll tax during recession but also fast declines in expansions. Any increase in profits due to a fall the period tax is likely to make firms more prone to post vacancies to reduce the marginal cost of hirings. It follows a labor hoarding phenomena and a positive impact on the job creation. Considering a flatter tax schedule depreciates labor market performances, consistent with previous studies (Feldstein 1976, Topel 1983). A 25% decrease of η_1 lowers wages because firms use the burden of the

[18] This case is probably the most realistic assumption. Indeed, the tax schedule is adjusted every years. The statutory tax rates, the slope and the Y-intercept may change. See Woodbury (2004) for a survey and estimations of tax schedule changes in three states.

[19] The case with $\tau_{\min}$, $\tau_{\max}$ constant and $\eta_0 = \tau(0)$ can not be evaluated since the steady state payroll tax is found to be outside of the statutory tax interval for certain values of η_1.

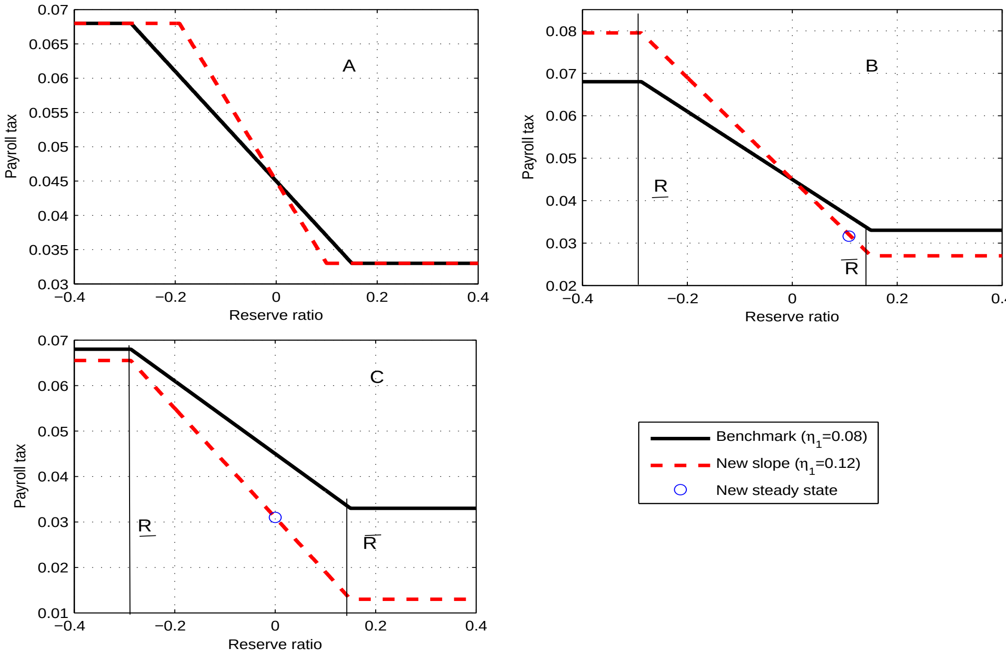

Figure 3: ***Varying the slope of the tax schedule.*** *A: Same statutory tax rates, same Y-intercept. B: Change of statutory tax rates, same Y-intercept. C: Change of statutory tax rates, change of the Y-intercept.*

payroll tax in the wage negotiation. It is worth noting that when η_1 becomes high, the steady state payroll tax hits the minimum rate and the reserve ratio goes to infinity. In this case an increase of η_1 doesn't impact the labor market. The reserve ratio absorbs all effects coming from η_1.

To eliminate the statutory taxes effects we enlarge the range of experience rating taxes for high value of η_1 by assuming that $\underline{\mathcal{R}}, \overline{\mathcal{R}}$ are constant (Panel B in table figure 3). It results in better labor market performances thanks to the adjustments of the statutory tax rates. The payroll tax can not reach $\tau_{\min}$, which reduce the ability of firms to translate slope effects into the reserve ratio. Compare to the previous case, the fall of unemployment and the separation rate are almost two times stronger while the rise of vacancies it two times higher when $\eta_1 = 0.16$. A flatter tax schedule with $\underline{\mathcal{R}}, \overline{\mathcal{R}}$ constant reduces $\tau_{\max}$ and increases $\tau_{\min}$. It follows that the payroll tax rate is more likely to reaches the new maximum rate. The reserve ratio goes to minus infinity, which depreciates the labor market performances by more than it does in the previous case. In addition, workers can use the gain, corresponding to the cost firms should have paid in the absence of statutory tax rates, as a threat to get higher wages. It results in an increase of average wages and a fall of profits.

The last strategy, $\eta_0 = \tau(0)$ and $\underline{\mathcal{R}}, \overline{\mathcal{R}}$ constant (Panel C figure 3), avoids the effects coming from both, the statutory tax rates and the reserve ratio. The effects induced by an increase of η_1 are roughly similar to the previous case. We deduce that the reserve ratio have little effects if the statutory tax rates are not reached. The interaction between the slope and the statutory tax rates are of a great importance. More experience rating may improve long-run labor market performances, especially if no legal constraints affect the tax adjustment.

4.1.2 Dynamic effects

We perform an impulse responses analysis in order to isolate the impact of η_1. Indeed, a 1% aggregate shock doesn't provide a sufficient impulsion to involve a large negative (positive) reserve ratio and to drive the tax rate to the upper (lower) bound. In order to fully concentrate on the dynamic effects of the slope, we assume as in the last case that $\eta_0 = \bar{\tau}$ and $\underline{\mathcal{R}}, \overline{\mathcal{R}}$ are constant. Figure 4 depicts the results. Following the shock, the job losers rate jumps above its steady state level and rapidly returns to its initial level. The number of unemployed workers increases with a one-lag period, inflating UI expenditures. Benefits paid to job losers raise while the initial decrease of the average payroll reduces the contributions collected after the shock. To balance the UI budget, the payroll tax is adjusted with a one-lag period thanks to the experience rating mechanism. Obviously, a less downward sloping curve increases the propagation of the productivity shock and magnifies the response of labor market outcomes. Conversely, a more downward sloping curve makes the response of contributions collected faster, limiting the decline of the reserve ratio. It reduces the firms' incentive to lay workers off as well as hiring them over the cycles. The jump of vacancies and the separation rate are weaker, dampening employment fluctuations. Note that if the unemployment and the separations paths remain virtually unchanged when varying η_1 comes from the steady state effects, which involve low long-run values of U and $G(\underline{\varepsilon})$. When looking on the increase in level *i.e.* not in log deviation from the steady state, it is straightforward that increasing the degree at which the contribution rate responds to variation of the firm account dampens unemployment and separation fluctuations (see figure 5).

