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"Unemployment Benefit Extensions Caused Jobless Recoveries!?"

by

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UNEMPLOYMENT BENEFIT EXTENSIONS CAUSED JOBLESS RECOVERIES!?*

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Abstract

The last three recessions in the United States were followed by jobless recoveries: while labor productivity recovered, unemployment remained high. In this paper, we show that countercyclical unemployment benefit extensions lead to jobless recoveries. We augment the standard Mortensen-Pissarides model to incorporate unemployment benefit expiration and state-dependent extensions of unemployment benefits. In the model, an extension of unemployment benefits slows down the recovery of vacancy creation in the aftermath of a recession. We calibrate the model to US data and show that it is quantitatively consistent with observed labor market dynamics, in particular the emergence of jobless recoveries after 1990. Furthermore, counterfactual experiments indicate that unemployment benefits are quantitatively important in explaining jobless recoveries.

Keywords: Unemployment Insurance, Business Cycles, Jobless Recoveries
JEL codes: E24, E32, J65

1 Introduction

A central question in macroeconomic analysis of the labor market is understanding the dynamics of unemployment. The emergence of jobless recoveries in the US economy presents a challenge for this research agenda. Jobless recoveries, phenomena in which aggregate labor productivity grows following a recession, but unemployment remains high, are a prominent and striking feature of the recessions of 1990-1991, 2001 and 2007-2009. These observations have been interpreted as a puzzle from the perspective of standard models of labor market dynamics, which attribute unemployment fluctuations to fluctuations in labor productivity. In this paper, we argue that jobless recoveries are a consequence of government policy, specifically of cyclical changes in unemployment insurance.

The unemployment system in the United States features automatic triggers that increase the duration of unemployment benefits during periods of high unemployment. Moreover, in all but one of the previous eight recessions, the government has enacted discretionary policies extending benefit duration further. The weeks of extended benefits available have increased over the last 50 years, reaching an unprecedented extension to 99 weeks of benefits available during the Great Recession. Crucially, because unemployment benefit duration is generally tied to the unemployment rate, high benefit durations persist long after labor productivity begins to recover following a recession.

To study the implications of this policy for the cyclical behavior of the labor market, we use a variant of the Mortensen-Pissarides equilibrium search model with aggregate shocks to labor productivity. Workers and firms in the model match pairwise to produce and bargain over wages. Unemployment benefits increase the unemployment rate by raising the workers' outside option in wage negotiations, thereby discouraging firms from posting job vacancies. If unemployment benefits were constant, a recovery in productivity in the model would imply a drop in unemployment. However, the actual unemployment insurance system extends the duration of unemployment benefits when unemployment is high. Because unemployment is high in the aftermath of a productivity drop, a recovery in productivity is likely to coincide with an extension of unemployment benefits, which can slow down or even prevent the recovery of employment. We argue that this channel lowers the correlation between productivity and unemployment and has the capacity to explain the emergence of jobless recoveries that we observe.

We quantitatively evaluate the importance of this channel in our calibrated model by simulating the series of productivity shocks observed in the 1960-2012 period and sequen-

tially introducing the unemployment benefit extensions enacted during this period. We find that the model accounts well for observed time series of unemployment, in particular the observations that recoveries were not jobless prior to 1990 and became jobless thereafter. We then conduct counterfactual experiments to quantify the importance of the extensions: specifically, we examine how the cyclical behavior of unemployment would have been different had the extensions not occurred. We find that the model incorporating the observed countercyclical unemployment benefit extensions accounts for the data substantially better than a model with a constant unemployment insurance policy. The model predicts a much faster recovery of employment if the unemployment benefit extensions are not enacted. This quantitative result is driven by the general equilibrium effect of unemployment benefits on firms' decisions to post vacancies, via their effect on the worker outside option in wage negotiations. Our analysis shows that appropriately incorporating unemployment benefit extensions is important in quantitatively accounting for unemployment dynamics.

In addition to matching the unemployment dynamics, we find that the model accounts for the apparent shift in the Beveridge curve observed following the 2007-2009 recession. The Beveridge curve - the observed negative correlation between unemployment and vacancies - is a robust feature of the post-war labor market. However, this correlation became substantially weaker in the aftermath of the last recession, as the rise in job postings was not accompanied by a comparable fall in unemployment. We show that our simulated model reproduces an unemployment-vacancy correlation very similar to the one observed in the data - including the 2007-2013 period, during which the model reproduces the perceived shift in the simulated Beveridge curve. In other words, the large unemployment benefit extensions implemented during this period acted as shocks that induced a substantial departure from the theoretical Beveridge curve, making it appear as if the curve itself shifted, although all the parameters of our model, including the matching function, have remained the same.

The analysis in our paper is distinct from the large body of research that tries to explain the high volatility of unemployment, following the Shimer (2005) puzzle. Our aim here is not to offer an explanation for the high unemployment volatility.[1] Rather, the quantitative success of our model is evidenced by the fact that it accounts well for the entire time series of unemployment. In particular, it correctly predicts the *timing*, not just the volatility, of unemployment dynamics, specifically the sluggish recovery of employment in the aftermath

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[1]Our calibration, described in detail in section 3, is different from the calibration strategy of Hagedorn and Manovskii (2008) but delivers similar parameter values; in particular, it implies a high value of non-market activity for unemployed workers. It is therefore not surprising that our model delivers a high volatility of unemployment in line with the data.

of a recession.

Our paper contributes to an already large and productive literature trying to account for the phenomenon of jobless recoveries. Previous research attempts to substantially modify existing models to account for the sluggish recovery of employment. Bernanke (2003) attributes jobless recoveries to sluggish aggregate demand. Groshen and Potter (2003) propose structural change as an explanation, and Bachmann (2011) studies the role of labor hoarding. Most recently, Berger (2011) has argued that countercyclical restructuring behavior of firms can generate jobless recoveries. This is by no means an exhaustive list.[2] Relative to this literature, our paper proposes a significantly smaller departure from a workhorse Mortensen-Pissarides model. Rather than modify the structural features of the model, we argue for incorporating a salient but previously overlooked feature of US government policy - time-varying unemployment insurance - into the standard framework. Our results imply not only that unemployment insurance is crucial for explaining the emergence of jobless recoveries, but also that a standard equilibrium search model explains unemployment dynamics very well once these time-varying policy changes are accounted for.

Our paper is also related to a recent literature attempting to quantify the importance of unemployment benefit extensions for unemployment in the 2007-2009 recession, including Nakajima (2011), Valletta and Kuang (2010), Fujita (2010), Rothstein (2011), and Hagedorn, Karahan, Manovskii, and Mitman (2013). Our paper differs substantially from this literature by using a calibrated general equilibrium model in which the only exogenous inputs are productivity shocks and changes in unemployment benefit duration. Furthermore, while the above-mentioned literature focuses only on the 2007-2009 recession and its aftermath, we use time-varying unemployment benefits to explain the entire time series of unemployment over the last 50 years. To the best of our knowledge, our paper is the first to link the growing generosity of extensions to the emergence of jobless recoveries, in particular to explain the unemployment experience of the 1990-1991 and 2001 recessions as well as the most recent one.

In section 2 we describe the model environment with time-varying unemployment benefits. In section 3 we lay out the calibration procedure. In section 4 we discuss the calibrated model's predictions and compare them with empirical estimates from the previous literature. In section 5, we describe the simulation and quantitative analysis that we conduct. Section 6 reports the results, and section 7 concludes. All tables and figures are collected in Appendix

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[2]Aaronson, Rissman, and Sullivan (2004) discuss existing explanations that have been proposed for jobless recoveries.

A. Appendix B provides an overview of the unemployment benefit extensions in the post-war period.

2 Model Description

2.1 Economic Environment

We consider a Mortensen-Pissarides model with aggregate productivity shocks. Time is discrete and the time horizon is infinite. The economy is populated by a unit measure of workers and a larger continuum of firms.

Agents. In any given period, a worker can be either employed (matched with a firm) or unemployed. Workers are risk-neutral expected utility maximizers and have expected lifetime utility

$$U = \mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t x_t,$$

where $\mathbb{E}_0$ is the period-0 expectation operator, $\beta \in (0, 1)$ is the discount factor, and x_t denotes consumption in period t. An unemployed worker produces h, which stands for the combined value of leisure and home production.

Firms are risk-neutral and maximize profits. Workers and firms have the same discount factor β. A firm can be either matched to a worker or vacant. A firm posting a vacancy incurs a flow cost k.

