Do Unemployment Benefit Extensions Explain the Emergence of Jobless Recoveries?[*]

Kurt Mitman[†]   Stanislav Rabinovich[‡]

December 27, 2014

Abstract

In this paper, we show that countercyclical unemployment benefit extensions can 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

The 2007-2009 recession was characterized by a large and persistent decline in labor input, in particular a high unemployment rate. Moreover, the unemployment rate remained persistently high long after 2009, consistent with the phenomenon of jobless recoveries that were also observed in the recessions of 1990-1991 and 2001. Building on these observations, recent research has suggested that policy-induced labor market distortions were a key driver of the recession and its aftermath. Mulligan (2010) and Ohanian (2010), in particular, have emphasized that a time-varying labor wedge - driven, for example, by taxes or social insurance - has the potential to explain much of the movement in the labor input during the Great Recession.

In this paper, we contribute to this literature by quantitatively evaluating the role of a particular government policy: the countercyclical extensions of unemployment benefits. Specifically, we introduce unemployment benefit extensions into an otherwise standard equilibrium search model of the labor market, and argue that these time-varying extensions, in conjunction with aggregate labor productivity shocks, can explain observed unemployment dynamics. In doing so, we extend the existing line of research in two ways. First, we evaluate the role of labor market distortions in a frictional labor market rather than a representative-agent real business cycle model. Second, unlike most previous research, we evaluate the role of unemployment benefit extensions over the last 50 years, rather than focusing solely on the Great Recession. In particular, we argue that unemployment insurance policy helps account for both the experiences of the last three recessions, which featured jobless recoveries, and the previous recessions, which did not.

The unemployment insurance (UI) 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 that extended UI benefit duration further. The weeks of extended UI 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 introduce countercyclical UI benefit extensions into the Mortensen-Pissarides equilibrium search model with aggregate shocks to labor productivity. 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. This channel lowers the correlation between productivity and unemployment and has the capacity to explain the emergence of jobless recoveries that we now observe. To be clear, we are not claiming that unemployment benefit extensions led to the rise in initial unemployment. Rather, benefit extensions propagate and amplify shocks that lead to increases in the unemployment rate, which endogenously leads to a drop in the correlation between productivity and employment.[1]

We quantitatively evaluate the importance of this channel in our calibrated model by simulating the series of productivity shocks observed in the 1960-2014 period and sequentially 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. The key to generating this result is the fact that the UI benefit extensions enacted after the recessions of 1990-1991, 2001, and 2007-2009 were large *relative* to the productivity recovery following these recessions. We also 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. The model predicts a much faster recovery of employment if the unemployment benefit extensions are not enacted.

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

---

[1]In this paper we consider shocks to labor productivity, but the mechanism would be the same for any economic shock that led to an increase in the unemployment rate.

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.

1.1 Relationship to the literature

The distortionary effects of unemployment insurance on unemployment have been recognized for a long time and are the subject of a large literature. Our innovation is to embed such distortionary effects into a general equilibrium model and to study their implications for the timing, rather than simply the magnitude, of unemployment.

To build some motivation for the analysis in this paper, consider the existing estimates of the elasticity of unemployment duration with respect to unemployment benefits. Research starting with the seminal work of Moffitt and Nicholson (1982), Moffitt (1985), and Katz and Meyer (1990) reached consensus estimates that a ten-week increase in benefit duration increases the average duration of unemployment spells by 1 to 2 weeks. Although this elasticity might appear small, it is far from innocuous, for two reasons. First, an apparently small increase in unemployment duration can correspond to a large increase in the aggregate unemployment rate: a simple back-of-the-envelope calculation implies a 10-week increase in benefit duration leads to a 0.7 percentage point increase in the unemployment rate.[2] 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). Note, however, that merely extrapolating the measured elasticities to the aggregate level says nothing about their implications for the timing of unemployment or its correlation with productivity. Although we will use the empirical estimates from the above literature as our calibration target, the ability of the model to match the timing of unemployment is a success of the theory.

We view our analysis as complementary to the existing research on policy-induced labor market distortions, (e.g. Mulligan (2002, 2010, 2012), Ohanian (2010), Herkenhoff and Ohanian (2011), among others): unlike previous research (one notable exception is Krause and Uhlig (2012) who investigate the effects of reforms to UI in Germany), our results point to

---

[2]In particular, set the unemployment rate equal to its steady-state value, $u = \frac{\delta}{\delta + f}$, where δ is the job separation rate and f is the job-finding rate, and use the fact that expected unemployment duration is equal to the reciprocal of the job-finding rate. At a weekly frequency, $f \approx 0.14$, and δ is an order of magnitude smaller ($\delta \approx 0.0081$). Then, a ten-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 0.7 percentage point increase in the unemployment rate.

UI benefit extensions as a particularly important contributor to a weak labor market recovery after the last three recessions. In this regard, our paper contributes to the literature trying to account for the phenomenon of jobless recoveries, and, more generally, trying to assess the efficacy of labor productivity as the primary driver of labor market fluctuations. The existence of jobless recoveries suggests that the answer to the latter question is negative; an important line of research therefore attempts to substantially modify existing models to account for the sluggish recovery of employment.

There are a variety of approaches to explaining jobless recoveries. 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. Berger (2011) has argued that countercyclical restructuring behavior of firms can generate jobless recoveries. This is by no means an exhaustive list.[3] Relative to this literature, our paper proposes a significantly smaller departure from a workhorse Mortensen-Pissarides model. In this sense, our paper is close in spirit to McGrattan and Prescott (2014), who likewise argue that small modifications to the benchmark model can be sufficient to explain the weak employment-productivity correlation. The mechanism in our paper is different, however. 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 paper is close in nature to the innovative work by Herkenhoff (2013), who argues that increased access to credit has led households to take on more debt and be pickier about finding jobs, leading to slower recoveries. Similar to that paper, we share the view that changes in the value of non-employment are important for generating observed unemployment patterns; our paper is distinct in emphasizing unemployment benefit extensions as the driving mechanism.

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. We stress that we are not suggesting UI benefit extensions as the sole driver of jobless recoveries. Instead, it is the combination of large UI benefit extensions with a comparatively small productivity recovery that generates the observed unemployment dynamics.

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 high unemployment volatility. Rather, the quantitative

---

[3]Aaronson et al. (2004) discuss existing explanations that have been proposed for jobless recoveries.

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 of certain recessions. Nearly all of the theories put forth by the literature to resolve the Shimer puzzle (e.g. wage rigidities in Hall (2005), small surplus in Hagedorn and Manovskii (2008), or marginal worker-firm matches in Menzio and Shi (2011)) feature a counterfactual correlation between labor productivity and unemployment close to unity. In contrast, our paper correctly predicts a much lower correlation between productivity and unemployment.

In section 2 we describe the model environment with time-varying unemployment bene-fits. In section 3 we lay out the calibration procedure. In section 4, we describe the simulation and quantitative analysis that we conduct. Section 5 reports the results. In section 6 we discuss the choices of calibrated parameter values and the calibrated model's implications. Section 7 concludes. All tables and figures are collected in Appendix A. Appendix B provides an overview of the unemployment benefit extensions in the post-war period.

2   Model Description

The model is a variant of the standard Mortensen-Pissarides model with aggregate pro-ductivity shocks, augmented to incorporate unemployment benefit expiration, and thereby accounting for the fact that the value of unemployment varies across unemployed workers. Specifically, workers in the model may lose UI eligibility while unemployed, and regain this eligibility while employed. The rate at which unemployment benefits expire may vary over time, and is the key policy variable that we focus on.

2.1   Economic Environment

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.

In any given period, a worker can be either employed (matched with a firm) or unem-ployed. 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.

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

$$M(u_t, v_t),$$

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: $M(u, v) \leq \min\{u, v\}$ $\forall u, v$. 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 $t + 1$.

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.

- 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.

8

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

$$\theta_t = \frac{v_t}{u_t^E + u_t^I} \tag{2}$$

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 $1 - e_t$.[4]

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 $1 - e_t$.

---

[4]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.

