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Unemployment insurance, Recalls and Experience Rating

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1 Introduction

In the U.S., between 30% and 50% of the unemployment spells end through recall to the previous employer (Fujita & Moscarini (2017)). As suggested by Katz (1986), the recall process may be related to entitlements to unemployment insurance (UI). We show, in Table 1, that the recall share[1] is significantly higher among UI recipients than nonrecipients[2]. We argue that a large part of the observed difference in recall shares is accounted for by the design of the UI financing scheme, characterized by an experience rating (ER thereafter) system. We use a search and matching model to study the extent to which the ER system affects the different extensive margin of labor adjustments over the business cycle.

Table 1: RECALL SHARE

	UI recipients	UI nonrecipients	Difference
Recall share	0.5100	0.3520	0.1580***
	(0.0063)	(0.0027)	

*Author calculations on SIPP data, waves 1990, 1991, 1992, 1993, 1996, 2001, 2004, 2008. Number of observations: 8,323. The recall share is defined as the share of completed unemployment spells that end in a recall. Standard errors in parentheses. *** $p<0.01$, ** $p<0.05$, * $p<0.1$.*

In most countries, the UI system is financed through uniform payroll taxes. In such systems, employers do not internalize the impact of layoffs on the UI financing. To allocates the UI costs to firms with more variable employment, the U.S. adopted an ER system. Under the ER system, each firm has a specific UI tax rate that depends on its layoff history. The UI tax rate increases gradually if UI benefits claimed by former employees rise and *vice versa*. As a result, the worker's UI status has a direct impact on the tax rate. ER penalizes firms that dismiss workers collecting UI benefits. As long as the laid-off worker remains unemployed and receives UI benefits, the firm supports the bill through an adequate variation in its individual payroll tax. If the firm wants to turn off the spigot of taxes, it can expect that the worker will find another job, will exhaust UI benefits or the firm can trigger the recall. We argue that the latter

[1] Fujita & Moscarini (2017) define the recall rate as the share of hirings that correspond to a recall, as opposed to a new job. Throughout the paper, we define the recall rate as the number of recalls divided by the number of unemployed. The recall share is the number of recalls divided by the total number of hires.

[2] As in Katz (1986), we refer as " UI recipients" and "nonrecipients" to define the unemployed workers who do collect and who do not collect UI benefits, respectively. This definition does not involve that nonrecipients are not eligible for UI benefits. In addition, UI recipients have different characteristics from nonrecipients in the SIPP data set. Some of these characteristics may influence recall probabilities. We show, in Section 2, that a positive and significant difference in recall share still persists after controlling for observable characteristics.

effect shapes the differences in recall probabilities between UI recipients and nonrecipients.

Several papers stress the key role played by hirings in explaining the variations in unemployment (see Elsby et al. (2009) for the discussion). However, understanding what channels govern fluctuation in hirings at business cycle frequencies is still a lively debate. Does it come from frictions and mismatches, job creations, the intensity of job search or recalls? Fujita & Moscarini (2017) unveil important characteristics on the cyclicality of hirings. Using different data sources[3], they show that the recall share is highly volatile and strongly procyclical, suggesting an important contribution of recalls to unemployment variations. In the US, economic recessions are often characterized by a sharp rise in unemployment and a brutal decline in hirings. Conversely, the recovery of the labor market is significantly slower. The dramatic surge in unemployment during the Great Recession and its slow decline is one illustrative example of the asymmetries in the labor market. The marked intensity of labor market fluctuations in the US highlights the usefulness of stabilization policies and calls for a clear understanding of the interplay between recalls, the UI and the ER system.

Our paper tries to bridge the gap between the recall and ER literature. First, several studies provide evidence of the incidence of recall. In the US, almost half of hires are recalls (Fujita & Moscarini (2017)). In Europe, recalls are also prevalent, (Winter-Ebmer (1998), Mavromaras & Rudolph (1998), Roed & Nordberg (2003), Jensen & Svarer (2003), Jansson (2002), Alba-Ramirez et al. (2007)), but to a lesser extent (20% to 40% of hires). Several arguments have emerged from the theoretical literature to explain the widespread use of recall: circumventing the time-consuming search process; lowering the uncertainty surrounding the match quality. However, in these models, the ER system is not taken into account. Second, several empirical and theoretical contributions investigate the impact of ER systems on the labor market. The pioneering works of Feldstein (1976) and Topel (1983) and several other studies[4] show that the way the UI is financed strongly impacts separation decisions and job search strategies. They underline the usefulness of this bonus-penalty system in reducing temporary layoffs and unemployment. Card & Levine (1994), L'Haridon & Malherbet (2009) and Albertini & Fairise (2013) show that the ER system stabilizes labor market flows and employment over the business cycle. Ratner (2013) investigates the role of ER with heterogeneous firms in a sS-type model and reaches a similar conclusion: more ER is likely to reduce job creation and job destruction. However, none of the previous studies make

[3]The Survey of Income and Program Participation (SIPP) and the Quarterly Workforce indicator (QWI) for the recall share and the Current Population Survey (CPS) for the exit rate of temporary layoffs.

[4]See also Baily (1977), Brechling (1977), Marks (1984), Anderson & Meyer (1993), Anderson & Meyer (2000), Card & Levine (2000), Cahuc & Malherbet (2004).

a distinction between recalls and new hires. The distinction between the UI recipients and nonrecipients is not investigated, while it may have nontrivial consequences in terms of policy recommendations. The originality of our study is to address these issues and to analyze the quantitative impact of ER on the labor market dynamics.

In this paper, we extend the search and matching model of Fujita & Moscarini (2017) in which hirings and separations are endogenous and where recalls and new hires are two distinct margins of hiring. We introduce two UI status for the unemployed: UI recipients and UI nonrecipients. The eligibility duration is finite and time-varying, in line with the working of extended benefits program in the US[5]. In addition, we introduce a tractable modeling of the ER system that depends on the firm's layoff history. It captures accurately the incentives faced by firms and workers alongside their experience with unemployment. The combination of individual productivity shocks and the ER system generates an endogenous distribution of firms across layoffs history and tax rates. We present a very detailed data set[6] on firms distribution across tax rate in the U.S. from 1998 to 2016. We show that our model reproduces fairly well the observed distribution. The model reproduces the gap in recall shares by UI status as well as the strong asymmetries in unemployment over the business cycle. Unemployment and separations increase more during economic contractions than they decrease during expansions. Recalls are found to contribute significantly to the nonlinear behavior of total hirings.

We evaluate the impact of ER on labor market outcomes in the long run and over the business cycle by simulating counterfactual scenarios. We wonder what would have been the path of the labor market during the Great Recession under alternative UI financing methods. It is shown that ER reduces job separations and hirings in the long run, leading to a lower turnover rate but ambiguous effects on total unemployment. In the short-run, it is shown that ER has stabilization virtues. If the UI were financed by complete flat-tax system, the collapse of the labor market during the Great Recession would have been significantly stronger. Under a flat-tax system, movements in the recall share of UI recipients and nonrecipients would have been very similar, suggesting the important role of ER in explaining the spread of recalls between the two types of UI status. These results are robust to the introduction of rigid wages that prevent firms to transfer UI taxes to workers through lower earnings.

The rest of the paper is organized as follows. Section 2 describes the data. Section 3 is devoted to the presentation of the UI financing mode. Section 4 presents the search and matching model. Section 5 investigates the quanti-

[5]In section 2, we present in more detail the different programs that affect the maximum duration of UI entitlement.

[6]From the Department of Labor, Employment & Training Administration (DOLETA:). See supplementary appendix for details.

tative impact of ER. Section 6 discusses related issues to ER and concludes. Section 7 provides a separate appendix with additional simulations, a model description, and the solution method.

2 Data

Measuring recall is a challenging task. This requires to distinguish unemployment spells that end in new hires and those that finish in recalls. The ideal data set is a panel that tracks individuals from their entry to unemployment to their exit to employment, and that identifies their previous and their new employer. However, such a data set is relatively scarce or incomplete. In our study, we take advantage of the Survey of Income and Program Participation (SIPP). The SIPP is a collection of panels[7]. Each panel is nationally representative and covers a multi-year period, which varies from three to five years. The SIPP tracks all employment relationships by assigning a unique identifier to each employer for each worker. This allows us to distinguish recalls from new job exits. We then follow the methodology described by Fujita & Moscarini (2017) for measuring recalls. We depart from the authors by distinguishing unemployed workers who receive state unemployment compensation from those who do not.

Table 1 presents the frequency of recall among UI recipients and nonrecipients of state unemployment compensation. Half of the unemployment spells end in recall for individuals who receive unemployment benefits, against one third for those who do not. A two-sample t-test indicates that this difference is statistically significant at the 1% level.

However, this positive association between recall and unemployment benefits may be the result of confounding factors. To test this association, we propose to estimate a probit model for experiencing recall. The set of explanatory variables include age, education, sex, unemployment rate, unemployment length, and time dummies. We also include a dummy variable that equals 1 if an individual has received a state unemployment compensation, and 0 otherwise. The estimates, provided in Table 6, show that the latter is statistically significant at the 1% level. We then calculate the predicted probability of recall for each type of unemployed workers, holding all other variables in the model at their means (Table 2). The results confirm that the recall share is significantly higher among recipients than nonrecipients of state unemployment compensation. These findings suggest that the UI system provides an incentive for employers and/or workers to use recall. We argue that such incentives are due in large part to the existence of the experience rating system.

[7] In our study, we use the following panels: 1990, 1991, 1992, 1993, 1996, 2001, 2004, and 2008.

Table 2: PREDICTED PROBABILITIES

Variables	Recall share	95% conf. interval 2.5%	97.5%
UI recipients	0.5610	0.5375	0.5845
	(0.0087)		
UI nonrecipients	0.4389	0.4218	0.4560
	(0.0120)		

Author calculations on SIPP data, waves 1990, 1991, 1992, 1993, 1996, 2001, 2004, 2008. Number of observations: 8,323. Predicted probabilities of recall, holding all other variables at their means. The recall share is defined as the share of completed unemployment spells that end in a recall. Standard errors in parentheses.

3 The unemployment insurance financing

3.1 Firms

The States of the U.S. use different methods of experience rating. We will describe the most commonly used method (33 States) known as the *reserve-ratio* method[8]. We mainly follow Brechling (1977), Topel (1983) and Anderson & Meyer (1993) to describe the method. Under the reserve ratio system, each firm i has its own account in the State UI fund. Every period, the firm account B_i is credited with the amount of UI payroll taxes and is debited with the benefits paid (by the UI) to the firm's laid-off employees. This accounting process defines the next period reserve balance B_i'. Its law of motion writes:

$$B_i' = B_i + \underbrace{\tau_i \, n_i \, \overline{w}}_{\substack{\text{Contributions} \\ \text{collected}}} - \underbrace{b \, u_i}_{\substack{\text{Benefits} \\ \text{paid}}} \tag{1}$$

Contributions collected correspond to the endogenous tax rate τ_i times the firm's taxable payroll. The latter equates the taxable wage base per employee $\overline{w}$ times the number of employees in the firm n_i. $\overline{w}$ is set by the UI in each State. It ranges between \$7000 and \$37000 per employee on an annual basis. When the wage per employee is lower than the taxable wage base, the entire wage is subject to the tax rate. Otherwise, $\overline{w}$ is the basis on which the tax is levied. $b \, u_i$ stands for the benefits charged to the firm under the regular unemployment compensation program. b is the level of unemployment benefits and u_i the layoffs of firm i that collect UI benefits. It evolves endogenously, depending

[8] 17 States use the *benefit-ratio* method. The principle remains the same. The tax is experienced-rated based on UI benefits received by the laid-off workers.

on new matches, recalls, or changes in the UI status of the unemployed. Dividing the employer's reserve balance by the average taxable payroll gives the reserve ratio:

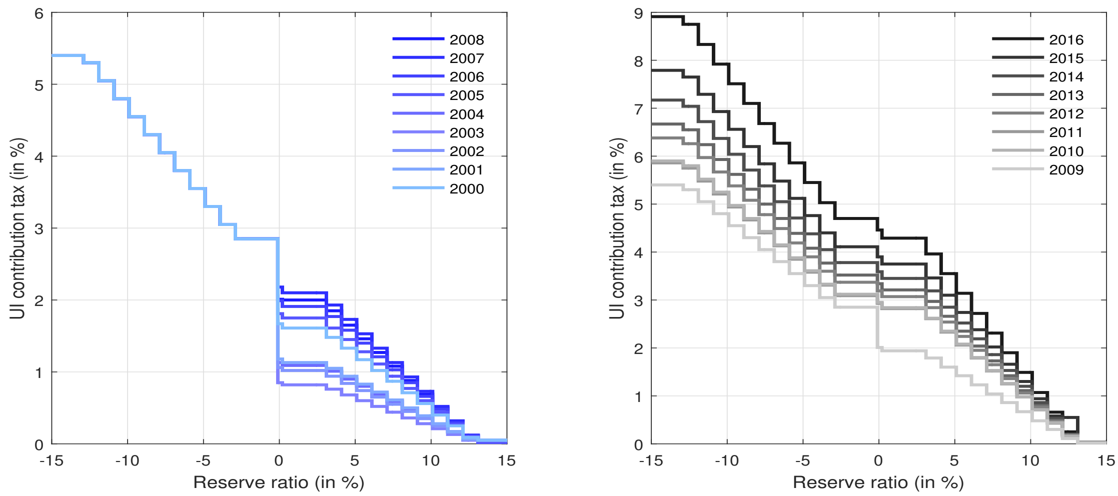
$$R_i = \frac{B_i}{n_i \, \overline{w}} \tag{2}$$

The reserve ratio is used to establish the tax assessed to an employer according to a specific tax schedule set by the UI in each State[9]. Under the reserve ratio method, the tax schedule relates τ to R_i. For example, the Arizona UI tax schedule is plotted in Figure 1. We consider the following approximation:

$$\tau(R_i) = \min(\max(\eta_0 - \eta_1 R_i, \tau_{\min}), \tau_{\max}) \tag{3}$$

η_0, η_1 define the y-intercept of the tax schedule *i.e.* the value of the tax rate for which the reserve ratio is zero, and the slope of the tax schedule, respectively. $\tau_{\min}$ and $\tau_{\max}$ correspond to the minimum tax rate and the maximum tax rate, respectively.