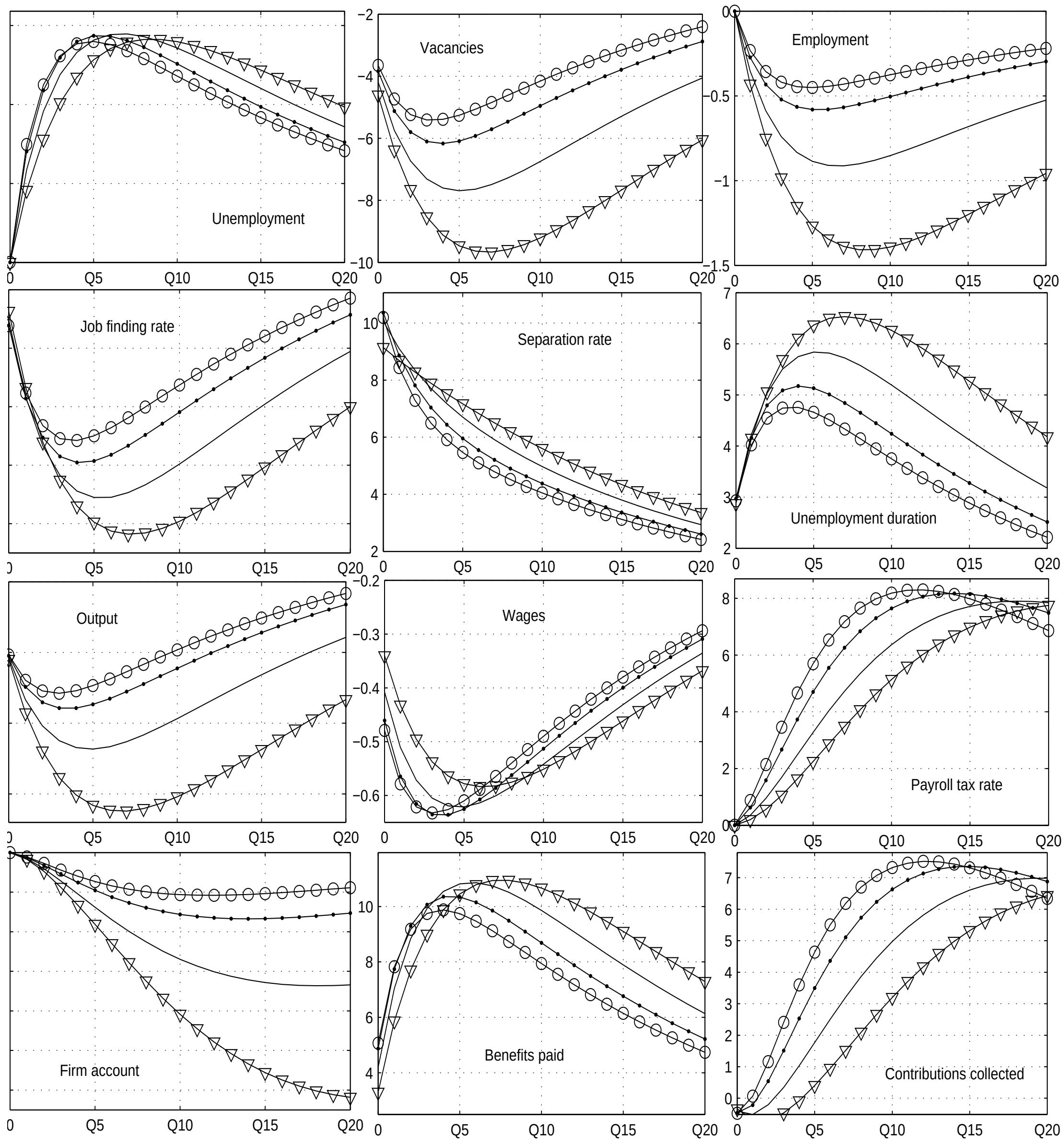

Figure 4: ***Impulse response function to a 1% negative productivity shock*** *Benchmark ($\eta_1 = 0.08$): solid line (no markers), $\eta_1 = 0.06$: downward-pointing triangle markers ,$\eta_1 = 0.12$: point markers, $\eta_1 = 0.16$: circle markers.*

The standard deviations effects (see table 6) confirm the ability of experience rating in reducing labor market fluctuations. Increasing the slope of the tax schedule by 50% ($\eta_1 = 0.12$) reduces the volatility of employment and vacancies by around 30% and 20% respectively. Such a reform makes the volatility of the job finding rate and the separation rate 2.8% and 1.9% lower. Recall however that when considering only variations in level, the volatility of unemployment and the transition rates are strongly reduced. Output variability falls when the experience rating degree increases while such a reform has no impact on average wage volatility and weakly reduces the persistence of the variables.

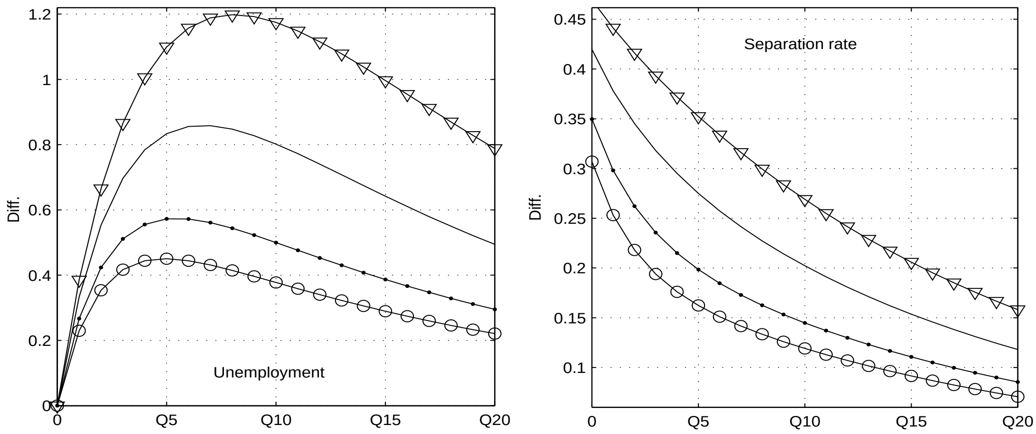

Figure 5: ***Impulse response function to a 1% negative productivity shock*** *Benchmark* ($\eta_1 = 0.08$)*: solid line (no markers),* $\eta_1 = 0.06$*: downward-pointing triangle markers ,*$\eta_1 = 0.12$*: point markers,* $\eta_1 = 0.16$*: circle markers.*

4.2 Do statutory tax rates affect employment dynamics?

The existence of the minimum and maximum rates limits the UI ability to balance the budget each period and can distort firms' hiring and firing practices. To study their impact, we perform a counterfactual analysis in which we compare the path of the labor market in the benchmark economy against an unconstrained experience rating system (when no statutory tax rate is applied, or if $\tau_t = \eta_0 - \eta_1 \mathcal{R}_t$). In other words, our question is: what would have been the path of the labor market in the absence of $\tau_{\min}$ and $\tau_{\max}$? Once again we simulate the model and compute first and second-order moments and correlations (see table 7).

