Macroeconomic Dynamics (2023), **27**, pp. 1424–1454
doi:10.1017/S1365100522000293

CAMBRIDGE UNIVERSITY PRESS

ARTICLE

Extension of unemployment benefits and changes in job search margins*

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Abstract

Unemployment insurance benefits are often extended during recessions. Existing research shows that this policy increases the unemployment rate and the duration of unemployment. But less is known about why these changes occur. I construct a job search model with an endogenous participation decision to quantify the contributions of (i) search effort, (ii) job selectivity, and (iii) labor market participation, to changes in unemployment outcomes. In a model calibrated to the US economy, I show that the increased participation accounts for a large fraction of the increase in the unemployment rate following a permanent extension of benefits. This finding indicates the importance of changes in the participation decision of workers facing extended benefits for the unemployment rate—a mechanism that is understudied and frequently overlooked in the quantitative labor market research exploring the impact of UI policies.

Keywords: Unemployment insurance; labor market; job search; labor market participation

1. Introduction

The extension of unemployment insurance (UI) is associated with a higher unemployment rate and a longer duration of unemployment.[1] How much of these changes in unemployment outcomes can be explained by the responses of unemployed workers to changes in their UI benefits? I propose three margins of adjustment by which unemployed workers may respond to changes in their UI benefits. In response to an extension of UI benefits, workers may (i) reduce their search effort, (ii) become more selective in accepting job offers, and (iii) stay attached to labor market for a longer period of time, especially if benefits are linked to the labor market activity. Using a structural model calibrated to the US economy, I quantitatively explore the extent changes in the unemployment outcomes, in particular the unemployment rate and the duration of unemployment, that can be attributed to each of these three margins.

To this end, I construct a job search model that features (i) job search effort, (ii) job selectivity, and (iii) an endogenous labor market participation decision. Using the calibrated model, I quantify the impact of an extension of UI benefits on unemployment outcomes when the benefits are extended both permanently and temporarily. I then decompose the impact of UI extension into changes generated by the proposed margins by performing a series of counterfactual experiments. I find that increased labor market participation can explain a large fraction of the increase in the unemployment rate. For instance, following a permanent extension of benefits from 6 to 9 months, the unemployment rate increases by about 0.85 percentage points. I find that the elevated participation accounts for about 17% of the increase, while the reduced search effort can explain

*The author would like to thank Lawrence Uren, Chris Edmond, May Li, Yusuf Mercan, John P Haisken-DeNew, Bruce Preston, Chris Skeels, the seminar participants at the University of Melbourne, the University of New South Wales, as well as the associate editor, and the two anonymous referees for helpful comments and discussions. All errors are mine.

around 30% and the increased selectivity can explain about 13% of the increase.[2] Furthermore, I examine the contribution of the proposed three margins to changes in the unemployment outcomes during times when jobs are hard to find. I, similarly, find that the response of participation margin to an extension of UI can explain a large share of increase in the unemployment rate. This finding indicates the importance of participation margin in explaining the impact of UI policy, which has not received much attention in quantitative job search models, particularly in the UI literature.

The model abstracts from the general equilibrium effects, in particular the response of firms' hiring decision to an extension of UI.[3] However, it encompasses a rich microeconomic framework that allows for a careful analysis of the influence of UI extension on the job search incentives of workers. Specifically, in the model, workers are heterogeneous in skill, the level, and the duration of UI benefits. In addition, workers are heterogeneous in their UI eligibility status. Upon beginning their unemployment spell, workers may receive UI benefits that depend on their past employment income. Duration of UI benefits, however, is limited, and workers exhaust their benefits over time. The limited availability of benefits generates heterogeneity in the workers' job search behavior over the spells of unemployment. After exhausting their benefits, UI-ineligible workers receive a fixed amount for consumption. This captures the value of other welfare programs that workers receive during unemployment. Unemployed workers may also choose to leave the labor market in which case they receive the value of home production during non-participation.

The limited availability of UI benefits and a non-trivial participation decision confront unemployed workers with a trade-off. On the one hand, workers with more periods of benefits have less incentives to engage in job search activity (i.e. they have low search effort and high job selectivity). But they are more likely to stay in the labor market and keep participating in the job search. On the other hand, workers with fewer periods of benefits have greater incentives to search for a job (i.e. they have high search effort and low job selectivity). They are, however, more likely to leave the labor market. An extension of UI benefits affects unemployment outcomes by changing this trade-off. First, it slows down the transition of unemployed workers to employment by reducing search effort and raising job selectivity, conditional on participation. Second, it reduces the transition of workers out of the labor market by increasing the return to job search. The increase in the return to the job search may also induce more non-participating individuals to return to the labor market.

Evaluating the usefulness of the UI extension policy requires a careful assessment of its costs and benefits. Typically, an increase in unemployment is viewed as a cost associated with an extension of UI. In this paper, I focus on the cost side of this policy and examine three margins that explain the increase in unemployment in response to an extension of UI benefits. It should be emphasized that evaluation of the benefits associated with this policy may also depend on why unemployment increases. For instance, higher selectivity may lead to higher unemployment, but it may also lead to better job matches between workers and firms. Similarly, longer labor market participation may increase unemployment, but it may also lead to a higher chance of finding a job for workers. Furthermore, from the policy-making perspective, it is important to understand the sensitivity of unemployment to the corresponding margins in order to conduct an efficient policy. From this perspective, this paper examines the sensitivity of unemployment to (i) search effort, (ii) job selectivity, and (iii) labor market participation and quantifies how much each margin drives changes in unemployment following an extension of UI benefits.

To quantify the impact of changes in UI policy, I calibrate the model to match several key moments of the US labor market during 2005–2007. I then conduct two policy experiments. In the first experiment, I investigate long-run changes in the unemployment outcomes when benefits are extended permanently.[4] I show that a permanent extension of UI benefits increases the unemployment rate, the average duration of unemployment, and the long-term unemployment rate. The results are consistent with the existing empirical findings. I then perform a counterfactual experiment to quantify the contribution of changes in the job search intensity, job selectivity,

https://doi.org/10.1017/S1365100522000293 Published online by Cambridge University Press

and labor market participation, to changes in the unemployment outcomes. I find that changes in the participation decision can explain a large fraction of the total impact on the unemployment rate and the duration of unemployment.

The model abstracts from the impact of a potential reduction in vacancy creation by firms in response to an extension of UI benefits. In theory, with an extension of UI benefits and increase in the return to job search unemployed workers may become more selective in accepting the job offers. To hire workers, therefore, firms may need to offer higher wages. This in turn reduces the surplus from a match for firms and may induce them to reduce their vacancy creation. To examine the impact of this channel on the results, I simulate an economy in which workers have permanently lower chances of transition to employment, from both unemployment and non-participation, when UI benefits are extended for three months. The difference, in the response of the unemployment outcomes, with the previous counterfactual experiment would capture the impact of hardship in finding jobs when workers may receive extended benefits. Similarly, I find that the response of the labor market participation can account for a large fraction of the total impact of the UI on the unemployment outcomes during times when jobs are harder to find.

In the second experiment, I ask how the labor market outcomes respond when the benefits are extended temporarily. This experiment analyses the transitional dynamics when benefits are extended for a limited period of time, such as at the beginning of a recession.[5] I perform this experiment together with a large, unanticipated job separation shock (e.g. a recession).[6] The extension of benefits is anticipated by workers and lasts for a limited period of time. I show that the labor market outcomes respond differently if benefits are extended temporarily compared to an economy with no UI extension. I also decompose the responses into changes induced by each decision margin in a series of counterfactual experiments. Importantly, I find that changes in the participation margin can explain a large fraction of responses of the unemployment rate during the transition period.

Literature Review. This paper relates to a large strand of empirical literature that studies the impact of UI policies on labor market outcomes.[7] Following the Great Recession and the unprecedented extension of UI benefits by the US government, this literature has received renewed interest, for example, Farber and Valletta (2015), Fujita (2010), Rothstein (2011). For instance, Rothstein (2011) shows that the extended benefits had a small effect on the increased unemployment rate and the long-term unemployment rate.[8] Importantly, Rothstein (2011) highlights the significance of the elevated participation during the Great Recession and finds that around half of the increase in the unemployment rate was related to slower transition of workers to out of the labor force.

Using a structural model that allows for decomposing the impact of UI extension into the change induced by labor market participation (and the other two margins), similar to Rothstein (2011), I find that the response of participation margin to the policy can explain a large fraction of the effect.

In an important contribution to the literature, Hagedorn et al. (2015) focus on the role of what they call the "macro effect," which involves the response of vacancy creation by firms to an extension of benefits and find a large impact of UI extension on unemployment. This result is challenged in a number of studies including Hall (2013), Dieterle et al. (2018), Amaral and Ice (2014), Marinescu (2017), Chodorow-Reich et al. (2018), and Coglianese (2015). For instance, Chodorow-Reich et al. (2018) find a small effect of UI extensions on the unemployment rate during the Great Recession.