Figure 1: UNEMPLOYMENT INSURANCE PAYROLL TAX SCHEDULE



Arizona, 2000-2016, Source: Arizona Department of Economic Security.

The tax schedule displayed in Figure 1 calls for several comments. It should be noted that all these comments apply to UI that implemented a reserve ratio method.

[9]The legal reserve ratio is revised each year and is divided by the average taxable payroll over the past three years. To simplify, we assume that the reserve ratio is based on the taxable payroll of the current period.

- τ increases in step as R decreases. When the sum of past contributions exceed the amount of benefits paid to the former employees, the reserve ratio is positive, implying a lower contribution rate in subsequent years and *vice-versa*. The slope of the tax schedule governs the degree at which the firm supports the cost it imposes on the UI. A steeper slope makes the firm more responsible for its dismissal decisions as the tax rate adjusts faster. Throughout the paper, we will refer to the **micro aspect** of ER.

- If the reserve ratio decreases sharply, the tax hits the maximum rate. In such a case, more layoffs do not result in a higher tax rate. Similarly, at the minimum rate (which can be greater than zero), hiring new workers or reducing layoffs does not result in a lower contribution rate.

- The tax schedule may change every year. It shifts up following an economic downturn and becomes lighter in normal time. The changes reflect the willingness of the State UI to keep its solvency. The shifting behavior of the tax schedule contrasts with the ER mechanism since it affects every firm, no matter their experience with unemployment. It is worth noting that the slope becomes steeper due to the stronger rise in the maximum rate than that of the minimum rate. In other words, the speed at which the tax rate adjusts to the layoff history is higher during recessions than during expansions. Changes in the tax schedule mainly occur in recessions. In good times or tranquil times the tax schedule remains virtually unchanged. Throughout the paper, we will refer to the **macro aspect** of ER to describe the shifts of the tax schedule.

- Firms without layoff history (new firms) pay the *new employer rate*. It remains mildly constant over the business cycle but varies between states. In most of the States, its value is the one implied by a zero-reserve ratio.

- The taxable wage base (the basis on which the tax rate is assessed) varies between states and increases with inflation but does not vary so much with the business cycle. The taxable wage base can not exceed the wage rate. The taxable wage represents, on average, between 20% and 40% of the total wage of a worker.

3.2 Unemployed workers

UI benefits in the US are available to workers who are unemployed through no fault of their own, available to work, and actively seeking work. To claim for UI, unemployed workers must meet monetary eligibility criteria and must have worked a defined period prior to the beginning date of the UI claim, known as the *Base period*. It is usually the first four of the last five completed calendar quarters prior to the beginning date of the UI claim. Under the regular unemployment compensation program, the weekly benefits amount is based on the wages earned during the Base Period of the claim. It equals 1/26 of the claimant's highest quarter earnings during the base period. Given a base period of one year and a benefits entitlement of 26 weeks (or half a year), the weekly benefits amount is about 50% of the previous earnings.

According to DOLETA[10] the duration of unemployment benefits entitlement may be extended for a prolonged period when the economy experiences a large unemployment increase. State UI trigger automatic extensions under the *Federal-State Extended Benefits* program of 13 or 20 additional weeks in periods of high unemployment. In addition, the *Emergency Unemployment Compensation* program was launched in 2008 and was redefined in the ARRA[11] enacted in 2009. It also increases the maximum benefit duration. Four waves called "Tiers" were implemented. The first one (Tier I) is effective without any conditions on states' experience with unemployment. Tiers II, III and IV require a condition on the insured and/or total unemployment rate to be effective[12]. Our objective is to capture the main characteristic of the UI system, including limited duration and benefits extension during recessionary episodes.

It is worth noting that the tax schedule shifts in recessionary episodes to absorbs the increase in UI costs. However, the UI benefits collected under the two extensions were not charged to the firms. Indeed, the extended benefits program are usually paid on a 50/50 basis by the state's unemployment trust fund and the federal government. However, during the Great Recession, several states' trust funds were bankrupt. The federal government then decides to cover all expenditures coming from the extended benefits program. The emergency unemployment compensation was 100 percent federally funded. Consequently, the two UI extensions did not affect the firms' ER. However, we do introduce them in the model because they may have an impact on job seekers' behavior, which can, in turn, affect firms' layoff and hiring decisions. In addition, one may wonder what would have been the evolution of the labor market if these benefits were charged to firms through the ER system. This counterfactual exercise can tell a rich story about the functioning of the ER system and its impact on the labor market.

4 The model

We extend the model of Fujita & Moscarini (2017) in which hirings and separations are endogenous. Hiring takes place through the matching process or

[10]Department of Labor Employment and Training Administration, `https://oui.doleta.gov/unemploy/euc.asp`

[11]American Recovery and Reinvestment Act.

[12]See Albertini & Poirier (2015) for a synthetic exposition of the UI extensions.

through the recall process. Separations are either temporary or permanent. The latter involves job destruction while the former corresponds to a layoff for which the job still exists but is vacant and attached to an unemployed worker as long as she does not find a new job. Wages are the outcome of a bilateral Nash bargaining process between the firm and the union. Firms are heterogeneous in their layoff history. Due to ER, the different employment trajectories generate an heterogeneity in the firm tax rate. The model of the UI approximates the *Reserve-ratio method* described previously. Separated workers, either temporary or permanently, may be UI recipients or nonrecipients. UI benefits exhaust at a given rate set by the UI. Aggregate productivity shock fuels up the cycle.

4.1 Economic disturbances

Agents are risk neutral. The discount rate is $r > 0$. A homogeneous consumption good, traded on a competitive market, is produced by firms using labor. A firm-worker pair produces a flow of output $p\varepsilon$. p stands for the aggregate component of productivity and is common to all firms. ε denotes the idiosyncratic component of productivity. Each component evolves according to a Markov process. The aggregate productivity shock occurs with arrival rate λ_p in which case a new value p' is drawn from the c.d.f. $P(p'|p)$. Similarly, λ_ε is the Poisson rate at which new idiosyncratic productivity shocks occur. The new individual productivity ε' is drawn as follows. With a probability δ, the new productivity is $\varepsilon' = 0$. This is an absorbing state *i.e.* the match is permanently destroyed. With a probability $1 - \delta$, a new productivity $\varepsilon' > 0$ is drawn from the c.d.f. $G(\varepsilon'|\varepsilon)$. Following an aggregate or an idiosyncratic shock, the match may be dissolved temporarily or permanently. For a new match, a new individual productivity ε' is drawn from $F(\varepsilon')$ that is independent from the previous productivity levels.

The firm and the worker (a pair or a match) can agree to suspend the production if the active match no longer generates a positive joint surplus. The relationship continues to exist and the match may be reactivated (in the event of a favorable evolution of productivity p or ε), giving rise to a recall. The unemployed worker is "attached" to the firm as long as its idiosyncratic productivity is higher than zero and if the inactive match generates a positive surplus. We can then refer to a vacancy-unemployed worker pair. We assume the idiosyncratic productivity of a mothballed match ε continues to evolve as for an active match with arrival rate λ_ε. When a new idiosyncratic productivity is drawn, with a probability $1 - \delta$, ε' is drawn from[13] $G(\varepsilon'|\varepsilon)$. It should

[13] Fujita & Moscarini (2017) notice that the idiosyncratic productivity of an inactive match could be drawn from a conditional distribution different from $G(\varepsilon'|\varepsilon)$. For the sake of simplicity, we assume that the two distributions are the same.

be stressed that when a match is mothballed, the *attached* unemployed worker holds the possibility to search for a new job. If she finds a new job, the firm loses its recall option. All firms belonging to an inactive match may search for an alternative match partner. However, in equilibrium, they all have an interest to exclusively opt for the recall.

The match is permanently destroyed when $\varepsilon' = 0$ (with probability δ) or if the match, either active or inactive, generates a negative surplus. In the latter case, the job is destroyed endogenously.

4.2 The unemployment insurance

4.2.1 UI status

The UI policy is summarized by the level of UI benefits $b(\nu)$ and the benefits duration $1/\pi(p,\nu)$ where $\nu = \{r, n\}$ is the UI status of the worker. $\nu = r$ stands for recipient and $\nu = n$ for nonrecipient. $\pi(p,\nu) \in [0,1]$ governs the rate at which benefits exhaust. Following Mitman & Rabinovich (2015), we assume that the duration depends on the aggregate productivity shock p as a proxy for the automatic benefits extensions. We have $b(r) > 0$ and $\pi(p,r) > 0$ for the UI recipients and $b(n) = 0$ and $\pi(p,n) = 0$, $\forall\ p$, for the UI nonrecipients.

We assume that a fraction φ of workers who separate are UI recipients. This means that the UI status is only known when the separation occurs, not before[14].

4.2.2 The experience rating system

The experience rating system described by the equations (1)-(3) will be adapted[15] to the case of a firm-worker pair alternating production and nonproduction periods. We denote by $\ell = \{1, 2, ..., L\}$ the firm-worker type associated to a layoff history or, equivalently, the value of the reserve ratio. The basic idea is to link the tax rate to the type ℓ and to determine the evolution of types that produces similar variations of the tax rate than that of the original reserve ratio method.

The tax rate in our model is $\tau(p,\ell)$. It depends on the aggregate productivity p, to capture the macro aspect of ER, and to the firm-worker type ℓ, to capture the micro aspect of ER. We assume that active firms and firms that

[14]We do not model the Base Period *i.e.* the period corresponding to the first four of the last five completed calendar quarters prior to the beginning date of the UI claim. Our modeling greatly simplifies the solution of the model and captures the idea that a fraction of workers have not worked long enough within the firms to be eligible or decide not to collect benefits. This is purely exogenous. A natural extension is the introduction of endogenous take-up rates as in Auray et al. (2019) and endogenous cost arising from worker and firm interactions as in Auray & Fuller (2018). However, this is beyond the scope of this paper.

[15]For tractability reasons. In particular, the model remains block recursive and the strategy allows to track each firm's layoff history in a simple manner.

suspend their production pay UI contributions. The evolution of type depends on whether the firm-worker pair is active, inactive, and if the attached unemployed collects UI benefits. We distinguish three cases:

1 The firm-worker pair of type ℓ is active. The reserve ratio increase due to the UI contributions. Indeed, the firm has only one job, which is either filled or unfilled. Furthermore, the firm always prefers recalls over new hires to save hiring costs. It follows that the firm can not be charged the UI benefits of previous employees while being matched with another employees[16]. The firm-worker pair of type ℓ then becomes of type $\ell' = \max(\ell + 1, L)$ with probability $\psi(p, \ell, n)$. The higher the firm-worker type, the lower the tax rate.

2 The firm-worker pair of type ℓ is inactive and the laid-off employee collects UI benefits. The contributions raise the reserve ratio while UI benefits charged to the firms reduce it. As the latter always exceed the former[17] the reserve ratio decreases and the firm-worker pair of type ℓ becomes of type $\ell' = \min(\ell - 1, 1)$ with probability $\psi(p, \ell, r)$.

3 The firm-worker pair of type ℓ is inactive and the laid-off employee does not collect UI benefits. This case is similar to the first one. The firm still pays the tax to the UI as long as the job exists but no new benefits are charged. The firm-worker pair of type ℓ becomes of type $\ell' = \max(\ell + 1, L)$ with probability $\psi(p, \ell, n)$.

$\psi(p, \ell, \nu)$ governs the pace at which the firm-worker pair switches type and how quickly the payroll tax adjusts to the firm's layoff history. It is a proxy for the slope of the tax schedule. With probability $\psi(p, \ell, n)$ the type increases ($\ell' > \ell$), leading to a lower tax rate. This occurs in active pairs or inactive pairs when no unemployment benefits are collected. On the opposite, $\psi(p, \ell, r)$ defines the pace at which the type decreases ($\ell' < \ell$) in inactive matches with an UI recipient. This modeling of ER allows us to track the layoff history of firms. As for the tax rate $\tau(p, \ell)$ the transition rates depend on the aggregate productivity p (macro ER) and the firm-worker type ℓ (micro ER). The steeper the tax schedule, the faster the switch from type ℓ to ℓ'. A firm with type $\ell \leq \underline{\ell}$ and $\ell \geq \overline{\ell}$ are at the maximum rate and the minimum rate, respectively. $\underline{\ell}$ and $\overline{\ell}$ define the interval between which the tax is experience-rated. Due to the finite number of type we impose $\psi(p, L, n) = 0$ and $\psi(p, 1, r) = 0$.