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:

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

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

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

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

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:

10

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

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

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:

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

The assumptions made above imply

$$\varpi_t = \frac{u_t^E + r_t u_t^I}{u_t^E + u_t^I} \quad (14)$$

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

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

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

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

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

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

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

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

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 aggregate US data targets over the 1960-2005 period and then assess the model's fit with respect to the time series of unemployment. As explained below, we target aggregate moments of the key data series over this period. We also use, as calibration targets, the literature's estimates on the elasticity of unemployment with respect to UI benefits. We *do not* target the correlation between unemployment and productivity, nor any other moment that directly affects the timing of unemployment or the speed of the recovery. The success of the model can then be assessed by how well it matches the time series of unemployment and its correlation with productivity - in particular, the absence of jobless recoveries prior to 1990 and their presence thereafter.

The model period is taken to be 1 week. We normalize mean weekly productivity to one. Following Hall and Milgrom (2008) we set $b = 0.25$. This is below the average replacement rate of unemployment insurance, and at the lower end of the range used in the literature,

but we deliberately opt for this low number to account for the fact that UI take-up rates are less than 100%.[5] 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. The standard benefit duration is 26 weeks; local and federal employment conditions trigger automatic 20-week and 33-week extensions. In the model we assume that $e_t = 1/59$ when unemployment is above 8% below the mean, $e_t = 1/46$ when unemployment is between 6.5% and 8%, and $e_t = 1/26$ otherwise.[6] We set the re-entitlement rate to $r = 1/24$ to account for the fact that it takes 6 months of employment to gain eligibility for unemployment benefits.

Following den Haan et al. (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;

---

[5]Note that a higher level of UI benefits would only increase the sensitivity of the worker's outside option with respect to the duration of these UI benefits, which is the key policy variable of interest.

[6]When the calibrated model is simulated, we do not use this function, but instead feed in the realized UI benefit extensions that took place. See Section 4.

(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. As mentioned in section 1.1, research by Moffitt and Nicholson (1982), Moffitt (1985), and Katz and Meyer (1990), among others, 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 section 6.2, we further discuss the choice of this estimate. Table 1 reports the calibrated parameters.[7]

4 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). The discretionary extensions of unemployment benefits are in addition to the EB program, which automatically extends unemployment benefits by 13 weeks for states experiencing high unemployment. In order to deal with the large number of policy changes while still solving a stochastic weekly model, we make simplifying assumptions regarding expectations about future policy. First, we assume that all discretionary policy changes (except for the EB program) are unanticipated; in other words, agents in the model know that benefits will be extended according to the EB program in times of high unemployment, but do not anticipate the additional, discretionary extensions. Second, we assume that all agents in the model believe that the legislation changes extending unemployment benefits are permanent when enacted.

The only exogenous inputs to the model are the realized series of 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 assume that productivity is constant each week within the quarter to construct the weekly 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.

---

[7]In section 6.1, we discuss the calibration of the value of non-market activity h.

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.

5   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

15

productivity, and the comparatively strong correlation between unemployment and lagged productivity.[8]

In addition to the correlation between unemployment and productivity, we also investigate the cyclical behavior of wages, since wages in the model respond to both productivity and unemployment benefits. We find that the elasticity of wages with respect to productivity is 0.52, in line with empirical estimates that range from 0.45 to 0.7, indicating that the cyclicality of wages is consistent with the data. In section 6.3 we discuss in more detail the behavior of wages and relate it to existing empirical estimates.

We next investigate whether the model is consistent with the emergence of jobless recoveries. In Figure 5, we plot the change in employment - actual[9] and predicted by the model[10] - 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.

5.1 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 9. To understand the movement, it is instructive to first review the theoretical Beveridge curve. The Beveridge curve is the theoretical steady state relationship between unemployment and vacancies. For a fixed job destruction rate, the theoretical Beveridge

---

[8]Note that the inclusion of time-varying unemployment benefit extensions was not guaranteed to improve the model's fit, since what matters for the latter is the timing of the extensions relative to productivity, which was not targeted in the calibration.

[9]Measured in the Current Population Survey.

[10]In order to generate employment numbers we take the labor force from the data.

curve is simply traced out by solving for the values of unemployment and vacancies, that solve:

$$u^* = \delta(1 - u^*) + \left(1 - f\left(\frac{v^*}{u^*}\right)\right) \tag{18}$$

Solving this equation generates a downward sloping curve in $u - v$ space. Movements along this theoretical curve, in the standard DMP model, are generated by movements in labor productivity: for each value of z there is a unique value of labor market tightness pinned down by the free entry condition. Thus, lower productivity leads to lower tightness, which results in a down-right shift along the Beveridge curve. It is important to note that tightness (and vacancies) adjust immediately (they are jump variables), but unemployment takes time to adjust. Thus, at a weekly frequency, a drop in productivity would imply an immediate drop in tightness (and vacancies) but a fixed unemployment rate. This would be a downward departure from the Beveridge curve. But, the model would transit in the upward-right direction along a path of constant tightness until it returned to the Beveridge curve. For small shocks, when aggregated to quarterly frequency, this movement would be masked and it would appear as if the economy remained on the theoretical Beveridge curve. However, for large shocks, it would take the economy time to return to the Beveridge curve and what appear to be "departures" from the "true" Beveridge curve would emerge.

In the context of our model, both productivity shocks and changes in policy induce movements along the Beveridge curve. It is important to note that the matching function is invariant over time, so that the same theoretical Beveridge curve remains unchanged. In order to elucidate this channel, in Figure 8, we simulate the our model economy for a long time with productivity equal to 1 and weeks of benefits fixed at 26. We then introduce a permanent increase in benefit duration to 99 weeks, keeping productivity fixed, and compute the dynamics of the model. The green dots represent points on the theoretical Beveridge curve. In response to the increase in benefits, vacancies fall immediately - generating what appears to be a downward departure from the Beveridge curve - and it takes approximately five quarters before the model returns to the theoretical curve along a counter-clockwise path. Unlike the standard DMP model, the dynamics do not imply that the model moves along a path of constant tightness. This is because larbor market tightness depends not only on policy and productivity, but the composition of the unemployed as derived in Equation 15. Thus, the equilibrium tightness changes along the path of adjustment as the relative fraction of eligible and ineligible unemployed equilibrate. Next, keeping policy fixed we increase productivity. Again, vacancies respond immediately, inducing a perceived upward

17

shift in the Beveridge curve, and then the economy transits counter-clockwise back to the theoretical curve.

The Great Recession began with a large negative productivity shock, followed by a large increase in unemployment benefits. This combination of negative 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.[11] It is important to note that in the counterfactual model without benefit extensions there is also a counter-clockwise movement of the Beveridge curve, induced by the large shocks to productivity. However, in the model without extensions, unemployment recovers quickly, so despite generating the appropriate shape, it generates a counterfactual timing of the recovery.

5.2   The Expiration of Benefits in 2014

We now use the model to examine how the labor market was affected by the expiration of unemployment benefit extensions in 2014. In December of 2013, Emergency Unemployment Compensation Act of 2008 (EUC08) provided an average federal entitlement of 29 weeks of benefits. Congress did not reauthorize the program (as it had done previously) and there was no "phase-out" period for EUC08 payments. Thus, the average entitlement to benefits abruptly fell to 26 weeks. The decision to not reauthorize benefit extensions was controversial - the Council of Economic Advisors predicted that 240,000 jobs would be lost in 2014 because of the negative impact on the aggregate demand.

Despite such dire predictions, the U.S. labor market has performed very well in 2014: average employment growth was about 25% higher in 2014 than in preceding years, the unemployment rate fell the fastest in a decade. It is difficult to ascertain, however, the extent to which the recovery in the labor market was due to productivity growth or the drop in unemployment benefits. Our model provides the perfect laboratory to answer that question. We extend out productivity data series through 2014:QIII and simulate the model under the actual expiration of benefits and under the counterfactual assumption that benefits were reauthorized through 2014:QIII. The results for unemployment and employment are plotted in Figures 10 and 11 respectively. The model again, does an excellent job of capturing the unemployment and employment dynamics relative to the data.

---

[11]A similar argument, that a large negative shock can result in a counter-clockwise movement in the unemployment-vacancy space, has been made by Christiano et al. (2014). However, the source of the shock is different: in our paper, this is driven entirely by the combination of labor productivity and unemployment benefit extensions.