Matching. Unemployed workers and vacancies match in pairs to produce output. The number of new matches in period t equals

$$M\left(u_t, v_t\right),$$

where u_t is the unemployment level in period t, and v_t is the measure of vacancies posted in period t.

The matching function M exhibits constant returns to scale, is strictly increasing and strictly concave in both arguments, and has the property that the number of new matches cannot exceed the number of potential matches: $M\left(u, v\right) \leq \min\{u, v\} \; \forall u, v$. We define

$$\theta_t = \frac{v_t}{u_t}$$

to be the market tightness in period t. We define the functions

$$f(\theta) = \frac{M(u,v)}{u} = M(1,\theta) \quad \text{and}$$

$$q(\theta) = \frac{M(u,v)}{v} = M\left(\frac{1}{\theta}, 1\right)$$

where $f(\theta)$ is the job-finding probability for an unemployed worker and $q(\theta)$ is the probability of filling a vacancy. By the assumptions on M made above, the function $f(\theta)$ is increasing in θ and $q(\theta)$ is decreasing in θ.

Existing matches are exogenously destroyed with a constant job separation probability δ. Thus, any of the $l_t = 1 - u_t$ workers employed in period t has a probability δ of becoming unemployed in period $t+1$.

Production. All worker-firm matches are identical: the only shocks to labor productivity are aggregate shocks. Specifically, a matched worker-firm pair produces output z_t in period t, where z_t is aggregate labor productivity. We assume that $\ln z_t$ follows an AR(1) process

$$\ln z_t = \rho \ln z_{t-1} + \sigma_\varepsilon \varepsilon_t, \tag{1}$$

where $0 \leq \rho < 1$, $\sigma_\varepsilon > 0$, and ε_t are independent and identically distributed standard normal random variables. We will write $z^t = \{z_0, z_1, ..., z_t\}$ to denote the history of shocks up to period t.

2.2 Government Policy

The government levies a constant lump sum tax τ on firm profits and uses its tax revenues to finance unemployment benefits b. Every worker, at each point in time, can be either *eligible* or *ineligible* for unemployment benefits, and receives b only if unemployed and eligible. We assume stochastic benefit expiration, similarly to Fredriksson and Holmlund (2001) and Faig and Zhang (2012). Eligible workers may lose their eligibility if unemployed, and ineligible workers may regain eligibility when employed. Specifically, the eligibility status of a worker evolves as follows:

- A worker who is eligible for unemployment benefits retains his eligibility the following period with probability 1 if employed, and with probability $1 - e_t$ if unemployed; with probability e_t he instead becomes ineligible.

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- A worker who is ineligible for unemployment benefits remains ineligible the following period if unemployed, and becomes re-entitled to unemployment benefits with probability r_t if employed.

This assumption is made to mimic the actual system of benefit expiration and re-entitlement in the US while ensuring the stationarity of the workers' and firms' decision problems. Finally, the government policy can potentially depend on the current state of the economy, in particular on the unemployment rate.

2.3 Timing

1. The economy enters period t with some distribution of workers across employment and eligibility states:

   - l_t^E = measure of eligible employed workers;
   - l_t^I = measure of ineligible employed workers;
   - u_t^E = measure of eligible unemployed workers;
   - u_t^I = measure of eligible unemployed workers.

   Note that $l_t^E + l_t^I + u_t^E + u_t^I = 1$.

2. The aggregate shock z_t then realizes and is publicly observed. Production and consumption then take place: employed workers get wage w_t^E if eligible for unemployment benefits and w_t^I if ineligible (see below for how wages are determined). Unemployed workers receive $h + b$ if eligible for benefits and h if ineligible.

3. Firms decide how many vacancies to post, at cost k per vacancy. This determines the market tightness

$$\theta_t = \frac{v_t}{u_t^E + u_t^I} \qquad (2)$$

4. $f(\theta)\left(u_t^E + u_t^I\right)$ workers find jobs. At the same time, a fraction δ of the existing $l_t = l_t^E + l_t^I$ matches are exogenously destroyed.

5. Eligible unemployed workers become ineligible with probability e_t and remain eligible with probability $1 - e_t$. At the same time, ineligible employed workers become eligible with probability r_t and remain ineligible with probability $1 - r_t$.

The laws of motion for the distribution of workers are then given by:

$$l_{t+1}^E = (1-\delta)\, l_t^E + f(\theta_t)\, u_t^E + r_t \left[(1-\delta)\, l_t^I + f(\theta_t)\, u_t^I\right] \tag{3}$$

$$l_{t+1}^I = (1-r_t)\left[(1-\delta)\, l_t^I + f(\theta_t)\, u_t^I\right] \tag{4}$$

$$u_{t+1}^E = (1-e_t)\left[\delta l_t^E + (1-f(\theta_t))\, u_t^E\right] \tag{5}$$

$$u_{t+1}^I = \delta l_t^I + (1-f(\theta_t))\, u_t^I + e_t\left[\delta l_t^E + (1-f(\theta_t))\, u_t^E\right] \tag{6}$$

2.4 Worker Value Functions

We characterize the problem of the worker recursively. The aggregate state of the economy in period t is denoted by $\Omega_t \equiv \left(z_t, l_t^E, l_t^I, u_t^E, u_t^I\right)$. The evolution of the aggregate state is then determined by equations (1), (3)-(6).

A worker entering period t eligible employed receives a wage w_t^E. Then he retains his job with probability $1-\delta$ and loses it with probability δ. If he loses his job, he also loses his eligibility with probability e_t and retains it with probability $1-e_t$.[3]

A worker entering period t as ineligible employed receives a wage w_t^I. Then he retains his job with probability $1-\delta$ and loses it with probability δ. If he retains his job, he becomes eligible the following period with probability r_t and remains ineligible with probability $1-r_t$.

A worker entering period t as eligible unemployed receives $h+b$ and finds a job with probability $f(\theta_t)$. If he remains unemployed, he loses his eligibility with probability e_t and retains it with probability $1-e_t$.

A worker entering period t as ineligible unemployed receives only h and finds a job with probability $f(\theta_t)$. If he remains unemployed, he also remains ineligible, and if he finds a job, he becomes eligible with probability r_t.

Denote the values of employed workers by W_t^E and W_t^I for eligible and ineligible workers, respectively. Similarly, denote the values of unemployed workers by U_t^E and U_t^I for eligible and ineligible workers, respectively. Then these values satisfy:

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[3]We assume that a worker who has just become unemployed may lose his eligibility immediately. This timing assumption does not affect any of the results and is made purely for analytical convenience; we could have alternatively assumed that an eligible worker who just lost his job spends one period as eligible and only then may lose his eligibility.

$$W_t^E(\Omega_t) = w_t^E + \beta(1-\delta)\,\mathbb{E}W_{t+1}^E(\Omega_{t+1})$$
$$+\beta\delta(1-e_t)\,\mathbb{E}U_{t+1}^E(\Omega_{t+1}) + \beta\delta e_t\mathbb{E}U_{t+1}^I(\Omega_{t+1}) \tag{7}$$

$$W_t^I(\Omega_t) = w_t^I + \beta(1-\delta)\,r_t\mathbb{E}W_{t+1}^E(\Omega_{t+1})$$
$$+\beta(1-\delta)(1-r_t)\,\mathbb{E}W_{t+1}^I(\Omega_{t+1}) + \beta\delta\mathbb{E}U_{t+1}^I(\Omega_{t+1}) \tag{8}$$

$$U_t^E(\Omega_t) = h + b + \beta f(\theta_t)\,\mathbb{E}W_{t+1}^E(\Omega_{t+1})$$
$$+\beta(1-f(\theta_t))(1-e_t)\,\mathbb{E}U_{t+1}^E(\Omega_{t+1})$$
$$+\beta(1-f(\theta_t))\,e_t\mathbb{E}U_{t+1}^I(\Omega_{t+1}) \tag{9}$$

$$U_t^I(\Omega_t) = h + \beta f(\theta_t)\,r_t\mathbb{E}W_{t+1}^E(\Omega_{t+1})$$
$$+\beta f(\theta_t)(1-r_t)\,\mathbb{E}W_{t+1}^I(\Omega_{t+1})$$
$$+\beta(1-f(\theta_t))\,\mathbb{E}U_{t+1}^I(\Omega_{t+1}) \tag{10}$$