In the case of a recall, the inactive firm-worker pair previously of type ℓ restarts an employment relationship of type ℓ. In case of a new job, a new firm-worker pair of type $M \in [1, L]$ is formed. The previous relation is forever

[16]If the attached unemployed worker finds a new job, the old relation no longer exists.

[17]We show in the appendix that this result holds for all admissible values of the tax schedule and UI replacement rate in the case of one firm-one worker setup.

destroyed. This type-M job characterizes new matches for which the "new employer rate" applies $\tau(p, M)$. The taxable wage base is $\overline{w}$.

4.3 Matching technology and match acceptance

The search process and recruiting activities are costly and time-consuming for both, the firms and the workers. All unemployed workers are engaged in the search process but with different search intensity s. Firms searching for a worker to fill their vacant job incurs a cost $c_v > 0$ per vacancy. Let $u \geq 0$ be the aggregate number of unemployed workers and $v \geq 0$ the mass of vacancies. The number of matches is given by the matching function

$$m(su, v) \leq \min(su, v) \tag{4}$$

The matching function is increasing and concave in its two arguments and homogenous of degree one. A vacancy is filled with probability q and an unemployed worker finds a job with probability ϕ. One has:

$$q = m(su, v)/v \tag{5}$$

$$\phi = m(su, v)/(su) \tag{6}$$

It should be stressed that these two probabilities only depend on the aggregate productivity: $\phi(p)$ and $q(p)$. The labor force is assumed to be constant over time and normalized at 1.

We denote by $J(p, \varepsilon, \ell)$, $V(p, \varepsilon, \ell, \nu)$, $W(p, \varepsilon, \ell)$ and $U(p, \varepsilon, \ell, \nu)$ the value of a filled job for the firm, an attached vacant job for the firm, an employed worker and an attached unemployed worker, respectively. The value functions depend on: the aggregate productivity p, the idiosyncratic productivity ε, the type ℓ determining the payroll tax level and the UI status (for inactive matches). For unattached economic agents, let $V_0(p)$ and $U_0(p, \nu)$ be the value of a vacant job and an unemployed worker, respectively.

We now define four conditions that determine if the match is active, inactive (production suspended), destroyed and how recall is accepted. Since the firm-worker pair does not know what UI status will prevail if the separation occurs, the optimal decisions are based on the expected value of a job:

$$\widetilde{X}(p, \varepsilon, \ell) = \varphi X(p, \varepsilon, \ell, r) + (1 - \varphi) X(p, \varepsilon, \ell, n), \quad X = U, V$$

For the sake of exposition, we define the following intermediary variables corresponding to the optimal decisions of the firm and the worker in active and in inactive jobs:

$$\begin{aligned}
\Lambda(p, \varepsilon, \ell, \nu) &= \max[J(p, \varepsilon, \ell), V(p, \varepsilon, \ell, \nu)] \\
\widetilde{\Lambda}(p, \varepsilon, \ell) &= \max[J(p, \varepsilon, \ell), \widetilde{V}(p, \varepsilon, \ell)] \\
\Gamma(p, \varepsilon, \ell, \nu) &= \max[W(p, \varepsilon, \ell), U(p, \varepsilon, \ell, \nu)] \\
\widetilde{\Gamma}(p, \varepsilon, \ell) &= \max[W(p, \varepsilon, \ell), \widetilde{U}(p, \varepsilon, \ell)]
\end{aligned}$$

The four conditions are:

(i) A firm-worker pair is active if:

$$\begin{array}{lll} \text{Worker:} & W(p,\varepsilon,\ell) & > & \max[\widetilde{U}(p,\varepsilon,\ell),\widetilde{U}_0(p)] \\ \text{Firm:} & J(p,\varepsilon,\ell) & > & \max[\widetilde{V}(p,\varepsilon,\ell),V_0(p)] \end{array}$$

It should be stressed that the two conditions must be satisfied for keeping the match active. Otherwise, the firm or the worker decides unilaterally to end the relation *i.e.* the job becomes inactive or is destroyed.

(ii) An active firm-worker pair is destroyed if:

$$\begin{array}{llll} \text{Worker:} & \widetilde{U}_0(p) & \geq & \widetilde{\Gamma}(p,\varepsilon,\ell) \\ \text{Firm:} & V_0(p) & \geq & \widetilde{\Lambda}(p,\varepsilon,\ell) \end{array}$$

If one of the two conditions is satisfied, the job is permanently destroyed.

(iii) An inactive firm-worker pair is destroyed if:

$$\begin{array}{llll} \text{Worker:} & U_0(p,\nu) & \geq & \Gamma(p,\varepsilon,\ell,\nu) \\ \text{Firm:} & V_0(p) & \geq & \Lambda(p,\varepsilon,\ell,\nu) \end{array}$$

If one of the two conditions is satisfied the job is permanently destroyed. Note that the above conditions depend on whether the unemployed worker collects UI benefits or not.

(iv) An unemployed worker that belongs to an inactive pair has a recall option $U(p,\varepsilon,\ell,\nu)$ but also searches for a new job. In case of a new contact (matching), the unemployed worker decides whether she accepts or turns down the offer. We have the following acceptance conditions:

$$W(p,\varepsilon',M) > \max[U(p,\varepsilon,\ell,\nu),U(p,\varepsilon',M,\nu)]$$

The probability that a new match is accepted for the worker is defined as:

$$a(p,\varepsilon,\ell,\nu) = \int \mathbb{1}\{W(p,\varepsilon',M) > \max[U(p,\varepsilon',M,\nu),U(p,\varepsilon,\ell,\nu)]\}dF(\varepsilon') \quad (7)$$

Lastly, the expected gain of searching for a job, conditional on having contact with a vacant job, of a worker who has a recall option is:

$$\begin{aligned} \Omega(p,\varepsilon,\ell,\nu) \;=\; & \int \mathbb{1}\{W(p,\varepsilon',M) \geq U(p,\varepsilon',M,\nu)\} \times \\ & \left\{ \max[W(p,\varepsilon',M),U(p,\varepsilon,\ell,\nu)] - U(p,\varepsilon,\ell,\nu) \right\} dF(\varepsilon') \end{aligned} \quad (8)$$

Equation (8) defines the expected gain of a new job given the recall option of the worker. If the new job involves lower returns than that of the recall option, the worker is better off as unemployed and refuses the new job opportunity.

4.4 Bellman equations

We now describe the value functions. The expected value for a firm with a filled job is given by the following Bellman equation:

$$\begin{aligned} rJ(p,\varepsilon,\ell) &= \max\Big\{p\varepsilon - w(p,\varepsilon,\ell) - \tau(p,\ell)\overline{w} + \lambda_p \int \Big(\widetilde{\Lambda}(p',\varepsilon,\ell) - J(p,\varepsilon,\ell)\Big)dP(p'|p) \\ &+ \lambda_\varepsilon\Big[\delta V_0(p) + (1-\delta)\int\Big(\widetilde{\Lambda}(p,\varepsilon',\ell) - J(p,\varepsilon,\ell)\Big)dG(\varepsilon'|\varepsilon)\Big] \\ &+ \psi(p,\ell,n)[\widetilde{\Lambda}(p,\varepsilon,\ell') - J(p,\varepsilon,\ell)],\ rV_0(p)\Big\} \end{aligned} \tag{9}$$

$p\varepsilon$ is the worker's productivity and $w(p,\varepsilon,\ell)$ is the wage rate. The expected value gives rise to three possibilities. First, at rate λ_p the job is hit by an aggregate productivity shock, leading to a temporary separation if the new value of the firm is lower than the value of a vacancy. Second, with arrival rate λ_ε the job is hit by an idiosyncratic productivity shock. The job is permanently destroyed with an exogenous probability δ. With probability $1-\delta$, a new individual productivity is drawn from $G(.)$, involving a separation if the job value falls below that of a vacant job. Lastly, the job switches type at rate $\psi(p,\ell,n)$. The new type is $\ell' = \min(\ell+1, L)$. Note that the endogenous job destruction occurs if the value of the filled-job falls below that of an unattached vacant job. In this case, the employment relation ceases permanently.

The value of a firm with a vacant job is somewhat more cumbersome due to the recall option and the UI status of the attached unemployed. It writes as follows:

$$\begin{aligned} rV(p,\varepsilon,\ell,\nu) &= \max\Big\{-\tau(p,\ell)\overline{w} + \lambda_p\int\Big(\Lambda(p',\varepsilon,\ell,\nu) - V(p,\varepsilon,\ell,\nu)\Big)dP(p'|p) \\ &+ \lambda_\varepsilon\Big[\delta V_0(p) + (1-\delta)\int\Big(\Lambda(p,\varepsilon',\ell,\nu) - V(p,\varepsilon,\ell,\nu)\Big)dG(\varepsilon'|\varepsilon)\Big] \\ &+ \psi(p,\ell,\nu)[\Lambda(p,\varepsilon,\ell',\nu) - V(p,\varepsilon,\ell,\nu)] \\ &+ \pi(p,\nu)(\Lambda(p,\varepsilon,\ell,\nu') - V(p,\varepsilon,\ell,\nu)) \\ &+ \phi(p)s(p,\varepsilon,\ell,\nu)a(p,\varepsilon,\ell,\nu)[V_0(p) - V(p,\varepsilon,\ell,\nu)],\ rV_0(p)\Big\} \end{aligned} \tag{10}$$

As shown by the first term on the right-hand side of Equation (10), the firm pays the mandatory UI contributions[18]. The aggregate and the individual component of productivity vary over time. In case of a favorable change,

[18] Although no worker is producing, we assume that inactive firms are assessed the UI payroll tax based on the constant taxable wage. This assumption allows us to capture in a simple

the suspended job can be reactivated. As long as the firm is attached to the worker, the reserve ratio continues to evolve. The firm-worker pair switches type, depending on the UI status of the unemployed worker. If the worker is UI recipient, the type decreases from ℓ to $\ell' = \min(\ell - 1, 1)$ with probability $\psi(p, \ell, r)$. On the contrary, the firm-worker type follows the reverse path with probability $\psi(p, \ell, n)$ and the type switches from ℓ to $\ell' = \max(\ell + 1, L)$. These shifts feedback on the payroll tax which, in turn, affects the value of the suspended job. The later the recall decision is taken, the more likely is the increase in the tax. Following a change in type, a recall decision can be made, provided that the value of the filled job is higher than the value of the corresponding suspended job. UI benefits exhaust at rate $\pi(p, \nu)$, thereby modifying the expected gains from the suspended job. If UI benefits are exhausted the type increases since no new benefits are charged and the firm pays the UI tax.

The last term on the right-hand side of Equation (10) determines the cost associated with the loss of the recall option. It might occur if the unemployed worker finds a new job at rate $\phi(p)$ and accepts it with probability $a(p, \varepsilon, \ell, \nu)$. The gains of an unemployed worker searching for a job is $\Omega(p, \varepsilon, \ell, \nu)$. In this case, the value of a vacant job becomes $V_0(p)$ (determined later). The inactive job may be forever destroyed if its value falls below that of an unattached vacant job. This is more likely to be the case through the increase in the tax.

The value of an employed worker is defined as follows:

$$
\begin{aligned}
rW(p,\varepsilon,\ell) \quad &= \quad \max\Big\{ w(p,\varepsilon,\ell) + \lambda_p \int \Big(\widetilde{\Gamma}(p,\varepsilon,\ell) - W(p,\varepsilon,\ell)\Big) dP(p'|p) \\
&+ \quad \lambda_\varepsilon \Big[\delta \widetilde{U}_0(p,\nu) + (1-\delta) \int \Big(\widetilde{\Gamma}(p,\varepsilon',\ell) \; - W(p,\varepsilon,\ell)\Big) dG(\varepsilon'|\varepsilon)\Big] \qquad (11) \\
&+ \quad \psi(p,\ell,n)\big[\widetilde{\Gamma}(p,\varepsilon,\ell') - W(p,\varepsilon,\ell)\big], \; \widetilde{U}_0(p)\Big\}
\end{aligned}
$$

As for the firm, the job is hit by an aggregate productivity shock at rate λ_p, an idiosyncratic productivity shock at rate λ_ε or a change in type at rate $\psi(p, \ell, n)$. The employment relationship ceases permanently at rate δ or if the employed value function decreases below the expected value of an unattached unemployed worker $\widetilde{U}_0(p)$.