The model and the counterfactual coincide in terms of unemployment and employment through December 2013, but diverge starting in January 2014. Productivity fell significantly in the first quarter of 2014. In the model, consistent with the data, that decline in productivity is offset by the elimination of benefits, and there is robust job growth in 2014:QI. In the counterfactual economy where benefits are extended, however, the unemployment rate rises in the first quarter of 2014 as a result of the productivity slowdown. The recovery in productivity in the second and third quarters of 2014 means that, even in the counterfactual economy, the unemployment rate falls and there is significant job growth. However, by September 2014, there were almost 1.25 million fewer jobs created in the counterfactual economy and the unemployment rate was 0.7 percentage points higher than in the economy where benefits were cut.

6   Discussion of the Results

In this section, we discuss several key modeling choices. In section 6.1, we discuss the calibrated value of h, the value of non-market activity. Section 6.2 reviews the available estimates, from the empirical literature, of the elasticity of unemployment with respect to unemployment benefits, and compares our model's predictions to these estimates. In section 6.3 we similarly review the literature examining the effect of unemployment benefits on wages, and show that our model is consistent with these estimates. In section 6.4 we dicuss the choice to abstract from worker search effort, and the consequences of relaxing this assumption.

6.1   The value of non-market activity

Our calibration procedure implies a large value of h. This might seem surprising, considering that empirical studies (e.g. Gruber (1997), Browning and Crossley (2001), Aguiar and Hurst (2005)) report a consumption drop for workers upon becoming unemployed. However, Aguiar and Hurst (2005), who properly distinguish between consumption and expenditure, show that the consumption drop for the unemployed is only 5%, illustrating that most earlier estimates of the consumption drop are biased upward. It is important to note that Aguiar and Hurst (2005) includes estimates for people both eligible and ineligible for unemployment benefits. Thus, the relevant comparison to their estimate in our model would be a weighted average of h and $h + b$. Moreover, the empirical estimates of the consumption drop still abstract from the leisure value of unemployment, or absence of disutility from work. Finally, because

benefits expire, the present-value utility of being unemployed and eligible for benefits is always lower than the value of being employed, even if the current consumption value, $h + b$, is higher than the wage one would have received.

A second potential concern is the behavior of h over the business cycle. Recent research by Chodorow-Reich and Karabarbounis (2013) investigated the cyclicality of the flow value of leisure and unemployment benefits, using a model different from ours. They find that the value of leisure - the analogue of h in our model - is pro-cyclical, and that the value of unemployment benefits is countercyclical. However, they find that the magnitude of b is so small (around 0.04) that the sum of the two components is pro-cyclical (and has an elasticity with respect to productivity of about unity). Two observations are in order regarding these results.

First, in our model, we have assumed that h is constant. Having a pro-cyclical value of h would, in fact, strengthen the mechanism that we have outlined here. If h rises when productivity recovers, but unemployment is still high, the surplus from hiring a worker would be even smaller than if h had remained constant. Thus, a pro-cyclical h would seem to only strengthen the persistence of unemployment during a productivity recovery.

Second, the argument that b is only about 0.04 of the average productivity of a worker seems broadly inconsistent with the data. To arrive at this number, Chodorow-Reich and Karabarbounis (2013) divide the total number of dollars paid out in benefits by the total number of unemployed workers, and then divide this ratio by GDP per capita. What matters theoretically, however, is the ratio between the unemployment benefits that a worker can receive and the productivity of that worker. Looking at what replacement rates workers actually receive conditional on filing for benefits, average replacement rates are 45 percent (taking into account that unemployment benefits are capped for some workers). Furthermore, in a bargaining model, the entitlement to benefits would affect the bargaining position even if workers haven't claimed them. This can be quantitatively very important if people who find jobs quickly don't file for benefits precisely because they expect to find jobs. Blasco and Fontaine (2012), for example, found that more than 50% of eligible unemployed who didn't take up benefits found jobs in less than 1 month. Thus, the fact that not all workers claim unemployment benefits need not diminish their importance for the workers' bargaining position.

A third potential concern is that h might be declining over the course of an unemployment spell if it represents a deteriorating asset position. This may be especially important in the context of jobless recoveries such as the most recent one, in which the many workers were

unemployed for a long duration. However, recent research by Herkenhoff (2013) has shown how borrowing opportunities improved for households over the last twenty years, making it easier for them to smooth consumption in recessions. Taking this channel into account would likely offset the effects of depreciation in h over the unemployment spell. We conclude that a constant value of h is a reasonable assumption.

6.2 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). Thus, we can interpret our findings as being conservative estimates of the overall effects of unemployment benefit extensions. As discussed in section 1.1, the estimate of 0.1 that we use may seem small (a ten-week increase in benefit duration results in a one week increase in unemployment duration), but it is not innocuous once we consider its aggregate implications for the unemployment rate.

The distortionary effect of unemployment insurance may theoretically be operating through at least two channels: the distortion of worker choice of search effort and the distortion of firm decisions to post vacancies. 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[12]. For this reason, in this paper we abstract from the search effort margin and attribute the entire elasticity to the vacancy creation effect. Section discusses this modeling choice further, as well as the consequences of introducing a search effort margin.

Complementing the work of Rothstein (2011) and Farber and Valletta (2013) on the Great Recession, Hagedorn et al. (2013) estimate the vacancy-creation effects of unemployment

---

[12]Indeed, Rothstein (2011) shows that the job finding rate of ineligible workers responds as much as that of the eligible ones to benefit extensions.

benefit extensions during the Great Recession, as well as during the 2002 recession. They conclude that extending benefit duration significantly increases unemployment and decreases employment and vacancies. Rogerson et al. (2013) explain how the results in Farber and Valletta (2013) and Hagedorn et al. (2013) are consistent with each other despite seeming at odds.[13]

An additional potential concern might be that the findings of Moffitt and Nicholson (1982), Moffitt (1985), and Katz and Meyer (1990) 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 consider the effect of a permanent extension. Thus, the model's predictions are consistent with the estimates of Card and Levine (2000) as well.

6.3   Behavior of wages

In the model, extending unemployment benefits, all things equal, increases the outside option of the workers and would lead to higher bargained wages. It is important to note that in equilibrium, this upward pressure on the wage is muted by the equilibrium effect through labor market tightness. Specifically, having to pay a higher wage to the worker lowers the surplus of the firm; this, in turn, lowers the vacancy-unemployment ratio, exerting downward pressure on the outside option of the worker, since being unemployed in a slack labor market is worse than in a tight one.

In the calibrated model, the net effect of unemployment benefits on wages is positive but small - a 13-week increase in the duration of unemployment benefits leads to a 0.16% increase in wages. This translates into an elasticity of wages with respect to unemployment benefit duration of 0.005. Small changes in wages, nonetheless, can lead to high labor market volatility, because even small changes in wages have large effects on profits, which drive vacancy creation decisions. The elasticity of *profits* with respect to unemployment benefit

---

[13]We find that our calibrated model is consistent with the effects of unemployment benefits on employment and vacancy creation measured by Hagedorn et al. (2013).

duration is -0.1, about 20 times larger in magnitude than the effect on wages themselves. Further, as noted in section 5, the business cycle behavior of wages is likewise consistent with the data: the elasticity of wages with respect to productivity in the model is 0.52, in line with empirical estimates that range from 0.45 to 0.7.

The empirical evidence on the effect of unemployment benefit duration on wages has generally fallen into two categories. The first uses administrative data on individual unemployment spells and exploits heterogeneity in benefit duration (due to age, previous employment, etc) to identify the effect on re-employment wages. Recent research by Nekoei and Weber (2014) using Austrian data found that a 9-week increase in unemployment benefit duration led to a 0.5% increase in wages. Prior studies, e.g. Card et al. (2007) and Lalive (2007), have yielded imprecise estimates of the effect of benefits on wages, and some studies have even found negative effects (however, these are mostly explained by the fact that higher unemployment benefits lead to longer unemployment duration). The effects of benefits on wages is still the focus of an active literature; however, the magnitude of the effect in our model is squarely in the bounds of the best current estimates.

A second strand of the literature looks at aggregated data on wages and examines how they respond to unemployment benefits. Hagedorn et al. (2013) measure the effects of unemployment benefit extensions on the wages of job stayers during the Great Recession. They use data from the Quarter Workforce Indicators (QWI), based on the Longitudinal Employer-Household Dynamics Program at the U.S. Census. The data contains the universe of employer-employee matches, and thus has all wages in a county and is not subject to imputation.[14] Hagedorn et al. (2013) report that a 20 week increase leads to a 0.27% increase in wages; thus, their estimate is consistent with the magnitude in our calibrated model.