Among quantitative macroeconomic models, this paper shares a few features with Andolfatto and Gomme (1996) which study the labor market impact of a reform in the UI system in Canada using a single agent search model with optimal participation decision. In contrast to Andolfatto and Gomme (1996), several of the labor market transitions are endogenous in this paper. This, in turn, allows decomposing the contribution of different decision margins, (i) search effort, (ii)

https://doi.org/10.1017/S1365100522000293 Published online by Cambridge University Press

job selectivity, and (iii) labor market participation to the total changes in the unemployment outcomes, which is absent in Andolfatto and Gomme (1996). In addition, I extend their work by studying the transitional dynamics of unemployment outcomes when benefits are extended temporarily and quantify how much each decision margin affects the responses. Nakajima (2012) builds on Mortensen and Pissarides (1994) and shows that the extended benefits during the Great Recession increased the unemployment rate. Rujiwattanapong (2016) studies the UI policy in the United States and shows that a reduction in the availability of benefits during the Great Recession could potentially lower the unemployment rate, the long-term unemployment, and the average duration of unemployment.

I contribute to these papers by introducing the participation margin as another mechanism to explain changes in unemployment following an extension of UI.

The rest of this paper is organized as follows. Section 2 describes the model. In Section 3, I calibrate the model. Section 4 discusses the main results, and Section 5 concludes.

2. Model environment

Time is discrete and runs forever, $t \in \{0, 1, 2, \ldots\}$. There is a mass normalized to one of individuals who maximize expected lifetime utility with discount rate $\beta \in (0, 1)$. In each period, individuals can be employed, unemployed with UI eligibility, unemployed without UI eligibility and non-participating. Individuals' preferences are represented by

$$\mathbf{u}(y, s) = u(y) - c(s),$$

where y denotes earnings, and s denotes search effort of unemployed workers. $u(.)$ is a strictly increasing and strictly concave utility function over earnings and $c(.)$ is strictly increasing and strictly convex function that represent cost of search.

Employed workers earn wh where w is the wage rate and h denotes their skill level. Unemployed individuals who are UI eligible receive the value of UI, b, that depends on their past employment earnings up to $\mathbf{T}$ periods following job separation.[9] Unemployed individuals who are UI ineligible receive a fixed amount of non-monetary transfer, $\tilde{b}$. This captures the value of food stamp or any welfare program services. Non-participating individuals receive xh where x captures value of home production/leisure and h denotes their skill level.

Labor market is frictional. While unemployed, workers can actively search for a job. In each period, unemployed workers may receive a wage offer from an exogenous (*iid*) wage offer distribution, $G(w)$ that depends on their search effort. This implies that the probability of finding a job for workers depends on their search effort and how selective they are in accepting the offer. When workers are eligible to receive unemployment benefits, the probability of finding a job depends on the amount of benefits that they receive, their skills, and the number of periods that they have received benefits, that is $(b, h, j)\ \forall j \leq \mathbf{T}$. When workers are not eligible to receive unemployment benefits, the probability of finding a job depends only on the skill (h) level.

In addition, unemployed workers may choose to quit the job search activity. In each period, they receive a value for home production, x, from an exogenous (*iid*) home production distribution $F(x)$. This may, in turn, induce the unemployed workers to exit from the labor market. Similar to finding a job, and among other dimensions, this decision also depends on the UI eligibility. Specifically, the labor market participation decision of unemployed workers depends on $(b, h, j)\ \forall j \leq \mathbf{T}$ when they receive UI benefits. It depends only on (h) when unemployed do not receive UI benefits.

There is no decision-making by the employed workers. In each period, they may lose their jobs or may exit the labor market. Upon job separation, workers may take up UI with probability $\mathcal{E}$. On the other hand, in each period, non-participating individuals may choose to return to job search activity. They may also transition to employment with an exogenous probability.

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2.1 Timing

Timing is as follows. At the beginning of a period, a previously unemployed worker with skill level h draws home productivity x from $F(x)$ and decides whether to participate or to drop out of the labor market. If the worker decides to participate in the labor market, she chooses the level of search effort that determines the probability that she receives a job offer. Specifically, the worker receives a job offer with probability, $f(s) \in (0, 1)$ with $f'(s) > 0$. If the worker accepts the job offer, she transitions into employment otherwise, she remains unemployed for one more period.

In each period, employed workers may lose exit the labor market with probability δ_{en}. They may also lose their jobs with probability δ_{eu}, which then they may begin collecting UI benefits with probability $\mathcal{E}$. Finally, in each period, previously non-participating individuals draw a value from $F(x)$ and choose to return to the labor market. Upon return, they can search for a job as UI ineligible unemployed.

In each period, all workers face stochastic accumulation or depreciation of skills depending on their labor market status. Following Ljungqvist and Sargent (1998, 2008), I assume that skills can be accumulated during employment and can be depreciated during unemployment and non-participation.[10] Specifically, in each period, employed workers with skill h may receive an upgrade of skill to $h' > h$ with probability $p_e(h, h')$. Unemployed workers and non-participating individuals with skill level h may lose skill to $h' < h$ with probability $p_u(h, h')$.

Skill loss creates hysteresis in unemployment and non-participation via changing the return to job search. Specifically, losing skill allows for negative duration dependence of unemployment. In other words, as time passes and unemployed experience a loss in their skill their chances of finding a job decrease. This may imply that workers may spend more time in unemployment. However, it should be emphasized that skill loss, in addition, decreases workers' tendency to participate in job search and may result in a transition to non-participation. Furthermore, changes in skills have implications for future earnings of workers. In particular, with a skill loss, unemployed would receive a lower earnings upon accepting a job offer. On the other hand, with a skill gain, employed may move up the job ladder over employment spell. I calibrate the skill transition probabilities by targeting relevant labor market transitions and changes in consumption following job loss.

2.2 Recursive problems

Employed. Let $V^e(w, h)$ be the present discounted value of expected utility of an employed worker with wage w and skill level h. This value is given by

$$V^e(w,h) = u(wh) + \beta(1-\delta_{en})\Bigg\{(1-\delta_{eu})\sum_{h'} p_e(h,h')V^e(w,h') + \delta_{eu}\sum_{h'} p_u(h,h')\Bigg[\mathcal{E}V^u(b,h',j=1) + (1-\mathcal{E})V^u_{ne}(h')\Bigg]\Bigg\} + \beta\delta_{en}\sum_{h'} p_u(h,h')\int V^n(x',h')dF(x'). \quad (1)$$

In each period, the employed workers receive a flow utility of earning which is the product of their wage and current skill level wh. The wage is assumed to be unchanging over tenure, while employment earnings may increase when workers receive an skill upgrade to $h' > h$.

In addition, in each period, employed workers may exit from the labor market with probability δ_{en}. They may also face a job separation with probability δ_{eu}. Following a job separation, a worker may become eligible for UI with probability $\mathcal{E}$. This implies that with probability $\mathcal{E}$, a worker would begin collecting UI and her value function would be $V^u(b, h', j = 1)$; otherwise, she would not receive UI and her value would be $V^u_{ne}(h')$.

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UI eligible unemployed. Let $V^u(b,h,j)$ be the present discounted value of expected utility of an UI-eligible unemployed worker who has received unemployment benefit, b for j periods and has skill level h. This value is represented recursively as follows:

$$V^u(b,h,j) = \max_{s\in(0,1]} \Bigg\{ u(b) - c(s) + \beta \sum_{h'} p_u(h,h') \Bigg[f(s) \iint \max\left\{V^e(w',h'), V^u(b,h',j+1), V^n(x')\right\} dF(x')dG(w') + (1-f(s)) \Bigg[\int \max\{V^u(b,h',j+1), V^n(x')\}\, dF(x') \Bigg] \Bigg] \Bigg\} \quad \forall\, j \le \mathbf{T}. \tag{2}$$

In each period, UI-eligible workers receive a flow value of $u(b) - c(s)$, where b is the amount of UI benefits that depends on their past earnings and $c(s)$ is the cost of searching for a job. In each period, unemployed workers first decide to participate or to drop out of the labor market. If they choose to participate, they receive a wage offer with probability $f(s)$ which then they decide to accept or to reject. If they reject the job offer, they remain unemployed for another period. With probability $1-f(s)$, however, workers do not receive a wage offer and stay unemployed for another period. If workers decide to drop out of the labor market, they receive the value of non-participation $V^n(x',h')$. During unemployment, workers choose the level of search effort s that maximizes their return to job search. This process continues recursively until UI benefits are exhausted.[11]

UI ineligible unemployed. Similarly, let $V^u_{ne}(h)$ be the present discounted value of expected utility of an UI-ineligible unemployed worker with skill level h. This value is represented recursively as follows:

$$V^u_{ne}(h) = \max_{s\in(0,1]} \Bigg\{ u(\tilde{b}) - c(s) + \beta \sum_{h'} p_u(h,h') \Bigg[f(s) \iint \max\left\{V^e(w',h'), V^u_{ne}(h'), V^n(x')\right\} dF(x')dG(w') + (1-f(s)) \Bigg[\int \max\{V^u_{ne}(h'), V^n(x')\}\, dF(x') \Bigg] \Bigg] \Bigg\}. \tag{3}$$

Equation (3) has a similar interpretation to equation (2) with the exception that once the UI benefit expires, the value functions become independent of level and duration of benefit receipt and workers only receive $\tilde{b}$.[12]