The value function for an unemployed worker writes:

manner the incentive of ER in our one-firm/one-worker setup. A more complex framework with the notion of firm size distribution as in Ratner (2013) is certainly a good candidate to take into account the effect of ER on the remaining employees. However, this is a highly complex task if we want to model recall decisions, the ER system and the heterogenous UI status. We prefer to keep the model tractable and sufficient interpretable. The model captures the effects of ER. In addition, we show that our model is able to replicate several stylized facts regarding firms and ER.

$$
\begin{aligned}
rU(p,\varepsilon,\ell,\nu) &= \max\Bigg\{\max_{s(p,\varepsilon,\ell,\nu)}\Bigg[b(\nu)+h-k(s(p,\varepsilon,\ell,\nu)) \\
&+ \lambda_p\int \Gamma(p',\varepsilon,\ell,\nu)-U(p,\varepsilon,\ell,\nu)dP(p'|p) \\
&+ \lambda_\varepsilon\Bigg(\delta U_0(p,\nu)+(1-\delta)\int\Gamma(p,\varepsilon',\ell,\nu)\,dG(\varepsilon'|\varepsilon)-U(p,\varepsilon,\ell,\nu)\Bigg) \\
&+ \psi(p,\ell,\nu)[\Gamma(p,\varepsilon,\ell',\nu)-U(p,\varepsilon,\ell,\nu)] \qquad (12)\\
&+ \pi(p,\nu)(\Gamma(p,\varepsilon,\ell,\nu')-U(p,\varepsilon,\ell,\nu)) \\
&+ \phi(p)s(p,\varepsilon,\ell,\nu)\Omega(p,\varepsilon,\ell,\nu)\Bigg],U_0(p,\nu)\Bigg\}
\end{aligned}
$$

where h is home production. The unemployed worker decides her optimal search effort s given the search cost function $k(s)$ with $k'(s)>0$ and $k''(s)\geq 0$, the expected gain of searching and her recall option. The optimal search decision is given by: $k'(s)=\phi\Omega$. The recall may occur either if the worker switches type or if a positive productivity (idiosyncratic or aggregate) shock hits the job. With probability $\pi(p,\nu)$ the worker changes UI status.

An unattached unemployed worker has the following value function:

$$
\begin{aligned}
rU_0(p,\nu) &= \max_{s_0(p,\nu)}\Bigg[b(\nu)+h-k(s_0(p,\nu))+\lambda_p\int U_0(p',\nu)-U_0(p,\nu)dP(p'|p) \\
&+ \pi(p,\nu)(U_0(p,\nu')-U_0(p,\nu))+\phi(p)s(p,\nu)\Omega_0(p,\nu)\Bigg] \qquad (13)
\end{aligned}
$$

As for an attached unemployed worker, the present value is equal to the sum of UI benefits and home production. Change in aggregate productivity may affect the value function through the change in UI benefits duration $\pi(p,\nu)$ and the change in the job-finding rate $\phi(p)$. $\Omega_0(p,\nu)$ defines the expected gain of a new job given the outside option of the worker and is defined by:

$$
\begin{aligned}
\Omega_0(p,\nu) &= \int \mathbb{1}\{W(p,\varepsilon',M)\geq U(p,\varepsilon',M,\nu)\}\ \times \qquad (14)\\
&\Bigg\{\max[W(p,\varepsilon',M),U_0(p,\nu)]-U_0(p,\nu)\Bigg\}dF(\varepsilon')
\end{aligned}
$$

4.5 Job creation condition

The value of a new vacancy is given by:

$$
rV_0(p) = q(p)\int \mathbb{1}\{J(p,\varepsilon',M)\geq \widetilde{V}(p,\varepsilon',M)\}[J(p,\varepsilon',M)-V_0(p)]dF(\varepsilon')-c_v
$$

For a new job, there is no layoff history and then no ER tax. IThe type is $M \in [1, L]$. A job is created only when the value of a filled job is higher than the value of a vacancy. The free entry condition $V_0(p) = 0$ implies:

$$\frac{c_v}{q(p)} = \int \mathbb{1}\{J(p, \varepsilon', M) \geq \widetilde{V}(p, \varepsilon', M)\} J(p, \varepsilon', M) dF(\varepsilon') \quad (15)$$

This is the standard job creation condition. This condition shows that the expected gain from hiring a new worker is equal to the average cost of search which is the marginal cost of a vacancy c_v times the average duration of a vacancy $1/q(p)$.

4.6 Wage negotiation

We follow Moyen & Stahler (2014) to set wages. They are determined through a Nash bargaining process between the firm and a union that maximizes the gain of its members from employment over unemployment. The idea is that all workers belong to the same union that seeks to maximize the employment surplus[19]. Since employed workers do not know what will be their UI status before the separation takes place, the outside option for firms and workers is a weighted sum of the value of vacancies $\widetilde{V}(p, \varepsilon, \ell)$ and unemployment $\widetilde{U}(p, \varepsilon, \ell)$ respectively. The outcome of the bargaining process is given by the solution of the following maximization problem:

$$\max_{w(p,\varepsilon,\ell)} \left(J(p, \varepsilon, \ell) - \widetilde{V}(p, \varepsilon, \ell)\right)^{1-\beta} (W(p, \varepsilon, \ell) - \widetilde{U}(p, \varepsilon, \ell))^{\beta}$$

where $\beta \in [0, 1]$ and $1 - \beta$ denote the firms' and workers' bargaining powers respectively. The optimality condition of the above problem is given by[20]:

$$\beta(J(p, \varepsilon, \ell) - \widetilde{V}(p, \varepsilon, \ell)) = (1 - \beta)(W(p, \varepsilon, \ell) - \widetilde{U}(p, \varepsilon, \ell)) \quad (16)$$

4.7 UI budget

In the short-run, the UI benefits may outweigh contributions collected because ER smoothes the benefits charged to the firm. Consequently, the firm does not pay the current UI costs of layoffs. This situation refers to the *imperfect*

[19] The standard approach is that wages are bargained between firms and each individual worker which, in our case, involves a two-tier wage structure because the fallback position of the workers is different. However, one also needs to specify a two-tier wage structure for attached and non-attached workers which would make the model very complex.

[20] Due to the complexity of the wage structure, we report the calculation in the separate appendix.

experience rating described by Feldstein (1976) and others. For simplicity, we assume that a lump-sum tax $T(p)$ balances the UI budget every period:

$$T(p) = u_0(p,r)b + \sum_{\ell=1}^{L} \left[\int \left(u(p,\varepsilon,\ell,r)b - n(p,\varepsilon,\ell)\overline{w}\tau(p,\ell) \right) d\varepsilon \right] \tag{17}$$

$n(p,\varepsilon,\ell)$ is employment. $u_0(p,r)$ defines the pool of UI recipients not attached and $u(p,\varepsilon,\ell,r)$ the pool of UI recipients attached to a firm. Due to the complex structure of the distribution of workers, we report the law motion of employment and unemployment in the supplementary appendix.

5 Quantitative analysis

5.1 Functional forms

We consider a standard Cobb-Douglas matching function:

$$m(u,v) = \mu(s\,u)^{1-\alpha}v^{\alpha}$$

with μ the matching efficiency and α the elasticity of the matching function with respect to vacancies. We use a search intensity function that ensures that the search intensity level is between 0 and 1. We assume that the search intensity represents the fraction of time devoted to job search.

$$k(s) = \frac{c_0}{1+\xi} \left[(1-s)^{-(1+\xi)} - 1 \right] - c_0\,s$$

where c_0 and ξ are parameters.

5.2 Calibration strategy

5.2.1 Productivity

The model is calibrated at weekly frequencies. We set the steady-state interest rate r to 0.1%, which corresponds to a 5% annual rate. The aggregate shock p and the individual shock ε evolve according to an order-one autoregressive process with persistence ρ_p and ρ_ε respectively. Their mean is set to one and their respective standard deviation is σ_p, and σ_ε. The two processes are discretized using the Rouwenhorst method with 21 grid points for the aggregate shock and 49 grid points for the individual shock. We follow Fujita & Moscarini (2017) to set the values of λ_ε, λ_p, ρ_ε, ρ_p, and σ_ε. The standard deviation of the aggregate shock is set to $\sigma_p = 0.015$, a value higher than the one picked by the authors. We pin down this value to make the model able to generate enough variations in unemployment in order to perform the counterfactual simulations. We do not focus on the standard deviation of the average labor productivity. In case of a new match, the individual productivity ε' is drawn from $F(\varepsilon')$, which does not depend on past productivity. We assume that ε' is drawn from a uniform distribution.

5.2.2 Labor market, stocks and flows

We impose $\alpha = 0.5$ and $\beta = 1 - \alpha$ as it is standard in the literature to impose the Hosios condition to be satisfied. As in Fujita & Moscarini (2017) the exogenous job destruction rate is set to $\delta = 0.0004$. The rest of the parameters are pin down to match empirical targets. Our strategy is somewhat different than that of Fujita & Moscarini (2017). In particular, we target seven first-order moments displayed in Table 3: the total unemployment rate, the insured unemployment rate, the temporary layoff rate, the total job-finding rate, the total separation rate, the recall share of the UI recipients and the recall share of the UI nonrecipients.

Table 3: LONG-RUN LEVELS

	Data	Model
Total unemployment rate	5.40	5.13
Insured unemployment rate	2.35	2.86
Temporary layoff / unemployed	25.02	34.68
Total job-finding rate	27.70	24.88
Total job separation rate	1.40	1.57
Recall share	46.70	51.45
- UI recipients	51.00	60.38
- UI nonrecipients	35.00	33.73

In the column Model, unconditional means are displayed.

The steady-state u is 5.4% on average over the last three decades, while the insured unemployment rate is equal to 2.35%. From the CPS, temporary layoffs represent one quarter of total unemployment. The employment to unemployment flows is 1.4% per month using SIPP. The total job-finding rate is around 27%, 14% for new matches and 13% for recalls. We use the recall shares displayed in Table 1 (51% for UI recipients and 35% for nonrecipients). We use a root finding procedure to calibrate the seven remaining parameters: μ, c_0, ξ, φ, c_v, λ_ε and h. The calibrated parameters are presented in Table 4. The model involves a matching efficiency close to that of Fujita & Moscarini (2017). The rate φ is found to be equal to one. However, together with the probability of benefits exhaustion, the model matches correctly the insured unemployment rate. The cost of posting a vacancy is somewhat above the value found by the authors but remains within the range of values used in the calibration of search and matching models. We also obtain an arrival rate of idiosyncratic shock slightly higher than Fujita & Moscarini (2017). They arrive on average slightly more than once a month. Lastly, the value of the home production, together with the level of benefits (b) explained later, involve a ratio of non-market activities over the labor productivity equal to 0.6, a value in the lower range of those used in the literature (see Hagedorn & Manovskii (2008) and Hall & Milgrom (2008)).

Table 4: CALIBRATION MODEL'S PARAMETERS

Variables	Symbol	Value
Real interest rate	r	0.001
Arrival rate of aggregate shock	λ_p	0.08
Autocorr. coefficient	ρ_p	0.974
Std. of p_t	σ_p	0.01
Arrival rate of idiosyncratic shock*	λ_ε	0.31
Autocorr. coefficient	ρ_ε	0.974
Std. of ε_t	σ_ε	0.035
Exogenous Separation rate	δ	0.0004
Vacancy posting costs*	c_v	0.85
Home production*	h	0.10
Matching elasticity	α	0.50
Worker bargaining power	β	0.50
Matching efficiency*	μ	0.08
Search cost scale*	c_0	0.7
Search cost curvature*	ξ	0.3
Taxable wage base	$\bar{w}$	0.40
Unemployment benefits	b	0.50
Fraction of UI recipients separation*	φ	1.00

Parameters with $*$ are pin down to match long-run values of selected variables

5.2.3 The UI

Workers' side. The level of unemployment benefits b is pinned down to match the average replacement rate, which is the proportion of workers wages replaced by UI benefits. The majority of states benefit formulas stipulate that around 50% of the unemployed worker's wages be replaced. Given that the average wage is equal to one, one has $b = 0.5$. To parameterize the rate at which benefits exhaust $\pi(p, \nu)$, we target the evolution of the maximum benefits duration during the Great Recession. As mentioned in Section 3, the maximum benefits duration is 26 weeks in normal times and may increase up to 99 weeks, depending on the total or the insured unemployment rate. Chodorow-Reich et al. (2019) introduce an explicit formulation for the duration of UI benefits. They consider four durations (in weeks). Denote by u_t the total unemployment rate, their formula is:

$$\text{UI benefit duration} = \begin{cases} 26, & \text{if } u_t < 6.5\% \\ 39, & \text{if } 6.5\% \leq u_t < 8\% \\ 52, & \text{if } 8\% \leq u_t < 9\% \\ 86.6, & \text{if } u_t \geq 9\% \end{cases}$$

However, unlike them, we do not condition the duration to the unemployment rate. Instead, $\pi(p, \nu)$ depends on the aggregate productivity as in Mitman & Rabinovich (2015). We adapt the above expression and determine $\hat{p}_i \in \boldsymbol{p}$, $i = 1, ..., 3$, the three thresholds of aggregate productivity below which the benefits duration changes. Formally, we have:

$$\frac{1}{\pi(p, r)} = \begin{cases} 26, & \text{if } p > \hat{p}_3 \\ 39, & \text{if } \hat{p}_3 \leq p < \hat{p}_2 \\ 52, & \text{if } \hat{p}_2 \leq p < \hat{p}_1 \\ 86.6, & \text{if } p \geq \hat{p}_1 \end{cases} \tag{18}$$

Note that $\pi(p, n) = 0$. We calibrate $\hat{p}_i$ to match the observed increase in the maximum benefits duration during the Great Recession by simulating the model with the aggregate productivity shock. We do so by solving for the path of the aggregate shock that makes the simulated series of the unemployment rate from the model as close as possible to the observed one. Given the path of the aggregate shock, we compute the duration $\pi(p, r)$ from Equation (18) and compare it to the observed UI benefits duration. We adjust $\hat{p}_i$ until the simulated duration matches the observed one. This result is reported in Section 5.