In summary, while measuring the effect of unemployment benefits on wages is still an active area of research, the magnitude of the effect in our calibrated model is widely consistent with both micro and macro strands of the current empirical literature.

6.4 Search Intensity

We have purposefully abstracted from search intensity of the unemployed in the context of our calibrated model. The motivation to do so is coming from the recent research by

---

[14]Some concerns have been raised about imputation in the context of Hagedorn et al. (2013). Those concerns are related to data concerning the unemployment rate provided by the Local Area Unemployment Statistics Program at the BLS. However, Hagedorn et al. (2013) replicate their findings using the universe of unemployment claims data and find the same effect, effectively mitigating any concern about imputation. Even more importantly, these concerns do not at all apply to the wage data, relevant for this discussion, since the wage data were not imputed.

Rothstein (2011) and Farber and Valletta (2013), who found that the job-finding rates of those eligible and ineligible for benefits were the same in the Great Recession. This implies that the distortionary effect of unemployment benefits is likely not driven by the search effort choices of the unemployed. As explained above in 6.2, we therefore interpret the earlier elasticity estimates of Moffitt and Nicholson (1982), Moffitt (1985), and Katz and Meyer (1990) - which are significantly larger than the estimates of Rothstein (2011) and Farber and Valletta (2013) - as capturing the combination of search effort and vacancy creation effects.

However, even if one were to interpret the findings above as purely search intensity effects (and to calibrate the model parameters accordingly), the main quantitative results are likely to be robust to this assumption. From the back of the envelope calculation presented in section 1.1, it appears that what matters is the magnitude of the effect on unemployment, not the exact channel through which the effect operates. In related work, Mitman and Rabinovich (2014) investigate a similar model in which wages are rigid (i.e. do not respond to unemployment benefits) and search effort is endogenous; thus, the only distortionary effect of unemployment benefits is through search effort. They find that the model yields quantitatively similar predictions to a Nash bargaining model. Thus, in terms of the time series of unemployment, we believe that our predictions would be consistent with the data even if we had made the opposite modeling choice - attributing the distortionary effect to search effort. Because such a model would give counter-factual predictions on the re-employment rates of eligible or ineligible workers, we chose the emphasise the macro (vacancy creation) channel.

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 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. Our results exploit the

insight by Bachmann (2011) that, at a minimum, some level of friction in the labor market is required. Further, 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.

References

AARONSON, D., E. RISSMAN, AND D. G. SULLIVAN (2004): "Assessing the jobless recovery," *Economic Perspectives*, 2–21.

AGUIAR, M. AND E. HURST (2005): "Consumption versus Expenditure," *Journal of Political Economy*, 113, 919–948.

BACHMANN, R. (2011): "Understanding the Jobless Recoveries After 1991 and 2001," working paper.

BERGER, D. (2011): "Countercyclical Restructuring and Jobless Recoveries," working paper.

BERNANKE, B. S. (2003): "The Jobless Recovery," *Remarks by Governor Ben S. Bernanke at the Global Economic and Investment Outlook Conference, Carnegie Mellon University, Pittsburgh Pennsylvania, November 6, 2003.*

BLASCO, S. AND F. FONTAINE (2012): "A Structural Model of the Unemployment Insurance Take Up," Working paper.

BROWNING, M. AND T. F. CROSSLEY (2001): "Unemployment insurance benefit levels and consumption changes," *Journal of Public Economics*, 80, 1–23.

CARD, D., R. CHETTY, AND A. WEBER (2007): "Cash-On-Hand and Competing Models of Intertemporal Behavior: New Evidence from the Labor Market," *The Quarterly Journal of Economics*, 122, 1511–1560.

CARD, D. AND P. B. LEVINE (2000): "Extended Benefits and the Duration of UI Spells: Evidence from the New Jersey Extended Benefit Program," *Journal of Public Economics*, 78, 107–138.

CHODOROW-REICH, G. AND L. KARABARBOUNIS (2013): "The Cyclicality of the Opportunity Cost of Employment," NBER Working Papers 19678, National Bureau of Economic Research, Inc.

CHRISTIANO, L. J., M. S. EICHENBAUM, AND M. TRABANDT (2014): "Understanding the Great Recession," NBER Working Papers 20040, National Bureau of Economic Research, Inc.

DEN HAAN, W. J., G. RAMEY, AND J. WATSON (2000): "Job Destruction and Propagation of Shocks," *American Economic Review*, 90, 482–498.

FAIG, M. AND M. ZHANG (2012): "Labor Market Cycles, Unemployment Insurance Eligibility, and Moral Hazard," *Review of Economic Dynamics*, 15, 41–56.

FARBER, H. S. AND R. G. VALLETTA (2013): "Do Extended Unemployment Benefits Lengthen Unemployment Spells? Evidence from Recent Cycles in the U.S. Labor Market," Working Paper 19048, National Bureau of Economic Research.

FREDRIKSSON, P. AND B. HOLMLUND (2001): "Optimal Unemployment Insurance in Search Equilibrium," *Journal of Labor Economics*, 19, 370–99.

GROSHEN, E. L. AND S. POTTER (2003): "Has structural change contributed to a jobless recovery?" *Current Issues in Economics and Finance*.

GRUBER, J. (1997): "The Consumption Smoothing Benefits of Unemployment Insurance," *American Economic Review*, 87, 192–205.

HAGEDORN, M., F. KARAHAN, I. MANOVSKII, AND K. MITMAN (2013): "The Effect of Unemployment Benefits on Unemployment: the Role of Macro Effects," working paper.

HAGEDORN, M. AND I. MANOVSKII (2008): "The Cyclical Behavior of Equilibrium Unemployment and Vacancies Revisited," *American Economic Review*, 98, 1692–1706.

HALL, R. E. (2005): "Employment Fluctuations with Equilibrium Wage Stickiness," *American Economic Review*, 95, 50–65.

HALL, R. E. AND P. R. MILGROM (2008): "The Limited Influence of Unemployment on the Wage Bargain," *American Economic Review*, 98, 1653–74.

HERKENHOFF, K. F. (2013): "The impact of consumer credit access on unemployment," working paper.

HERKENHOFF, K. F. AND L. E. OHANIAN (2011): "Labor Market Dysfunction During the Great Recession," NBER Working Papers 17313, National Bureau of Economic Research, Inc.

KATZ, L. F. AND B. D. MEYER (1990): "The impact of the potential duration of unemployment benefits on the duration of unemployment," *Journal of Public Economics*, 41, 45–72.

KRAUSE, M. U. AND H. UHLIG (2012): "Transitions in the German labor market: Structure and crisis," *Journal of Monetary Economics*, 59, 64–79.

LALIVE, R. (2007): "Unemployment Benefits, Unemployment Duration, and Post-Unemployment Jobs: A Regression Discontinuity Approach," *American Economic Review*, 97, 108–112.

MCGRATTAN, E. R. AND E. C. PRESCOTT (2014): "A Reassessment of Real Business Cycle Theory," *American Economic Review*, 104, 177–82.

MENZIO, G. AND S. SHI (2011): "Efficient Search on the Job and the Business Cycle," *Journal of Political Economy*, 119, 468 – 510.

MITMAN, K. AND S. RABINOVICH (2014): "Optimal unemployment insurance in an equilibrium business-cycle model," *Journal of Monetary Economics*.

MOFFITT, R. (1985): "Unemployment Insurance and the Distribution of Unemployment Spells," *Journal of Econometrics*, 28, 85–101.

MOFFITT, R. AND W. NICHOLSON (1982): "The Effect of Unemployment Insurance on Unemployment: The Case of Federal Supplemental Benefits," *The Review of Economics and Statistics*, 64, 1–11.

MULLIGAN, C. B. (2002): "A Century of Labor-Leisure Distortions," NBER Working Papers 8774, National Bureau of Economic Research, Inc.

——— (2010): "Aggregate Implications of Labor Market Distortions: The Recession of 2008-9 and Beyond," NBER Working Papers 15681, National Bureau of Economic Research, Inc.

——— (2012): *The Redistribution Recession: How Labor Market Distortions Contracted the Economy*, no. 9780199942213 in OUP Catalogue, Oxford University Press.