Our major findings are: 1) $\tau_{\min}$ and $\tau_{\max}$ tend both to increase the average level of unemployment, separations and vacancies. 2) Strong deviations of aggregate variables can be observed when the payroll tax hits a statutory tax rate but 3) the overall impact (on the whole simulated sample) is weak. Lets first investigate the difference between the constrained and the unconstrained UI system once the payroll tax hits the statutory tax rates (see figure 6 and table 3). When the tax rate hits the minimum or the maximum rate, the unemployment and the separation rate are always higher than in the unconstrained experience rating system. On average, they are 7.5% higher and seem to peak at +16.5%. The largest deviations arise from vacancies which can fluctuate above and below the unconstrained case, from -12% to +18% at $\tau_{\min}$ and from -5% to more than 25% at $\tau_{\max}$. The average is above the unconstrained UI in both cases.

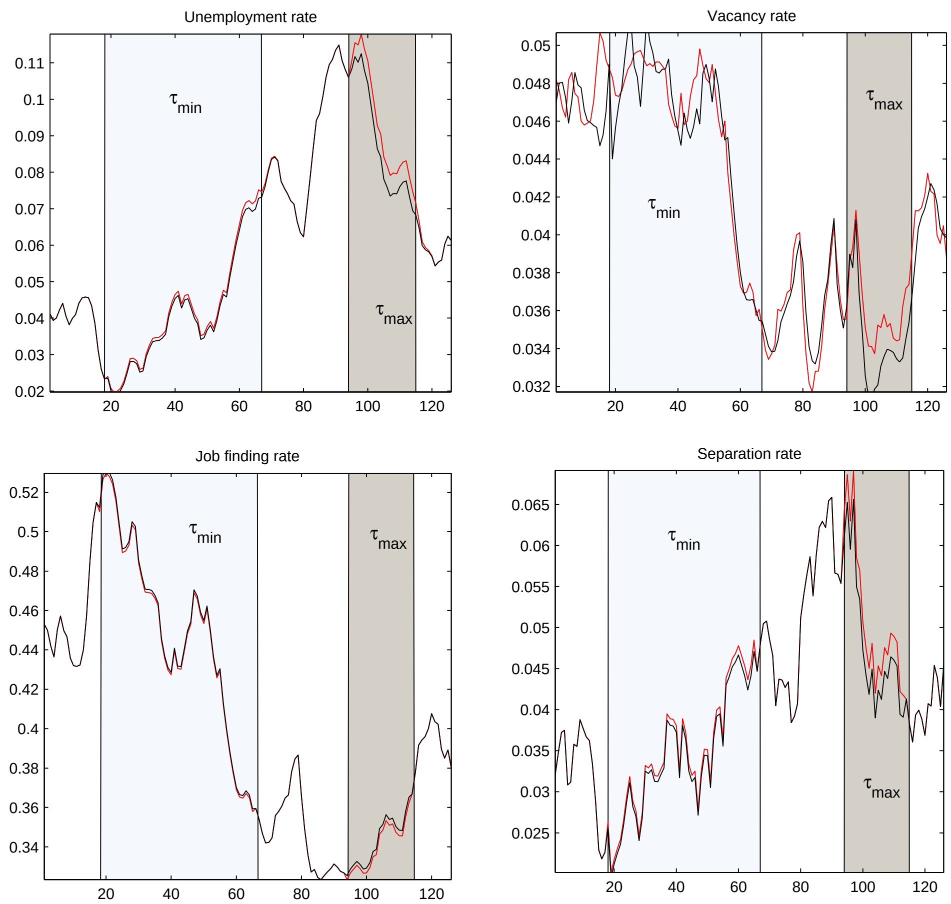

Figure 6: ***A simulated path for the constrained and the unconstrained model*** *Constrained model: red line. Unconstrained model: black line. The first shaded area correspond to the case where the tax rate hits the lower bound of the tax schedule ($\tau_{\min}$). The second shaded area correspond to the case where the tax rate hits the upper bound of the tax schedule ($\tau_{\max}$).*

	Deviations at $\tau_{\min}$			Deviation at $\tau_{\max}$		
	Minimum	Average	Maximum	Minimum	Average	Maximum
Output	-0.35	-0.10	0.26	-1.53	-0.75	0.18
Employment	-0.35	-0.10	0.25	-1.46	-0.71	-0.18
Unemployment	-4.33	2.33	4.10	1.88	7.55	16.53
Vacancy	-12.12	0.44	18.26	-5.76	5.59	25.73
Tightness	-1.79	-0.92	2.07	-60.2	-2.63	0.48
Job finding rate	-0.54	-0.28	0.62	-1.81	-0.79	0.15
Separation rate	-4.01	1.93	3.95	0.00	7.23	16.75
Wages	-0.08	0.03	0.71	-1.50	-0.50	0.00

Table 3: ***Constrained vs unconstrained model.*** *The model is simulated 10^5 times. We discard all observations where the payroll tax varies between $\tau_{\min}$ and $\tau_{\max}$. The deviations are expressed in percentage difference from the case where there is no statutory tax rate.*

The intuition is simple. Once an employer reaches the minimum tax rate he has to pay more to the UI than the fiscal cost of a laid off employee. Because the marginal tax cost becomes equal to zero, firms cannot reduce the contribution rate anymore and receive an "implicit negative subsidy". The implicit cost induced by the boundary $\tau_{\min}$ may reduce the incentive for firms to post vacancies. On the other side, an employer may have some incentives to increase the payroll and to raise the reserve ratio in such a way it prevents from potential increases of the payroll tax. Indeed, if the reserve ratio is sufficiently high, an increase of the separation rate is less likely to drive the reserve ratio on the experience rating zone. As a consequences, an employer may be more prone to post vacancies and to increase the separation rate together.

The intuition is similar for the maximum rate. In bad states, the unemployment insurance can not fully recover its expenditures and must report the burden of benefits paid in the future. The gap between benefits paid and contributions collected continues to increase while the payroll tax is constrained by the legal maximum rate. If the reserve ratio depreciates strongly, employers will face recurrent periods at the maximum rate until the next trend reversal. Since at the maximum tax rate, further job terminations cannot result in more contributions, their incentive to avoid the maximum rate is low. During this period the marginal tax cost is equal to zero, making the firing process cheaper. Employers are free to layoff workers without extra costs. $\tau_{\max}$ generates a "positive implicit subsidy" and make employers more prone to rise the layoff rate by more than it would have been in the absence of the legal constraint. This may lead to excessive match dissolutions in recessions and more unemployment. However, the implicit subsidy increases firms' profit and may foster job creation as attest the deviation of vacancies.

