Effects of Extended Unemployment Benefits on Labor Dynamics

Miquel Faig, University of Toronto*
Min Zhang, SUFE†
Shiny Zhang, University of Toronto*

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Abstract

The extension of unemployment benefits during downturns has significantly increased the variability of unemployment and vacancies in the United States. Taking this into account reduces the value of leisure necessary to explain the wide labor market business cycles that we observe using the Mortensen and Pissarides model. In the version of this model that we analyze, unemployment benefits not only expire but they must be earned with employment. Our preferred calibration predicts that the enactment of the Emergency Unemployment Compensation program in 2008 increased the unemployment rate by 0.5 percent.

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1 Introduction

In the United States, the statutory duration of unemployment insurance (UI) benefits varies systematically depending on the state of the economy. In recessions, a large fraction of UI recipients see the period they are eligible for UI benefits prolonged automatically by the Extended Benefits Program as the unemployment rates in their states cross the thresholds for this program to take effect. In addition, the Federal Government has legislated ad-hoc extensions of benefits in each recession since the Second World War. As a result, the normal period of UI eligibility of 26 weeks has been extended to an average length of 55 weeks in the downturns prior to the Great Recession, and to an all time high

*150 St. George Street, Toronto, Canada, M5S 3G7.
†Shanghai University of Finance and Economics, and the Key Laboratory of Mathematical Economics (SUFE), Ministry of Education, Shanghai 200433, China.

of 99 weeks during and after this episode. The objective of this paper is to examine how this state-contingent duration of UI benefits has contributed to the wide unemployment cycles observed in the United States. In particular, we take first the Mortensen-Pissarides model extended with an endogenous eligibility of UI benefits as in Zhang and Faig (2012) and ask how important is the state-contingent statutory duration of UI benefits for the ability of this model to generate realistic unemployment cycles. Then, we use a calibrated version of the model and ask how much the high unemployment experienced during the Great Recession may result from the desincentive effects of the extensions of the statutory duration of UI benefits to unprecedented high levels.

As stressed by Shimer (2005), the Mortensen-Pissarides model has difficulty in generating the wide cycles followed by unemployment and vacancies. For realistic cyclical variations in productivity, one requires unrealistic high values of leisure to generate the large labour cycles that we observe (see Hagedorn and Manovskii, 2008). Only with these high values of leisure, the profit rate of employing a worker is small, and so it is strongly affected by productivity shocks. The systematic extension of the statutory duration of benefits in recessions provides an additional indirect channel for productivity to affect labor market flows. As a result, it offers the possibility of generating realistic labor market cycles with lower, more plausible, values of leisure.

To explore this possibility, we extend the version of the Mortensen-Pissarides model in Zhang and Faig (2012) where workers must be employed for a while to become eligible for UI benefits, which do not last forever. This is a suitable framework for our objectives because not only the duration of UI benefits over the cycles is explicitly modelled, but also it permits to calibrate the model in such a way that, realistically, unemployment and vacancies can respond strongly to productivity shocks and moderately to policy changes in unemployment insurance.

In the extension of the model to be explored here, the duration of UI eligibility is made to be contingent on the aggregate state of the economy. Specifically, our numerical implementation targets empirical moments for the United States in the period 1951-2003. Consistent with the policies from this period, the expected statutory duration of benefits is assumed to take two values: it lasts for 26 weeks when the economy is in a normal state, and it last for 55 weeks when productivity is below a certain threshold (one third of the time). As in Zhang and Faig (2012), the remaining targets are the stylized facts described in Shimer (2005) about trends and cycles in the labor market, key institutional features of the UI system, and empirical estimates of how the UI system affects flows in the labor market.

Our results show that making the duration of benefits contingent on the aggregate productivity of the economy significantly reduces the value of leisure that is required to generate the business cycle properties of unemployment and vacancies. For example, in our preferred calibration where we target the standard deviations of unemployment and vacancies conditional on labor productivity, the calibrated value of leisure falls from 0.84 to 0.75. The reason why this fall is not larger is that in our calibration we target empirical results showing moderate effects of unemployment insurance policies on labor market flows.

With our calibrated parameter values, we then address the contribution of the Emergency Unemployment Compensation program which was enacted initially in June 2008 (EUC 2008) and has gradually extended the statutory length of UI benefits to up to 99 weeks. To do so, we compare the economic performance across four regimes that differ in the duration of UI eligibility in low productivity states: 99 weeks (EUC 2008 becomes the new norm), 55 weeks (average practice in 1951-2003), 39 weeks (elimination of ad-hoc Federal extensions), and 26 weeks (elimination of all UI extensions during downturns). In our preferred calibration, the average unemployment rate in recessions across these regimes differs moderately but significantly. For example, comparing the regime with extensions to 99 weeks versus 39 weeks, the latter of which is the closest in our modelling strategy of not having enacted EUC 2008, the average unemployment rate in recessions falls by 0.5 percent. This prediction squares well with empirical estimates of the effects of EUC 2008 as it lies at the upper end of the range of effects (0.1 to 0.5 percent) estimated by Rothstein (2011) and Valletta and Kuang (2010) and is somewhat lower than alternative estimates (around 1 percent) by Aaronson, Mazumder, and Schechter (2010), Fujita (2011), Mazumder (2011), and Nakajima (2012). Despite this relative agreement, it should be stressed that all these estimates focus on somewhat different channels through which EUC 2008 may adversely affect unemployment. For example, Rothstein allows for movements in and out of the labor force, while we abstract from those. In contrast, we contribute to the extant literature by allowing macroeconomic effects through the stronger bargaining position EUC 2008 offers to employed workers in addition to moral hazard effects on job search.