NEKOEI, A. AND A. WEBER (2014): "Does Extending Unemployment Benefits Improve Job Quality?" NRN working papers 2014-04, The Austrian Center for Labor Economics and the Analysis of the Welfare State, Johannes Kepler University Linz, Austria.

OHANIAN, L. E. (2010): "The Economic Crisis from a Neoclassical Perspective," *Journal of Economic Perspectives*, 24, 45–66.

ROGERSON, R., R. SHIMER, AND M. PITTS (2013): "Delving into Labor Markets," http://macroblog.typepad.com/macroblog/2013/10/delving-into-labor-markets.html.

ROTHSTEIN, J. (2011): "Unemployment Insurance and Job Search in the Great Recession," NBER Working Papers 17534, National Bureau of Economic Research, Inc.

SHIMER, R. (2005): "The Cyclical Behavior of Equilibrium Unemployment and Vacancies," *American Economic Review*, 95, 25–49.

——— (2012): "Reassessing the ins and outs of unemployment," *Review of Economic Dynamics*, 15, 127 – 148.

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
Correlation Matrix	u	1	-0.8686	-0.8968	-0.2144
	v		1	0.9775	0.2008
	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
Correlation Matrix	u	1	-0.7729	-0.8745	-0.2829
	v		1	0.9528	0.4000
	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
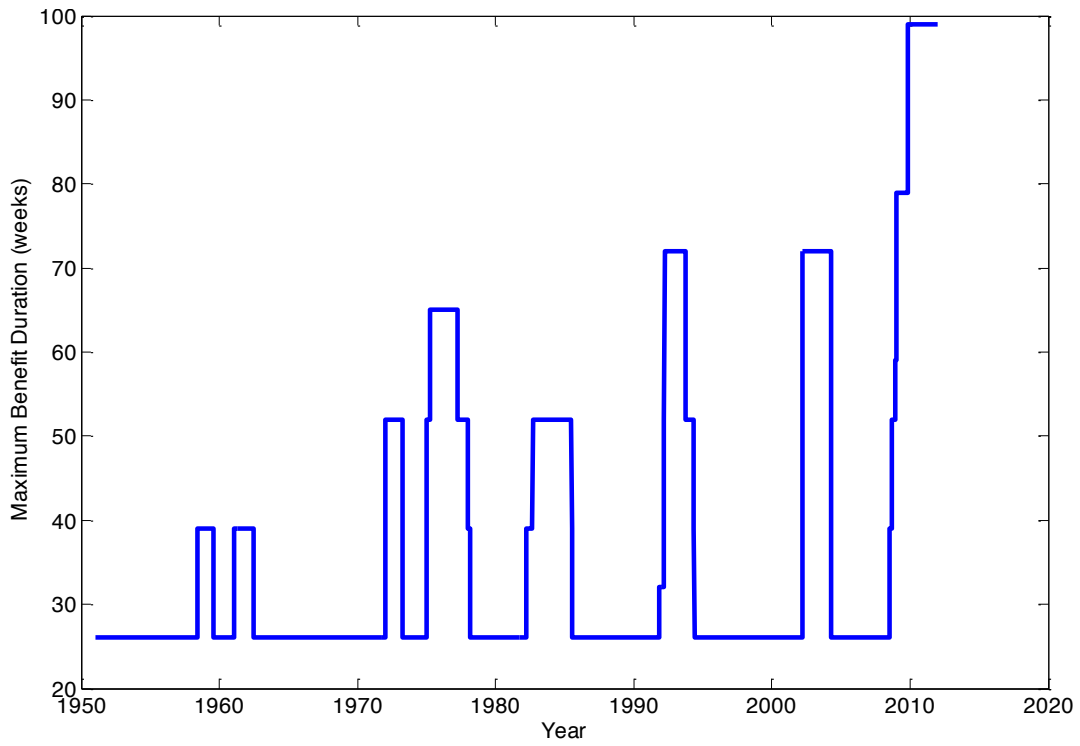
Figure 1: Maximum possible benefit duration available during the Post-War period. The extensions include a combination of discretionary federal extensions and the state-federal extended benefits program.
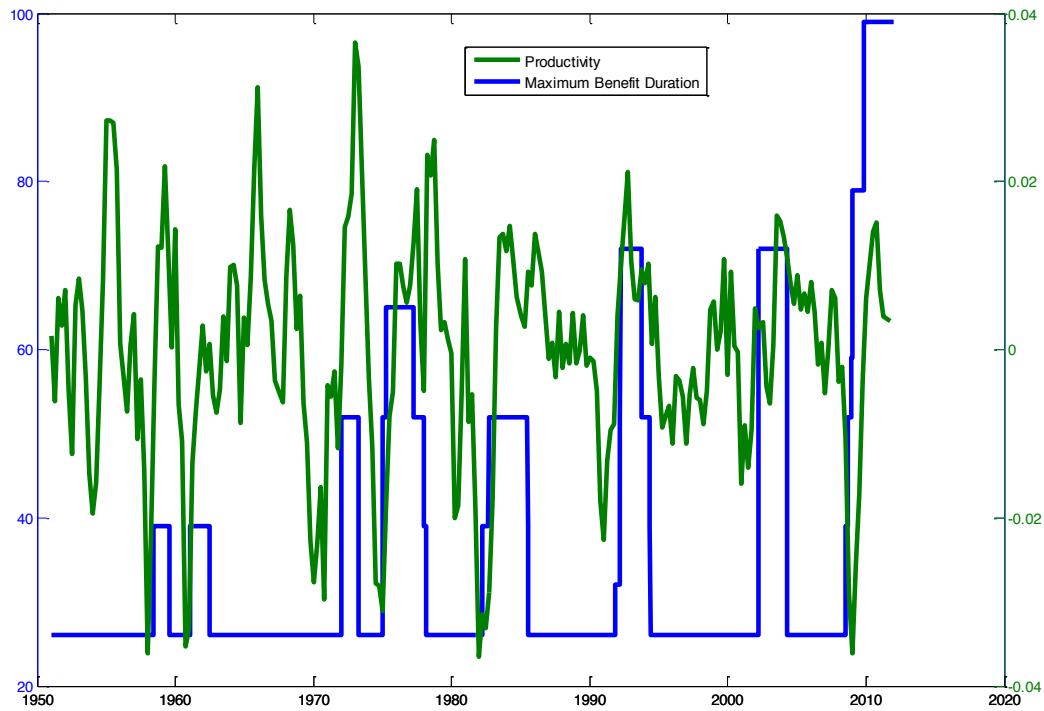
Figure 2: Maximum possible benefit duration available during the Post-War period and productivity. Productivity is calculate as log deviation from HP filtered trend of output per worker in the non-farm business sector reported by the Bureau of Labor Statistics. In the recessions follow the 1981-1982 recession, benefit extensions were more likely to occur after productivity had already begun to recover.
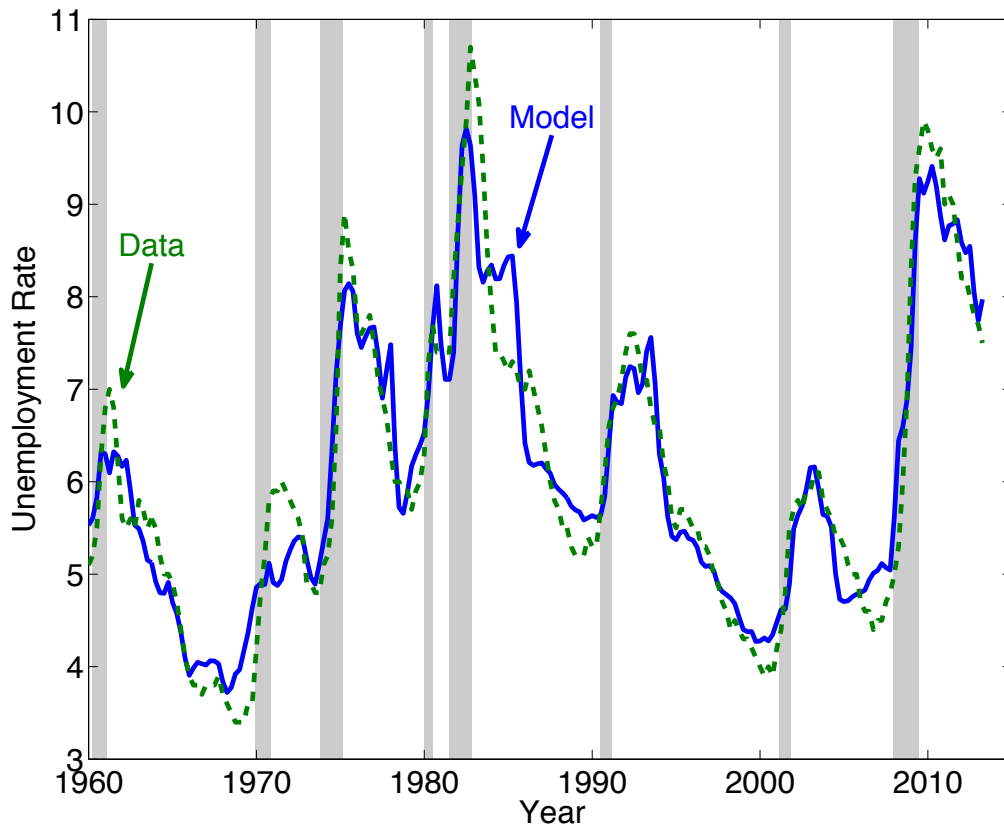