The impact of the legal constraints on output, wages and the job finding rate is lower. The effect of statutory tax seems to be weak (see table 7) on the whole sample[20]. If we remove them, the separation rate and unemployment rate only fall by about 2% while vacancies are just a tiny bit higher. The reason is that there are positive and negative deviations which reduce the average impact of the statutory tax rates. In addition, the tax is equal to $\tau_{\min}$ or $\tau_{\max}$ only one third of the time. Since most of aggregate variables share the same path two-thirds of the time, the overall impact is shown to be weak. However, we can argue that during recessions and expansions sizeable deviations of unemployment, separation and vacancies can be observed.

5 Firing tax vs Experience rating

The general principle of experience rating seems to be very similar to a firing tax financing unemployment benefits. However, the mechanisms behind experience

[20]Periods of experience rating and periods where the tax reaches $\tau_{\min}$ or $\tau_{\max}$.

rating differ from the firing tax in many aspects: 1) An increase of the layoff rate raises, not reduces, the payroll tax rate. This is of particular importance because when the extra cost arise from a firing tax, the payroll tax rate is either assumed to be constant[21] or vary in order to balance the UI budget. In the latter case, firing taxes may lead to procyclical payroll taxes, which is in stark contrast with the empirical evidence. 2) Employers' contributions are not adjusted instantaneously following a mass layoff event. Experience rating smooth the payroll tax adjustment. Firms never support the cost of dismissals instantaneously when separations occur. This may have important implications on hirings and firings as firms discount the intertemporal value of a job. 3) The extra cost a firm have to support when its layoff rate increases is proportional to wages while it is not the case with firing taxes. Wages adjustments may strongly influences the labor turnover over the cycle, especially if the payroll tax adjusts sluggishly. 4) Experience rating makes firms liable for UI benefits paid to claimants over the past, leading to important persistence of the tax level 5) A firing tax strongly affect the wage bargaining process. It creates a *two-tiers* wage structure in which new and old workers threat points are different[22]. 6) Last but not least, the tax schedule in experience rating systems exhibits strong non-linearities, *i.e.* a maximum rate and a minimum rate. These differences have been neglected so far in previous theoretical evaluations and provide a clear distinction between experience rating and firing tax systems.

The propagation mechanisms suggest the two systems may have different consequences on labor market outcomes. But, why making such a distinction? Comparing the two systems is twofold. First, it may help to disentangle the backward effects coming from the firm account that records the layoffs history and which is absent in a firing tax environment. Second, it is useful for policy recommendation. Should firms be charged in proportion to the cost incurred by the UI fund now or later? Intuitively, the two incentive methods reduce the job separation rate. But less clear is the impact on hirings. In this exercise we make a parallel between experience rating systems and firing taxes.

5.1 Steady state effects

As before we start our discussion on the steady state effects. We assume the UI budget constraint writes as:

$$G(\varepsilon_t^o)N_t^o\mathcal{F}_t = \tau\Upsilon_t - bS_t + T_t \tag{38}$$

where $\mathcal{F}_t$ and T_t are equal to zero in our benchmark calibration. In order to evaluate the impact of the firing tax we consider two instruments that raise $\mathcal{F}_t$: 1) A decrease of the lump-sum transfer or 2) a fall of the payroll tax. In the

[21] If lump-sum tax balances the UI budget.

[22] This result arise from stochastic job matching.

first one the lump-sump transfer is assumed to be exogenous $T_t = T$ while in the second τ vary and T_t is always equal to zero. The two cases offer alternative evaluations[23]. In the first case we isolate the pure effect of the firing tax while the second allows us to deals with the effects of the payroll tax and the firing tax together and to draw a parallel with experience rating systems. We compare an increase of τ or T that involve a similar value of the steady state firing tax. Results are reported in table 4.

When the lump-sum transfer falls, the increase of the firing tax reduces unemployment and separations ($\underline{\varepsilon}^o$). It increases output and the fob finding rate. However, firing taxes reduce job creation through the number of vacancies posted and the threshold $\underline{\varepsilon}^n$. The reason is that firing taxes introduces a labor hording phenomena. They reduce the incentive for firms to layoff workers but they also discourage hirings. Firms take into account the cost of firing in their hiring decisions. $\mathcal{F}$ reduces the expected gains from a new job. Then, firms are less prone to post vacancies and are more picky on the initial idiosyncratic productivity: $\underline{\varepsilon}^n$ increases. The impact on new and old wages differs because of the two-tiers wage structure. Only workers in old jobs can use the firing tax as a treat to get higher wages. Then, the cost of firings translate into lower wage, especially for new matches.

When the payroll tax is reduced instead of the lump-sum transfer, the impact of $\mathcal{F}$ on output, unemployment, the separation rates and the unemployment duration is qualitatively similar but quantitatively stronger. For $\mathcal{F} < 10\%\bar{w}$, more vacancies are posted (+1.5%). This comes from the decline of the payroll tax. It compensate the fall of the expected value of a job induced by the firing cost and increases the incentive of firm to post vacancies. Higher values of $\mathcal{F}$ do not create a sufficient financial incentive to offset the negative effect on the expected gains from a job. It results in a fall of vacancies. The average wage in old jobs is increasing with the firing tax. The intuition is similar to the previous case. The fall of the payroll tax strengthen workers threat point. It allows them to claim for sharing the increase of the match surplus coming from the decline of τ. The previous results shows that the behavior of wages and hirings (through vacancies and the separation threshold of new matches) are crucial to explain the differences between experience rating systems and firing taxes[24]. In the two case previously considered (with and without a payroll tax change), the firing tax leads to huge falls of the firm profit compare to a shift of the slope. Consequently, firms always prefer experience rating systems to firing taxes.

[23] Note that assuming an exogenous firing tax ($\mathcal{F}$) and an endogenous lump-sum tax or payroll tax used to balanced the UI budget is strictly similar for this exercise.

[24] The unit of measurement of η_1 and $\mathcal{F}$ is clearly different. It's not straightforward that a 50% increase of η_1 is equivalent to $\mathcal{F}$ equal 5% or 10% of the average wage. We can not deduce which one have a stronger impact on labor market outcomes. However, despite the lacks of comparison criterions we can easily understand the difference between $\mathcal{F}$ and η_1.