Firms' side. Calibrating the ER system is a difficult task because the states of the US apply different ER methods. In addition, we model ER with stochastic type switching as an approximation for the current reserve ratio system. To discipline the choice of the UI parameters, our strategy is to match moments of selected variables using data provided by the Experience Rating Report from the Department of Labor, Employment and Training Administration[21]. This aggregate data set provides (*i*) the average tax rates, (*ii*) the distribution of

[21] See appendix A of the supplementary appendix for more detail.

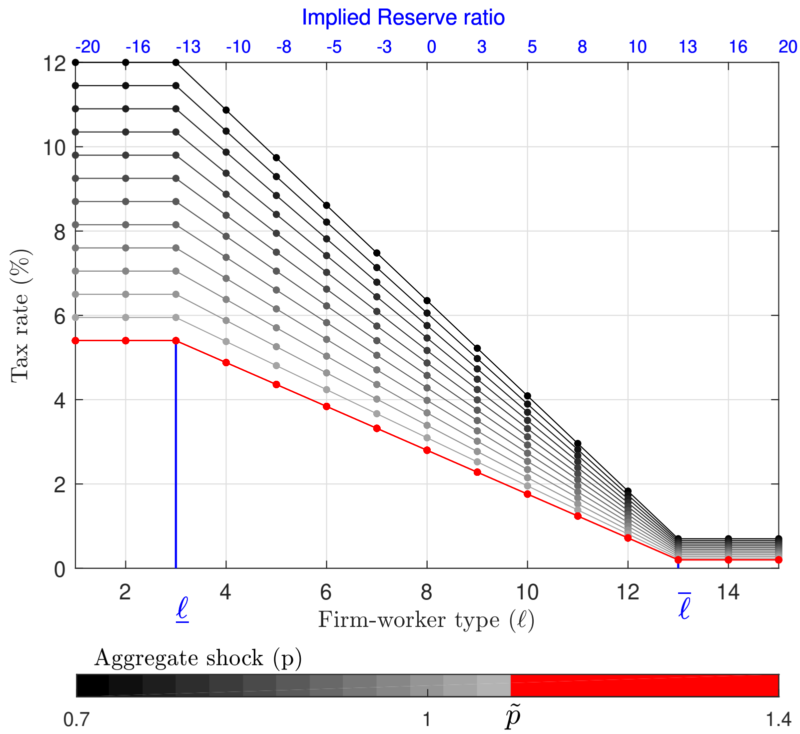
taxable payrolls, (*iii*) the distribution of total payrolls, (*iv*) the distribution of benefits charged and (*v*) the distribution of total contributions as a function of the level of the reserve ratio. For instance, for (i), the data gives the average tax rate levied on employers with a reserve ratio between 0 and 1%, between 1% and 2%, etc. For (ii), it provides the fraction of the taxable wages that belongs to each reserve ratio category. These statistics are useful to evaluate the model's ability to reproduce an "aggregate" ER system. The distributions are available for each state of the U.S. and from 1998 onward on a yearly basis. Our objective is to reproduce these targets using UI parameters.

The UI is characterized by: the tax schedule $\tau(p, \ell)$, the transition rates $\psi(p, \ell, n)$, the taxable wage base $\bar{w}$, the new employer type M. The number of parameters being huge, we need to impose some restrictions to avoid over-identification issues. To begin, we consider $L = 15$ types or reserve ratio levels. In the data, the range of reserve ratio is split into 70 levels. We then group these levels so as to get 15 levels. We summarize the tax schedule $\tau(p, \ell)$ by seven parameters:

- $\tau_{\min}(\underline{p})$ the minimum tax rate in the worse aggregate state
- $\tau_{\min}(\overline{p})$ the minimum tax rate in the best aggregate state
- $\tau_{\max}(\underline{p})$ the maximum tax rate in the worse aggregate state
- $\tau_{\max}(\overline{p})$ the maximum tax rate in the best aggregate state
- $\underline{\ell}$ the threshold type at and below which the tax rate is equal to the maximum rate
- $\overline{\ell}$ the threshold type at and above which the tax rate is equal to the minimum rate
- $\widetilde{p}$ the threshold aggregate productivity above which no shift in the tax schedule occurs.

When $\ell \in]\underline{\ell}, \overline{\ell}[$ the tax is experience-rated in the sense that the marginal tax cost is not zero. Otherwise, the tax is located on one of the two statutory rates. We set the bounds so as to match the range of experience-rated taxes over the reserve ratio levels from the data. To capture the observed stability of the tax schedule in good times (see Figure 1), we assume that the tax schedule does not shift when $p \geq \widetilde{p}$. Then, for $p \in [\widetilde{p}, \overline{p}]$, $\tau_{\max}(p) = \tau_{\max}(\widetilde{p})$ and $\tau_{\min}(p) = \tau_{\min}(\widetilde{p})$. Intermediate values of the tax rate, that is $p \in]\tau_{\min}, \widetilde{p}[$, are assumed to be equidistant between the lowest and the highest rate. We can then express the entire tax schedule based on these seven parameters. We set the value for the first four parameters and use the three last ones as well as the taxable wage base $\overline{w}$ to match the distributions (*i*)-(*v*). In the data, the minimum rate across states and over times ranges from 0.2% to 0.7%. The maximum rate ranges from 5.4% to 12%. We take these values to set $\tau_{\min}(\underline{p})$, $\tau_{\min}(\overline{p})$, $\tau_{\max}(\underline{p})$ and $\tau_{\max}(\overline{p})$ respectively. Figure 2 depicts the tax schedule. The new employer tax rate is located at the zero reserve ratio level, that is $M = 8$.

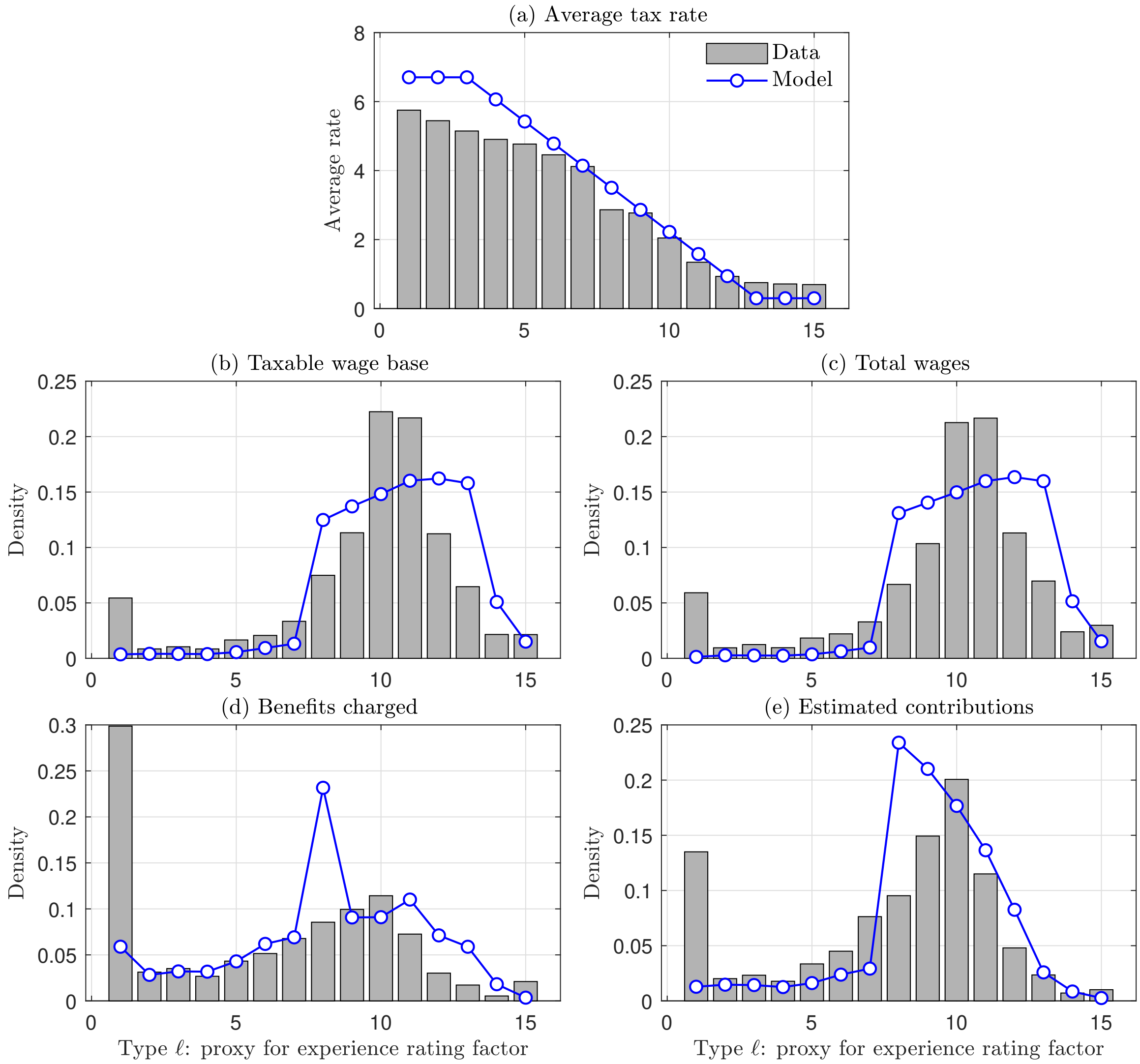
Figure 2: Tax schedule.



The calibration of the transition probabilities $\psi(p, \ell, \nu)$ is more complex and difficult to expose here without deriving several formulas. For the sake of presentation, we report these formulas in the supplementary appendix. The general idea is that we simulate individual firm trajectories in the original reserve ratio method described by Equations (1) to (3) and estimate the transition probabilities $\psi(p, \ell, \nu)$ so as to make the variation in the tax rate from the model with types as close as possible to that with the original reserve ratio representation.

Figure 3 shows the distributions (*i*) to (*iv*) from the data and from the model's simulation. The model produces consistent average tax rate over the different reserve ratio levels (Panel a). As for the tax schedule, the left and the right of the reserve ratio spectrum corresponds to the statutory rates. The minimum rate is well identified and constant when $\ell \geq \overline{\ell}$. For low types, the maximum rate seems not stable as we could have expected. However, it should be noted that this corresponds to an average rate and the states apply different maximum rate. It is then possible that there are more heterogeneities in the maximum rate among states than at the minimum rate. Except for extremely low reserve ratio levels, the model does a very good job at matching the concentration of the taxable and the total payroll (Panels b and c). The same is true for the flows of benefits and contributions (Panels d and e). In the data, most firms are located on the right side of the zero reserve ratio. They are assessed a tax rate lower than the new employer rate. The model underestimates the concentration of the variables for extremely low reserve ratio levels.

Figure 3: Experience rating and firms distribution.



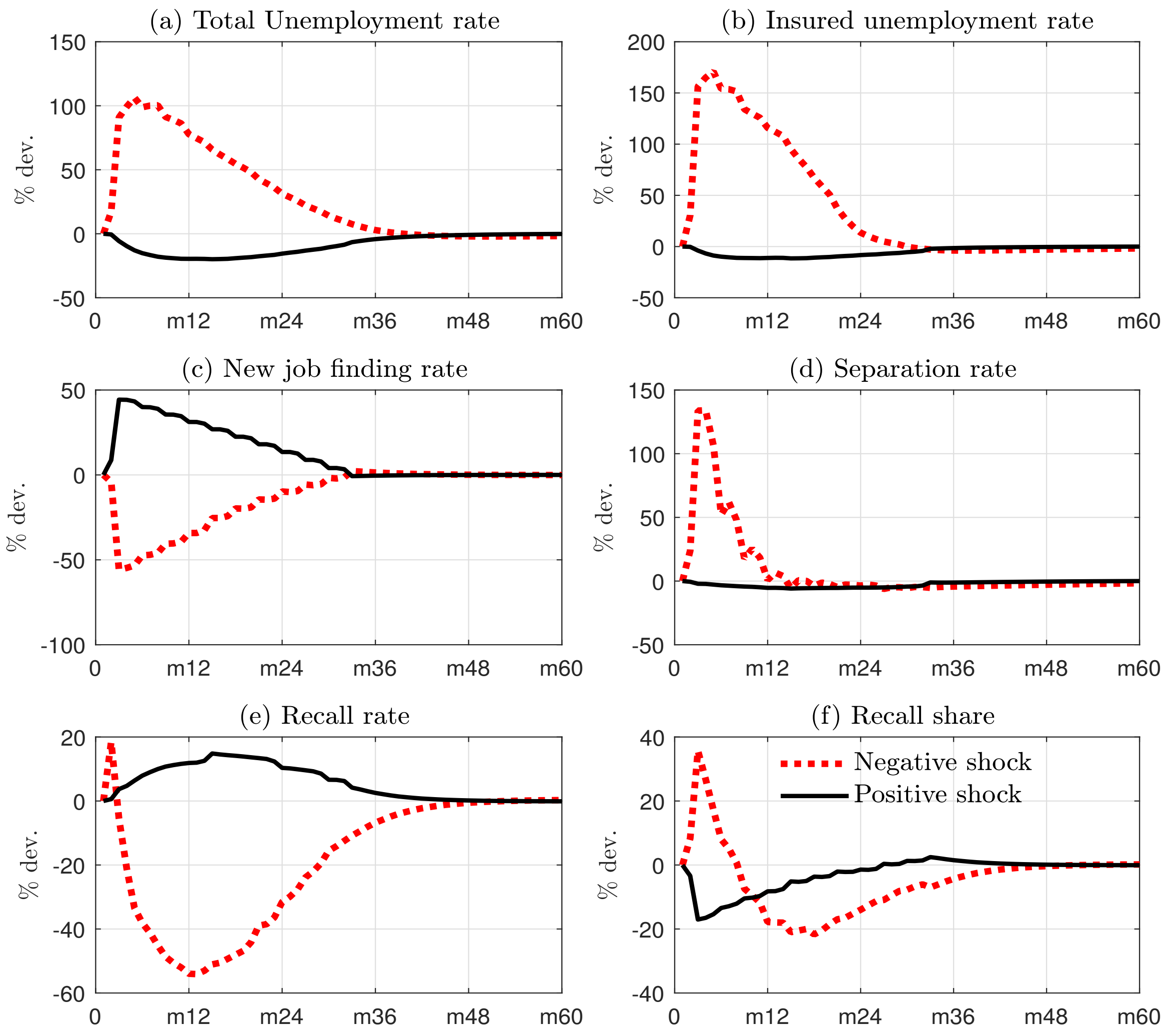
Data extracted from the Experience Rating Report ETA204 published by the Department of Labor, Employment and Training Administration. `https://oui.doleta.gov/unemploy/DataDownloads.asp`

5.3 Impulse response function

We investigate how the model behaves over the business cycle. Figure 4 displays the impulse response functions to a negative (red dashed line) and to a positive (black solid line) aggregate productivity shock. The size of the negative shock is set to match the increase in the total unemployment rate of 100%, which is equivalent to the observed increase during the Great Recession. The positive shock is of the same magnitude.