Non-participating. Finally, the value of non-participation is

$$V^n(x,h) = u(xh) + \beta \Bigg[(1-f_{ne}) \sum_{h'} p_u(h,h') \int \max\left\{V^u_{ne}(h') - \psi, V^n(x',h')\right\} dF(x') + f_{ne} \sum_{h'} p_e(h,h') \int (V^e(w',h') - \psi) dG(w') \Bigg]. \tag{4}$$

During non-participation, the flow utility of individuals consists of the value of home production/leisure x and skill level h. In each period, non-participating individuals may transition to employment with probability f_{ne}. Otherwise, they may choose to return to unemployment. Non-participation is costly. The utility cost of non-participation is captured by ψ. If the cost is paid, individuals can return to the labor market as either an employed or an UI-ineligible unemployed worker. It should be emphasized that not allowing workers to receive UI benefits upon returning to the labor market reflects a feature of the UI system in the United States specifying that

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unemployed workers are eligible to receive UI benefits as long as they maintain the job search activity. By assumption, individuals do not search for a job during non-participation. This implies that unemployed workers would lose their UI eligibility when they choose to quit the job search activity.[13]

2.3 Decision margins

The optimal decisions associated with equations (1)–(4) can be characterized by a set of decision margins, $\{s(b,h,j), s_{ne}(h), \tilde{w}(b,h,j), \tilde{w}_{ne}(h), \tilde{x}(b,h,j), \tilde{x}_{ne}(h)\}$ that specifies the optimal search intensity, reservation wage, and reservation participation, depending on workers heterogeneity for UI-eligible and UI-ineligible workers. UI-eligible workers are heterogeneous in the amount of UI benefits, skill level, and duration of receiving the benefits, whereas UI-ineligible workers differ based on their skill level.[14]

The limited availability of UI influences the expected continuation return to job search and confronts the UI-eligible workers with a decision between receiving $\tilde{b}$ as they exhaust the benefits, accepting a job offer and receiving (wh) or dropping out of job search and receiving (xh). Since on average $\tilde{b}$ is smaller, in magnitude, than return to employment and non-participation the expected return to remaining unemployed would be decreasing for UI-eligible workers. The decreasing return to job search, in turn, implies that UI-eligible workers would search more intensively, become less selective in accepting the job offer, and become less engaged in labor market participation as j increases. The problem for UI-ineligible workers is similar except that their return to job search does not change with j, and the corresponding decisions are shaped by the level of skill over unemployment.

As discussed above, the decision between choosing employment or non-participation is influenced by the respective expected return over unemployment (level of surplus) and is determined by the heterogeneity of individuals in the model. For instance, higher-skilled individuals may be more prone to dropping out of the labor market for a given draw for x, but they are more likely to remain in non-participation once they have not depleted their skills. On the other hand, a high draw for x may induce the lower-skilled workers to drop out of the labor market. However, with a reversal of x they are more likely to pay the cost (i.e. ψ) and return to the labor market in the following periods. Therefore, lower skilled are more likely to shape the marginally attached individuals to the job search.

To gain further insight about the implications of the model, in this section, I characterize the decision margins in a simplified version of the model. To fix ideas, I keep the skill level of a workers unchanged and explore the decision margins for a UI-eligible unemployed worker who has received benefits for j periods. I discuss the implications of the full model in Section 4.

In a simplified model, the value function for an unemployed worker who is eligible to receive UI benefits is as follows.

$$V^u(j) = \max_{s\in(0,1]} \Bigg\{ u(b) - c(s) + \beta \Bigg[f(s) \iint \max\left\{V^e(w'), V^u(j+1), V^n(x')\right\} dF(x')dG(w') + (1-f(s)) \Bigg[\int \max\{V^u(j+1), V^n(x')\}\, dF(x') \Bigg] \Bigg] \Bigg\} \quad \forall\, j \leq \mathbf{T}.$$

The following results hold.[15]

PROPOSITION 1. *The value function $V^u(j)$ is decreasing with j $\forall\, j \leq \mathbf{T}$. In addition, since workers lose their UI eligibility after $j = \mathbf{T}$, then $V^u(\mathbf{T}) \geq V^u_{ne}$.*

This result allows us to characterize the decision margins over the duration of unemployment until UI benefits expire.

PROPOSITION 2. *Conditional on the labor market participation, the optimal search effort $s(j)$ is increasing with j $\forall\, j \leq \mathbf{T}$.*

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This result implies that the search effort of workers increases as UI benefits expire, that is, $j = \mathbf{T}$. This implies that, since workers may enter into unemployment without UI benefits, the UI-ineligible unemployed workers have the highest search effort in the model, conditional on participation.

Following a similar argument, I show that job selectivity of workers declines with increase in j.

PROPOSITION 3. *Conditional on the labor market participation, the job selectivity characterized by reservation wage* $\tilde{w}(j)$ *is decreasing with* $j \ \forall\, j \leq \mathbf{T}$.

This result also implies that as UI benefits expire, workers become less selective in accepting job offers. Therefore, conditional on participation, their exit rate to employment increases until $j = \mathbf{T}$ and it remains unchanged once they lose their UI eligibility.[16]

Finally, I show that the probability of participating in the job search decreases as UI benefits expire.

PROPOSITION 4. *The labor market participation characterized by reservation participation* $\tilde{x}(j)$ *is decreasing with* $j \ \forall\, j \leq \mathbf{T}$.

Knowing how each decision margin changes with changes in j, it follows that in response to an extension of UI benefits from $\mathbf{T}$ to $\mathbf{T} + \Delta$, the return to unemployment increases. This implies that search effort declines, but the job selectivity and the labor market participation increase, which in turn drives the transitions of workers between unemployment and non-participation in the model. I analyze this in detail in the next sections.

3. Calibration

In this section, I calibrate the model parameters to reproduce some of the key labor market outcomes of the US economy for working age population (aged 16–64) between 2005 and 2007.[17] The emphasis of this paper is to decompose changes in the unemployment outcomes into the changes induced by the workers' job search margins. These margins directly influence the transition of workers between the three labor market states. Therefore, I base the calibration strategy on matching the model's parameters with the key labor market transitions in the data.

Labor market transition. I use the monthly basic data from the Current Population Survey (CPS) to estimate the transition probabilities given by $p_{i,jt} = ij_t / i_{t-1}$ for $i, j \in \{E, U, N\}$.[18] The CPS is a survey of American households administered by the Bureau of the Census under the supervision of the Bureau of Labor Statistics (BLS) and is the primary source of data on labor force statistics in the United States. In each sample, about 50,000 households are selected that represent the US population as a whole. Households are interviewed in a 4-8-4 pattern. They are interviewed each month for 4 consecutive months and are re-interviewed 8 months later for another round of 4 consecutive months. Therefore, eight rotation groups (cohort of households starting their interviews in a month) are interviewed each month.

Despite many advantages that include a large sample and the possibility of tracking individual outcomes over time, the CPS data have some limitations that may cause biased estimation of the labor market transitions. This limitation originates from the fact that individuals self-report their labor market status in the CPS interviews. Officially, individuals are classified as unemployed if they report that they have been searching for a job in the past four weeks prior to the interview. An individual who has not actively searched for a job or is unavailable to begin a job is classified as out of the labor force. This implies that the distinction between unemployment and non-participation may sometimes be unclear especially when the job search is not continuous. This issue also affects the self-reported duration of unemployment by individuals and may cause the reported duration of unemployment to cover periods of non-participation.

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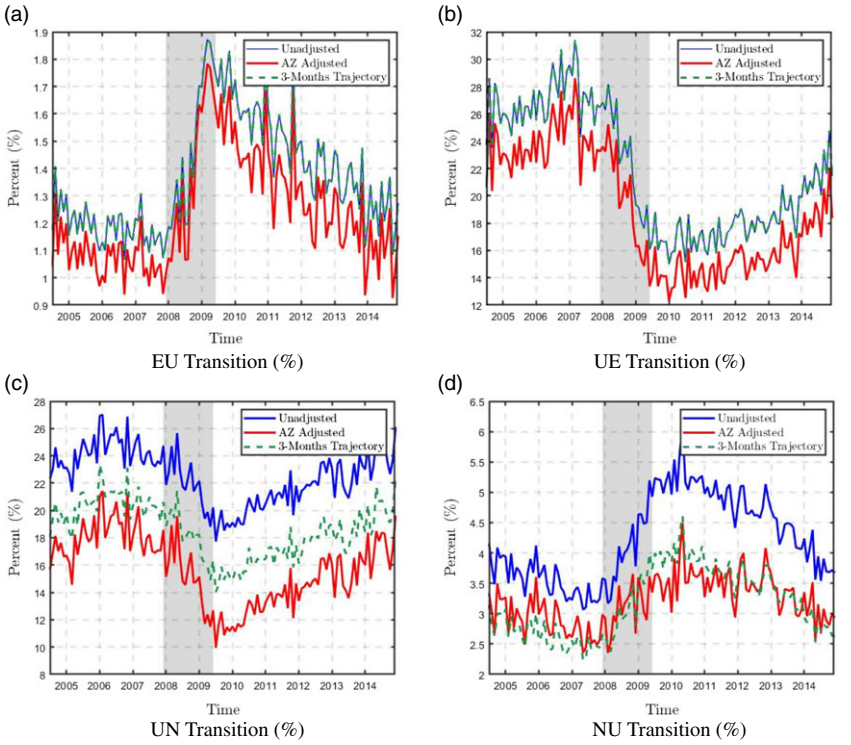

Notes: All series are seasonally adjusted. Shaded area denotes Great Recession.