The rest of the paper is organized as follows. Section 2 briefly summarizes the model employed in Zhang and Faig (2012), and how it is modified so that the duration of UI benefits is state-contingent. Section 3 calibrates the modified model to data in the United States and analyzes its quantitative predictions. Finally, section 4 concludes.

2 The Baseline Model

In the economy, there is a measure one of workers, and a large measure of potential firms which can enter freely into the labor market. Both workers and firms are infinitely lived, risk neutral, maximize their expected utilities, and discount the future at the rate r. To produce, a firm and a worker must match to form an employment relationship. Searching to form these matches takes place in a single labor market according to a matching technology that yields constant returns to scale in the vacancies posted by firms, v_t, and unemployment, u_t: $M(v_t, u_t)$. Because of these constant returns to scale, the probability with which a worker finds a firm (finding rate) is a function of the vacancy-unemployment ratio $\theta_t = v_t/u_t : f(\theta_t) = M(v_t, u_t)/u_t = M(\theta_t, 1)$. Likewise, the probability of a firm finding a worker (filling rate) is a function of θ_t that satisfies:

$$q(\theta_t) = \frac{M(v_t, u_t)}{v_t} = \frac{M(v_t, u_t)}{u_t}\frac{u_t}{v_t} = \frac{f(\theta_t)}{\theta_t}. \tag{1}$$

Once a match has been formed, it produces output every period until it breaks down. The surplus from the match is divided between the two parties according to the generalized axioms of Nash, with $\beta \in (0, 1)$ being the bargaining power for workers. If the surplus of a match when a worker and a firm meet is negative, the match is immediately dissolved, and we say that the worker has rejected the job offer. Likewise, if in the course of time the surplus of a match turns negative, it dissolves at that point, and we say that the worker has quit the job. In addition to these quits, an employment match may dissolve exogenously as a result of separations occurring with a probability s per period.

Following Zhang and Faig (2012), workers are divided into four groups by their employment state and UI eligibility status. Let i denote if a worker is eligible to collect UI ($i = 1$) or not ($i = 0$). Each period, ineligible workers who are employed become entitled to UI (a transition from $i = 0$ to $i = 1$) with a constant probability g. Likewise, unemployed workers who are collecting UI run out of benefits exogenously (a transition from $i = 1$ to $i = 0$) with a state-dependent probability d_t. In our numerical simulations, the variable d_t takes two values, one for normal states and one for bad states, which are differentiated by the level of aggregate productivity.

As is the case in most countries, we assume that UI benefits are meant to be collected by workers losing their jobs involuntarily and not rejecting reasonable offers, but the UI agency has limited information, in particular, about employment rejections. Therefore, in the model, all the eligible workers who lose their jobs because of an exogenous separation are allowed to collect UI while this eligibility lasts. In contrast, workers who are detected quitting a job or rejecting an offer of employment lose their eligibility. The UI agency has no difficulty in detecting quits, but it does not always catch a rejection. So, if an unemployed worker rejects an offer, then the probability of a transition from $i = 1$ to $i = 0$ increases from d_t to $\gamma + d_t(1 - \gamma)$, where γ is the probability of being caught by the UI agency when a job is rejected. To minimize the complexity of our algebra, we will denote as π_t the probability with which a worker who rejects an offer continues collecting UI next period, so $\pi_t = (1 - d_t)(1 - \gamma)$.

The unemployment system is financed by a mandatory state-contingent UI contribution fee, τ_t, imposed on employed workers.[1] Since the UI agency can borrow and save at the interest rate r, the UI program can run deficits or surpluses over time.

[1] Zhang and Faig (2012) allows for this fee to be dependent on the workers type.

In this setup, UI benefits have a disincentive effect towards accepting job offers. This effect is inconsequential for high productivity matches, but is relevant for low productivity ones. To allow for realistic equilibrium outcomes where some offers are rejected while others are not, we assume that the quality of matches is heterogenous. Specifically, we assume that at the beginning of the period after a match is formed workers randomly draw a match-specific productivity ϵ from an exogenous cumulative distribution function $H(\epsilon)$ with a finite support $E \subset R_+^m$. The total productivity of the formed match in period t is then defined as $p_t(\epsilon) = \overline{p}_t + \epsilon$, where $\overline{p}_t$ is aggregate productivity common to all matches in period t. The common component $\overline{p}_t$ is assumed to be a stochastic variable that follows a Markov chain and takes values in a finite support $P \subset R_+^n$.

From the workers point of view, after the realization of the match-specific productivity ϵ, they decide whether or not to accept or reject the offer of employment implied by the match. If the workers reject the offer, they collect UI benefits with the probability π_t as long as they are eligible for UI. If they accept the offer, they start an employment relationship with the match quality ϵ that stays constant during the spell of employment. In period t, the effective job-finding rate for workers of type i is the product of the rate at which they match with a firm and the probability of accepting the ensuing job offer: $f(\theta_{t-1})\left[1 - H\left(\hat{\epsilon}_t^i\right)\right]$, where $\hat{\epsilon}_t^i$ is the critical value of ϵ that determines if a worker of type i accepts the job $(\epsilon \geq \hat{\epsilon}_t^i)$ or not $(\epsilon < \hat{\epsilon}_t^i)$ given the state of the economy in period t. In each period, employed workers receive a wage rate $w_t^i(\epsilon)$ net of the UI fee τ_t. Unemployed workers receive utility from leisure ℓ, and, if they are eligible for UI, UI benefits b. Both ℓ and b are assumed to be positive, and ℓ is assumed to be always smaller than the productivity in a match: $\ell < p_t(\epsilon)$ for $i \in \{0, 1\}$, all t and $\epsilon \in E$. However, we allow for $\ell + b$ to exceed labor productivity, which opens the door to some offers being rejected in equilibrium to collect UI.[2]