Firing tax	0	No τ change			τ change		
		$0.05\overline{w}$	$0.1\overline{w}$	$0.2\overline{w}$	$0.05\overline{w}$	$0.1\overline{w}$	$0.2\overline{w}$
Output	100.00	100.77	101.37	102.02	101.58	102.51	103.19
Wage new	100.00	98.57	97.15	94.41	99.71	99.08	97.29
Wage old	100.00	99.76	99.55	99.20	100.92	101.52	102.24
Vacancies	100.00	98.47	96.51	91.04	101.56	100.22	92.65
Profits	100.00	71.80	38.67	-44.50	68.93	35.49	-44.61
Unemployment	5.64	4.73	3.90	2.52	4.00	2.90	1.52
Job finding rate	40.09	41.72	43.52	47.66	43.8	47.17	53.77
Separation rate $\underline{\varepsilon}^n$	4.00	5.90	7.84	11.85	5.60	7.40	11.34
Separation rate $\underline{\varepsilon}^o$	4.00	3.47	2.98	2.13	3.17	2.54	1.62
Unemployment duration	2.60	2.55	2.49	2.38	2.42	2.29	2.10
Payroll tax	4.50	4.50	4.50	4.50	3.13	2.23	1.12

Table 4: ***Steady states effects of firing taxes.***

5.2 Business cycle effects

To understand how the two systems differ over the business cycle we investigate how the economy reacts to shocks when a firing tax is used to finance a budget unbalance instead of a payroll tax shift. To avoid steady state effects, we do not remove the payroll tax. We simply assume it doesn't vary over the cycle as in the previous exercise (first case). At the steady state, the firing tax is equal to zero and the payroll tax ensures a balanced budget $\tau\Upsilon = bS$ ($T_t = 0$). In order to make a rigorous comparison with experience rating systems we assume the firing tax F_t only finance a fraction α of the budget unbalance:

$$G(\underline{\varepsilon}_t^o)N_t^o F_t = \alpha(\tau\Upsilon_t - bS_t) \tag{39}$$

Changing the value of α doesn't affect the steady state at all and offer a direct a comparison with η_1. As in the experience rating case, the difference between contribution collected (coming now from the firing tax) and the benefits paid are financed through a lump-sum tax:

$$T_t = G(\underline{\varepsilon}_t^o)N_t^o F_t + \tau\Upsilon_t - bS_t \tag{40}$$

Results are reported in figure 7[25].

[25] The deterministic steady state differs from the experience rating economy even if the steady state value of the firing tax is equal to zero. Indeed, the shadow value of the firm account Λ^3 being equal to zero, it affects the average wage (25) and the job destruction condition (28). The model with firing taxes involves lower value of b, h and $\overline{w}$ which are likely to reduce fluctuations of the unemployment and vacancies in the benchmark ($\alpha = 0$). In this exercise we do not try to compare the benchmark economy with experience rating to firing taxes. We only compare the effects induced by a change of α to the effects induced by a change of η_1.

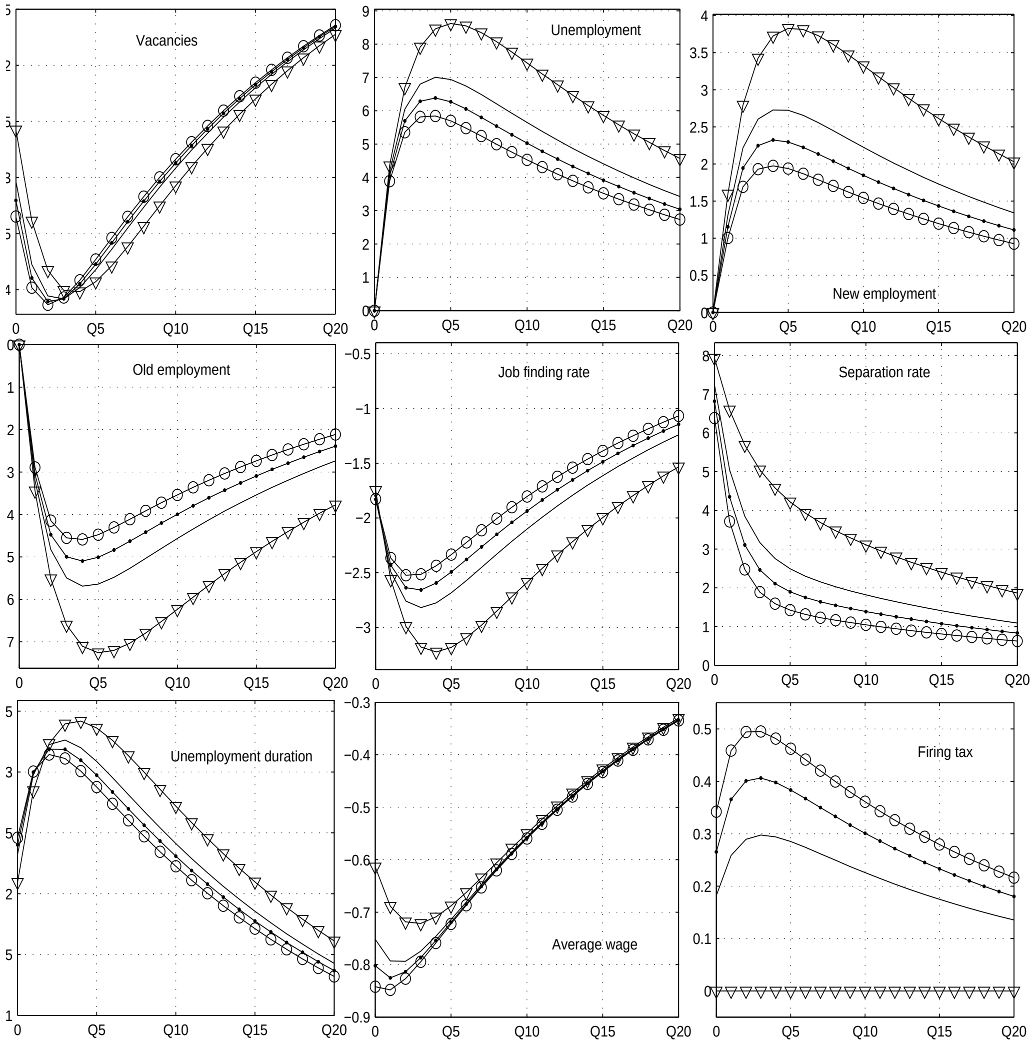

Figure 7: ***Impulse response function - firing tax model.*** *($\alpha = 0.08$): solid line (no markers), $\alpha = 0$: downward-pointing triangle markers, $\alpha = 0.12$: point markers, $\alpha = 0.16$: circle markers.*

Increasing the degree at which the firing tax respond to the UI unbalance dampens employment, unemployment, the tightness (through the job finding rate) and the separation rate. The major difference is that firing taxes are not able to smooth the fluctuations of vacancies. The path of vacancies is similar when α is equal to 0, 0.08, 0.12 or 0.16. The spike of the separation rate is not as reduced as in the experience rating case. In addition, the two separation rates (new jobs and old jobs) move in opposite direction as shown by (29). The rapid increase of the firing tax makes firms more picky at the match selection in bad times. f_t increases while $1 - G(\varepsilon_t^n)$ falls. It follows that the impact on the unemployment duration $\frac{1}{f_t(1-G(\varepsilon_t^n))}$ is ambiguous contrary to experience rating systems. We conclude that charging firms to the cost incurred by the UI immediately (via firing taxes) is detrimental for hirings in recessions. The sluggishness of the contribution rate in experience rating systems avoids important declines of firms profits in recessions. Then, vacancies are higher on average, fall less during recession but increase less in expansions.