Figure 1. Labor market transition.

The literature has addressed this issue and provided corrections for classification errors. One approach to address this issue is proposed by Abowd and Zellner (1985) that adjusts for spurious transitions by estimating misclassification probabilities using CPS re-interview. The second approach focuses on the reversal of transitions between unemployment (U) and non-participation (N) in a 3-month trajectory and counts individuals as unemployed if their trajectory is in the form of UNU and non-participating if the 3-month trajectory has the form of NUN.[19]

To provide a better understanding of this issue, Figure 1 displays the estimated unadjusted transition probabilities together with the two discussed adjusting approaches of Abowd and Zellner (1985) (AZ adjusted) and the 3-month trajectory approach.

The impact of the Great Recession on the labor market transitions is displayed in the shaded area. For instance, Figure 1c shows a significant decrease in the UN during the Great Recession which is then followed by a gradual recovery after the Great Recession. An opposite of this trend can be seen in Figure 1d. Labor market, during the Great Recession, experienced an influx of non-participating individuals returning to unemployment. This caused an increase in the NU until a few months after the Great Recession. It is, however, displayed that the NU transition is followed with a gradual reversal over time.

Figure 1 displays that although the unadjusted transitions follow a similar trend as the adjusted series, accounting for the spurious transitions can cause differences in the magnitude of transitions, especially for the transitions between U and N. Importantly, it shows that adjusting for spurious transitions does not affect the transition probabilities between employment and unemployment as significantly as transitions between unemployment and non-participation. This particularly highlights the issue corresponding to the self-reporting of labor market status in the

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CPS. While in the model search is continuous and individuals are placed into non-participation once search stops, the distinction between unemployment and non-participation in data may render an overestimation or underestimation of the true transition probabilities.

This exercise provides a brief review of some of the issues around the estimation of the transition probabilities in the data. However, the goal of this paper is not to provide a preference over the approaches for adjusting for the classification errors in the data. Rather, this paper explains how some of the mechanisms that explain shaping these transitions may respond to a UI policy. For this reason, in this section, I proceed with targeting moments associated with the unadjusted transitions. This in turn implies that the targeted moments may overstate their true empirical values, in particular the moments related to the transitions between unemployment and non-participation.

Functional forms and parameters estimation. The model period is one month. I set the discount factor to $\beta = 0.95^{(1/12)}$. I also set $\mathbf{T} = 6$ that corresponds to the duration of payments under regular 26 weeks benefits program in the USA. I set $\delta_{eu} = 0.0119$, $\delta_{en} = 0.0263$ and $f_{ne} = 0.0708$ corresponding to the average EU, EN, and NE transition probabilities. The UI take-up rate is set to $\mathcal{E} = 0.77$ taken from Auray et al. (2019) which calculates an average UI take-up rate of around 77% in the USA.

The period utility function is

$$\mathbf{u}(y, s) = u(y) - c(s) = \log(y) - \gamma \frac{s^{1+\mu}}{1+\mu},$$

where $y = \{wh, b, xh\}$ over employment, unemployment, and non-participation, respectively. The parameters $\gamma > 0$ and $\mu > 0$ represent the scale and the elasticity of search with respect to effort, respectively.

In general, standard job search models find a negative relationship between risk aversion and job selectivity. They show that the more risk-averse workers choose to accept jobs faster (lower selectivity) via assigning lower value to the expected future return from the job search.[20] In this paper, unemployed workers have the option to choose not to participate in the job search besides choosing employment that affects their expected future return from the job search. Therefore, while the overall implications for the calibration are complex, risk aversion may facilitate matching the transition targets, especially the transition of workers out of unemployment.

Unemployed workers meet jobs according to a linear function with respect to their search effort, $f(s) = \lambda s$. With this linear functional form, it is not possible to separately identify both λ and γ. Therefore, I normalize the scale of disutility of search to, $\gamma = 1$.

Wage offer distribution is assumed to be log-normal $\log w \sim (\mu_w, \sigma_w^2)$. To calibrate the moment of this distribution, I normalize $\mu_w = 0$, but choose σ_w so that the (50/10) wage gap in the grid be close to 1.7, consistent with the estimates from Autor et al. (2008).

There are three high-, medium-, and low-skill levels, $h \in \{\underline{h}, h_m, \overline{h}\}$ corresponding to the high school, some college, and college graduates in the CPS. I assume that high and low skills are evenly spaced around the medium-skill level, that is, $\underline{h} = h_m - \epsilon$ and $\overline{h} = h_m + \epsilon$. I normalize $h_m = 1$ and set $\epsilon = 1/5$ consistent with the relative supply of college/high school graduates of around 1.5 from Autor (2014).

UI-eligible workers are compensated proportionally to their past employment earnings according to $b = \tau \times wh + \tilde{b}$ for $\mathbf{T} = 6$ months following job separation. following Birinci and See (2019) I set $\tau = 0.52$.[21] Unemployed workers who are ineligible to collect UI are assumed to receive $\tilde{b}$. This includes workers who exhaust their UI and individuals who return to the labor market.

The rest of parameters $(\lambda, \mu, \psi, \tilde{b}, p_e(h, h'), p_u(h, h'), F(x))$ are jointly estimated given the functional forms and the parameter values specified above.

To estimate the skill transition probabilities $p_e(h, h'), p_u(h, h')$, I follow Ljungqvist and Sargent (1998, 2008) and allow workers to gain or lose only one unit of skill in each period. Specifically,

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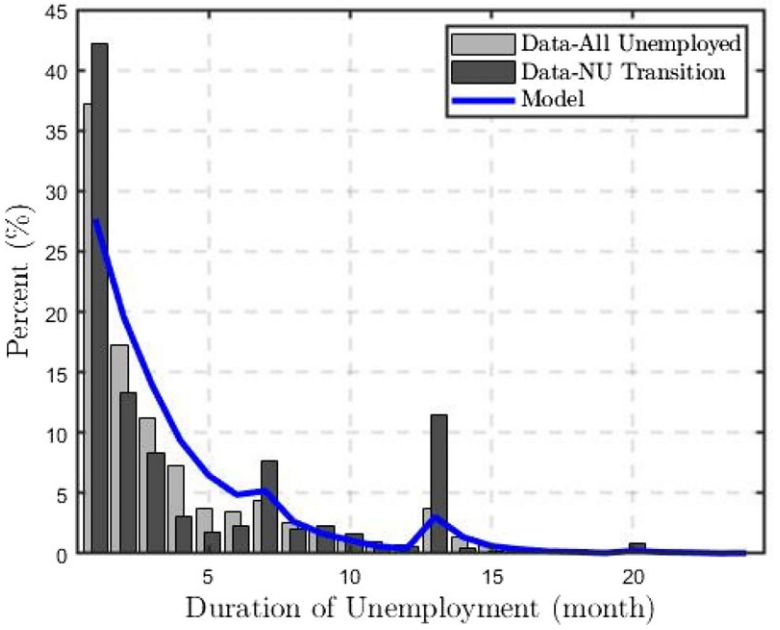

Figure 2. Distribution of duration of unemployment.

in each period, employed workers can experience one unit skill upgrade and unemployed can lose one unit of skill. This implies that the $\underline{h}$ and $\overline{h}$ would become absorbing states for unemployed and employed, respectively.[22] As discussed previously, allowing for skill loss during unemployment helps the model to generate hysteresis in unemployment via affecting the transition out of the unemployment. In addition, allowing for an accumulation of skill over employment has implications for the return to job search via affecting the employment earnings. To account for this, I target the 16% average food consumption drop following a job separation from Stephens Jr (2004).

It is empirically difficult to estimate the distribution of home production $F(x)$ directly from data. To characterize this distribution, I assume that individuals draw x from a log-normal distribution with $\log(x) \sim N(\mu_x, \sigma_x^2)$ which is *iid* over time and across individuals. I then estimate the moments of this distribution, that is, (μ_x, σ_x^2), by targeting several transition rates between unemployment and non-participation from the data.

Previously, I discussed that, due to classification errors, the self-reported duration of unemployment in the CPS may cover the periods of non-participation. In other words, individuals who transition from non-participation to unemployment may report their unemployment duration from the last time that they hold a job instead of from the period that they (re)entered the labor market. This implies that individuals who return to job search from non-participation prior to the interview may form a significant share of unemployed with duration longer than one month. This is noted in Elsby et al. (2011) which shows that a significant (approximately 60%) share of inflows into unemployment with (reported) duration longer than one month originates from non-participation.[23] To account for this, I compute the empirical distribution of duration of unemployment corresponding to the transitions from non-participation to unemployment using the CPS data. I then use this distribution to allocate the duration of unemployment for individuals who return to unemployment from non-participation in the model. Figure 2 shows the distribution of duration of unemployment reported by all unemployed (*Data-All Unemployed*) as well as the distribution of duration of unemployment reported by individuals who transition from non-participation to unemployment (*Data-NU transition*).

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Moments. To estimate the 8 parameters of the model $\{\lambda, \mu, \psi, \tilde{b}, p_e(h,h'), p_u(h,h'), \mu_x, \sigma_x\}$, I use the following 9 moments.