Figure 3: Simulated and actual unemployment from January 1960 through June 2013. NBER dated recessions are shaded.
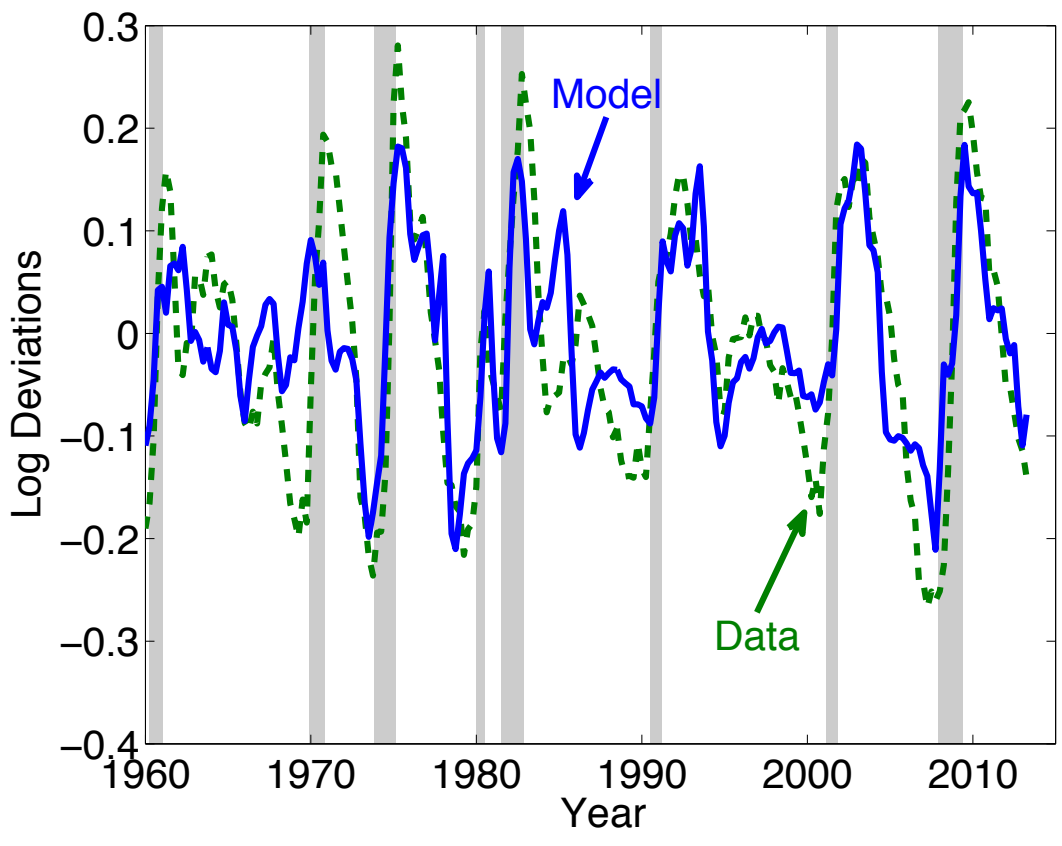
Figure 4: Log deviations from HP filtered trend for simulated and actual unemployment from January 1960 through June 2013. NBER dated recessions are shaded.
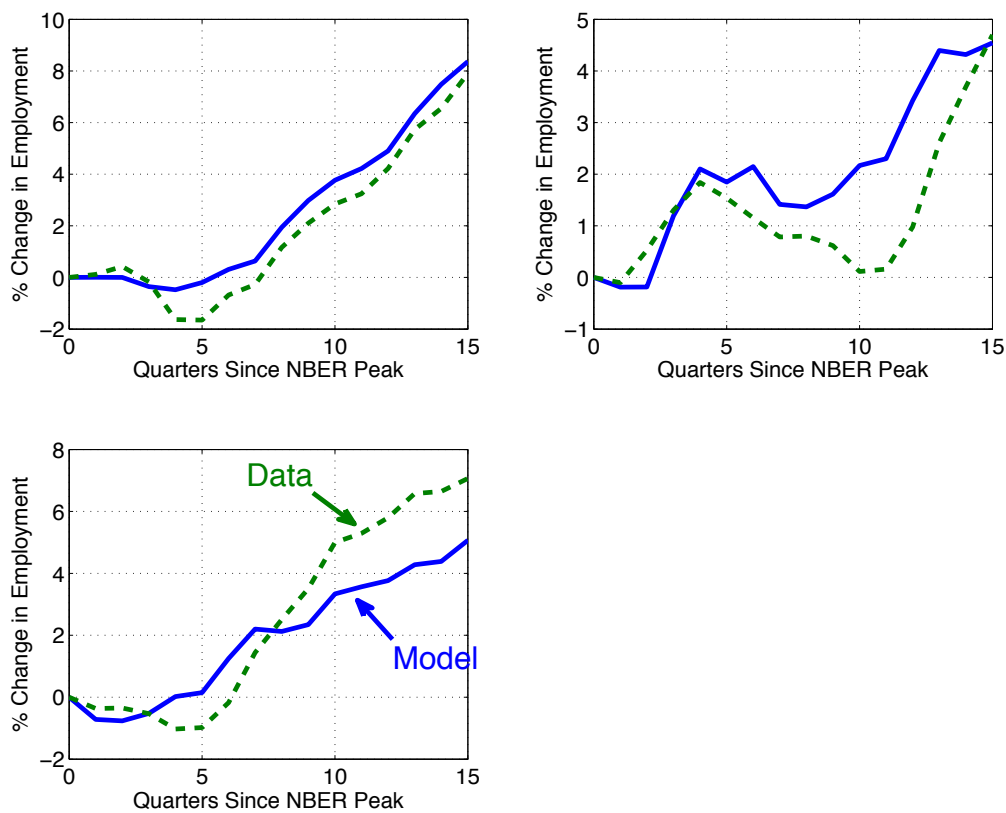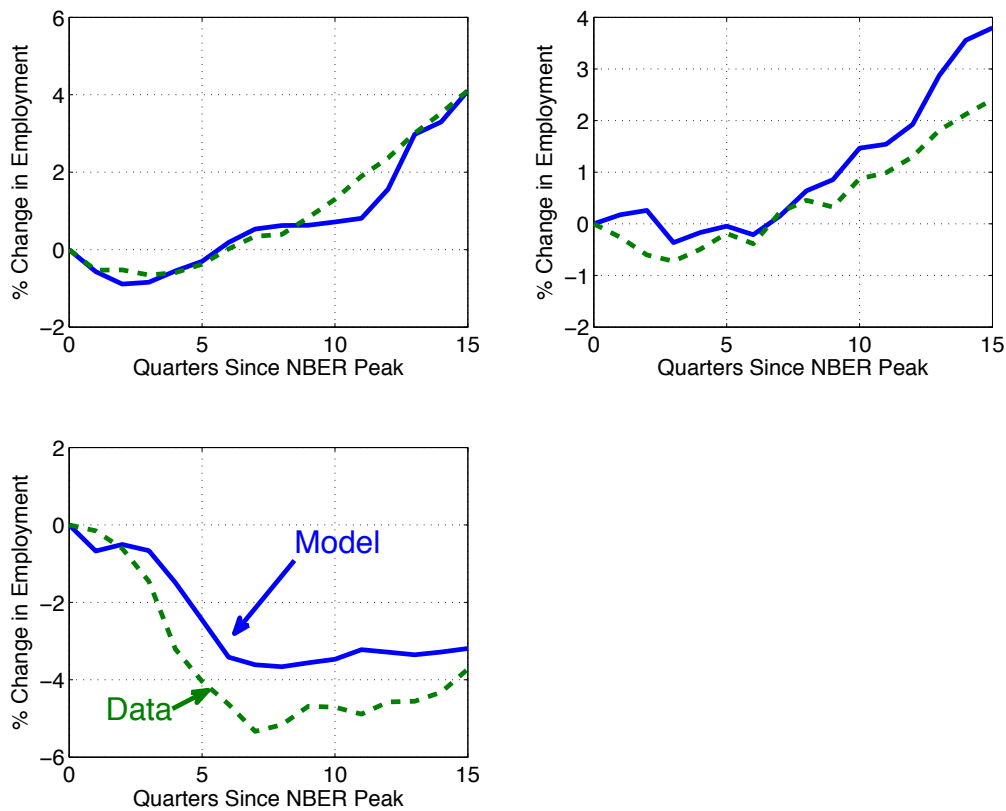
Figure 5: Simulated and actual percentage change in employment from NBER peak before the 1973-75, 1980 and 1981-82 recessions. The blue line is the model and dashed green line is the data. Data and model are not filtered. Data is from CPS, total non-farm employment.
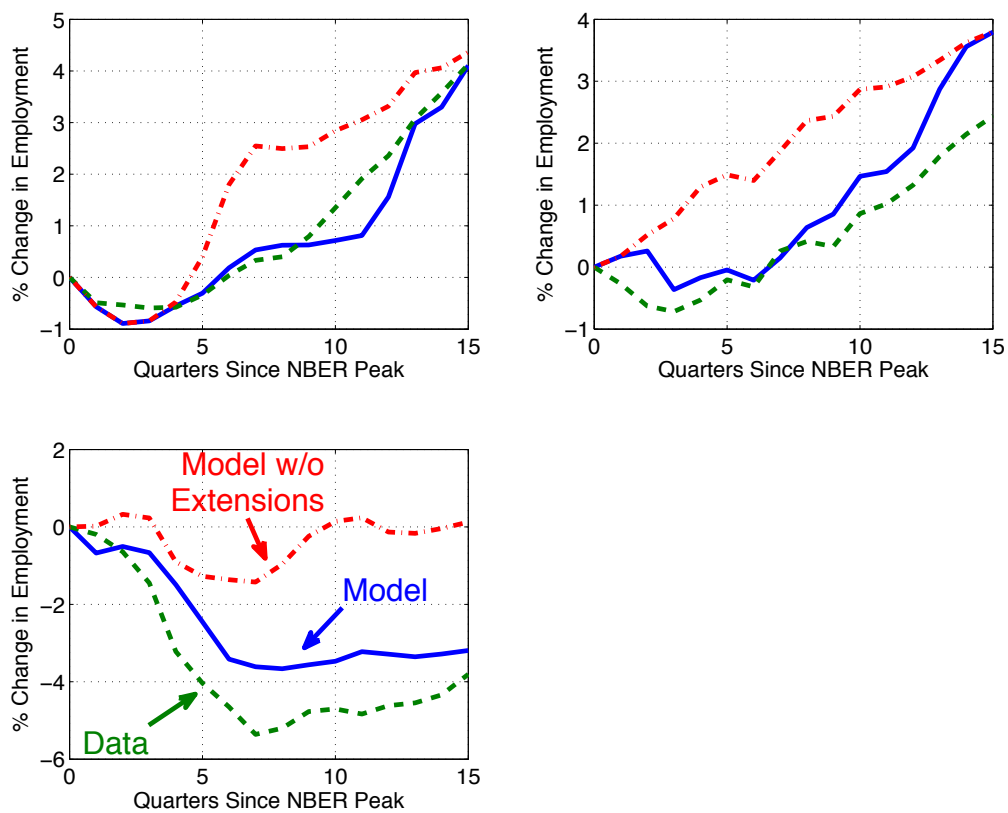
Figure 6: Simulated and actual percentage change in employment from NBER peak before the 1990-91, 2001 and 2007-09 recessions. The blue line is the model and dashed green line is the data. Data and model are not filtered. Data is from CPS, total non-farm employment.