The model involves strong non-linearities. Unemployment increases more during the recession scenario than it decreases during the expansion scenario. Starting from an initial rate of around 5%, unemployment double following a negative shock while it falls by 20% when the shock is positive (Panel a). The non-linearity is even stronger for the insured unemployment rate. The asymmetric behavior of unemployment echoes to Hairault et al. (2010) who point out the adjustment of the job-finding rate. The authors show that the total job-finding rate declines more after an adverse shock than it increases after a positive shock. In our model, the response of the job-finding rate is nonlinear but it does not solely explain the asymmetries. The separation rate (Panel d) contributes to the surge in unemployment in the short-run. In addition, the recall rate (panel c) falls more upon the recessionary shock than it increases after a positive shock. The downward adjustment of the recall rate is highly persistent, which causes unemployment to linger. The recall share increases on impact following a negative shock, meaning that recalls do not decline as much as new matches in the short-run. This observation is consistent with the counter-cyclical behavior of the recall share found in Fujita & Moscarini (2017). The burst in the recall share is short-lived, involving that the recall opportunities decline quickly as time goes by.

Figure 4: Impulse response function

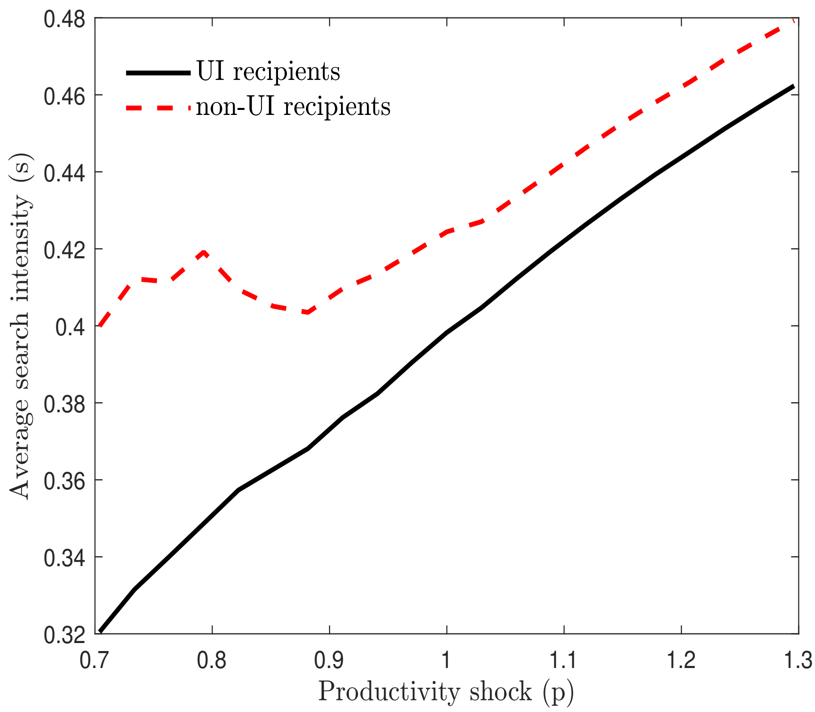


The positive and the negative shock have the same magnitude. The path of the shock adjusts according to the transition matrix $P(p'|p)$ given the arrival rate of aggregate shock λ_{ε}.

As shown previously, the long-run level of the recall share is significantly higher for UI recipients than for nonrecipients. How does the UI status shape the adjustment of recalls along the business cycle? Figure 6 shows that the qualitative adjustment of the variables is roughly similar following a positive productivity shock. On the contrary, the recall share of the recipients increases following a negative shock while it declines for the nonrecipients. The total recall share then hides major differences in the dynamics of recall shares by UI status. The total recall share seems driven by the recall share of the recipients.

What accounts for the difference? In our model, two channels affect the recall decisions: (i) the search intensity and (ii) the ER system. UI recipients have a lower incentive to search for a new job (see Figure 5). This effect is widely documented in the literature since the seminal work of McCall (1970) and Mortensen et al. (1970). From (i), a lower search intensity decreases the exit rate to a new job. This effect is reinforced by the unemployment benefit extensions which increases the gap in search intensity between the two. From (ii), the ER system makes firms more prone to recall UI recipients in order to avoid the increase in future taxes. Consequently, the two effects would play in the same direction. To identify the contribution of each channel in shaping the adjustment of recalls, we mute channel (i) by imposing that the search intensity of the UI recipients is similar to that of the nonrecipients.

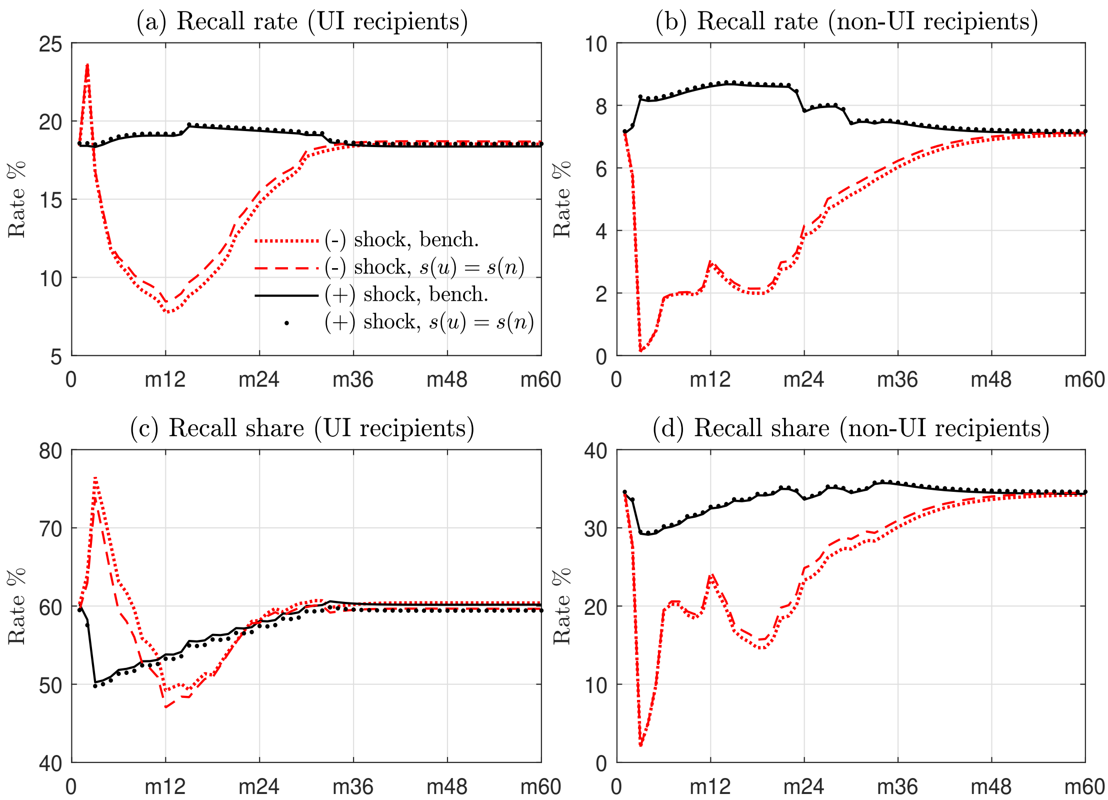
Figure 5: Search intensity profile



Average search intensity of UI recipients and nonrecipients as a function of the aggregate productivity shock. It is averaged over types and individual productivity using stationary distribution of the unemployed.

Figure 6 displays the impulse response functions under the benchmark scenario (different search intensity levels) and when the search intensity is similar among the unemployed workers with different UI status. It is shown that search intensity does not account for much the differences in recalls (rates and shares) between the two. It has no impact following a positive productivity shock and slightly reduces the variations in the recall rate following a negative shock. We conclude that the ER system accounts for the bulk of difference in recalls between recipients and nonrecipients in the long run and in the short run. The expectation of higher future taxes significantly alters recall decisions. This effect is further amplified in recessionary periods during which the shift of the tax schedule increases the burden of UI contributions. We further investigate this effect in the next section.

Figure 6: Impulse response function - Recall



The positive and the negative shock have the same magnitude. The path of the shock adjusts according to the transition matrix $P(p'|p)$ given the arrival rate of aggregate shock λ_ε. $s(r) = s(n)$: search intensity of the UI recipients is the same than that of the nonrecipients.

5.4 Counterfactual experiments

To study the interaction between recalls and ER, we perform various counterfactual experiments based on historical time series. In particular, we wonder what would have been the path of the labor market under alternative UI financing schemes.

(1) Flat tax: the tax rate is constant over time and identical across firms. $\tau(p, \ell) \longrightarrow \tau(p_{ss}, M)$, $p_{ss} = 1$. It corresponds to an UI without ER. All firms are assigned the new tax rate that prevails at the steady state[22].

(2) No micro ER: the tax rate remains state-dependent to the aggregate productivity (upward and downward shifts of the tax schedule) but identical across firms. $\tau(p, \ell) \longrightarrow \tau(p, M)$. It corresponds to an UI without the individual incentives of the experience rating. All firms are assigned the new tax rate. It may evolve according to the aggregate productivity shock.

(3) No macro ER: the tax rate is heterogeneous across firms according to their experience with unemployment but no shift of the tax schedule occurs along the business cycle. $\tau(p, \ell) \longrightarrow \tau(p_{ss}, \ell)$. This is the pure effect of experience rating.

The methodology is as follows. We first solve for the path of the aggregate shock that makes the simulated series of the unemployment rate from the model as close as possible to its empirical counterpart. Given the path of the productivity shock, we simulate the path of the endogenous variables under the alternative scenarios. We compare the adjustment of the variables under the alternative scenarios to those implied by the benchmark.

5.4.1 Model fit

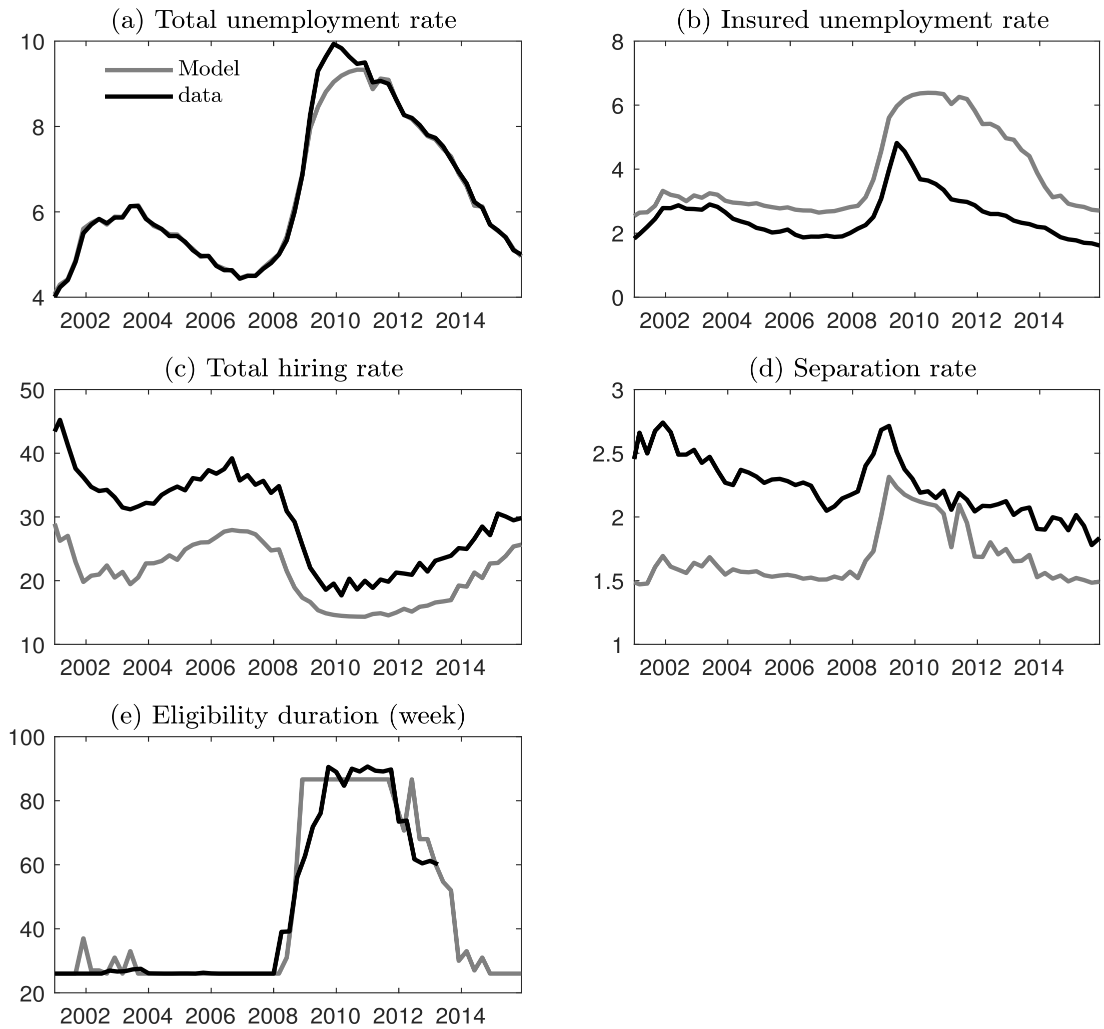
Figure 7 shows the path of the simulated variables from the model against the one from the data. The model does a decent job at matching the variations of the variables not targeted by the aggregate productivity shock. It slightly overestimates the persistence of the insured unemployment rate but produces a consistent decline in total job-finding rate and the observed short-lived burst in the job separation rate[23]. While the model does not have an explicit formu-