- Average UE= 0.2697, UN= 0.2493, NU= 0.0356 transition rates.
- Average duration of unemployment of 4.018 months (17.41 weeks), LTU rate of 18.83%[24]. The STU rate of 65.30%.[25]
- Average consumption drop following a job loss of 16% consistent with Stephens Jr (2004).
- Average NU= 0.0382 and UN= 0.2687 transition rates among low-skill individuals.

Estimation method. The parameters are estimated using Simulated Method of Moments. Specifically, $\Theta = \{\lambda, \mu, \psi, \tilde{b}, p_e(h,h'), p_u(h,h'), \mu_x, \sigma_x\}$ solves

$$\Theta = \arg\min \left(m(\Theta) - \bar{m}\right)' \Omega \left(m(\Theta) - \bar{m}\right),$$

where $m(\Theta)$ and $\bar{m}$ are the corresponding computed moments from the model and data. Ω is the variance-covariance matrix of moments which is a diagonal matrix of inverse of the variance of moments.

Table 1 summarizes the parameters values.

Table 1. Parameter values

Parameter	Description	Parameter value
Externally calibrated		
β	Discount factor	$0.95^{1/12}$
δ_{eu}	Employment to unemployment transition rate	0.0119
δ_{en}	Employment to non-participation transition rate	0.0263
f_{ne}	Non-participation to employment transition rate	0.0708
$\boldsymbol{\mathcal{E}}$	UI take-up rate	0.77
μ_w	Mean of wage distribution	0
σ_w	Std of wage distribution	0.2749
τ	UI replacement rate	0.52
h	Skill set	$h \in \{1-1/5, 1, 1+1/5\}$
T	Maximum duration of UI	6
Internally calibrated		
ψ	Cost of return to labor market	1.6062
$\tilde{b}$	Earnings of UI ineligible	0.4003
λ	Job offer meeting	0.7900
μ	Curvature of search cost	0.2403
$p_u(h,h')$	Unemployed skill loss probability	0.3012
$p_e(h,h')$	Employed skill upgrade probability	0.0031
μ_x	Mean of home production distribution	0.3368
σ_x	Std of home production distribution	0.7889

3.1 Steady-state results

Table 2 reports the steady-state results. In general, the model does well in replicating the targeted moments. As discussed earlier, the focus of the calibration is on targeting the transition of workers across the three labor market states, which is shaped by the decision-making of individuals in the model. In that regard, the model, among the targeted moments, generates a lower

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UE transition (on average) relative to its target. However, the average transition from unemployment to non-participation and the average transition from non-participation to unemployment are closely targeted by the model.[26]

Overall, the lower UE and UN transition rates together result in a higher unemployment rate in the model (5.86%) compared with the data (4.94%). The model's implied average duration of unemployment is close to its empirical value. However, the average duration of unemployment among UI-eligible workers in the model is smaller than the data. It should be emphasized that the CPS does not report whether individuals receive UI. I, therefore, estimate the unemployment rate and the average duration of unemployment among UI-eligible workers by focusing on a group of individuals whose primary reason for unemployment is reported as job loss or temporary layoff.[27]

A number of papers estimate the average consumption drop upon job separation. The empirical evidence suggests a range of estimated drop in consumption from 6.8% in Gruber (1997) to 19% in Aguiar and Hurst (2005). Using both the Health and Retirement Study (HRS) and Panel Study of Income Dynamics (PSID), Stephens Jr (2004) estimates that food consumption drops by around 16 and 12 percent, respectively. The model generates a slightly smaller decrease in earnings upon job separation relative to the targeted value. However, the result is consistent with the empirical findings and lies within the plausible range of values.[28]

Among other moments (not explicitly targeted), the model generates a higher fraction of UI receipt across unemployed. This can be explained by the lack of quit or other mechanisms that may result in UI ineligibility directly after job loss. By assumption, following a job separation, every worker is eligible to receive UI; however, only a fraction take up UI. Past research has found that slightly more than half of all unemployed are eligible to collect UI benefits.[29] Given that not every eligible worker takes up UI, the share of UI receipt among unemployed is larger in the model.

Table 2, in addition, shows that the model slightly underestimates the share of short-term (unemployed less than 3 months) and long-term (unemployed more than 6 months) unemployed relative to data. This implies that the model generates more medium-term (unemployed between 3 and 6 months) unemployment relative to the data. This can also be seen as in Figure 2 (*Data-All*

Table 2. Steady-state results

Moment	Model	Data
Targeted		
Average UE transition (%)	20.04	26.97
Average UN transition (%)	20.85	24.93
Average UN transition of low skill (%)	22.04	26.87
Average NU transition (%)	3.85	3.56
Average NU transition of low skill (%)	3.80	3.82
Average duration of unemployment (months)	3.97	4.02
Short-term unemployment (%)[30]	62.51	65.30
Long-term unemployment rate (%)[31]	16.06	18.83
Earning drop upon job separation (%)	13.73	16
Other moments		
Unemployment rate (%)	5.86	4.94
among UI eligible	3.17	2.39
Employment to population ratio (%)	70.32	71.73
Non-participation rate (%)	25.30	24.55
Average duration of unemployment (months)		
among UI eligible	2.96	3.86
Fraction of unemployed receiving UI (%)	52.61	36

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Unemployed) that displays the distribution of duration of unemployment estimated using CPS and the one generated by the model (blue line).

Consistent with the empirical findings, Figure 2 shows that the model does well in generating the negative duration dependence observed in data. The literature proposes *unobserved heterogeneity* and *true duration* dependence (such as skill loss) as the key mechanisms for the negative duration dependence of unemployment observed in data.[32] A strand of the literature shows that labor market heterogeneity plays a key role in generating negative duration dependence of unemployment.[33] In particular, using data from the Survey of Income and Program Participation (SIPP) Fujita and Moscarini (2017) defines heterogeneity as workers who return to former employer vs workers who find a new employer and shows that the recalls of former employees who separate into unemployment mainly drive the negative duration dependence in data.[34]

The model does not feature recalls. However, the model features both heterogeneity and true duration dependence as mechanisms that explain the negative duration dependence that is discussed in the literature. Specifically, the model incorporates heterogeneity by distinguishing between types of unemployment based on UI entitlement and re-entry to the labor market that in turn implies a different job search. Unemployed also face a stochastic skill loss that generates a decrease in the transition to employment that in turn help to generate the true duration dependence. Together, these features allow the model to generate negative duration dependence.

Finally, as discussed previously, a significant share of re-entrant (i.e. individuals who transition into unemployment from non-participation) report a duration of unemployment that exceeds the number of periods that they have returned to the job search activity. This is displayed in Figure 2 as *Data-NU Transition* (dark-gray bars). It is shown that (similar to Elsby et al. (2011)) around 40% of re-entrants report a duration of unemployment longer than one month (i.e. a fresh start). In addition, Figure 2 displays the role of re-entrants in generating the upticks in the distribution at the longer duration of unemployment. Allowing workers to draw a duration of unemployment from this distribution upon re-entering the labor market facilitates approximating the share of unemployment at the right tail of the distribution, in particular around the upticks.

4. Policy experiments

In this section, I conduct two policy experiments related to UI extensions. In the first experiment, I examine the impact of a permanent UI extension policy. This experiment explores the long-run changes in the equilibrium unemployment outcomes due to variation only in the potential duration of benefits, **T**. The results of this experiment can also be interpreted as differences in unemployment outcomes of economies with similar labor market parameters, but different maximum duration of UI benefits. I then decompose the responses of the unemployment outcomes into changes attributed to changes in each of the workers' decision margins, that is, search effort, job selectivity, and labor market participation.

In the second experiment, I examine the impact of a temporary UI extension. Specifically, I focus on the responses of unemployment outcomes to a large job separation shock (e.g. a recession) which is followed by an extension of benefits for a limited period. In this experiment, I compute the transition path of unemployment outcomes when benefits are extended temporarily and compare them with the counterfactual scenario in which benefits are not extended. Finally, to explain how much the decision margins account for the responses of the unemployment outcomes, I compute the counterfactual transition paths in which only one of the decision margins responds to the UI extension at a time.

4.1 Permanent UI extension policy

Table 3 reports changes in the unemployment outcomes in responses to a permanent increase in the maximum duration of UI benefits from 6 months (baseline) to 9 and 10 months. The last

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Table 3. Permanent changes in the duration of UI benefits

Model outcome	T = 6 (baseline)	T = 9	T = 10	T = 6 & τ+10 (pp)
Average UE transition (%)	20.04	18.55	18.03	19.13
Average UN transition (%)	20.85	17.10	16.19	19.73
Average NU transition (%)	3.85	4.04	4.10	4.00
Short-term unemployment (%)	62.51	55.87	53.88	60.67
Long-term unemployment (%)	16.06	21.31	23.19	16.51
Average duration of unemployment (months)	3.97	4.35	4.50	4.06
among UI eligible	2.96	3.80	4.08	3.08
Unemployment rate (%)	5.86	6.71	6.99	6.24
Non-participation rate (%)	25.30	24.48	24.26	25.04

column of the table, in addition, reports the effect of a permanent increase in the UI replacement rate, τ, by 10 percentage points, while keeping the UI benefits duration at $\mathbf{T} = 6$ months.