The assumption that the value of output always exceeds the value of leisure is not sufficient to guarantee that quits never occur among the UI-ineligible workers. The reason that a workers may quit is to avoid a high contribution fee or to pursue much better job opportunities. These possibilities never occur in our numerical simulations. Thus, to simplify algebraic expressions in the analysis that follows, we will assume that the contributions fees are sufficiently low and the heterogeneity of matches is sufficiently narrow for the UI-ineligibles not to quit in equilibrium.[3]

Ex-ante, all firms possess the same production technology and preferences. Each firm chooses to either stay idle or be active in the labor market. An active firm is paired up with a worker of type $i \in \{0, 1\}$ with the probability $q(\theta_t)\, u_t^i/u_t$ in each period, where

[2] With match heterogeneity, even in the absence of a UI system, quits and rejections may happen in equilibrium because if a worker is poorly matched he/she has an incentive to seek better matches. This point is not clearly stated in Zhang and Faig (2012).

[3] See Zhang and Faig (2012) for an analog analysis with the possibility of quits, but with uncontingent duration of benefits.

u_t^i is the measure of unemployed workers of type i and u_t is total unemployment. Upon successfully forming a match, the firm obtains a flow profit $p_t(\epsilon) - w_t^i(\epsilon) - \tau_t$. An active firm searching for a worker incurs a flow cost c for maintaining a job vacancy.

2.1 Laws of Motion

The laws of motion for the measures of employed workers of types 0 and 1 respectively are:

$$e_t^0(\epsilon) = (1-s)(1-g)\, e_{t-1}^0(\epsilon) + u_{t-1}^0 f_{t-1} h(\epsilon)\, A_t^0(\epsilon)\,, \text{ and} \quad (2)$$

$$e_t^1(\epsilon) = (1-s)\, e_{t-1}^1(\epsilon) + (1-s)\, g e_{t-1}^0(\epsilon) + u_{t-1}^1 f_{t-1} h(\epsilon)\, A_t^1(\epsilon)\,. \quad (3)$$

where $h(\epsilon)$ is the density function of ϵ, and $A_t^i(\epsilon)$ for $i \in \{0,1\}$ is an indicator function that an unemployed worker of type i accepts a job with match quality ϵ in period t. These equations take into account that in equilibrium workers do not quit their jobs but a fraction s of them suffer an exogenous separation each period. Also, they take into account that a fraction g of employed workers gain eligibility each period. Finally, these equations take into account that the measure of unemployed workers of type i finding a job of quality ϵ is the product $f_{t-1}h(\epsilon)$. The laws of motion for unemployed workers of type 0 and 1 respectively are:

$$u_t^0 = e_{t-1}^0 s + u_{t-1}^0 \left[1 - f_{t-1}\left(1 - H_t^0\right)\right] + u_{t-1}^1 \left[(1 - f_{t-1})\, d_t + f_{t-1} H_t^1 (1 - \pi_t)\right], \text{ and}$$

$$u_t^1 = e_{t-1}^1 s + u_{t-1}^1 \left[1 - f_{t-1}(1 - H_t^1) - (1 - f_{t-1})\, d_t - f_{t-1} H_t^1 (1 - \pi_t)\right]. \quad (4)$$

where H_t^i is the probability with which a worker of type i rejects an offer in period t. These equations use that employed workers lose jobs with probability s and unemployed workers of type i find jobs with probability f_{t-1} and reject them with probability H_t^i. Also, they use that UI eligibility is lost for a fraction d_t of the type 1 unemployed who do not find a job, and for a fraction $1 - \pi_t$ of the type 1 unemployed who find a job and reject it.

The aggregate state of the economy, denoted by a vector x_t, includes: the common component of labor productivity $\overline{p}_t$, and the distribution of workers by employment status, eligibility for UI and match quality, namely u_t^0, u_t^1, $e_t^0(\epsilon)$ and $e_t^1(\epsilon)$, for all $\epsilon \in E$ (One of these measures can be dropped because the total measure of workers is always one). The set of all possible aggregate states is denoted as $X \subset R^{n+2m+1}$. The dynamics of x_t inside this set are dictated by the Markov chain followed by the common component of productivity and the laws of motion of the distribution of workers. In the recursive formulation of an equilibrium that follows, all endogenous variables and value functions are functions of the state of the economy, so x subscripts will replace the t subscripts used up to this point and a prime will denote next period.