2.5 Firm Value Functions

A firm matched to an eligible worker receives profits $z_t - \tau - w_t^E$ and retains the worker for the next period with probability $1-\delta$. A firm matched to an ineligible worker receives profits $z_t - \tau - w_t^I$ and retains the worker for the next period with probability $1-\delta$. If it retains the worker, the worker becomes eligible the next period with probability r_t. Denote the value of a vacancy by V_t and denote by J_t^E, J_t^I the values of a firm matched with an eligible and an ineligible worker, respectively. Then the values of a matched firm satisfy:

$$J_t^E(\Omega_t) = z_t - w_t^E - \tau + \beta(1-\delta)\,\mathbb{E}J_{t+1}^E(\Omega_{t+1}) + \beta\delta\max\{0, V_{t+1}(\Omega_{t+1})\} \tag{11}$$

$$J_t^I(\Omega_t) = z_t - w_t^I - \tau + \beta(1-\delta)(1-r_t)\,\mathbb{E}J_{t+1}^I(\Omega_{t+1})$$
$$+\beta(1-\delta)\,r_t\mathbb{E}J_{t+1}^E(\Omega_{t+1}) + \beta\delta\max\{0, V_{t+1}(\Omega_{t+1})\} \tag{12}$$

A firm posting a vacancy in period t suffers a flow cost k and fills its vacancy with probability $q(\theta_t)$. Let ϖ_t be the probability that, conditional on filling a vacancy, the worker hired by

the firm is eligible for benefits. Then the value of a vacancy satisfies:

$$V_t\left(\Omega_t\right) = -k + \beta q\left(\theta_t\right)\left\{\varpi_t \mathbb{E}J_{t+1}^E\left(\Omega_{t+1}\right) + \left(1 - \varpi_t\right)\mathbb{E}J_{t+1}^I\left(\Omega_{t+1}\right)\right\} \tag{13}$$

The assumptions made above imply

$$\varpi_t = \frac{u_t^E + r_t u_t^I}{u_t^E + u_t^I} \tag{14}$$

Free entry of firms guarantees that the value of a vacancy is always zero in equilibrium, so we will have:

$$k = \beta q\left(\theta_t\right)\left\{\varpi_t \mathbb{E}J_{t+1}^E\left(\Omega_{t+1}\right) + \left(1 - \varpi_t\right)\mathbb{E}J_{t+1}^I\left(\Omega_{t+1}\right)\right\} \tag{15}$$

2.6 Wage Bargaining

We make the assumption, standard in the literature, that wages are determined according to Nash bargaining: the wage is chosen to maximize a weighted product of the worker's surplus and the firm's surplus. An eligible worker's surplus from being employed is defined by $\Delta_t^E = W_t^E - U_t^E$, and an ineligible worker's surplus from being employed is $\Delta_t^E = W_t^E - U_t^E$. Similarly, we define the surplus of a firm employing an eligible worker to be $\Gamma_t^E = J_t^E - V_t$, and for a firm employing an ineligible worker, $\Gamma_t^I = J_t^I - V_t$. The wage w_t^E is chosen to maximize the product

$$\left(\Delta_t^E\right)^\xi \left(\Gamma_t^E\right)^{1-\xi} \tag{16}$$

and similarly, the wage w_t^I is chosen to maximize the product

$$\left(\Delta_t^I\right)^\xi \left(\Gamma_t^I\right)^{1-\xi}, \tag{17}$$

where $\xi \in (0,1)$ is the worker's bargaining weight. Since the value of a vacancy is always zero, we have $\Gamma_t^i = J_t^i$ for $i = E, I$ and so the first-order conditions for the bargaining problems (16), (17) imply $\Delta_t^E = \xi\left(\Delta_t^E + J_t^E\right)$ and $\Delta_t^I = \xi\left(\Delta_t^I + J_t^I\right)$.

2.7 Equilibrium

We now define the recursive equilibrium of the model.

Definition 1 *Given a policy $(\tau, b, e\left(\cdot\right), r\left(\cdot\right))$, an equilibrium is a set of functions for wages $w^E\left(\Omega_t\right)$, $w^I\left(\Omega_t\right)$, market tightness $\theta\left(\Omega_t\right)$, and value functions*

$$\left\{W^E\left(\Omega_t\right), W^I\left(\Omega_t\right), U^E\left(\Omega_t\right), U^I\left(\Omega_t\right), J^E\left(\Omega_t\right), J^I\left(\Omega_t\right), V\left(\Omega_t\right)\right\}$$

such that:

1. *The value functions satisfy the worker and firm Bellman equations (7)-(13)*

2. *Free entry: The value $V(\Omega_t)$ of a vacant firm is zero for all Ω_t*

3. *Nash bargaining: The wage $w^E(\Omega_t)$ maximizes equation (16), and $w^I(\Omega_t)$ maximizes equation (17)*

4. *Laws of motion: The aggregate state Ω_t evolves according to equations (1), (3)-(6).*

3   Calibration

We calibrate the model to match US data over the 1960-2005 period to match several salient features of the US labor market. The model period is taken to be 1 week. We normalize mean weekly productivity to one. Following Hall & Milgrom (2008) we set $b = 0.25$ to match the average replacement rate of unemployment insurance after accounting for the fact that take-up rates of unemployment are less than 100%. The tax rate is set so that the government balances its budget on average, resulting in $\tau = 0.023$. The function $e(\cdot)$ mimics the variation in benefit duration in the US economy.

Following den Haan, Ramey, and Watson (2000), we assume the functional form of the matching function to be

$$M(N, v) = \frac{uv}{[u^\lambda + v^\lambda]^{1/\lambda}}$$

The choice of the matching technology is driven by the requirement that the job-finding rate and the job-filling rate always be strictly less than 1. We obtain:

$$f(\theta) = \frac{\theta}{(1 + \theta^\lambda)^{1/\lambda}}$$

$$q(\theta) = \frac{1}{(1 + \theta^\lambda)^{1/\lambda}}$$

Following Shimer (2005), labor productivity z_t is taken to mean real output per worker in the non-farm business sector. This measure of productivity is taken from the quarterly data constructed by the BLS. We also use the seasonally adjusted unemployment series constructed by the BLS, and measure vacancies using the seasonally adjusted help-wanted index constructed by the Conference Board.

We set the discount factor $\beta = 0.99^{1/12}$, implying a yearly discount rate of 4%. The parameters for the productivity shock process are estimated, at the weekly level, to be $\rho = 0.9895$ and $\sigma_\varepsilon = 0.0034$. The job separation parameter δ is set to 0.0081 to match the average weekly job separation rate. We set $k = 0.58$ following Hagedorn and Manovskii (2008), who estimate the combined capital and labor costs of vacancy creation to be 58% of weekly labor productivity.

This leaves three parameters to be calibrated: (1) the value h of non-market activity; (2) the worker's bargaining weight ξ; and (3) the matching function parameter λ. We calibrate these three parameters jointly to match three data targets, chosen to capture relevant statistics from the US labor market. The first two of these statistics are the average vacancy-unemployment ratio of 0.634 and the average job-finding rate of 0.139. The third target is the elasticity of unemployment duration with respect to potential unemployment benefit duration. Classic research based on large benefit extensions during the recessions of the 1980's, starting with e.g., Moffitt and Nicholson (1982), Moffitt (1985), and Katz and Meyer (1990), reached consensus estimates that a one week increase in benefit duration increases the average duration of unemployment spells by 0.1 to 0.2 weeks. We target 0.1, the lower end of this range. In the next section, we discuss the choice of this estimate. Table 1 reports the calibrated parameters.

4   Discussion: The Effect of Benefit Extensions

As described above, our calibration procedure has used findings from the previous literature estimating the effect of unemployment benefits on unemployment duration. In what follows, we discuss the various available estimates in the literature and compare them to our model's predictions.

Our chosen target for the elasticity of unemployment duration with respect to unemployment benefits lies at the lower end of the range of estimates obtained by Moffitt and Nicholson (1982), Moffitt (1985), and Katz and Meyer (1990).[4] Thus, we can interpret our

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[4]Our model has deliberately abstracted from worker choice of search effort. The classic studies by Moffitt and Nicholson (1982), Moffitt (1985), and Katz and Meyer (1990), measuring the effect of unemployment insurance on unemployment duration, do not disentangle the effect on worker search intensity from the effect on firms' vacancy creation, and thus we interpret their estimates as measuring the combination of these two effects. On the other hand, recent innovative work by Rothstein (2011) and Farber and Valletta (2013) estimates the effect reflecting an individual worker's search intensity response to unemployment benefits and finds that this effect is small. For the purpose of our positive analysis, we see attributing the entire elasticity to the vacancy creation effect as innocuous, and expect similar positive results if instead we calibrated to some combination of vacancy creation and search effort margins.

findings as being conservative estimates of the overall effects of unemployment benefit extensions. The estimate of 0.1 that we use implies that a ten-week increase in benefit duration results in a one week increase in unemployment duration. Although this elasticity might appear small, it is not innocuous in the context we study, for two reasons. First, an apparently small increase in unemployment duration can correspond to a large increase in the aggregate unemployment rate.[5] Second, the unemployment benefit extensions we consider are large, especially the extensions in the most recent recession, which increased potential benefit duration by up to 73 weeks (for a maximum of 99 weeks).