Past research estimates that the average duration of unemployment increases by around 0.08 and 0.2 weeks in response to one week increase in the UI duration. For instance, following a 13-week extension of UI in New Jersey, Card and Levine (2000) estimate one week increase in the duration of unemployment. Moffitt (1985) estimates that a 1-week extension of UI increases the average duration of unemployment among UI recipients by around 0.15 weeks. Katz and Meyer (1990) estimate the impact of 0.16–0.2 weeks. More recently, using a sample of workers in Austria, Nekoei and Weber (2017) estimate that a 9-week extension of UI leads to around 0.29 weeks increase in the duration of unemployment. Schmieder et al. (2016) obtain an estimate of 0.15 months in response to a 1-month change in the duration of UI in Germany. Following a 16-week cut in the duration of UI in Missouri, Johnston and Mas (2018) estimate that a 1-month reduction in the duration of UI leads to a 0.45 months reduction in the duration of unemployment among the UI recipients and a 0.25 months reduction in the unemployment. Valletta (2014) obtains an estimate of approximately 1.3 and 1.7 weeks increase in the duration of unemployment for a 100-week extension of UI for the periods of 2007–2011 and 2000–2004, respectively.

In summary, the literature finds a range of 0.03–0.45 months increase in the duration of unemployment in response to one month increase in the duration of UI. I use this range to relate the model's responses to the empirical findings.

Unemployment, labor market participation, and duration of unemployment. Table 3 shows that a 3 month of additional UI benefit is associated with an increase in the average duration of unemployment among UI-eligible workers by around 0.84 months. This implies that each additional month of UI benefits is associated with an increase in the overall average duration as well as the average duration of unemployment among UI-eligible workers by around 0.13 and 0.28 months, respectively.

The model estimated response of unemployment spells to a change in the duration of UI is in the upper range of the empirical estimates. To understand this finding, it is worth noting that the model findings are associated with only a change in the maximum duration of benefits, hence with an extension of UI workers can freely adjust their decision margins. In reality, however, the extension of benefits and its continuation are typically a policy response to a labor market slack. The extension of benefits may not be perfectly anticipated by workers so that they may not be able to freely adjust their decisions to the policy immediately. Furthermore, in the model, I assume a full UI eligibility upon a job separation. As discussed previously, this assumption in turn causes an overestimation of the share of UI receipt in the model that results in an overestimation (slightly)

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of the response to a change in the duration of UI. In reality, however, not every worker is eligible to collect UI following a job separation.

Table 3 also reports the response of the long-term unemployment rate and the unemployment rate to a permanent increase in the maximum duration of UI benefits. Relative to the baseline economy, 3 month of extended UI benefits increases the unemployment rate and the long-term unemployment rate by around 0.85 and 5.25 percentage points, respectively.

Furthermore, non-participation in job search activity decreases with the greater availability of UI benefits. Table 3 reports that a 3-month increase in the **T** is associated with around 0.9 percentage points decrease in non-participation. This can also be explained by changes in the transition of workers in and out of non-participation as a result of changes in **T**.

Past research has found that the average duration of unemployment increases between 0.5 and 1.5 weeks in response to a 10 percentage points increase in the replacement rate of UI.[35] In the baseline model, the response of the average duration lies at around the lower end of the range of empirical findings. Specifically, the last column in Table 3 reports that for an increase in the replacement rate of the same size, the average duration of unemployment among UI-eligible workers increases by around 0.12 months (around 0.52 weeks).

Labor market transitions. The average transition rate from unemployment to employment decreases with both an extension of UI duration and an increase in the UI replacement rate. It is well known that more generous UI systems discourage workers from search and reduce their transition to employment. The first row in Table 3 reports that with 3 additional months and 10 percentage point higher replacement rate of UI benefits, the average UE transition rate decreases by around 1.49 and 0.9 percentage points, respectively.

The average transition rate from non-participation to unemployment also increases with an increase in the generosity of the UI program. An increase in the generosity of UI, in terms of both larger **T** and larger replacement rate, increases the return to job search activity which results in an increase in the transition of non-participating individuals to unemployment.

The second row in Table 3, in addition, reports that an increase in the generosity of UI encourages longer participation of workers in the job search activity that results in a slower transition of unemployed to non-participation. This is consistent with the recent empirical findings in Farber et al. (2015), Rothstein (2011), and Valletta (2014). Specifically, I find that the average UN transition rate decreases by around 3.65 percentage points with a 3-month increase in the duration of UI. Table 3 also reveals that an extension of UI results in a larger response of UN transition rate relative to UE transition rate. This result is also consistent with empirical findings that UI extension increases the duration of unemployment primarily through reducing the transition of unemployed to out of the labor force (UN) rather than employment (UE).

4.1.1 Counterfactual mechanisms

Table 3 shows the quantitative implications of an increase in **T** in the model. It does not, however, explain to what extent changes in each decision margin contribute to an overall change in the outcomes. In response to an increase in **T**, workers may search less intensively for a job. They may also become more selective in accepting a job offer. If benefits are linked to labor market activity, they may remain attached to labor market for a longer period of time.

In this section, I quantify the portion of changes in the outcomes explained by changes in (i) job search intensity, (ii) job selectivity, and (iii) labor market participation decisions. I allow each decision margin to respond to the UI extension policy one at a time, while the other margins remain unresponsive to the policy. The results are reported in Table 4.[36] The first column reports the overall changes in the outcomes going from an economy with $\mathbf{T} = 6$ months of benefits (baseline) to an economy with $\mathbf{T} = 9$ months of benefits. The second to fourth columns display the contribution of the decision margins to the overall outcomes.[37]

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Table 4. Impact of decision margins on the outcomes

	Total change	Counterfactual ΔT_{9-6}		
Model outcome	ΔT_{9-6}	Job Search	Job selectivity	LM participation
Average UE transition	−1.49	−1.56	−0.75	0.33
Average UN transition	−3.75	−0.34	−0.03	−1.07
Average NU transition	0.19	−0.00	−0.00	0.19
Short-term unemployment	−6.64	−2.04	−0.94	−1.09
Long-term unemployment	5.24	0.34	0.39	0.85
Average duration of unemployment (months)	0.38	0.08	0.04	0.07
among UI eligible	0.85	0.14	0.07	0.06
Unemployment rate	0.85	0.31	0.13	0.17
Non-participation rate	−0.82	0.18	0.11	−0.49

Notes: All the numbers except for the average duration of unemployment are reported in percentage points changes.

It should be emphasized that the overall change of each outcome is the result of a change in all of the three margins. This implies that the sum of the counterfactual changes associated with each decision margin may not equal to the total change for each outcome due to the non-linearity captured in the interaction of the decision margins.

Job search. The decline in the search effort, associated with an extension of UI benefits, results in a decline in the UE transition rate. This also results in a decrease in the UN transition rates. Overall, a decrease in the job search effort can increase the unemployment rate by around 0.31 percentage points, which in turn can explain around 36% of the total change.

Job selectivity. Similar to job search, an increase in job selectivity following an extension of UI results in a decrease in the UE and a small decrease in the UN transition rate that, together, explain around 15% of the overall increase in the unemployment rate.

Labor market participation. Finally, an increase in the labor market participation following an extension of UI benefits increases the transition of unemployed to employment by around 0.33 percentage points. The increase in this margin also lowers the UN transition rate and increases the participation rate among the non-participating individuals.[38] Together, these changes can explain an increase in the unemployment rate by around 0.17 percentage points which translates into around 20% of the total change.

The results of Table 4 point to the decrease in the job search effort as the primary source of the increase in the unemployment rate. However, Table 4 also shows that the response of the participation margin to an extension of UI has a significant bearing on the increase in the unemployment rate. Specifically, it is shown that when an extension of UI benefits increases workers' tendency to participate longer in the labor market, the resulting increase in the unemployment rate can explain around 20% of the overall increase in the unemployment rate. This finding indicates the importance of labor market participation margin in explaining the impact of UI policy, which has not received much attention in quantitative job search models studying the impact of UI policy on the labor market.

The role of skill heterogeneity. In Section 2.3, I discussed how skill heterogeneity affects workers' decision margins. It was discussed that skill heterogeneity influences the job finding process and also the attachment of individuals to the labor market by affecting their decision margins. In this section, I examine how skill heterogeneity may drive the response of workers to an extension of UI. In doing so, I begin by examining how much UE, UN, and NU transitions respond to an

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Table 5. The role of skill heterogeneity

	Total change	Counterfactual ΔT_{9-6}		
Model outcome	ΔT_{9-6}	Job search	Job selectivity	LM participation
Low skill				
Average UE transition	−1.25	−1.55	−0.72	0.43
Average UN transition	−3.98	−0.35	−0.02	−1.12
Average NU transition	0.19	0	0	0.19
Medium skill				
Average UE transition	−3.86	−1.55	−0.66	−0.66
Average UN transition	−1.32	−0.35	−0.12	−0.54
Average NU transition	0.2	−0.03	−0.01	0.14
High skill				
Average UE transition	−8.11	−2.01	−1.14	−2.47
Average UN transition	−0.4	−0.1	−0.04	−0.17
Average NU transition	0.06	−0.05	−0.08	0.1

Notes: All the numbers except for the average duration of unemployment are reported in percentage points changes.

extension of UI across different levels of skills. This experiment explains how different types of workers contribute to shaping the responses following an extension of UI. I then decompose the portion of the change in each labor market transition explained by changes in job search intensity, job selectivity, and labor market participation decisions for each level of skill.[39]

Table 5 reports the overall responses of UE, UN, and NU transitions as well as the contribution of each decision margin to each outcome following a 3-month extension of UI, for each skill level. As expected, it is shown that with an extension of UI, across different skill levels, the UE transition of high-skilled unemployed workers decreases the most. High-skilled workers, by assumption, receive a higher amount of benefits during unemployment that negatively affects their search intensity and positively affects their job selectivity in the model. An extension of benefits leads to a further decrease in job search and a further increase in job selectivity of high-skilled individuals which together explain the larger decrease in the transition to employment relative to other skill levels. In addition, high-skilled workers are more likely to participate in the job search activity in the model. This explains why the response of the UN among the high-skilled workers is lowest across the skill levels.