2.2 Bellman Equations

For a worker of type i, let the values of being unemployed and employed in a match of quality ϵ respectively be U_x^i and $W_x^i(\epsilon)$. The value of an unemployed worker ineligible for UI is the utility of leisure for the current period plus the sum of the expected present values of being matched with a firm next period and continuing being unemployed. These events happen with probabilities $f_x = f(\theta_x)$ and $1 - f_x$, respectively. Hence,

$$U_x^0 = \ell + \rho \left(f_x E_x \left[E_\epsilon W_{x'}^0(\epsilon) \right] + (1 - f_x) E_x U_{x'}^0 \right), \tag{5}$$

where ρ is the discount factor $1/(1+r)$, and the expectation operators calculate averages over ϵ in E_ϵ and over x' conditional on x in E_x. The value of an unemployed worker eligible for UI includes the utilities from leisure and UI benefits for the current period, and takes into account the possibilities of rejecting a job offer and losing eligibility in calculating the expected present values for next period:

$$\begin{aligned} U_x^1 &= \ell + b + \rho f_x E_x \left[E_\epsilon \max \left\{ \tilde{W}_{x'}^1(\epsilon), \pi_{x'} U_{x'}^1 + (1 - \pi_{x'}) U_{x'}^0 \right\} \right] & (6) \\ &\quad + \rho (1 - f_x) E_x \left[d_{x'} U_{x'}^0 + (1 - d_{x'}) U_{x'}^1 \right]. & (7) \end{aligned}$$

If the worker rejects an offer, the probability to continue receiving UI next period is $\pi_{x'}$. So, the expected value in case of a rejection is $\pi_{x'} U_{x'}^1 + (1 - \pi_{x'}) U_{x'}^0$. If the worker accepts the offer, the value is denoted as $\tilde{W}_{x'}^1(\epsilon)$. This value differs from the value of an employed worker eligible for UI, $W_{x'}^1(\epsilon)$, because the worker always loses eligibility after a quit but is able to collect UI with probability $\pi_{x'}$ after a rejection. As a result, once an offer is accepted the outside options for the worker change. Consequently, if Nash bargaining takes place at all times, as we assume, at the moment of accepting a job offer there will be a one time transfer from firms to workers. This transfer compensates workers for the increased probability of being detected "cheating" in case a job dissolution takes place .

For matches involving a worker eligible to collect UI, the value of the worker is the current wage plus the sum of the expected present values of losing the job or remaining employed next period:

$$W_x^1(\epsilon) = w_x^1(\epsilon) + \rho \left[s E_x U_{x'}^1 + (1 - s) E_x W_{x'}^1(\epsilon) \right] \tag{8}$$

Analogously, the value of the firm is the current profits plus the expected value of the firm next period:

$$J_x^1(\epsilon) = p_x(\epsilon) - \tau_x - w_x^1(\epsilon) + \rho(1-s) E_x J_{x'}^1(\epsilon). \tag{9}$$

Similar structure applies to the values of a worker ineligible for UI and the firm that hires such worker, but for those one must take into account the gains to the worker of obtaining UI eligibility:

$$W_x^0(\epsilon) = w_x^0(\epsilon) + \rho\left(sE_x U_{x'}^0 + (1-s)\left[gE_x W_{x'}^1(\epsilon) + (1-g) E_x W_{x'}^0(\epsilon)\right]\right), \text{and} \tag{10}$$

$$J_x^0(\epsilon) = p_x(\epsilon) - \tau_x - w_x^0(\epsilon) + \rho(1-s)\left[gE_x J_{x'}^1(\epsilon) + (1-g) E_x J_{x'}^0(\epsilon)\right]. \tag{11}$$

In equilibrium, idle firms must have no incentive to enter the labour market and post a vacancy. So, the cost of posting a vacancy must be equal to the expected present value of matching with a worker, who conditional with a match occurring will be of type i with probability u_x^i/u_x :

$$c = \rho q(\theta_x) E_\epsilon\left[\left(u_x^0/u_x\right) E_x J_{x'}^0(\epsilon) + \left(u_x^1/u_x\right) E_x \max\left\{\tilde{J}_{x'}^1(\epsilon), 0\right\}\right], \tag{12}$$

where $\tilde{J}_{x'}^1(\epsilon)$ denotes the value of the firm matched with a UI-eligible worker prior making any hiring transfer to the worker.

2.3 Nash Bargaining

The total surplus of an ongoing match involving a worker of type i is the sum of the value gained by the firm, $J_x^i(\epsilon)$, and the value gained by the worker from the match, $W_x^i(\epsilon) - U_x^0$. Since a breakdown in bargaining would render the worker ineligible to collect UI, the outside value of the worker is U_x^0 regardless of being eligible for UI or not. Hence,

$$S_x^i(\epsilon) = W_x^i(\epsilon) - U_x^0 + J_x^i(\epsilon). \tag{13}$$

For newly formed matches involving an eligible worker, the probability of losing eligibility in the initial period after a rejection is $1 - \pi_x$. So, the total match surplus is:

$$\tilde{S}_x^1(\epsilon) = \tilde{W}_x^1(\epsilon) - \pi_x U_x^1 - (1-\pi_x) U_x^0 + \tilde{J}_x^1(\epsilon). \tag{14}$$

Define V_x^i for $i \in \{0,1\}$ as the expected match surplus of a newly formed match:

$$V_x^0 = E_\epsilon S_x^0(\epsilon), \text{ and } V_x^1 = E_\epsilon \max\left\{\tilde{S}_x^1(\epsilon), 0\right\}. \tag{15}$$

The Nash bargaining rule implies that the firm that hires workers of type i obtains $(1-\beta)$ fraction of the total surplus:

$$J_x^i(\epsilon) = (1-\beta) S_x^i(\epsilon), \text{ for } i \in \{0,1\}, \text{ and } \tilde{J}_x^1(\epsilon) = (1-\beta) \tilde{S}_x^1(\epsilon). \tag{16}$$

So, in a new match of quality ϵ, a worker eligible for UI receives a lump-sum payment $J_x^1(\epsilon) - \tilde{J}_x^1(\epsilon)$ upon accepting the job offer.

2.4 Equilibrium

An equilibrium is determined by the set of equations formed by the laws of motion (2) to (4), the Bellman equations (5) to (11), the free entry condition (12), the match surplus definitions (13) to (14), and the Nash bargaining rules (16).