One potential concern could be that the findings from the literature that we use were based on the records of UI recipients and that non-recipients might react differently. But this was shown not to be the case by Rothstein (2011). Indeed, he shows that the job finding rate of ineligible workers responds as much as that of the eligible ones to benefit extensions.

Another potential concern might be that these findings were obtained from the recessions of the 1980's, and that these recessions could, perhaps, be somehow fundamentally different from the subsequent ones. Card and Levine (2000) estimate the effects of a temporary unemployment benefit extension that took place in New Jersey in 1996. They find that a short-term extension of benefit duration by 13 weeks led to a 16.6% decline in the exit rate from unemployment. In our model, a permanent 13 week benefit extension leads to a 17.5% decrease in the exit rate from unemployment. It is expected that our model should over-predict the numerical value from Card and Levine (2000), since they were measuring the effect of a temporary extension, whereas in the model we measured the effect of a permanent extension.

Finally, Hagedorn, Karahan, Manovskii, and Mitman (2013), estimate the effects of unemployment benefit extensions during the Great Recession, as well as during the 2002 recession. They conclude that extending benefit duration significantly increases unemployment, decreases employment and increases equilibrium wages. We find that our calibrated model is consistent with the effects of unemployment benefits on employment and vacancy creation measured by their study.

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[5]For an illustrative example, set the unemployment rate equal to its steady-state value, $u = \frac{\delta}{\delta + f}$, and use the fact that expected unemployment duration is approximately equal to the reciprocal of the job-finding rate. Then, a one-week increase in unemployment duration is equivalent to slightly more than a 10% decrease in the job-finding rate, which, in turn, translates into a 0.75 percentage point increase in the unemployment rate.

5 Simulation

In order to determine to what extent unemployment benefit extensions played a role in generating jobless recoveries, we simulate our model from 1960 forward. Over that time period, as discussed in Appendix B, there were 19 changes to unemployment benefit duration (excluding extensions and reauthorizations). In order to deal with this large number of policy changes while still solving a stochastic weekly model, we make the following simplifying assumptions: (1) we assume that all discretionary policy changes are unanticipated, and (2) we assume that all agents in the model believe that the policy changes are permanent when enacted.

The only exogenous inputs to the model are labor productivity and the changes in unemployment benefits. We construct the labor productivity series using output per worker as reported by the BLS. We HP filter the quarterly data with a smoothing parameter of 1600, then compute the log deviation from the filtered series. We then construct a smooth weekly series such that the quarterly average of the weekly series matches the quarterly detrended series. We take the unemployment rate in December 1960 as the initial condition and then simulate the model forward, feeding in the constructed series for productivity and policy changes. The equilibrium is thus a rational expectations one, but not one with perfect foresight over productivity or policy realizations. At dates which correspond to policy changes, we implement the policy change and simulate the model forward, allowing the unemployment rate to evolve endogenously.

As is standard in business cycle literature, we extract the trend in unemployment from both the data and the model using the HP filter with smoothing parameter of 1600. Because there are significant low frequency movements in unemployment in the data (e.g. the rise in unemployment in the 1970s and 1980s, plausibly due to the baby boomers entering the labor force) that we abstract from in the model, when we compare the model to the data we add in the data trend to the deviations from trend computed in the model. When computing business cycle statistics, however, we calculate them using log deviations from trend.

6 Results

The simulated model is able to account for key features of the post-war labor market. In Figure 3, we plot the unemployment rate generated from the model and that observed in the data. The model with the implemented US unemployment benefit policy generates a time series of unemployment that closely matches what is seen in the data. In addition, in Figure

4 we plot the log deviations from trend both in the data and in the model. Again, notice that the model does an excellent job of matching the data. Next, we confirm the model's ability to match key business cycle statistics. Tables 2 and 3 report the summary statistics from US data and from the model. The model under-predicts the volatility of the labor market. This can also be seen in the time series plots: the model does not attain the same peaks in unemployment as in the data. In the model we have assumed a constant job separation rate, whereas layoffs typically spike at the beginning of recessions. Indeed, our estimates seem consistent with the finding that fluctuations in the job-finding rate (the source of variation in our model) account for three-quarters of the fluctuations in unemployment (Shimer 2012).

Table 4 reports the same summary statistics from the simulated model with no benefit extensions. In addition, we report in Table 5 the autocorrelation of unemployment and, in Table 6, the correlation of unemployment with productivity lagged one quarter. These results show that the calibrated model performs well in matching the cyclical behavior of unemployment. Furthermore, shutting down time-varying unemployment benefit extensions would substantially worsen the model's ability to match the observed dynamics, in particular the persistence of unemployment, the weak correlation between unemployment and productivity, and the comparatively strong correlation between unemployment and lagged productivity.

We next investigate whether the model is consistent with the emergence of jobless recoveries. In Figure 5, we plot the change in employment - actual[6] and predicted by the model - relative to the NBER peak before the 1973-1975, 1980 and 1981-1982 recessions. The model replicates the response of employment over those periods quite well. Next, in Figure 6, we similarly plot the change in employment for the 1990-1991, 2001 and 2007-2009 recessions. The model is able to replicate the observation that, unlike the previous three recessions, the recovery of productivity was not matched in this case by a rapid rise in employment.

Finally, we examine the role of unemployment benefit extensions in generating jobless recoveries. To do so, we perform a counterfactual experiment in which we shut down all benefit extensions (i.e. fix the weeks of benefits at 26) and re-simulate the model. The result is shown in Figure 7 for the 1990-1991, 2001 and 2007-2009 recessions. The figure illustrates that the model without the additional extensions cannot generate jobless recoveries: employment recovers much faster in the model than it does in the data. Unemployment benefit extensions are thus quantitatively important for explaining the cyclical behavior of employment.

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[6]Measured in the Current Population Survey.

6.1 The Beveridge Curve in the Great Recession

The model is also able to successfully replicate the counterclockwise movement in the Beveridge curve in the Great Recession. The model and data Beveridge curves are plotted in Figure 8. This suggests that the large unemployment benefit extensions implemented during this period acted as shocks that induced a substantial departure from the theoretical Beveridge curve, making it appear as if the curve itself shifted, although all the parameters of our model, including the matching function, have remained the same. In order to elucidate the effect of benefit extensions on the Beveridge curve, in Figure 9 we plot the simulated Beveridge curve when productivity is held constant during the Great Recession and subsequent recovery, but benefit extensions are still enacted. The timing of the dynamics of unemployment significantly lags the data (because the drop in productivity preceded benefit extensions); however, it shows that the change in benefits alone can generate counterclockwise movement in the Beveridge curve.

Intuitively, the mechanism behind this result is as follows. The true movement in the Beveridge curve is driven by both the extensions of benefits and shocks to labor productivity. In general, unemployment adjusts quickly such that it reaches its steady state level within a quarter. When the economy is hit by large shocks or policy changes, however, market tightness adjusts immediately but unemployment can lag. A large drop in productivity, or an extension of benefits, would result in a downward-right drop in unemployment-vacancy space, followed by in increase towards the upper right along a path of constant market tightness.[7] When productivity rises, or benefits are decreased, the unemployment-vacancy combination moves towards the upper left on impact, then towards the lower left as unemployment responds. Thus, a combination of negative productivity shocks and increases in benefits resulted in the observed movement to the lower right. As productivity recovered and then benefits were reduced, the unemployment-vacancy combination shifted first up and then towards the left, generating the counter-clockwise shape.

7   Conclusion

The last three recessions in the US were characterized by the presence of jobless recoveries. The last three recessions also featured extensions of unemployment benefits duration of unprecedented size. The thesis of this paper is that these two features of the recent recessions

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[7]In our model this is only approximately true. Market tightness is not a sufficient state variable in our model, since the level of unemployment and fraction of eligible unemployed are also state variables in the firm's free entry condition.

are linked: unemployment benefit extensions in recessions slow down the recovery of employment. Once these time-varying extensions are incorporated into an equilibrium search model, we argue that the model is able to reproduce observed unemployment dynamics. Thus, the emergence of jobless recoveries can be explained by counter-cyclical US benefits policy.