On the other hand, low-skill individuals are more marginally attached to the job search activity. An extension of UI increases the return to job search for low-skill individuals which leads them to participate longer in the labor market. This is shown by the highest (among other skill groups) decrease in the UN transition. Furthermore, an extension of UI results in a higher participation among low- and medium-skill workers. This is also shown by a higher response of the NU transition to an extension of UI among low- and medium-skill individuals.

Similar to Table 4, a decrease in job search following an extension of UI results in a decrease in UE. This is shown across all the skill levels with the largest decrease among the high-skilled workers. An increase in labor market participation due to an extension of UI, in addition, results in a higher NU and a lower UN with the most impact on the low-skilled individuals.

General equilibrium effect. The results presented in this section abstract from two main general equilibrium effects (i) change in the wage offer distribution and (ii) endogenous adjustment in the vacancy creation by firms. Through the first channel, in a general equilibrium setting, firms may offer higher wages to fill a vacancy with more selective workers. This may in turn increase the return to job search and may encourage longer participation in the labor market. The empirical

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literature, however, has found mixed results on this effect. For instance, while Johnston and Mas (2018), Card et al. (2007) find statistically insignificant impact of UI on re-employment wages, Nekoei and Weber (2017) obtain a positive impact of extended UI on wages.

Through the second general equilibrium channel, firms may reduce their vacancy creation. This effect would lower the return to job search and may in turn lead to a decrease in job finding and higher unemployment. The empirical literature also shows mixed findings for the vacancy adjustment channel, aka "macro effect." While some studies such as Hagedorn et al. (2015) find a large effect of vacancy creation on unemployment, this result has been challenged by some other studies such as Marinescu (2017) and Coglianese (2015) that find no robust effect of UI extension on vacancy creation.

It should be emphasized that although the model abstracts from the general equilibrium effects, focusing on a partial equilibrium setting, however, allows modeling the decision margins of unemployed workers in a richer, tractable environment with a large state space and a duration-dependent problem in which strategies change over time.

The next experiment addresses the second GE channel and examines (approximately) how accounting for the general equilibrium effect of vacancy creation may affect the unemployment outcomes.

4.1.2 The impact of vacancy creation

Previously, it was discussed that the model abstracts from the response of vacancy creation by firms to UI extension, while in general equilibrium, one may expect that firms reduce their job creation which may result in a slower transition of individuals to employment. To account for this effect, I simulate an economy in which individuals have permanently lower chances of transition to employment, following an extension of UI, from both unemployment and non-participation. I then compare the results with the baseline economy. The difference in the outcomes would highlight the role of slower transition to employment for the labor market outcomes.

To this end, I re-calibrate the two parameters f_{ne} and λ that directly affect the transition of individuals to employment.[40] The former controls for the transition of non-participating individuals to employment, while the latter controls for the transition of unemployed workers to employment. It should be emphasized that both parameters affect the return to job search activity. For instance, a lower value for λ not only implies a lower UE transition but it may also result in a higher UN and a lower NU transition due to decreasing the return to job search.

In doing so, I decrease $f_{ne} = 0.0581$ reflecting changes in the NE transition in the US economy between 2008 and 2011. I also re-calibrate the job offer meeting rate $\lambda = 0.787$ so that (for a simpler comparison) the response of the unemployment rate to an extension of UI be close to the baseline model.[41]

The results are reported in Table 6. The first column shows total changes in the model outcome in the baseline economy with higher values for f_{ne} and λ. The second column shows total changes in the outcome in this experiment. Similarly, the rest of columns report the counterfactual changes in the outcome associated with the responses of the three decision margins, separately. To have a better understanding of the results, it is worth noting that a decrease in the individual's chances of finding a job and an extension of UI benefits implies two offsetting effects on the return to job search. On the one hand, an extension of benefits raises the return to job search by subsidizing longer periods of unemployment. On the other hand, the return to job search decreases due to a permanently slower transition to employment. Therefore, changes in the unemployment outcomes are ambiguous and depend on the relative strength of these forces.

Similar to the results presented in Table 4, in this experiment, I find that the response of participation margin to a change in UI policy can explain a significant response of the unemployment outcomes. For instance, Table 6 reports that a 3-month extension of UI in an economy with low job findings increases the unemployment rate by around 0.85 percentage points. The

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Table 6. Impact of decision margins on the outcomes—Low job finding

	Total change		Counterfactual ΔT_{9-6}		
Model outcome	Baseline	Low Job Finding	Job Search	Job Selectivity	LM Participation
Average UE transition	−1.49	−1.27	−1.71	−0.65	0.47
Average UN transition	−3.75	−4.69	−0.18	0.00	−1.69
Average NU transition	0.19	0.12	0.00	0.00	0.12
Short-term unemployment	−6.64	−7.97	−2.25	−0.80	−1.71
Long-term unemployment	5.24	6.32	0.49	0.31	1.10
Average duration of unemployment (months)	0.38	0.45	0.09	0.03	0.09
among UI eligible	0.85	0.86	0.14	0.05	0.10
Unemployment rate	0.85	0.85	0.27	0.09	0.21
Non-participation rate	−0.82	−0.88	0.28	0.12	−0.57

Notes: All the numbers except for the average duration of unemployment are reported in percentage points changes.

decomposition experiment reveals that the increase in participation can explain around 25% of the total change, which is around 5 percentage points higher than the baseline. This finding, in addition, highlights the important role of labor market participation for the unemployment rate in times that jobs are harder to find.

4.2 Temporary UI extension policy

In this section, I examine the impact of a temporary extension of UI benefits. I analyze an environment in which the policy reacts to an increase in the unemployment rate by temporarily providing workers with additional periods of benefits. In the previous policy experiment, all workers were entitled to receive the extended benefits once they were separated from their previous job. However, in this experiment, not every worker can receive the extended benefits. More specifically, only workers who are laid-off during the extension period and workers who were still eligible to receive the benefits at the onset of the program could potentially receive the extended benefits. Workers who had exhausted their regular UI before activation of the program do not receive the extended benefits.

In this experiment, starting from the distribution of workers in the baseline economy, I begin with doubling the job separation rate δ_{eu} in the initial period. The shock is assumed to be unanticipated by workers and reverts to the baseline value in the following periods. I then extend the duration of benefits, **T**, by 3 months for a limited period of time and simulate the economy and track workers after the shock.[42] I assume that the extension of benefits is anticipated by workers. In other words, workers treat the policy change as permanent and immediately adjust their decision margins. The extended UI lasts for a limited time period, and once the extension period expires, workers re-adjust their decisions margins back to the pre-shock episode.

I proceed with conducting two scenarios. In the first scenario, I examine how some of the labor market outcomes respond to the shock and the subsequent extension of UI. I compare the results to an economy when government stays unresponsive to the shock. In the next scenario, I examine the contribution of each of the job search decision margins to the overall response of the labor market outcomes.[43]

Figure 3a shows the response of the unemployment rate. Following a job separation shock, both series (No Policy and 3-Month Extension) initially jump up. The two series, however, respond quite differently over the extension period and the entire simulation period. In the No Policy scenario, unemployment gradually declines after the job separation shock. However, since workers anticipate the UI extension and respond to that by reducing their search effort, increasing their

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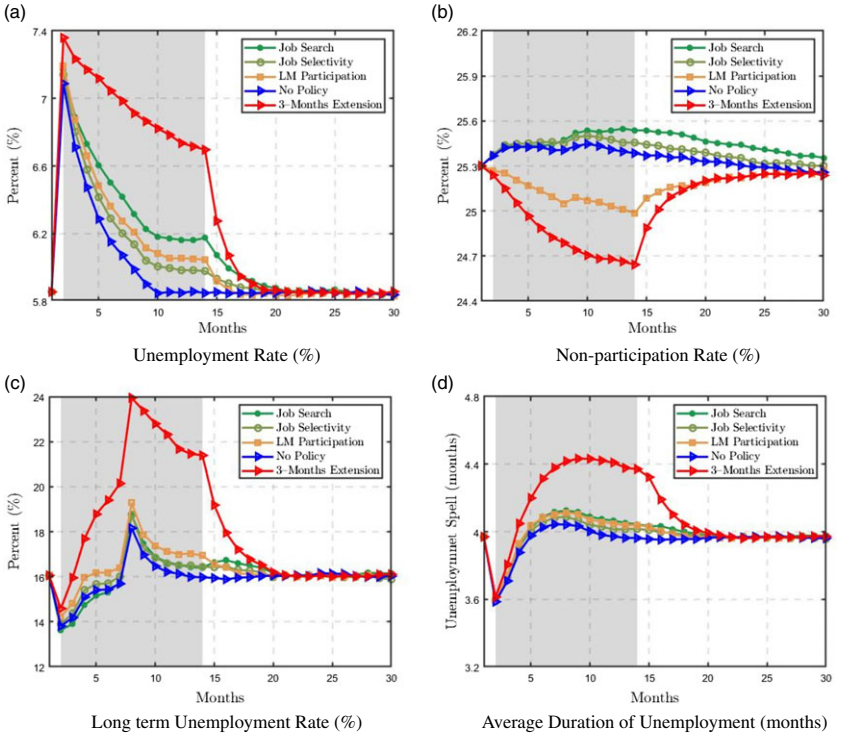

Notes: Shaded area denotes the UI extension period.