Following Mortensen and Nagypál (2007), we are going to characterize an equilibrium by focussing on the match surpluses. To this end, we will characterize first the value of UI eligibility to an unemployed worker and to a firm-worker pair in an employment relationship.

The value of UI eligibility to an unemployed worker is $\hat{U}_x \equiv U_x^1 - U_x^0$. Substituting the value functions U_x^0 and U_x^1 from (5) and (6) into the definition of $\hat{U}_x$, and simplifying with the help of the Nash bargaining rules (16), and the definitions of $S_x^0(\epsilon)$, $\tilde{S}_x^1(\epsilon)$, and V_x^i, we obtain:

$$\hat{U}_x = b + \rho E_x \left([1 - f_x(1-\pi_{x'}) - (1-f_x) d_{x'}] \hat{U}_{x'} \right) + \rho\beta f_x \left(E_x V_{x'}^1 - E_x V_{x'}^0 \right). \tag{17}$$

Therefore, eligibility for UI gives unemployed workers current UI benefits plus the expected present value of being eligible for UI while unemployed next period plus the difference in expected utility values attained by eligible and ineligible workers in case they get matched elsewhere next period.

The total value of UI eligibility to a firm-worker pair when the worker becomes eligible for UI is $\hat{B}_x(\epsilon) = J_x^1(\epsilon) + W_x^1(\epsilon) - J_x^0(\epsilon) - W_x^0(\epsilon)$. Substituting (8) to (11) into this definition and simplifying with the definitions of $\hat{U}_x$ and $\hat{B}_x(\epsilon)$, we obtain:

$$\hat{B}_x(\epsilon) = \rho \left[s E_x \hat{U}_{x'} + (1-s)(1-g) E_x \hat{B}_{x'}(\epsilon) \right]. \tag{18}$$

That is, UI eligibility for a firm-worker pair gives the worker the prospect of collecting UI in case of an exogenous separation. An analogous argument to the one in Zhang and Faig (2012) implies that both $\hat{U}_x$ and $\hat{B}_x(\epsilon)$ are non-negative.

Substituting the value functions from (5) to (11) into (13) and using $\hat{U}_x$ and $\hat{B}_x(\epsilon)$ to simplify, the surplus of an employment match that involves an ineligible worker is:

$$S_x^0(\epsilon) = p_x(\epsilon) - \ell - \tau_x + \rho\left[(1-s)\, E_x S_{x'}^0(\epsilon) - \beta f_x E_x V_{x'}^0 + (1-s)\, g E_x \hat{B}_{x'}(\epsilon)\right]. \quad (19)$$

The existence of the UI system affects this match surplus in two ways: the firm has to pay the current contribution fee τ_x and the worker gains UI eligibility next period with the probability g as long as the employment continues by then.

Combining the definitions of $\hat{U}_x$ and $\hat{B}_x(\epsilon)$ with those of $S_x^i(\epsilon)$ for $i \in \{0,1\}$ and $\tilde{S}_{x'}^1(\epsilon)$, and using $\tilde{W}_x^1(\epsilon) + \tilde{J}_x^1(\epsilon) = W_x^1(\epsilon) + J_x^1(\epsilon)$ (utility is transferable), we obtain:

$$S_x^1(\epsilon) = S_x^0(\epsilon) + \hat{B}_x(\epsilon), \text{ and } \tilde{S}_x^1(\epsilon) = S_x^0(\epsilon) + \hat{B}_x(\epsilon) - \pi_x \hat{U}_x. \quad (20)$$

Consequently, eligibility for UI by an employed worker has two opposing effects on a match surplus: Eligibility for UI brings total gains $\hat{B}_x(\epsilon)$ to the firm-worker pair involved in the match. However, UI eligibility tends to reduce the match surplus when a firm-worker pair first meets because the worker's outside value increases by $\pi_x \hat{U}_x$. Since $\pi_x \geq 0$, (20) implies $S_x^1(\epsilon) \geq \tilde{S}_x^1(\epsilon)$ for all $x \in X$ and $\epsilon \in E$.

A stochastic recursive equilibrium is fully characterized by equations (17) to (20), together with the laws of motion of x, the definitions in (15), and the following restatement of the condition for free entry:

$$c\theta_x = \rho f(\theta_x)(1-\beta)\left[\left(u_x^0/u_x\right) E_x V_{x'}^0 + \left(u_x^1/u_x\right) E_x V_{x'}^1\right]. \quad (21)$$

This system of functional equations is the one we solve numerically in the simulations of the next section.

3 Numerical Analysis

This section analyzes the quantitative predictions of the model laid out in Section 2. This numerical analysis pursues two objectives. The first one is to show that when one recognizes that the duration of UI benefits in the United States is dependent on the state of the economy, then the value of leisure required to fit the high variability of unemployment and vacancies does not need to be so extremely high as it is required in the standard analyses with constant expected duration of UI benefits. The second objective is to calculate the effect of having extended the effective duration of UI benefits in 2008 to 99 weeks, which is almost double the average duration it had in previous recessions.