While our results provide a stark link between unemployment benefits and jobless recoveries, we see our findings as complementary to the existing literature. For example, we take the labor productivity process as exogenous in our model. Combining our mechanism with that in Berger (2011), for example, could both generate jobless recoveries and explain productivity dynamics in the post-War US.

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A Tables and Figures

Table 1: Internally Calibrated Parameters

	Parameter	Value
h	Value of non-market activity	0.81
ξ	Bargaining power	0.13
λ	Matching parameter	0.40

Table 2: Summary Statistics, Quarterly US Data, 1960:I to 2013:II

		u	v	v/u	z
Standard Deviation		0.1201	0.1276	0.2758	0.0120
	u	1	-0.8686	-0.8968	-0.2144
Correlation	v		1	0.9775	0.2008
Matrix	v/u			1	0.1434
	z				1

Table 3: Results from the Calibrated Model

		u	v	v/u	z
Standard Deviation		0.0866	0.1077	0.2138	0.0120
	u	1	-0.7729	-0.8745	-0.2829
Correlation	v		1	0.9528	0.4000
Matrix	v/u			1	0.2627
	z				1

Table 4: Results from the Model with No Benefit Extensions

		u	v	v/u	z
Standard Deviation		0.0794	0.0684	0.1431	0.0120
Correlation Matrix	u	1	-0.7905	-0.8925	-0.7548
	v		1	0.9116	0.8407
	v/u			1	0.8193
	z				1

Table 5: Autocorrelation of Unemployment

Quarter Lag	Data	Model	Model w/o Extensions
0	1	1	1
1	0.9154	0.8833	0.8576
2	0.7478	0.6602	0.5598
3	0.5375	0.4517	0.2408
4	0.3193	0.2753	-0.0336
5	0.1254	0.1173	-0.2302
6	-0.0428	-0.02	-0.3484
7	-0.188	-0.1248	-0.3919