5.2.1 Welfare evaluations

So far, we have focused on the consequences of reforming the tax schedule on labor market outcomes. It seems natural to ask whether experience rating is desirable from a welfare perspective. What is the welfare cost of the distortions induced by experience rating? Does it offset search externalities? Is experience rating preferred to firing taxes? What is the optimal level of the slope or the firing tax? Distortions due to adjustment delays, the proportionality of the contribution rate to wages and the statutory taxes could in principle suggest that the less distortional firing costs should be preferred. However, the effectiveness of such a policy also depends on their ability to offset the distortions caused by search externalities. Then, to answer these questions, it seems relevant to understand 1) How inefficient are search externalities? and 2) what is the welfare cost (gain) of the UI? Distortions induced by search externalities can be determined by comparing the first-best allocation (Pareto) to a laissez-faire economy. The distortions induced by the UI experience rating system can be evaluated by comparing the benchmark allocation to a laissez-faire allocation or to the Pareto allocation (see appendix A). In addition, experience rating systems will be compared to a system where a firing tax is used to finance unemployment benefits as in the previous section[26]. However, recall that shutting down the UI at the "*new Hosios condition*" will not necessarily restore efficiency because q_t moves over time and is likely to change following structural reforms of the tax schedule. Then $\xi = 0.5$ and $\psi = 0.73$ will no longer be an optimal rule to offset search externalities.

According to E, when $\xi = 0.5$ and $\psi = 0.7$, the welfare cost of the benchmark economy (with UI) relative to the Pareto allocation is about 0.33%. Employment and vacancies are too low compare to the first-best allocation (Pareto). The laissez-faire economy involves a strong fall of the welfare cost. Only for high values of the firm bargaining power and low value of the elasticity of the matching function w.r.t. unemployment ($\xi = 0.7$ and $\psi = 0.7$), the benchmark experience rating economy is preferred to a situation without UI. The benchmark firing tax system is shown to be highly welfare detrimental whatever the level of search externalities. The important welfare cost comes essentially from the exogenous payroll tax. However it is shown that the UI system, either under experience rating or firing taxes, is not optimal. If the tax schedule or the firing tax is

[26]The steady state value of the firing tax is equal to 0 in the benchmark. The firing tax is determine by (39) and the lump-sum transfer by (40). When we optimize the welfare with respect to the firing tax we reduce the exogenous payroll tax.

reformed so as to maximize the welfare, the UI can strongly offset inefficiencies and be preferred to a no UI situation. Under the second-best allocation, the welfare cost of UI experience rating is similar to the laissez-faire economy if ψ is low but it is almost 6 times lower if ψ is high ($\psi = 0.7$). In addition, the optimal policy that implement the second-best allocation should be conducted by an increase of firing taxes only if the firm bargaining power is high ($\xi = 0.7$) and if the elasticity of the matching function w.r.t. vacancies is low ($1-\psi = 0.3$). In the other cases, the optimal policy should be conducted by an experience rating system. Important increases of the slope can be required to reduce the welfare cost, from 0.11 to more than 3. Finally, it is shown that removing the statutory tax rates involves a welfare gain less than 0.001%.

6 Conclusion and discussion

This paper studies the dynamic effects of unemployment insurance experience rating systems using a DSGE business cycle model with search and matching frictions. We provides new insights on the effects of the tax schedule, especially the statutory tax rates which have been neglected from previous studies. We shows this incentive-based method is likely to reduce labor market fluctuations. Increasing the slope of the tax schedule (more experience rating) reduce layoffs and unemployment but promote vacancies posting. The existence of statutory tax rates (minimum and maximum payroll tax rates) distort the way firms adjust employment. Once the payroll tax hits these legal constraints, strong deviations of the labor market can be observed when comparing to an unconstrained economy. Firing taxes have similar effects on unemployment and separations but discourage hirings. Both system reduce the inefficiencies of search externalities. The preference of a system depends on how the search externalities distort the economy.

Further analysis has to be devoted to the impact of statutory tax rates. One important argument that justifies the use of imperfect experience rating and the statutory tax rates by policy makers is to avoid plant closing and firms entry and exit. By limiting the burden of UI contributions it is often argued that it could reduce firm closures, especially in strong cyclical sectors such as the manufacturing sector. In addition, new firms (without a layoff history) are rated at a "*New Employer Rate*" which could have potential impact on the decision to enter the market and on aggregate employment. Our paper can be viewed as a first-step to understand how experience rating of the unemployment insurance impacts labor flows. Including heterogeneity among firms as in Veracierto (2009), Elsby and Michaels (2010) and Fujita and Nakajima (2010) to study how it affects firm closures requires a much more complex framework but is an interesting issue for future research.

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A The Pareto allocation

The Pareto allocation can be derived from the central planner's problem. The central planner's has to choose a sequence of $D_t^S = \{C_t, \underline{\varepsilon}_t, \theta_t, N_t\}$ solving the following problem :

$$\max_{D^S} \quad E_0 \sum_{t=0}^{\infty} \frac{(C_t + S_t h)^{1-\sigma}}{1-\sigma}$$

s.t.

$$\begin{array}{ll} \Delta^1 : & -N_t + S_{t-1} f_{t-1} + (1 - G(\underline{\varepsilon}_{t-1}))N_{t-1} \\ \Delta^2 : & Y_t - C_t - \Gamma(\theta_t, \underline{\varepsilon}_t, N_t) \end{array} \tag{41}$$

where:

$$\begin{aligned} S_t &= 1 - (1 - G(\underline{\varepsilon}_t))N_t \\ f_t &= \chi \theta_t^{1-\psi} \\ Y_t &= N_t z_t \int_{\underline{\varepsilon}_t}^{\bar{\varepsilon}} x dG(x) \\ \Gamma(\theta_t, \underline{\varepsilon}_t, N_t) &= \frac{\psi_v}{1+\gamma_v} \left[S_t \theta_t + S_t f_t Q\right]^{1+\gamma_v} \end{aligned}$$

The first order conditions are:

$$\begin{array}{ll} \partial C_t : & (C_t + S_t h)^{-\sigma} = \Delta_t^2 \\ \partial \underline{\varepsilon}_t : & h N_t G'(\underline{\varepsilon}_t)\Delta_t^2 + \beta E_t(N_t G'(\underline{\varepsilon}_t) f_t - N_t G'(\underline{\varepsilon}_t))\Delta_t^1 - N_t z_t \underline{\varepsilon}_t G'(\underline{\varepsilon}_t)\Delta_t^2 - \Gamma'(\underline{\varepsilon}_t)\Delta_t^2 = 0 \\ \partial \theta_t : & \beta E_t \Delta_{t+1} S_t (1-\psi) \dfrac{f_t}{\theta_t} - \Gamma'(\theta_t)\Delta_t^2 = 0 \\ \partial N_t : & -h(1 - G(\underline{\varepsilon}_t))\Delta_t^2 - \Delta_t^1 + \beta E_t \Delta_{t+1}^1 (1 - \Gamma(\underline{\varepsilon}_t))(1 - f_t) + \Delta_t^2 \left(\dfrac{Y_t}{N_t} - \Gamma'(N_t)\right) \end{array}$$