[22] Note that in scenario **(1)** and **(2)** the tax rates are $\tau(p, M)$ and $\tau(p_{ss}, M)$ respectively. Imposing $\ell = M$ corresponds to a zero reserve ratio. This assumption ensures that the aggregate UI budget (benefits paid minus contributions collected) remains similar to that of the benchmark case. By doing so, the results from the counterfactual experiments do not hinge on an increase or a decrease in the aggregate UI budget.

[23] Note that in the data, these two rates are computed from the CPS using Shimer (2005)'s methodology based on short-term unemployment. The long-run values may then be different from the means reported in Table 3 using the PSID data.

lation of the unemployment benefits extension that depends on the effective unemployment rate as in Chodorow-Reich et al. (2019) it produces an accurate evolution of the maximum benefit duration observed during the Great Recession.

Figure 7: Model vs data - aggregate variables



Data sources. Total unemployment rate: CPS. Insured unemployment rate: U.S. Employment and Training Administration, s.a. with X13. Total job finding rate and separation rate: monthly rate, build using Shimer (2005)'s methodology on CPS data. Benefit duration: U.S. Employment and Training Administration data, weekly claims data for extended benefits and emergency unemployment compensation program, authors' calculations.

5.4.2 Alternative scenarios

Scenarios **(1)** to **(3)** allow to decompose the impact of the main components of the ER system. We first discuss the long-run effects of these scenarios. The main message that emerges from Table 5 is that the micro aspect of ER seems to have a sizeable impact on the labor market. Indeed, removing the micro aspect (scenarios **(1)** and **(2)**) involves significant changes in ins and outs of unemployment. In scenario **(3)**, mean levels of the variables are almost identical to that of the benchmark case, involving that the macro aspect of ER has no sizeable impact on the steady-state levels.

The total unemployment rate seems to be unaffected by the financing scheme. However, the modest change in unemployment actually hides significant changes in labor flows and in the composition of hirings. Indeed, the total job-finding rate increases under scenarios **(1)** and **(2)** by more than 12% and so does the separation rate. Removing the individual incentives provided by the micro aspect of ER reduces the costs of dismissals. On the one hand, it makes firms more prone to use layoffs. On the other hand, if affects positively the expected value of a job, which foster hirings. It results in a higher labor market turnover, with ambiguous effects on unemployment.

Since the recall margin bypasses the costly and time-consuming search process, the recall share strongly increases under scenarios **(1)** and **(2)**. This means that without the micro aspect of ER, the increase in hirings would have translated through the recall margin. The gains in the recall rate mainly belong to UI recipients. This is consistent with our predictions on the heterogeneous impact of ER on recall by UI status. In the benchmark case, the ER system creates an incentive to discriminate recall practices in favor of the UI recipients. When this incentive is muted, these practices are no longer relevant. The difference between the two is thus reduced when the core mechanism of ER is turned off. Note that there are still some differences in recalls between due to composition effects. As shown by Fujita & Moscarini (2017) through hazard rate decompositions, short-term unemployed are more likely to be recalled than long-term unemployed. On average, UI recipients have shorter unemployment spells than the nonrecipients. As the formers have a stronger attachment to their previous employer than the latter, their chances of being recalled remain greater. The job-finding rate for new hires seems, however, not affected by the financing scheme.

We now investigate the dynamic effects of the ER[24] (Figure 8). The flat tax system **(1)** prolongs the burst in separations until 2015 but also implies a more modest decrease in the total job-finding rate. Since the former effect

[24]For the sake of comparison and since we discuss previously the steady-state effects, we normalize the time series as of 2007=100 and present the results in percentage deviation from this level. By doing so, we focus on the dynamic effects of the policy experiments.

Table 5: UNCONDITIONAL MEAN

	Benchmark	Flat tax (1)	No Micro ER (2)	No Macro ER (3)
Total unemployment rate	5.1	5.2	5.2	5.1
Insured unemployment rate	2.9	3.3	3.3	2.9
Total job-finding rate	24.9	28.9	28.9	24.9
Total job separation rate	1.6	1.8	1.8	1.6
Recall share	51.5	58.7	58.7	51.5
- UI recipients	60.4	62.6	62.6	60.1
- UI nonrecipients	33.9	50.4	50.3	34.4
Recall rate	13.5	17.9	17.9	13.5
- UI recipients	18.4	20.4	20.3	18.2
- UI nonrecipients	7.0	13.5	13.5	7.1
New job-finding rate	12.8	12.9	12.9	12.8
- UI recipients	12.4	12.7	12.7	12.4
- UI nonrecipients	13.2	13.4	13.4	13.2

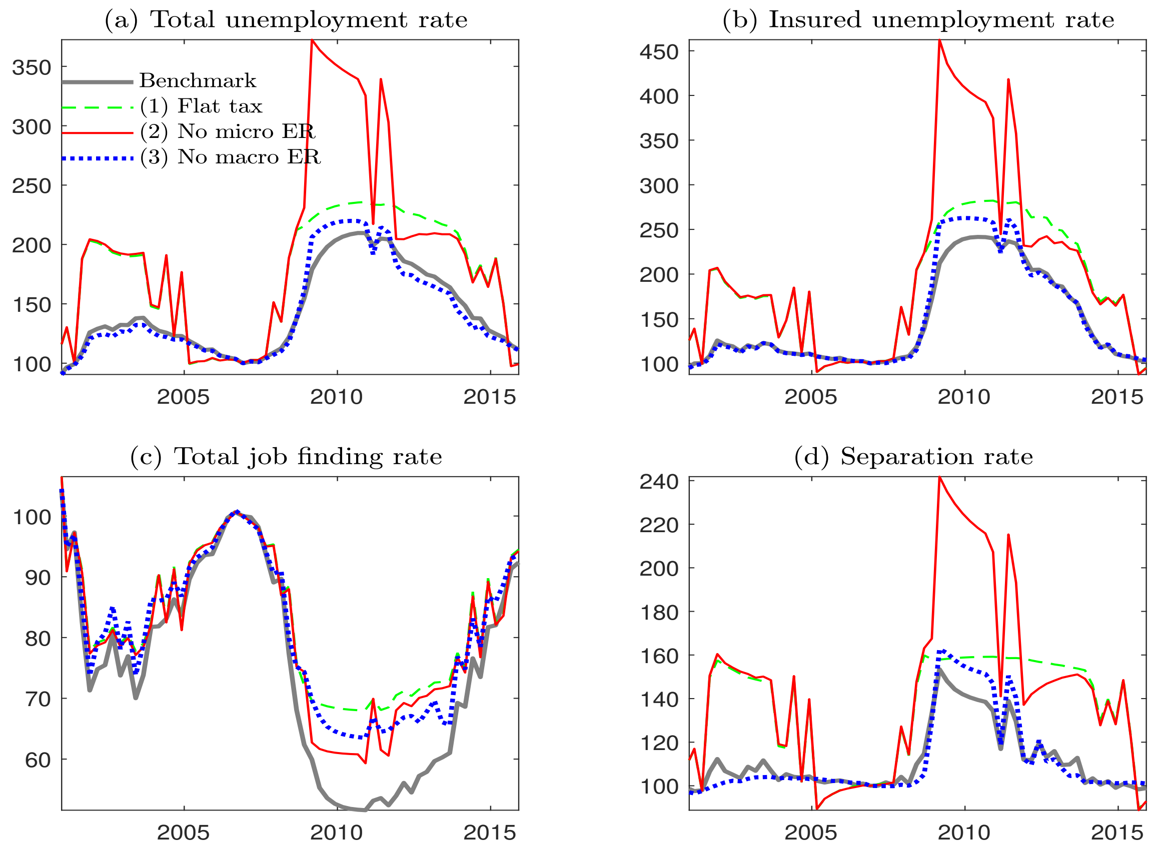
Steady-state analysis. Level of the variables are displayed. The recall rate and the new job-finding rate are displayed at monthly frequencies.

dominates the latter, the surge in unemployment is shown to be larger and more persistent.

The largest changes in the dynamic of the labor market come from the scenario **(2)**. In this case, the separation rate explodes during the Great Recession, which causes the total unemployment rate to increases dramatically. This case is interesting because the absence of the micro aspect of ER also characterizes the flat tax scenario but no such rise in labor market fluctuations is detected. This result echoes Burda & Weder (2016) who show that counter-cyclical UI taxes amplify the magnitude and the persistence of the labor market fluctuations. They show that a counter-cyclical payroll tax prevents wages from adjusting and strengthens the model's endogenous propagation mechanism. The macro aspect of ER involves similar effects. The difference between scenario **(1)** and **(2)** is that in the latter, firms face upward shifts in the tax schedule during recessionary periods. This worsens their profitability as they share equally the burden of tax increases. The less productive firms respond to the rise in the tax through layoffs. When the macro aspect of ER works in isolation, it acts as an amplifier of labor market fluctuations.

Under scenario **(3)**, the absence of the macro aspect does not affect significantly the labor market fluctuations. The rise in the separation rate is a bit stronger and the decline in hirings is smoother. This result may seem counterintuitive in light of the amplifying role of the macro aspect described previously. We argue that the interaction between the micro and the macro aspect has different effects than the sum of each aspect taken in isolation. Indeed, when the two aspects are combined (benchmark), the macro aspect acts as an amplifier of the micro aspect. The range of experience-rated taxes increases and so does the slope of the tax schedule (see Figure 1). This reinforces the initial effect of ER. Under scenario **(3)**, the core mechanism of ER is still working but on a narrowed range of tax rates. This has two effects. On the one hand, it curbs the decline in firms' profitability during the recession. On the other hand, it reduces the expected future penalty for firms with more volatile employment. These two opposite forces lead to a higher total job finding rate and a higher job separation rate compared to the benchmark case.

Figure 8: Counterfactual simulations



We normalize the time series as of 2007=100 and and express the variable in percentage deviation from this level. The total job-finding rate is displayed at monthly frequencies.