Table 6: Correlation with lagged productivity, z_{t-1}

Variable	Data	Model	Model w/o Extensions
u_t	-0.4321	-0.4420	-0.8929
v_t	0.4680	0.5047	0.6927
v_t/u_t	0.4102	0.4589	0.8016
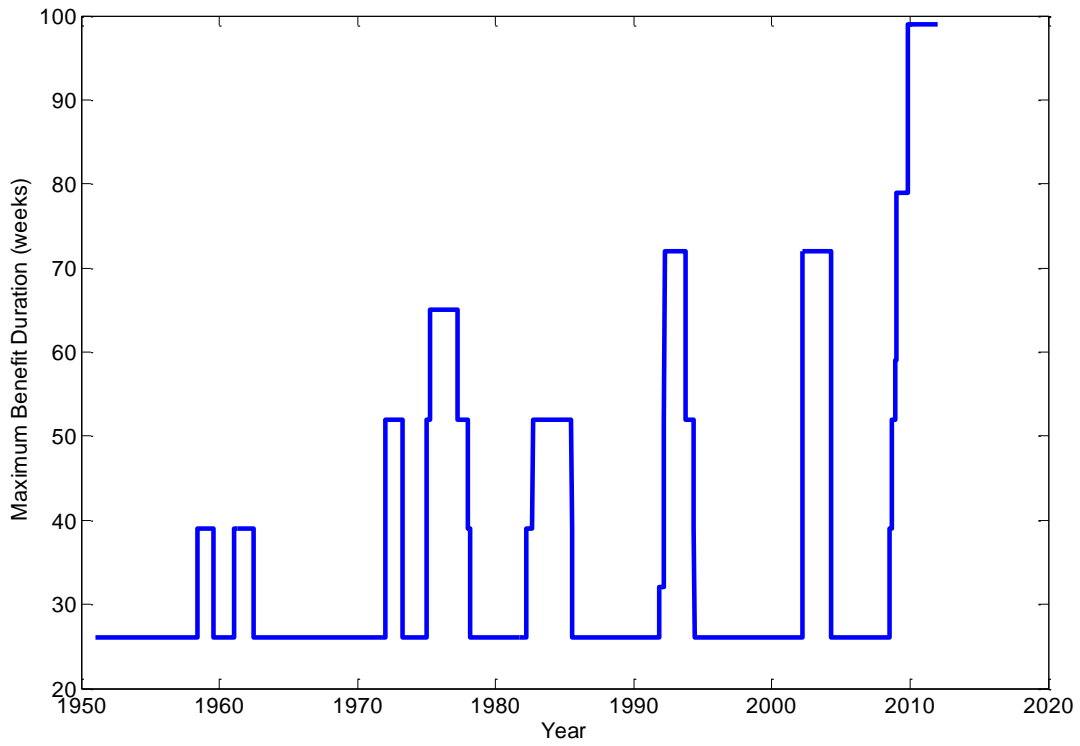
Figure 1: Maximum possible benefit duration available during the Post-War period. The extensions include a combination of discretionary federal extensions and the state-federal extended benefits program.
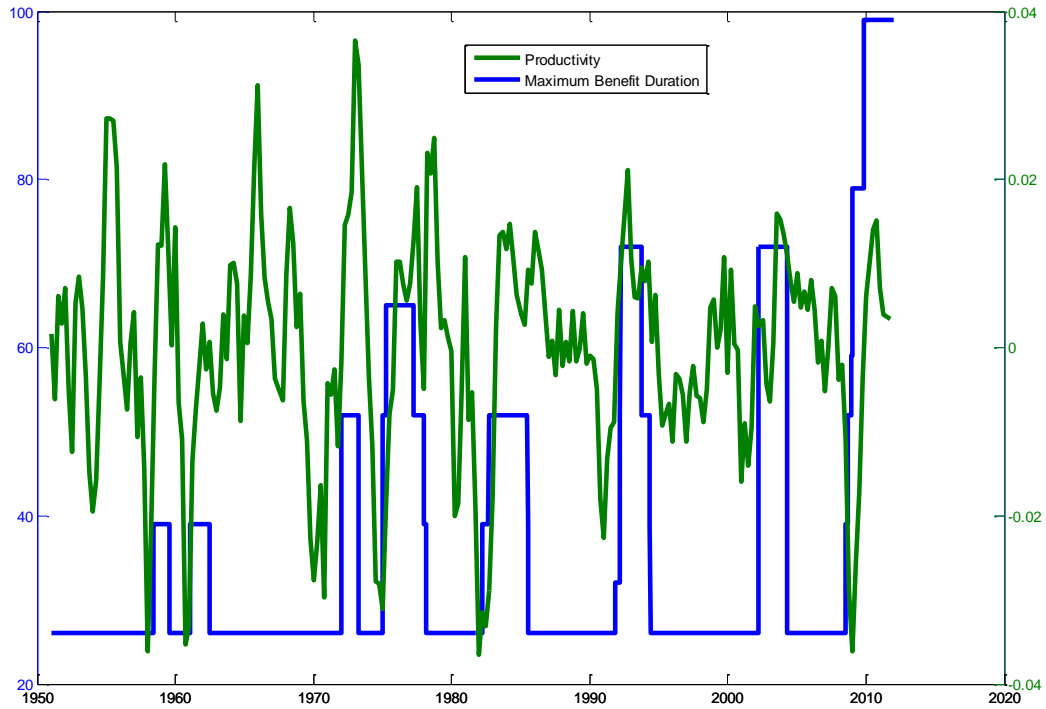
Figure 2: Maximum possible benefit duration available during the Post-War period and productivity. Productivity is calculate as log deviation from HP filtered trend of output per worker in the non-farm business sector reported by the Bureau of Labor Statistics. In the recessions follow the 1981-1982 recession, benefit extensions were more likely to occur after productivity had already begun to recover.
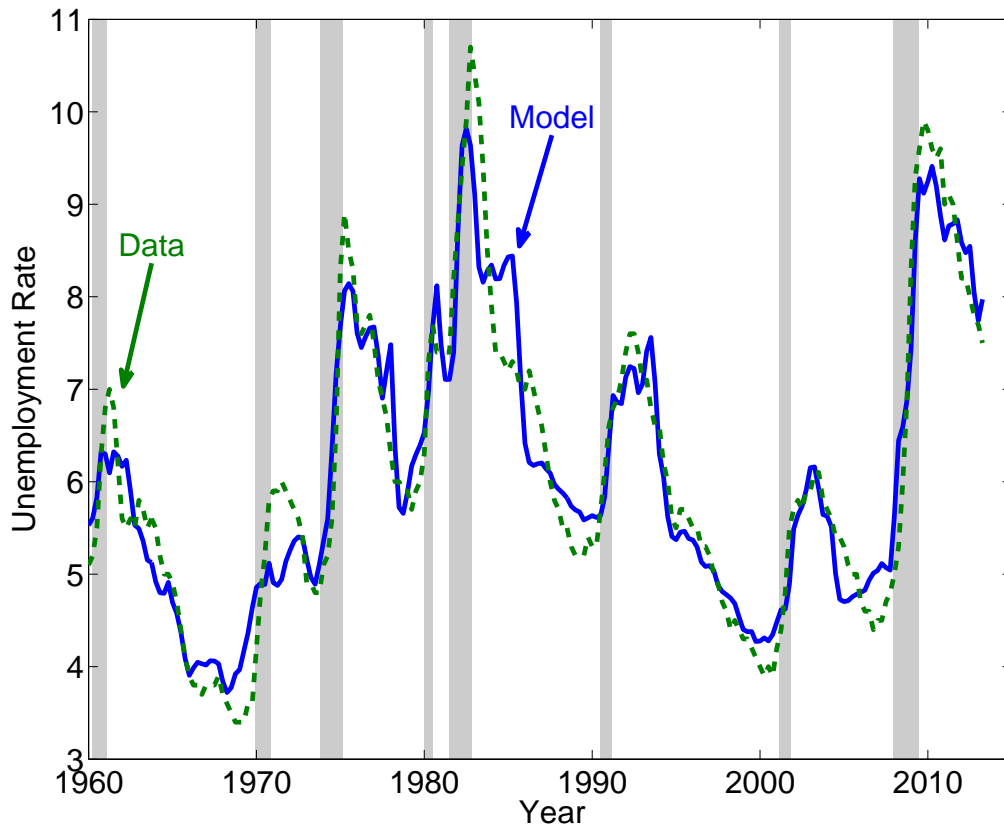
Figure 3: Simulated and actual unemployment from January 1960 through June 2013. NBER dated recessions are shaded.
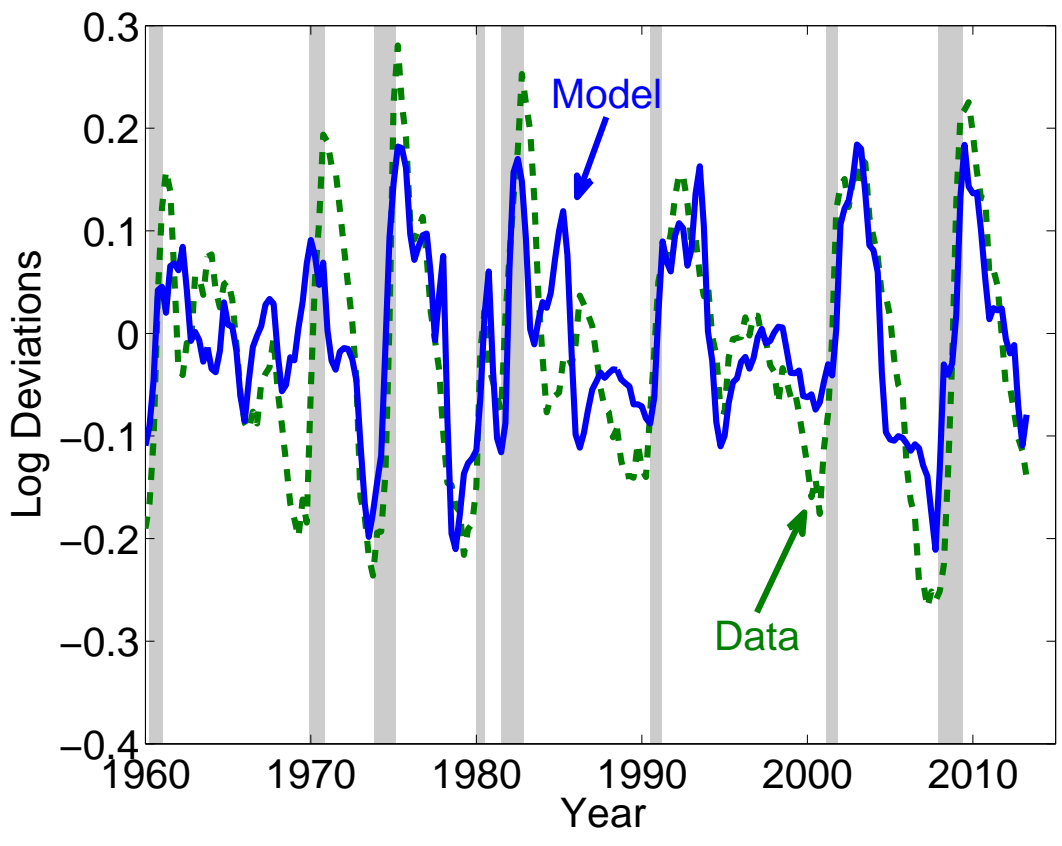
Figure 4: Log deviations from HP filtered trend for simulated and actual unemployment from January 1960 through June 2013. NBER dated recessions are shaded.
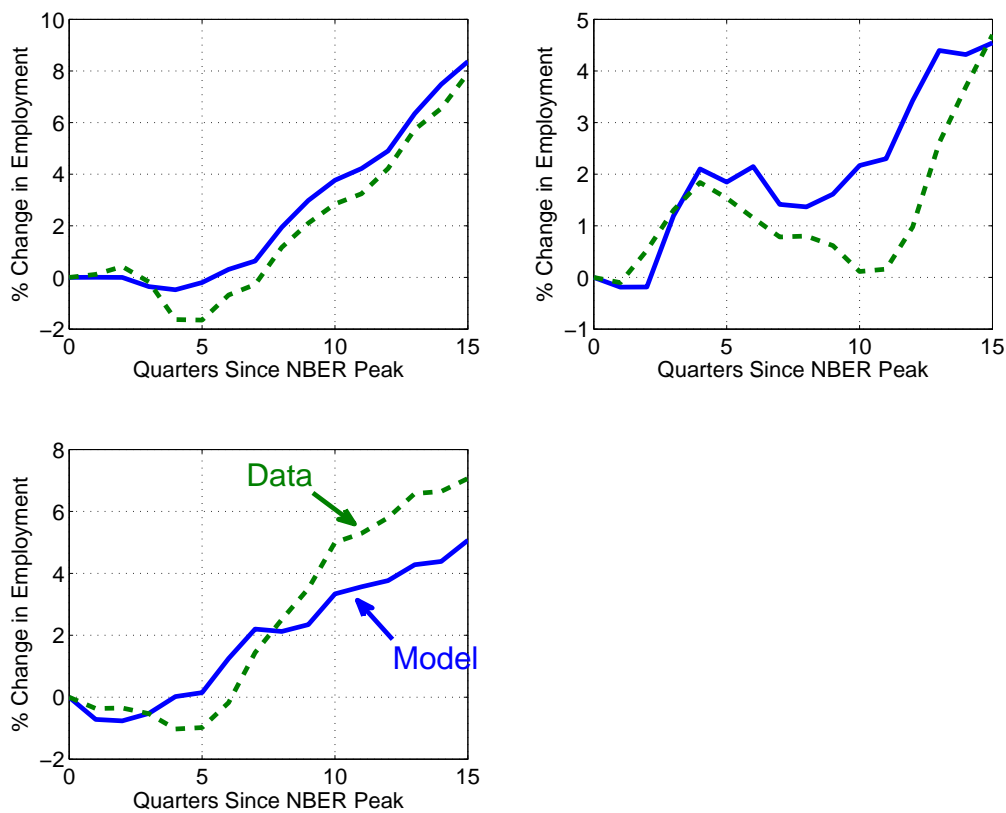
Figure 5: Simulated and actual percentage change in employment from NBER peak before the 1973-75, 1980 and 1981-82 recessions. The blue line is the model and dashed green line is the data. Data and model are not filtered. Data is from CPS, total non-farm employment.
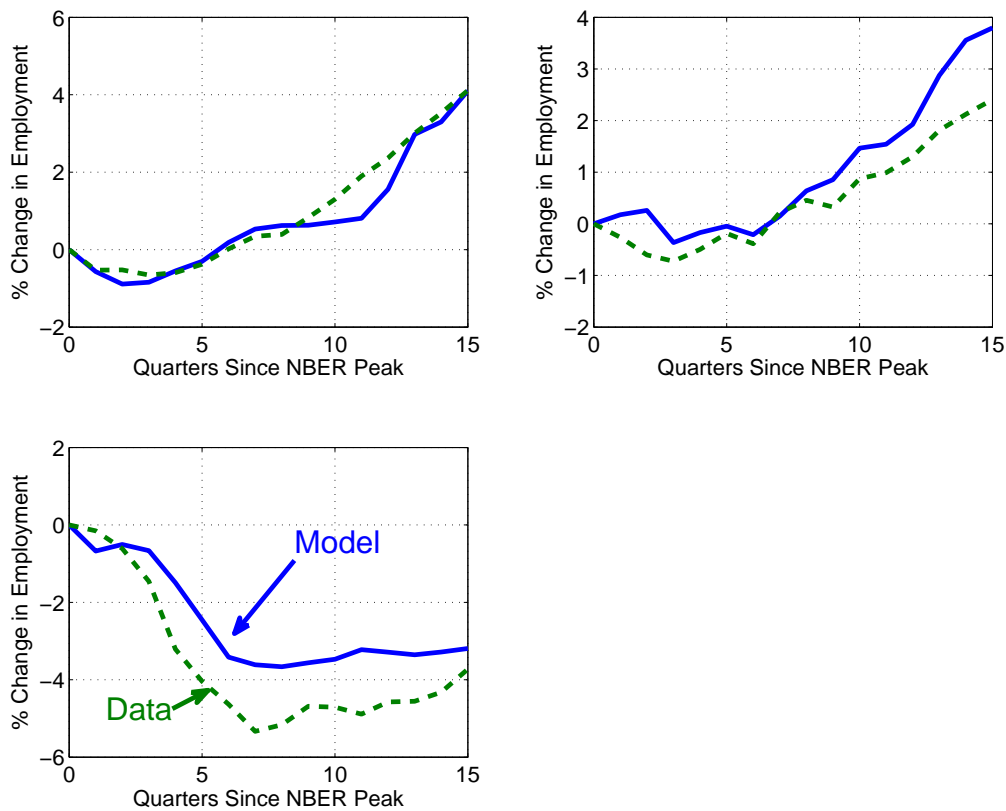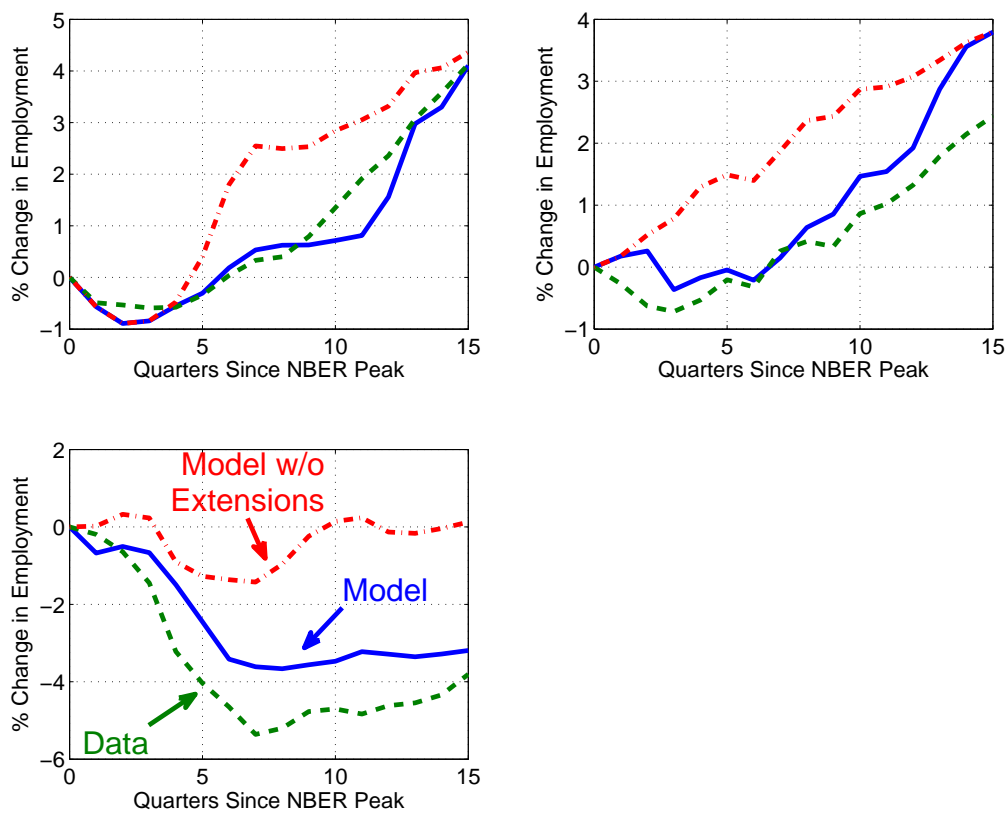
Figure 6: Simulated and actual percentage change in employment from NBER peak before the 1990-91, 2001 and 2007-09 recessions. The blue line is the model and dashed green line is the data. Data and model are not filtered. Data is from CPS, total non-farm employment.