Our numerical analysis adopts the following specifications. First, the matching function is Cobb-Douglas: $M(v,u) = \mu v^{1-\eta} u^{\eta}$.[4] As a result, the finding rate is: $f(\theta) = \mu\theta^{1-\eta}$,

[4] In principle, a Cobb-Douglas matching function should be truncated to ensure that the finding and the filling rates are probabilities, but in our simulations this is not necessary because these probabilities

so it is a constant elasticity function of the vacancy-unemployment ratio. Second, the common part of the aggregate labor productivity is assumed to be a stochastic process that satisfies $\overline{p}_x = p_{\min} + e^y (p^* - p_{\min})$, where $p_{\min}$ is the lower bound on possible productivities, p^* is the median productivity, and y is a zero mean random variable that follows a symmetric 51-states Markov process in which transitions only occur between contiguous states. The value of p^* is calibrated so the average labour productivity is one. The value of $p_{\min}$ is picked so that the difference in logs between p^* and $p_{\min}$ is four times the observed standard deviation of labor productivity. The stochastic process of y has a transition matrix governed by two parameters: the step size of a transition, δ, and the probability that a transition occurs, λ.[5] Third, the distribution of match qualities is uniformly distributed with a discrete support of 201 possible qualities evenly spread in an interval $[-\bar{\epsilon}, \bar{\epsilon}]$. Finally, the UI contribution fee is constant over time, and on average finances the cost of UI benefits.

3.1 Parameterization

Our calibration targets aim to replicate the most prominent rates and flows in the labor market, and, in a stylized way, the key features of the UI system in the United States, and its impact on labor market flows. We adopt one week as the length of the model period. To match empirical moments of lower frequencies, we aggregate consecutive weekly data from our simulations to construct suitable variables of the appropriated frequency.

We calibrate the model in two stages. In the first stage, we set the five top parameters in Table 1 independently from the rest. The interest rate (r) is set to correspond to a typical annual rate of 4 percent. The value of c is normalized to one. The probability to earn UI eligibility (g) in one period is set to match the average time it takes for a worker to gain UI eligibility (20 weeks).[6] Finally, the probabilities of losing UI benefits in normal times (d_0) and in recessions (d_1) are set to match the average duration of UI benefits in normal times (26 weeks) and recessions (55 weeks).

In the second stage, we jointly calibrate the remaining thirdteen parameters of the model to match the eleven targets at the bottom of Table 1, in addition to the Hosios condition, and a zero average budget deficit for the UI system. The first seven of these targets are empirical moments from the United States that describe the main features of the business cycle in the labor market, and were constructed from the data reported by Shimer (2005) or its original sources.[7] Note that, following Mortensen and Nagypál

are in the interior of the zero-one interval.

[5] See Zhang (2008) for further details on the modelling of this stochastic process.

[6] See Card and Riddell (1992) and Osberg and Phipps (1995) for the weeks needed to gain eligibility.

[7] For these calculations, we used Table 1 in Shimer (2005). The average short-term unemployment rate from 1951(1) to 2003(12) was calculated using Shimer's methodology from the following series of the Current Population Survey by the Bureau of Labor Statistics: (i) Number of Unemployed for Less than 5 Weeks (Series ID: LNS13008396) and (ii) Civilian Labor Force Level (Series ID: LNS11000000),

(2007), we conduct a calibration using moments conditional on aggregate labor productivity $\bar{p}$, which is the only variable with exogenous shocks in our simulations. So, we multiplied the unconditional standard deviations reported by Shimer with the respective correlations of each variable with $\bar{p}$. For comparison purposes, we also conduct a calibration using unconditional moments.

Table 1

Calibration Targets

Annual real interest rate (r)	0.04
Cost of posting a vacancy (c)	1
Average weeks of employment needed for UI eligibility ($1/g$)	20
Average weeks before UI benefits expire ($1/d_0$) in normal times	26
Average weeks before UI benefits expire ($1/d_1$) in recessions	55
Average labor productivity	1
Standard deviation of labor productivity (*quarterly in logs*)	0.020
Autocorrelation of labor productivity (*quarterly in logs*)	0.878
Average unemployment rate	0.0567
Average short-term unemployment rate	0.0244
Standard deviation of unemployment rate conditional or not on $\bar{p}$ (*quarterly in logs*)	0.0775/0.190
Standard deviation of θ conditional or not on $\bar{p}$ (*quarterly in logs*)	0.151/0.382
Effective replacement rate of UI benefits (b/w)	0.25
Fraction of time the economy is in recession ($d_t = d_1$)	1/3
Increased average unemployment duration (*in weeks*) if (b/w) increases by 0.1	1
Increase in the elasticity of duration of unemployment with respect to b due to eligibility	0.3

NOTE: These are the targets that our calibration of the model aims to reproduce. Most of these targets correspond to empirical moments in the United States. Each one of the first five targets pins down one parameter, specified in parenthesis. The rest collectively pin down the remaining parameters. We conduct two different simulations depending on if the targeted standard deviations of unemployment and θ are conditional on $\bar{p}$ (conditional moments) or not (unconditional moments).

The last four targets in Table 1 correspond to key characteristics of the UI system in the United States and how this system influences labor flows. As for the level of UI benefits, we target the effective replacement rate measured as the product of the take-up rate (fraction of eligible unemployed workers who actually collect UI) and the observed replacement rate conditional on receiving benefits. As explained by Blank and Card (1991), the take-up rate was fairly stable around 0.7 over their period of study (1977-1987). Meanwhile, the replacement rate for those who receive benefits averaged 0.357 over

both available at http://www.bls.gov/cps/. Finally, the average labour productivity being one is a normalization.