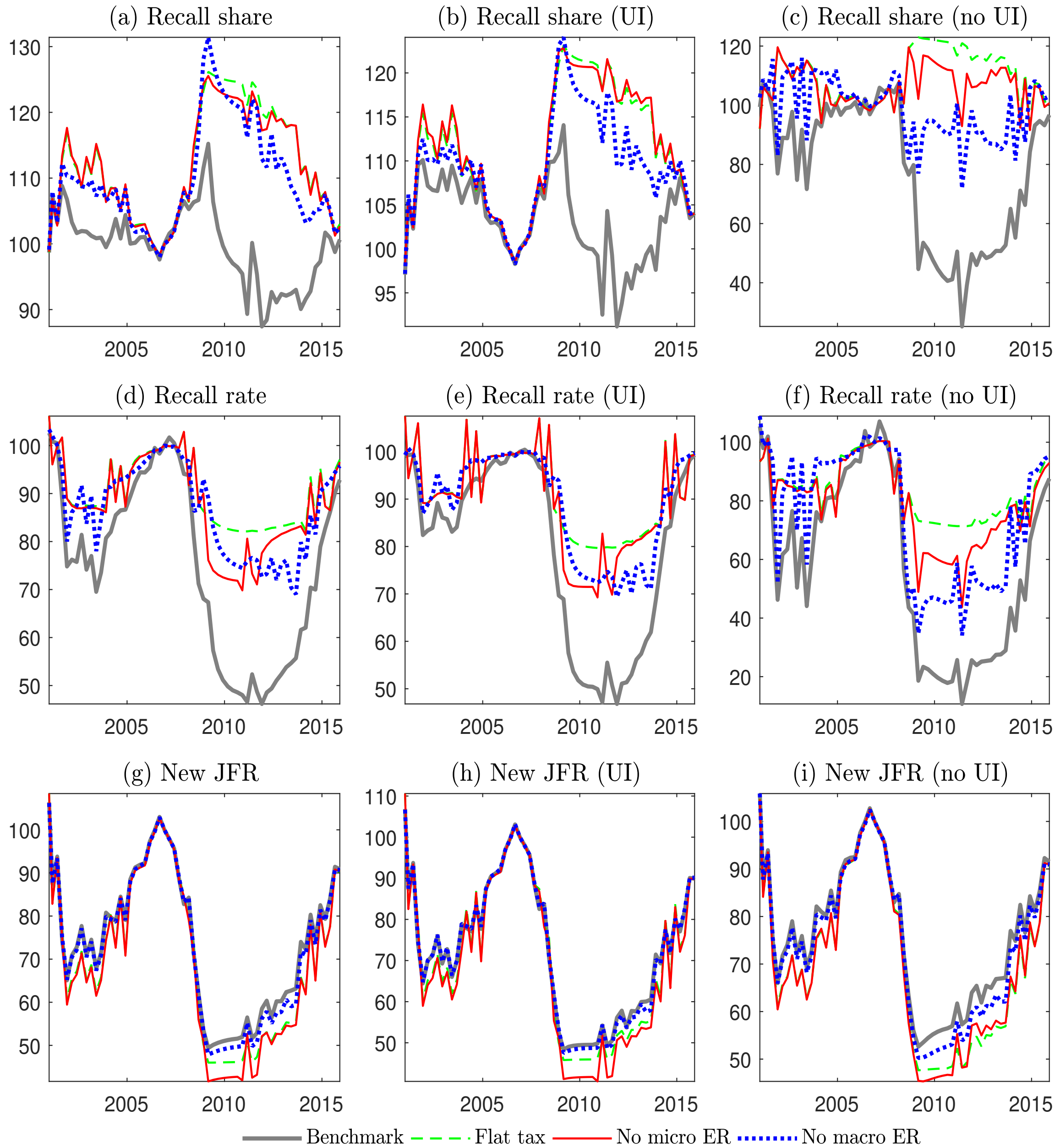
Figure 9 decomposes hirings into recalls and new jobs. In the benchmark case, Panels (e) and (f) exhibit a stronger decline in the recall rate for the UI nonrecipients than for the recipients. The recall share of the recipients (Panel

b) increases early in the crisis and falls slightly below its 2007 level thereafter. The recall share of the nonrecipients (Panel c) does not display such a rise and decreases by around 70% between 2007 and 2010. Again, as no UI costs are charged to the employer of UI nonrecipient, ER deters firms from rehiring ex-employees that do not collect benefits. The opposite is true for the workers collecting benefits. The quicker the recall decision, the lower the increase in the tax.

Panels (d) and (g) show that the alternative financing schemes mainly affect the recall margin. The recall rate is well above the value from the benchmark case in the trough of the recession. In addition, the decline in the new job-finding rate becomes deeper, which results in a jump in the share of recalls.

Under scenarios **(1)** and **(2)**, the fall in the recall rate is weaker for both, the UI recipients and the nonrecipients but the largest differences concern the latter. As mentioned before, the reason is that absent of the individual incentives provided by the micro aspect, there are no reason to discriminate between the two groups. In these cases, the decline in the recall rate (Panels e and f) becomes very similar.

Figure 9: Counterfactual simulations



We normalize the time series as of 2007=100 and express the variables in percentage deviation from this level. The recall rate and the new job-finding rate are computed at monthly frequencies.

5.5 Robustness and related issues

5.5.1 Rigid wages

In our model, wages are endogenously determined through a Nash bargaining process. An important implication from Nash bargained wages (and from many other forms of wage negotiation) is that wages absorb a significant share of the variations in the tax rate. The underlying mechanism lies in the firm's ability to use the tax as a threat in the negotiation to lower wage. How sensitive are wages with respect to the ER tax?

To our knowledge, the only study that deals with this issue is Anderson & Meyer (2000). They focus on Washington State, which was forced by the Federal legislation to adopt an ER system in 1985. Before that date, the tax rate was identical for all employers (flat-tax). Using this natural experiment, they show that the average tax rates largely passed on to workers through lower earnings. However, they also document that the firm can shift much less of the difference between its tax rate and the industry average. In other words, the macro aspect of ER led to a significant decline in wages while the micro aspect did not. In this sense, the Nash bargained structure seems appropriate to describe the observed downward adjustment of wages following the reform but it certainly absorbs too much of the tax variations at the firm level. How does ER propagate in the labor market if wages do not adjust to tax variations?

To address this issue, we mute the wage effects of the ER by considering rigid wages in the spirit of Blanchard & Galí (2010). Formally the wage rate is:

$$w(p, \varepsilon, \ell) = (p\varepsilon)^{\gamma}$$

Wages are now completely disconnected from ER. What are the implications? In recessions, the increase in the tax, either by the micro or by the macro aspect of ER, does not result in a lower wage. The firm's surplus of an active job declines more than under the Nash sharing rule. On one side, it may further increase separations and lower hirings. On the other side, the disincentive effects of ER are stronger as the firm is no longer able to share the burden of UI costs with the worker. The impact is ambiguous since the two forces play in the opposite direction. However, in light of the previous results, one might expect that removing the micro aspect of ER is likely to amplify the collapse of the labor market during the Great Recession.

The model is calibrated following the same procedure as for the Nash structure and we perform the same exercises. We report all the result in the supplementary appendix. The general result that emerge from the model with real wage rigidities is that many of the results hold but the quantitative effects are larger in some experiments. The ability of the model to match the empirical targets (long-run and time series) and to produce non-linearities remains intact. The search intensity channel still does not explain the difference in recall shares between UI recipients and nonrecipients.

Regarding the counterfactual, the increase in the separation rate that result from scenario **(1)** and **(2)** is much stronger in the long run. The decline in the total job-finding rate is larger, leading to higher unemployment at the steady state. In the short-run, removing the micro aspect of ER **(2)** generates a larger increase in unemployment due to the rise in separations. In this scenario, the new job-finding rate declines much more with rigid wages.

5.5.2 UI benefit extension

Throughout the paper, we mainly focused on the interaction between ER and firms' recall decisions during the Great Recession. From the workers' side, an important UI benefit extension has been launched in the US during this turbulent period. The policy has been frequently pointed out as an important distortion on the labor market for having reducing job search and job acceptance (see Barro (2010)). Hagedorn et al. (2013) argue that the wage pressure induced by the benefit extension reduced the incentive for firms to invest in job creation. They find that the unemployment benefit extension is responsible for a 3.6 percentage points increase in unemployment. Fujita (2011), Rothstein (2011), Farber & Valletta (2015), Nakajima (2012) and Chodorow-Reich et al. (2019) find a much more modest impact: between 0.1 and 1.8 percentage points increase in the unemployment rate are accounted for by the UI extension. Albertini & Poirier (2015) found that the UI extension has reduced unemployment by around 0.7 percentage points due to the economic environment characterized by a liquidity trap and the fall in aggregate demand. Do we have something new to say about the 2009 UI extension? Contrary to the previous studies using theoretical frameworks, our model features two distinct hiring margins, endogenous separations and an ER system. As shown previously, these aspects are important for the labor market dynamic and may have non-trivial consequence for the policy evaluations. To quantify the impact of the policy, we provide two additional exercises.

First, we take advantage of our structural model which features the UI extension to study its impact on the labor market dynamics. We wonder what would have been the path of unemployment, hirings and separations if the maximum benefit duration was held constant at its pre-recession level, that is 26 weeks ($\eta(p) = \eta(p_{ss})$). We label this scenario **(4) No UI ext.**. Second, we study the interaction between ER and the UI extension. As mentioned in Section 3, the benefits collected under the UI extensions were not charged to firms. One may wonder what would have been the consequences if it had been the case. This counterfactual exercise can tell a rich story about how much firms can support tax and what margin would be affected. We see that the effects of ER are strongly nonlinear. One may naturally wonder whether charging additional UI costs to the firm has symmetrical effects than reducing it (scenario **(1)-(3)**). For this experiment, we compute the costs incurred to the UI by the benefits extension. Then, we solve for the increase in the taxable wage base[25] needed to cover these UI expenditures. We label this scenario **(5) ER financed**.

Simulations of scenario **(4)** reported in appendix B.1 show that the overall impact of the UI extension is weak. At most, unemployment would have decreased by 0.5 percentage points absent of the UI extension. The decline is mainly due to the lower rise in the separation rate. The two hiring margins seem unaffected. These results support the view that the UI extension has a negligible impact on the labor market performances. Two main reasons explain this result. First, as shown before, the search intensity channel does not have a strong impact on the exit rate from unemployment. Second, the upward pressure on wages caused by the higher outside option is offset by the downward pressure coming from the rise in the tax. The two effects plays in opposite direction, leading to a much small impact than what Hagedorn et al. (2013) found. Scenario **(5)** leads to a further decline in hirings and a lower increase in separations. These two contrasting force drive the average increase in unemployment above its benchmark value by 0.5 percentage point during the Great recession. This scenario involves a strong decline in the recall share. Asking firm to pay immediately the increase in UI expenditures is likely to lower the labor market turnover and increase slightly the unemployment rate. With rigid wages, scenario **(4)** involves a stronger decline in unemployment and scenario **(5)** causes a larger but short-lived burst in unemployment.

6 Conclusion

In this article, we shed new light on the interactions between unemployment insurance, recalls, and experience rating. We conduct an original empirical analysis to determine the impact of UI status on the recall probability. Our estimates from the SIPP provide evidence that UI recipients have a higher probability of being recalled, compared to those that do not receive state unemployment compensation. The result is robust after controlling for individual characteristics, including the unemployment duration. Why is there such a difference? We suspect that the financing scheme in the US may contribute to the gap in the recall rate between the two types of unemployed. Indeed, ER generates an incentive for firms to recall UI recipients because they avoid a future increase in the UI tax. These interactions have strong implications for cyclical unemployment.

To address this issue, we develop a search and matching model in which new hires and recalls are endogenous and distinct processes. We generate an heterogeneity in firms' layoffs history and UI taxes to capture the main features of the ER system. Our model reproduces the share of recalls out of hires

[25] In an alternative experiment, we adjust the maximum tax rate rather than the taxable wage base to finance the UI extension. The results are the same.

by UI status but also the heterogeneity in firms' experience with the UI. Using a counterfactual analysis approach, we evaluate what would have been the labor market dynamics during the Great Recession in the absence of ER. We conclude that both, the job-finding rate and the separation rate, would have been higher. However, the rise in job separation would have been much larger than the increase in hirings, thereby increasing further the surge in unemployment. More generally, we show that ER has stabilization virtues that mainly transit through separations and recalls of individuals qualified for unemployment benefits.

While our paper allows a better understanding of the labor market by highlighting the interactions between unemployment insurance, recalls, and experience rating, a great deal of work remains to be done. Firstly, ER may impact the labor market dynamics through both the extensive and intensive margin. As highlighted by Burdett & Wright (1989), Atkinson & Micklewright (1991), and Krueger & Meyer (2002), UI has important implications for labor market participation, search behavior, and hours worked per worker. Further research is needed to quantify the impact of ER on each of these channels. Second, our paper leaves aside the question of the optimal level of ER. Albertini & Fairise (2013) have shown that a layoff tax financing unemployment benefits is able to offset labor market inefficiencies caused by search frictions and real wage rigidities. The question of inefficiencies coming from the recall option naturally arises. On the one hand, rehiring avoids congestion externalities and the costly hiring technology from matching frictions. On the other hand, the implicit attachment between the firm and the worker may distort job search strategies. The firm decides the timing of recall while workers only have expectations of being recalled. Fujita & Moscarini (2017) show that around 15% of workers with no rehiring expectations were recalled. Without commitment, some unemployed workers may unnecessarily devote time in job search while other may wait for a recall that will never happen. Katz & Meyer (1990) report that 83% of unemployed workers with no recall expectations are searching for a job whereas only 52% of unemployed workers with recall expectations are searching. Fernández-Blanco (2013) shows that this double job-finding channel involves externalities. The reason is that workers engage in a job search activity given the uncertainty of rehiring. However, unemployed workers do not internalize the impact of search on the loss of the firms' recall option. These labor market inefficiencies leave room for policy interventions and call for an investigation of the optimal design of the ER system.

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Table 6: PROBIT MODEL FOR EXPERIENCING RECALL

Variables	Recall
Has received state unemployment compensation	0.3074***
	(0.0351)
Age	0.0312***
	(0.0062)
Age squared	-0.0001
	(0.0001)
Education	
High school graduate	-0.1126***
	(0.0409)
Some college	-0.3049***
	(0.0429)
College degree	-0.2484***
	(0.0508)
Female	0.0625**
	(0.0296)
Unemployment rate	0.0346
	(0.0269)
Unemployment length dummies	YES
Panel dummies	YES
Month dummies	YES
Constant	-1.2141***
	(0.1930)
Observations	8,323

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

*Author calculations on SIPP data, waves 1990, 1991, 1992, 1993, 1996, 2001, 2004, 2008. Number of observations: 8,323. The recall share is defined as the share of completed unemployment spells that end in a recall. *** $p<0.01$, ** $p<0.05$, * $p<0.1$.*