Figure 7: Simulated and actual percentage change in employment from NBER peak before the 1990-91, 2001 and 2007-09 recessions. The blue line is the model, the red dot-dashed line is the model without extensions, and green dashed line is the data. Data and model are not filtered.
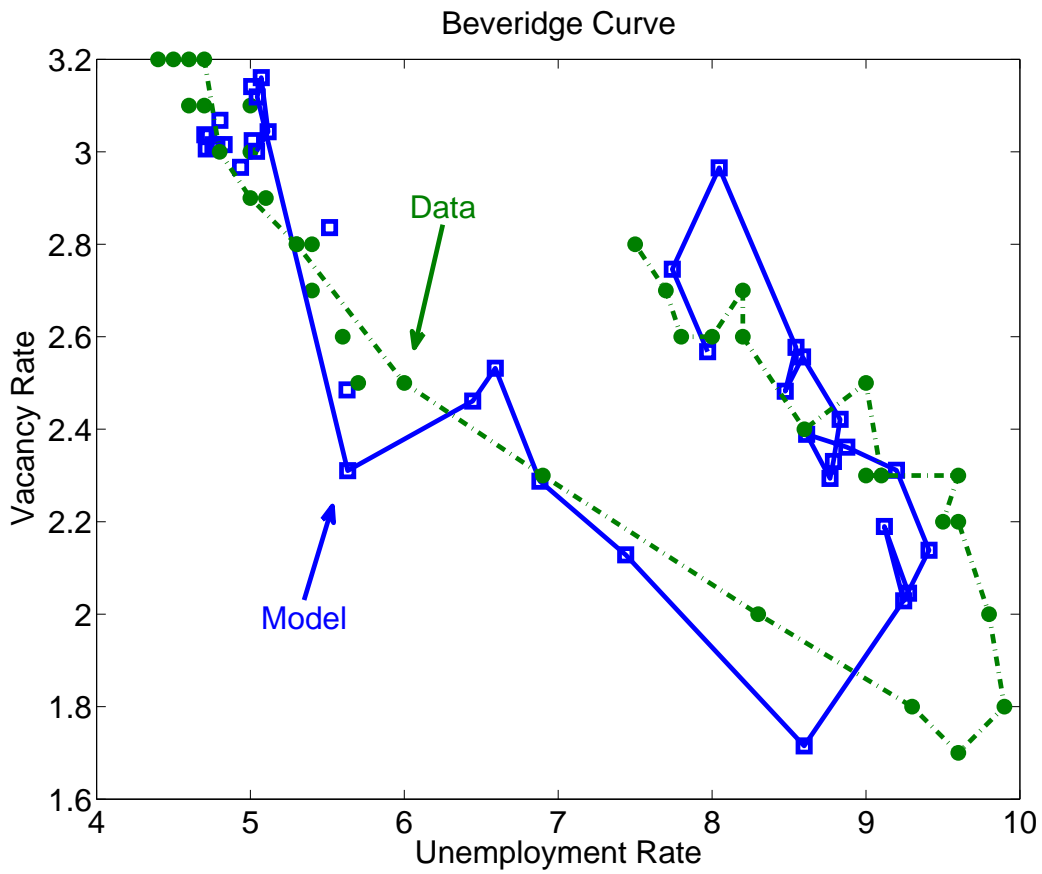
Figure 8: Simulated and actual Beveridge curve from January 2005 through December 2011. The unemployment and vacancy rates come from the BLS JOLTS database. Both series are plotted as quarterly averages of monthly (JOLTS) and weekly (model) data.
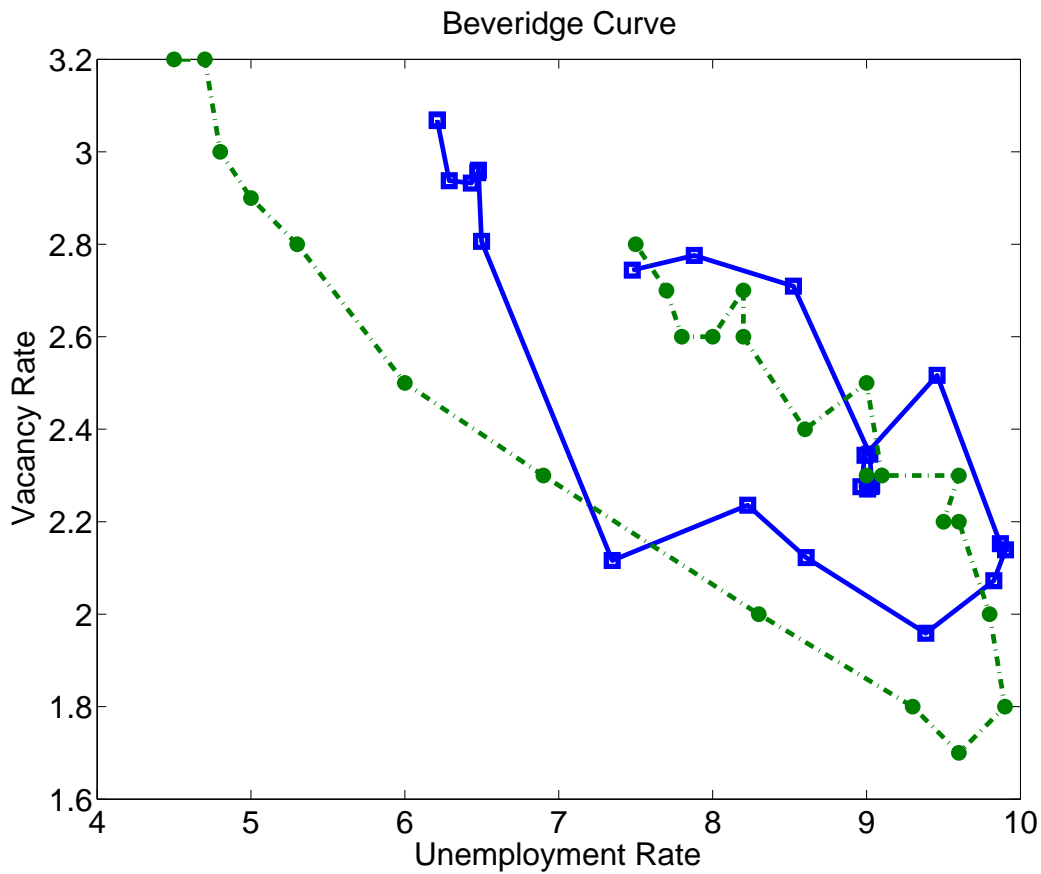
Figure 9: Actual and counterfactual Beveridge curve from 2007 Q:IV-2013 Q:II. The unemployment and vacancy rates come from the BLS JOLTS database. Both series are plotted as quarterly averages of monthly (JOLTS) and weekly (model) data. Labor productivity is held constant during the model simulation and only benefit extensions are enacted.