Since $V_t = \theta_t S_t$ we can deduce from the different derivative of the hiring cost function that:

$$\begin{aligned} \Gamma'(\underline{\varepsilon}_t) &= \Gamma'(V_t) N_t G'(\underline{\varepsilon}_t)\theta_t \\ \Gamma'(\theta_t) &= \Gamma'(V_t) S_t \frac{\kappa + (1-\psi) q_t Q}{\kappa + q_t Q} \end{aligned}$$

We therefore have:

$$\begin{aligned} \Delta_t^2 &= (Y_t - \Gamma(\theta_t, \underline{\varepsilon}_t, N_t) + S_t h)^{-\sigma} \\ \frac{\Gamma'(V_t)}{q_t} &= (1-\psi)\frac{\kappa + q_t Q}{\kappa + (1-\psi) q_t Q} \beta E_t \frac{\Delta_{t+1}^2}{\Delta_t^2} z_{t+1} \int_{\underline{\varepsilon}_{t+1}}^{\bar{\varepsilon}} x - \underline{\varepsilon}_{t+1} dG(x) \\ 0 &= z_t \underline{\varepsilon}_t - h + \Gamma'(V_t)\theta_t + (1 - f_t)\beta E_t \frac{\Delta_{t+1}^2}{\Delta_t^2} \int_{\underline{\varepsilon}_{t+1}}^{\bar{\varepsilon}} x - \underline{\varepsilon}_{t+1} dG(x) \end{aligned}$$

While the competitive economy without labor market institutions is from (9), (28) and (29):

$$\begin{aligned}
\lambda_t &= (Y_t - \Gamma(V_t) + S_t h)^{-\sigma} \\
\frac{\Gamma'(V_t)}{q_t} &= \xi\beta E_t \frac{\lambda_{t+1}}{\lambda_t} z_{t+1} \int_{\underline{\varepsilon}_{t+1}}^{\bar{\varepsilon}} x - \underline{\varepsilon}_{t+1} dG(x) \\
0 &= z_t \underline{\varepsilon}_t - h + \Gamma'(V_t)\theta_t + (1 - f_t)\beta E_t \frac{\lambda_{t+1}}{\lambda_t} \int_{\underline{\varepsilon}_{t+1}}^{\bar{\varepsilon}} x - \underline{\varepsilon}_{t+1} dG(x)
\end{aligned}$$

We can easily deduce that the condition which ensure efficiency of the competitive equilibrium is:

$$\xi = (1 - \psi)\frac{\kappa + q_t Q}{\kappa + (1 - \psi) q_t Q}$$

B Welfare costs

In order to compare the different alternative allocations, we compute the welfare cost in equivalent consumption. We evaluate the fraction of the consumption stream from an alternative policy needed to achieve the welfare in the Pareto allocation. Let $\mathcal{W}_0^*$ be the welfare under the Pareto allocation and let C_t^a and S_t^a denote an alternative allocation. The welfare cost Ω is obtained by solving the following equation :

$$\mathcal{W}_0^* = E_0 \sum_{t=0}^{\infty} \beta^t \frac{\left[(1 + \Omega)\left(C_t^a + S_y^a h\right)\right]^{1-\sigma}}{1 - \sigma} \tag{42}$$

Ω can be written as follows :

$$\Omega = \left(\frac{\mathcal{W}_0^*}{\mathcal{W}_0^a}\right)^{\frac{1}{1-\sigma}} - 1 \tag{43}$$

with :

$$\mathcal{W}_0^a = E_0 \sum_{t=0}^{\infty} \beta^t \frac{(C_t^a + S_t^a h)^{1-\sigma}}{1 - \sigma} \tag{44}$$

Ω is numerically computed using the PEA methods[27]. $\mathcal{W}_0^a$ measure the welfare under an alternative allocation.

[27]Note that the PEA method avoids the problem of spurious welfare reversals induced by local approximations. We can compute the welfare cost using means of the simulated series: $\mathcal{W}_0^*$ and $\mathcal{W}_0^a$

C Steady state effects of the slope

	Bench.	$\eta_1 = 0.06$	$\eta_1 = 0.12$	$\eta_1 = 0.16$
η_0 FIXED AND $\tau_{\min}, \tau_{\max}$ CONSTANT				
Output	100.00	97.31	101.28	101.28
Wages	100.00	98.77	101.24	101.24
Vacancy	100.00	88.95	105.15	105.15
Profits	100.00	103.28	71.39	71.17
Unemployment	5.64	8.11	4.47	4.47
Job finding rate	40.10	35.49	42.99	42.99
Separation rate	4.00	4.85	3.53	3.53
Unemployment dur.	2.60	2.96	2.41	2.41
Payroll tax	4.50	6.30	$\tau_{\min}$	$\tau_{\min}$
Reserve ratio	0.00	-0.29	∞	∞
η_0 FIXED AND $\underline{\mathcal{R}}, \overline{\mathcal{R}}$ CONSTANT				
Output	100.00	96.69	102.02	102.82
Wages	100.00	106.51	101.39	102.14
Vacancy	100.00	86.46	107.94	110.54
Profits	100.00	85.47	96.09	93.91
Unemployment	5.64	8.68	3.78	2.87
Job finding rate	40.10	34.62	45.05	47.69
Separation rate	4.00	5.03	3.23	2.87
Unemployment dur.	2.60	3.04	2.29	2.16
Payroll tax	4.50	$\tau'_{\max}$	3.16	2.63
Reserve ratio	0.00	$-\infty$	0.11	0.11
$\eta_0 = \tau(0)$ AND $\underline{\mathcal{R}}, \overline{\mathcal{R}}$ CONSTANT				
Output	100.00	96.71	102.12	102.90
Wages	100.00	98.51	101.48	102.24
Vacancy	100.00	86.56	108.28	110.77
Profits	100.00	103.91	95.82	93.62
Unemployment	5.64	8.66	3.70	2.98
Job finding rate	40.25	34.65	45.34	47.99
Separation rate	4.00	5.03	3.18	2.83
Unemployment dur.	2.60	3.04	2.28	2.14
Payroll tax	4.50	6.71	3.10	2.57
Reserve ratio	0.00	0.00	0.00	0.00

Table 5: ***Steady states effects*** *The unemployment duration is measured in quarters.* $\tau_{\min}$ *means the payroll tax reaches the minimum tax rate.* $\tau_{\max}$ *means the payroll tax reaches the maximum tax rate. A prime superscript is used when the statutory tax rate are recalculated i.e.* $\underline{\mathcal{R}}, \overline{\mathcal{R}}$ *are constant.*