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.
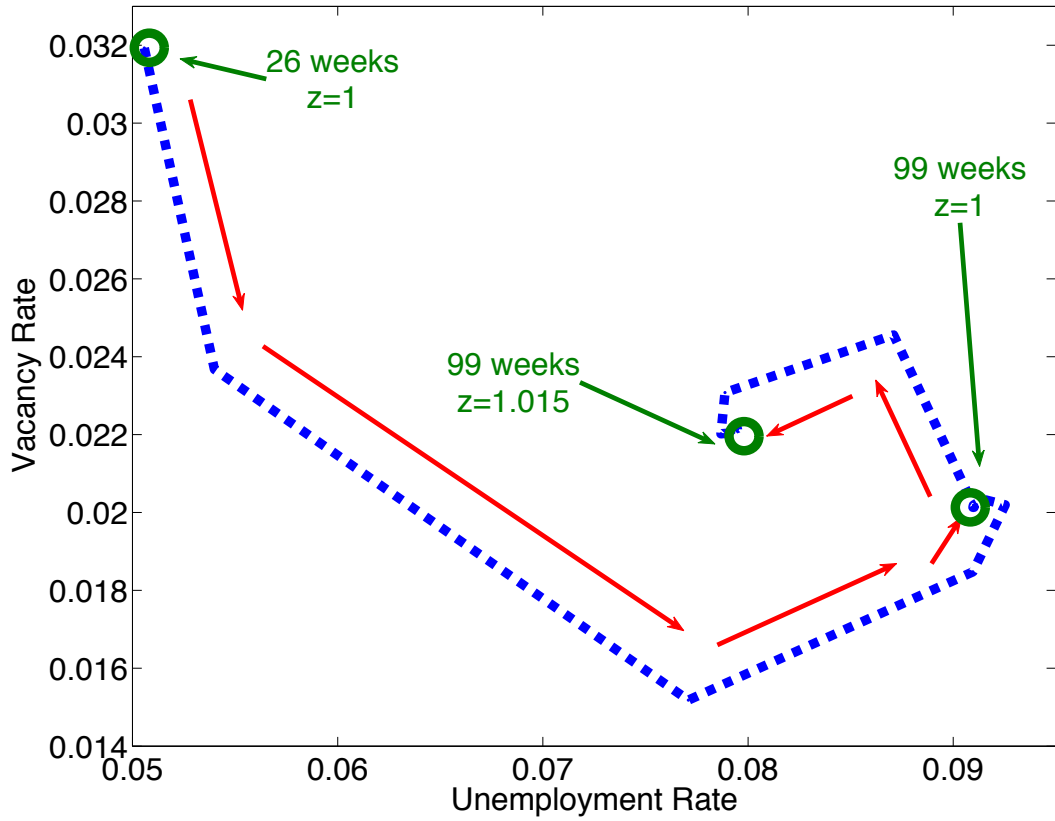
Figure 8: Simulated Beveridge curve. Productivity is held constant at 1 and benefits are permanently increased to 99 weeks. Then productivity increases to 1.015.
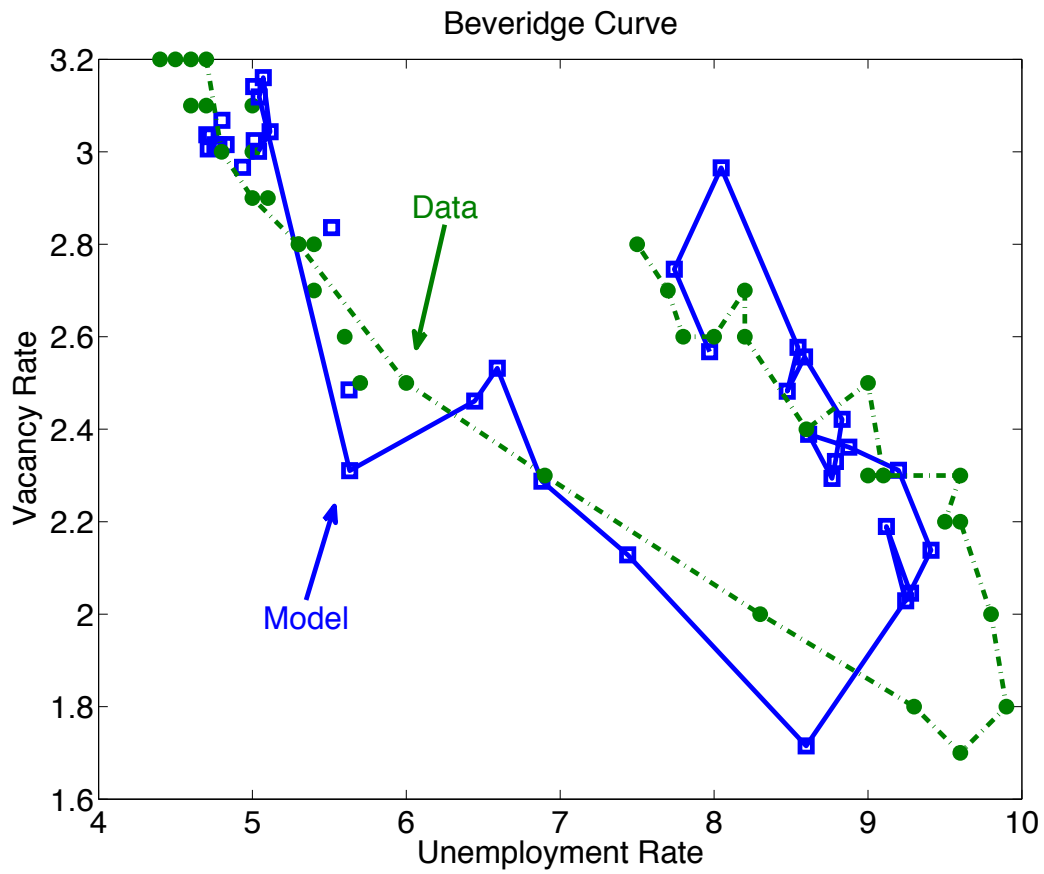
Figure 9: Simulated and actual Beveridge curve from January 2005 through December 2011. The unemployment and vacancy rates come from the BLS JOLTS database. Both series are plotted as quarterly averages of monthly (JOLTS) and weekly (model) data.
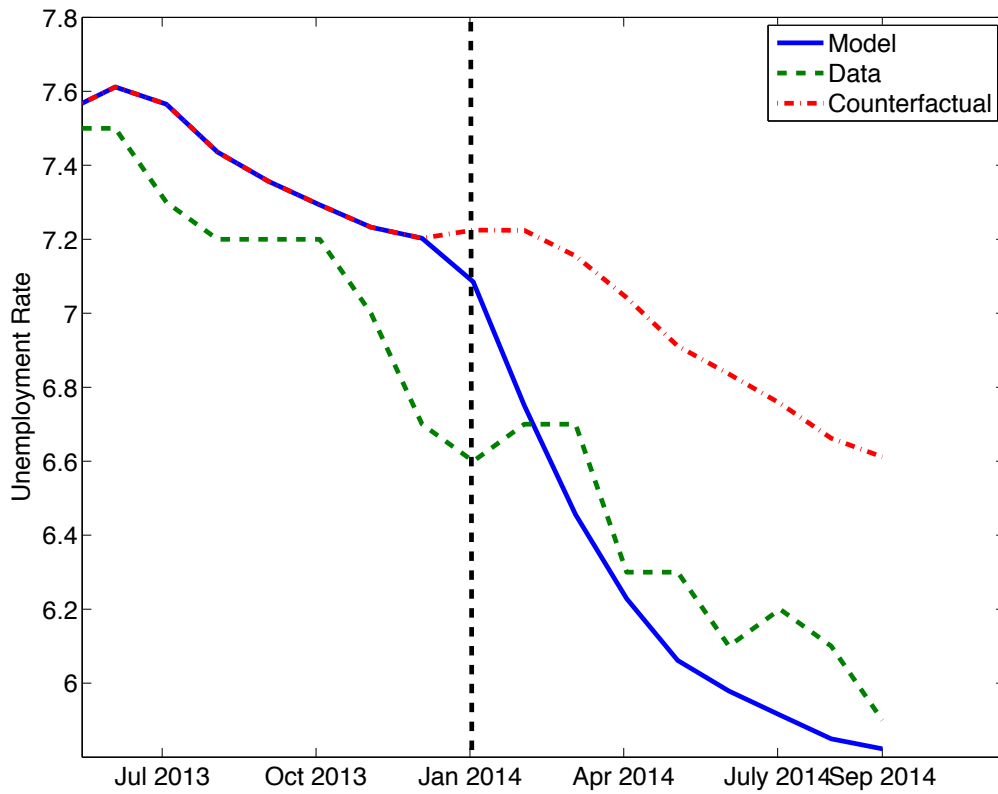
Figure 10: Simulated and actual unemployment rate. The blue line is the model, the red dot-dashed line is the model with benefits extended through 2014:QIII, and green dashed line is the data. Data and model are not filtered.
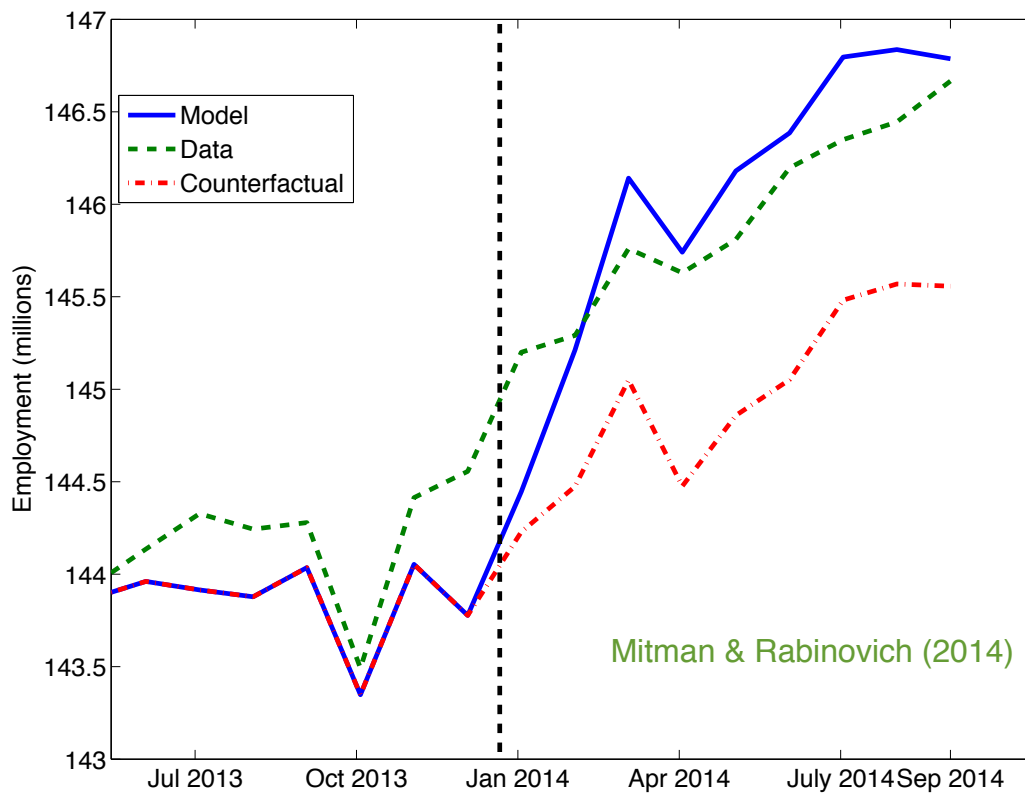
Figure 11: Simulated and actual employment. The blue line is the model, the red dot-dashed line is the model with benefits extended through 2014:QIII, and green dashed line is the data. Data and model are not filtered.

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[15]. 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-

---

[15]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 or reauthorized 12 times to day, gradually raising the maximum additional benefits provided by the federal government to 53 weeks, and thereby making the total compensation that an unemployed worker could receive 99 weeks (26 state + 20 EB + 53 EUC08). The program expired on January 1, 2014.

In summary, 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.