B The Post-War US Unemployment Insurance System: An Overview

By the late 1950s, most unemployment insurance systems in U.S. states offered 26 weeks of benefits to newly displaced workers. The deep recession of 1957-58, however, prompted the federal government to lengthen the duration of benefits available. Under the Temporary Unemployment Compensation Act (TUC), the federal government offered interest free loans to states in order to provide up to 13 additional weeks of benefits. Seventeen states opted to participate in the program, which lasted from June of 1958 until June of 1959.

The first federally financed extension of unemployment benefits occurred during the 1960-1961 recession. The federal government passed the Temporary Extended Unemployment Compensation Act (TEUC). Whereas TUC was a voluntary program, TEUC was mandatory for all states and provided up to 13 weeks of additional benefits to unemployed workers from April 1961 until June 1962. The extra weeks of benefits were entirely financed by the federal government (which raised the Federal Unemployment Tax to offset the extensions).

Guided by TUC and TEUC, the federal government sought to develop an automatic system of extending unemployment benefits during recessions. In 1970 the Employment Security Amendments developed the Extended Benefits (EB) program, which would provide additional weeks of benefits to states experiencing high unemployment. The EB program is a state-federal partnership, with the costs of the extended benefits shared equally between the state and federal government. The EB program provided up to 13 weeks of additional benefits. The extended benefits can be "triggered" nationally when the unemployment rate crosses certain thresholds, or triggered within individual states when the state-level unemployment crosses certain thresholds.

Following the recession of 1969-1970, in addition to additional benefits provided by the EB program, the federal government passed the Emergency Unemployment Compensation Act of 1971 (EUCA) which provided for an additional 13 weeks of benefits to states with high unemployment financed fully by the federal government. Thus, unemployed workers could receive up to 52 weeks of benefits under the regular, EB and EUCA programs[8]. The EUCA provided benefits from January 1972 through March 1973.

During the 1973-1975 recession, the federal government passed the Federal Supplemental Benefits (FSB) program, which was in effect from January 1975 through October 1977. The program initially provided for 13 weeks of additional benefits financed from the federal government, but was amended to provide 26 weeks of benefits in March 1975. The EB program triggered on nationwide from February 1975 through December 1977. Thus, from March 1975 through October 1977 displaced workers could receive a total of 65 weeks of benefits (26 state + 13 EB + 26 FSB).

In 1980 and 1981, through the Omnibus Reconciliation Acts of those years, the federal government altered the EB program. It eliminated the national trigger for EB and raised the thresholds for the state level triggers. In addition, it imposed stricter eligibility requirements for unemployed workers to receive benefits under the EB program.

During the 1981-1982 recession, the federal government established the Federal Sup-

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[8]The triggers under EUCA were different than under the EB program. Thus some states only qualified for EB, others only for EUCA, and others for both EB and EUCA.

plemental Compensation (FSC) program in September of 1982. The tightening of the EB program under the OBRA legislation made roughly half of states ineligible to additional benefits under that program. FSC was amended several times from 1982 through early 1985. For the majority of the program duration, it provided up to 14 additional weeks of benefits financed by the federal government. Thus, the maximum weeks of benefits that could be received were 53 (26 state + 13 EB + 14 FSC).

After the 1990-1991 recession, the federal government passed the Emergency Unemployment Compensation (EUC) Act of 1991. The extension was amended several times from 1991 through 1994 providing at various times an additional 20, 26, 33 or 15 additional weeks of benefits. The benefits were financed entirely by the federal government. The maximum weeks of benefits that an individual could have received was 72 (26 state + 13 EB + 33 EUC). In addition, the EB program was amended to increase the maximum number of weeks payable. States with unemployment rates above 8% would now receive 20 weeks of benefits instead of 13.

In March 2002, after the 2001 recession, the federal government passed the Temporary Extended Unemployment Compensation (TEUC) act. The act provided up to 26 additional weeks of federally financed unemployment benefits through March of 2004. The maximum weeks of benefits that an individual could have received was 72 (26 state + 13 EB + 26 EUC).

During the 2007-2009, the federal government passed the Emergency Unemployment Compensation (EUC08) Act of 2008. The program initially provided up to 13 weeks of additional benefits financed by the federal government. The EUC08 has been amended 8 times to day, gradually raising the maximum additional benefits provided by the federal government to 53 weeks, making to total compensation that an unemployed worker could receive 99 weeks (26 state + 20 EB + 53 EUC08). The program is currently set to expire at the end of 2013.

Beginning in the 1950s, federal unemployment benefit extensions in recessions have become increasingly generous. This is illustrated in Figure 1, where we plot the time path of maximum benefit duration from 1950 to 2011. In Figure 2 we plot the time path of maximum benefit duration together with the time series for aggregate labor productivity. This figure illustrates that, in the recessions following the 1981-982 recession, benefit extensions were more likely to occur *after* productivity had already begun to recover.