the period 1972-2003.[8] The economy is assumed to be in recession and so the probability is losing UI is d_1 when aggregate productivity is below a certain threshold, which is picked so that the economy is in recession 1/3 of the time. Recession here refers to a period over which extraordinary measures were taken by the Federal Government to extend the duration of UI benefits from 1955 to 2003.[9] To be consistent with the survey by Atkinson and Micklewright (1991) on the effects of UI on labor flows, we aim to parameterize the model so increases in UI benefits affect the unemployment rate moderately through the duration of unemployment spells, but not through their incidence.[10] To attain this, we target the effect of a 10 percentage point increase in the replacement rate to raise the average duration of unemployment by one week.[11] Also, we assume that workers who quit a job cannot collect UI as already embedded in all the equations presented above. Finally, we aim that an increase in benefits has a realistic effect on the rejection of job offers. To this end, we target the extra elasticity of duration of unemployment with respect to b for those who are eligible to collect UI relative to those who are not. Meyer and Mok (2007) reported an estimate of 0.3 based on a reform at State of New York in 1989. In their study they compared the durations of unemployment for workers who got an increase in b in the reform with other unemployed workers in the same localities who did not receive such a raise. Quite convincingly, this analysis isolated the individual responses to the increase in b for those who received it, controlling for other effects taking place through the posting of vacancies and the remuneration of workers.

3.2 Calibration Results

The calibrated model can successfully replicate all the targets listed in Table 1. The parameter values obtained in the second stage of the calibration are reported in Table 2. To compare, we report not only the parameter values calibrated when d is contingent on $\bar{p}$, but also the ones when d is constant, so there are no extensions of UI benefits in recessions. The key point from this table is that the values of leisure required to match the targeted moments are significantly lower in the simulations where the duration of UI

[8]This ratio is reported in the annual report and financial data of the U.S. Department of Labor Employment and Training Administration (Column 33), which is available at http://workforcesecurity.doleta.gov/unemploy/hb394.asp.

[9]See the Department of Labor web page for information on the Extended Benefits Program (http://www.oui.doleta.gov/unemploy/extenben.asp) and the various special extended programs since 1945 (http://www.oui.doleta.gov/unemploy/spec_ext_ben_table.asp). Also, note that according to this definition recessions are more frequent than according to the standard NBER definition.

[10]The survey by Atkinson and Micklewright (1991) remarks the importance of the outflows from unemployment in explaining the effect of benefits on overall unemployment. Also, Sider (1985), Pissarides (1986), and Burda (1988), after examining a variety of countries and time periods, emphasize that variations in unemployment duration are the primary driving force of variations in unemployment.

[11]Moffitt and Nicholson (1982) estimate that a 10 percentage point increase in the replacement rate leads to an increase in unemployment duration of up to one week. For the same change, Moffit (1985) and Meyer (1990) offer estimates of around 0.5 weeks and 1.5 weeks, respectively.

benefits is contingent on $\bar{p}$. In the calibrations to conditional moments, the value of leisure falls from 0.84 to 0.76. In the calibrations to unconditional moments, the value of leisure falls from 0.93 to 0.9. Consequently, with extensions of UI benefits the margin between the average productivity of labor and the value of leisure increases by almost 50 percent in the calibration to conditional moments and around 30 percent in the calibration to unconditional moments.

TABLE 2

Parameter Values

Moments to be matched	Conditional on $\bar{p}$		Unconditional	
Duration of UI benefits	Contingent on $\bar{p}$	Constant	Contingent on $\bar{p}$	Constant
	(1)	(2)	(3)	(4)
p^*	0.9978	0.9981	0.9985	0.9984
$\bar{\epsilon}$	0.0111	0.0072	0.0018	0.0008
ℓ	0.7587	0.8364	0.9041	0.9257
λ	0.3747	0.3753	0.3771	0.3772
δ	0.0727	0.0726	0.0723	0.0723
s	0.0079	0.0079	0.0079	0.0079
μ	0.3097	0.3765	0.5261	0.6488
η	0.7381	0.6850	0.6538	0.6030
β	0.7381	0.6850	0.6538	0.6030
b	0.2457	0.2459	0.2462	0.2463
τ	0.0117	0.0113	0.0117	0.0112
γ	0.2953	0.3905	0.5222	0.5460

NOTE: With these parameters the model replicates the moments in Table 1. In the columns "conditional on $\bar{p}$", the model is calibrated to match the standard deviations of log of unemployment and the log of the vacancy/unemployment ratio conditional on productivity. In the columns "unconditional", these targeted standard deviations are unconditional. In the columns "contingent on $\bar{p}$", the expected duration of UI benefits is 55 weeks in recessions and 26 in normal times. In the columns "constant", the duration of UI benefits is always 26 weeks.

To understand why the value of leisure falls when d is contingent on $\bar{p}$, note that the programs that extend the duration of UI benefits in recessions tend to exacerbate the variability of unemployment and vacancies. In the absence of the programs extending the duration of UI benefits in recessions, our model predicts that the standard deviations of these variables would have been substantially lower. For example, using the parameters from the calibration to conditional moments and a duration of UI benefits contingent on $\bar{p}$, we calculate that if the expected duration of UI benefits had been constant at 26 weeks, the unconditional standard deviation of unemployment would have fallen from

0.086 to 0.054, that is a drop of 37 percent. Analogously, in the calibration to unconditional moments, the standard deviation of unemployment would have fallen from 0.19 to 0.12, again close to a 37 percent drop. As a result of these drops, we do not require such tiny margins between $\bar{p}$ and ℓ for productivity shocks to have substantial effects on unemployment when d is contingent on $\bar{p}$. So, the values of leisure needed to match the wide labor market cycles experienced in the United States do not need to be so high either. Since the model has been calibrated to have moderate effects to changes in UI policies, the reductions in the values of leisure, even though they are significant, they are also moderate.