D Cyclical properties of the model (I)

	Data	Bench.	$\eta_1 = 0.06$	$\eta_1 = 0.12$	$\eta_1 = 0.16$
MEAN LEVELS					
Output	-	100.00	96.88	102.25	103.11
Employment	-	100.00	96.95	102.21	103.05
Wages	-	100.00	98.55	101.44	102.18
Vacancy	-	100.00	88.66	107.69	110.22
Tightness	-	100.00	60.77	161.41	203.12
Unemployment	5.64	6.12	8.99	4.05	3.26
Job finding rate	45.21	40.25	35.39	45.32	47.92
Separation rate	3.51	4.13	5.10	3.28	2.91
STANDARD DEVIATIONS					
Output	1.58	1.62	1.80	1.45	1.38
Employment	0.63	0.79	1.03	0.56	0.46
Wages	0.68	0.60	0.54	0.64	0.65
Unemployment	12.35	12.80	11.54	13.51	13.54
Vacancies	13.93	5.88	6.51	5.15	4.76
Tightness	25.72	16.77	16.03	17.09	16.95
Job finding rate	8.30	4.31	4.25	4.24	4.13
Separation rate	5.64	10.60	10.26	10.32	9.87
1^{st} ORDER AUTOCORRELATION					
Output	0.85	0.87	0.89	0.84	0.83
Unemployment	0.87	0.91	0.92	0.90	0.89
Vacancies	0.91	0.87	0.88	0.86	0.85
Job finding rate	0.80	0.90	0.91	0.89	0.88
Separation rate	0.48	0.67	0.70	0.64	0.62
CORRELATION					
$U_t,\ V_t$	-0.92	-0.55	-0.54	-0.60	-0.63
$U_t,\ Y_t$	-0.84	-0.79	-0.80	-0.78	-0.77
$N_t,\ Y_t/N_t$	0.26	0.49	0.43	0.53	0.55

Table 6: ***Cyclical properties*** *US statistics are computed using a quarterly HP-filtered data from 1951Q1:2006Q4. Data is constructed by the BLS from the CPS. The help-wanted advertising index is provided by the Conference Board. Job finding and separation probabilities are build by Shimer (2005). Mean levels are computed as the average value of gross variables and normalized to 100.00 except the last three rows. The model is simulated 500 times over 120 quarters horizon. Results are reported in logs as deviations from an HP trend with smoothing parameter 1600. We discard the first 2000 observations.*

E Cyclical properties of the model (II)

	Benchmark	no $\tau_{\min}$	no $\tau_{\min}$	full unconstrained
Mean levels				
Output	100.00	100.05	100.08	100.14
Employment	100.00	100.05	100.07	100.13
Wages	100.00	100.04	100.06	100.10
Vacancy	100.00	100.12	99.95	100.04
Tightness	100.00	101.59	100.47	102.15
Unemployment	6.12	6.07	6.05	6.00
Job finding rate	40.25	40.38	40.32	40.46
Separation rate	4.13	4.10	4.09	4.07
Welfare cost	100.00	99.99	100.00	99.99
Standard Deviations				
Output	1.62	1.61	1.62	1.62
Employment	0.79	0.78	0.79	0.78
Wages	0.60	0.60	0.60	0.60
Unemployment	12.80	12.77	12.84	12.83
Vacancies	5.88	5.86	5.79	5.76
Tightness	16.77	16.70	16.83	16.76
Job finding rate	4.31	4.29	4.33	4.31
Separation rate	10.60	10.59	10.61	10.59
1^{st} order autocorrelation				
Output	0.87	0.87	0.87	0.87
Unemployment	0.91	0.91	0.91	0.91
Vacancies	0.87	0.87	0.87	0.87
Job finding rate	0.90	0.90	0.90	0.90
Separation rate	0.67	0.67	0.67	0.67
Correlation				
$U_t,\ V_t$	-0.55	-0.54	-0.57	-0.56
$U_t,\ Y_t$	-0.79	-0.79	-0.79	-0.79
$N_t,\ Y_t/N_t$	0.49	0.48	0.49	0.49

Table 7: ***Cyclical properties*** *US statistics are computed using a quarterly HP-filtered data from 1951Q1:2006Q4. Data is constructed by the BLS from the CPS. The help-wanted advertising index is provided by the Conference Board. Job finding and separation probabilities are build by Shimer (2005). Mean levels are computed as the average value of gross variables and normalized to 100.00 except the last three rows. The model is simulated 500 times over 120 quarters horizon. Results are reported in logs as deviations from an HP trend with smoothing parameter 1600. We discard the first 2000 observations.*

EXPERIENCE RATING

	$\xi = 0.5$ $\psi = 0.7$			$\xi = 0.5$ $\psi = 0.5$			$\xi = 0.7$ $\psi = 0.7$			$\xi = 0.5$ $\psi = 0.45$		
Economy	B	LF	2^{nd}	B	LF	2^{nd}	B	LF	2^{nd}	B	LF	2^{nd}
Welfare cost	0.3334	0.0059	0.0019	0.7295	0.1425	0.1555	0.1517	0.2373	0.0485	0.8669	0.2372	0.2460
Output	96.11	100.46	100.14	94.82	98.43	98.32	97.52	102.89	100.19	94.43	97.92	97.86
Employment	96.22	100.4	100.14	94.90	98.44	93.33	97.61	102.84	100.20	94.50	97.93	97.87
Vacancies	96.51	108.49	108.84	68.80	75.61	75.40	125.69	132.32	138.61	64.55	70.14	70.04
η_1	0.08	0.00	0.61	0.08	0.00	1.56	0.08	0.00	0.11	0.08	0.00	3.01
τ	4.5	0.0	1.7	4.5	0.0	2.3	4.5	0.0	2.7	4.5	0.0	2.1
FIRING TAXES												
Welfare Cost	3.4770	0.0106	0.0198	3.7796	0.0209	0.2156	3.1066	0.0356	0.0153	3.9219	0.0656	0.3232
Output	94.21	100.03	89.69	93.83	99.87	85.76	94.24	100.04	93.17	93.61	99.72	84.79
Employment	94.36	100.03	99.99	93.97	99.88	99.66	94.39	100.04	100.01	93.74	99.72	99.45
Vacancies	208.27	92.76	68.58	85.54	90.21	37.58	243.65	50.33	101.20	75.17	82.83	32.91
$\mathcal{F}$	0.00	0.00	0.32	0.00	0.00	0.37	0.00	0.00	0.26	0.00	0.00	0.38
τ	4.5	0.0	0.0	4.5	0.0	0.0	4.5	0.0	0.0	4.5	0.0	0.0

Table 8: ***Welfare costs and optimal policies***. *B: Benchmark, LF: laissez-faire and* 2^{nd}*: second-best allocations*