Another point to note from Table 2 is that the values of γ (probability of catching a worker who tries to collect UI after rejecting a job) falls when d is contingent on $\bar{p}$. The values of γ have to fall in these calibrations because low values of leisure reduce the effect of UI on unemployment. Since in our calibration this effect is targeted to a fixed value, other parameters that have sizeable effects on this target, such as γ, have to adjust. The lower is the probability γ the stronger are the effects of UI on the bargaining power of UI eligible workers, and so the stronger its effects on wages and unemployment. Therefore, the drops in γ compensate for the drops in ℓ to keep unchanged the targeted effects of UI. Furthermore, the drops in γ tend to exacerbate the amplitude of cycles in the labor market, so they reinforce the reduction in ℓ. This interaction between γ and ℓ is particularly strong in the calibration to conditional moments. And this is the reason why the relative drops in ℓ are weaker in the calibration to unconditional moments than the calibration to conditional ones.

3.3 Effect on Unemployment of Extending UI Benefits in Recessions

This subsection inquires on the effect on unemployment of extending UI benefits in recessions. To this end, we use the model calibrated in Section 3.2 and compare the predicted unemployment rates with alternative expected durations of UI benefits (d_1^{-1}) in recessions. Specifically, this analysis considers the following alternative UI regimes: In Regime 1, there are no extensions of UI benefits during recessions, and $d_1^{-1} = 26$ weeks. In Regime 2, there is the basic Extended Benefits (EB) Program prolonging the UI entitlement during downturns to $d_1^{-1} = 39$ weeks.[12] Regime 3 is the one used for the calibration in Section 3.2, and this regime mimics the average practice over the period 1951-2003, in which $d_1^{-1} = 55$ weeks. Finally, Regime 4 corresponds to the one where the EUC program enacted in 2008 becomes the norm in future recessions. So, $d_1^{-1} = 99$ weeks.

[12] As explained in the web page http://www.oui.doleta.gov/unemploy/extenben.asp of the Department of Labor some states have an additional extension of 7 weeks for very high levels of unemployment.

Table 3 reports the average unemployment rate during recessions predicted by our simulations. The magnitude of the effect of changing the duration of UI benefits depends on if we calibrate the parameters to match conditional or unconditional moments. In our preferred calibration to conditional moments, extending UI benefits from 26 weeks to 55 weeks increases the average unemployment rate in recessions by 0.5 percent. So, the model predicts that the various programs extending UI benefits during the post Second World War recessions exacerbated the unemployment rate during downturns by 0.5 percent. The recent extension to 99 weeks has amplified this effect to 0.75 percent. In the calibration to unconditional moments, these effects would be much stronger. The extension to 55 weeks would increase the unemployment rate by 1.2 percent, and the extension to 99 weeks would magnify this effect to reach 2 percent.

TABLE 3

Average Unemployment Rate in Recessions

Expected duration of UI benefits in recessions	Conditional Moments	Unconditional Moments
26 weeks	5.88	6.12
39 weeks	6.15	6.74
55 weeks	6.35	7.28
99 weeks	6.63	8.15

NOTE: Comparison across regimes with alternative values of d_1 shows a significant but moderate effect of programs extending the duration of UI benefits during downturns. In the columns "conditional moments", the model is calibrated to match the standard deviations of log of unemployment and the log of the vacancy/unemployment ratio conditional on productivity. In the columns "unconditional moments", these targeted standard deviations are unconditional.

Several recent papers (see Section 1) have considered the effect of enacting EUC 2008. In our simulations, this effect corresponds to a comparison of the regime with 99 weeks of entitlement to UI benefits with the regime with 39 weeks. Therefore, as shown in Table 3, the model predicts that the enactment of EUC 2008 would be responsible for increasing the unemployment rate by 0.5 percent in the calibration to conditional moments, and by 1.4 percent in the calibration to unconditional moments. As discussed in Section 1, the prediction using the calibration to conditional moments squares well with earlier estimates, while the prediction using unconditional moments would be at the upper end of the available estimates.

In our model, the predicted moderate effect of EUC 2008 on the unemployment rate come from having calibrated our model to target moderate effects of UI on unemployment. However, these moderate effects do not mean that all changes in UI policies have weak effects. For example, using the parameters of Table 1 column (1) our model predicts that if, as is the case in Spain, the replacement rate were to increase to 0.65 and the expected duration of UI benefits were to be constant at 2 years then the average unemployment rate in recessions would climb to 18 percent. Furthermore, if the probability of detection γ of workers "cheating" where to drop to half the value we have calibrated for the United States, we would predict an average unemployment rate in recesions of 25 percent (coincidently the level observed in Spain in 2012). Consequently, our model is capable of explaining strong variations in unemployment with more radical changes in policy than the passage of EUC 2008.

4 Conclusions

The programs extending UI benefits during recessions in the United States have had a significant effect on the volatility of unemployment. In their absence, we estimate that the standard deviation of unemployment since the Second World War would have fallen by around 36 percent. Likewise, without the adverse incentive effects of EUC 2008, which are at the core of our model, the unemployment should have been around 0.5 percent lower. These effects are moderate because we calibrate our model to match weak effects of UI policies on unemployment, but they are still significant because of the large wide fluctuations in the number of weeks that UI eligibility has lasted in our period of analysis. Therefore, the state-contingent duration of UI benefits is an important piece of the puzzle of why unemployment has experienced such wide cycles in the recent history of the United States, and it should not be forgotten in future explorations of labor market cyclicality.

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