Figure 3. Impulse responses to a transient, unexpected job separation shock and subsequent UI extension.

job selectivity, and staying longer in the labor market, the unemployment rate in the 3-month extension scenario remains higher over the extension period. Since workers anticipate that the UI is extended temporarily, they adjust their decision margins back to the pre-shock episode. This results in a sharp decrease in the unemployment rate once the extension period expires followed by a gradual decline to the steady-state level.

The response of the non-participation rate is shown in Figure 3b. It is also shown that the non-participation rate responds quite differently depending on the response of the UI policy to the job separation shock. Specifically, following a job separation shock and an increase in the size of the unemployment pool, the number of workers who transition to non-participation increases. This results in an increase in the non-participation rate initially which is then followed by a gradual decline over time. However, the response of the UI policy results in an increase in the labor market participation among the unemployed workers that in turn offset the impact of the shock and causes a decline in the non-participation rate over the extension period. It is also shown that once the extension period expires and workers adjust their decision margin back to the pre-shock episode, the non-participation gradually increases toward the No Policy scenario.

The bottom panel in Figure 3 shows the responses of the long-term unemployment rate and the average duration of unemployment. Figure 3c shows that, in response to the shock, the long-term unemployment rates initially jump down. The magnitude of decrease depends on the response of the UI policy implying that with UI policy in place, the long-term unemployment rate declines more than the No Policy scenario. Over time, the unemployment rate declines and composition of unemployment pool changes toward workers with longer unemployment spells. This results in an increase in the long-term unemployment rate over the extension period which is followed by a gradual decline toward the No Policy scenario after the end of this period. It is worth noting

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that the model allows for workers to accumulate skills over employment spell implying that the highest skill would be an absorbing state in the employment. Since the majority of workers who get the separation shock are high-skilled and have higher chances of participation (i.e. a group of workers with similar job search behavior), they enter into long-term unemployment at about the same time. This explains the sharp increase in the long-term unemployment rate during the extension period.

Figure 3d shows that the average duration of unemployment also follows a similar path. Following a job separation shock that results in an increase in the share of short-term unemployed in the unemployment pool, the average duration of unemployment for both scenarios initially jumps down by around 0.4 months. Over the extension period, which is followed by (i) a decline in the job search effort; (ii) an increase in the job selectivity, and (iii) an increase in the labor market participation, workers spend more time in unemployment that results in an increase in the duration of unemployment. It is also shown that once the extension period expires and the duration of UI reverts back to normal times, the average duration of unemployment in the 3-month extension scenario gradually declines toward the No Policy scenario.

4.2.1 Counterfactual mechanisms

Similar to the previous section, I analyze the extent to which the response of each of the decision margins (i.e. job search, job selectivity, and labor market participation) impacts the results. For this scenario, specifically, I allow each of the decision margins to respond to the job separation shock once at a time, while holding the other two margins unchanged at their pre-shock values.

I find that the decrease in the job search and the increase in the labor market participation can each explain a large fraction of the changes in the unemployment rate and the duration of unemployment. This can be seen in Figure 3 where the contribution of the job search and the labor market participation to the increase in the unemployment rate, the long-term unemployment rate, and the average duration of unemployment are relatively larger than the job selectivity.

Figure 3b, in addition, shows that the response of the labor market participation alone can explain a large fraction of the response of the non-participation rate. Intuitively, an extension of benefits results in an increase in the return to job search among the unemployed that, in turn, translates to a decrease in the job search effort and an increase in the job selectivity. Abstracting from an increase in the labor market participation results in an increase in the transition of unemployed workers out of the labor market that, in turn, results in an increase in the non-participation rate.

5. Conclusion

The empirical literature shows that extension of UI benefits increases the unemployment rate and the duration of unemployment. Few studies, however, have examined the role of underlying mechanisms explaining the policy impact on the labor market outcomes. In this paper, I construct a job search model with an endogenous participation decision to examine the impact of UI extension policy on unemployment outcomes. The model is partial equilibrium and abstracts from the general equilibrium effects, in particular the response of firms' vacancy creation to an extension of UI. However, the model encompasses a rich microeconomic framework that allows for a careful examination of the responses of job search incentives to an extension of UI.

There are several channels by which an extension of UI benefits can impact the labor market. In response to an extension of benefits, workers may search less intensively for a job. They may become more selective in accepting the offers. Moreover, if the benefits are linked to the job search process, workers may remain in the labor market for a longer period of time. I quantify

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the impact of each of these margins on unemployment outcomes. I find that the response of participation margin can explain a large fraction of the impact of an extension of UI benefits on the unemployment outcomes, in particular, the unemployment rate.

This finding indicates the importance of accounting for the response of participation margin when examining the impact of a policy on the labor market—a mechanism that is frequently understudied in majority of the quantitative job search models exploring the impact of UI.

Notes

1 See Machin and Manning (1999), Card and Levine (2000), Katz and Meyer (1990), Moffitt (1985) and more recently Rothstein (2011), Kroft et al. (2016), Nakajima (2012), among others.

2 Later, I will discuss that the rest of the effect can be explained by the interaction of all three margins.

3 I conduct an experiment to approximate the impact of this effect on the baseline results in Section 4.1.2.

4 Alternatively, one may interpret the results as differences in unemployment outcomes between economies with similar labor market parameters, but different maximum duration of UI benefits.

5 Examples of such policies are the Extended Benefit and Emergency Unemployment Compensation (EUC) programs in the USA that make available additional weeks of benefits for workers who have exhausted regular benefits during periods of high unemployment.

6 In particular, I follow Ljungqvist and Sargent (1998, 2008) in this experiment.

7 See Katz and Meyer (1990), Moffitt (1985), Card and Levine (2000), Hamermesh (1977), Schwartz (2013), Lalive (2008), among others.

8 This finding points to a demand shock as the major cause of the increase in the unemployment rate during the Great Recession in the United States.

9 This allows for a richer characterization of unemployed workers' decision-making. However, it comes at the (computational) cost of an additional state variable in the model.

10 In Ljungqvist and Sargent (1998, 2008), workers can be either employed or unemployed. In this paper, I assume that while out of the labor market, individuals may lose skills similar to when they are unemployed.

11 This recursive formulation implies a different value function for each $j \leq \mathbf{T}$.

12 It should be noted that in the equation (2), the continuation value of UI-eligible unemployed workers at $j = \mathbf{T}$ is the same as the value of job search for UI-ineligible workers as in equation (3).

13 In reality, it is hard to verify who is searching so workers may receive benefits even when they are not searching. To keep the model tractable, I assume that workers receive benefits as long as they search for a job.

14 Please see Appendix B for further details.

15 The proofs are in Appendix B.

16 These results are similar to the findings of Mortensen (1977). On the empirical side, a number of studies, see Fujita (2010) for instance, show that exit rate from unemployment decreases over unemployment with a spike around the expiry date of UI benefits which can be explained by workers leaving the labor market. In the model, as discussed, skill loss generates a variation in the exit rate from unemployment which allows the model to generate a negative duration dependence of unemployment.

17 I choose this time period since the unemployment rate was fairly steady, and the duration of unemployment was not (if at all) affected by any major UI policy.

18 All the estimated transitions use CPS weights.

19 See Rothstein (2011), Elsby et al. (2015), Fujita et al. (2011) for instance. Elsby et al. (2015) refer to this as deUNUified and deNUNified flows, respectively.

20 See Pissarides (1974), Nachman (1975), for instance.

21 This estimate is also consistent with the estimates of net replacement rate of unemployment insurance by OECD. See https://www.oecd.org/about/publishing/36965805.pdf, for instance.

22 This process is similar to the change in the persistent component of skill in Braxton et al. (2020).

23 Similarly, for the calibration period, I find that around 60% of the respondents who were classified as non-participating in the previous interview report a duration of unemployment of more than one month.

24 Defined as share of unemployed workers with more than 26 weeks (6 months) of unemployment.

25 Defined as share of unemployed workers with less than 13 weeks (3 months) of unemployment.

26 It is not a big surprise that a model of job search is unable to capture several of the transition rates simultaneously. This point is also emphasized by Pries and Rogerson (2009), Andolfatto and Gomme (1996), and Garibaldi and Wasmer (2005).

27 Workers who were laid-off from their last jobs, rather than those who are newly entered or have quit, are eligible to receive UI, Rothstein (2011).

28 It should also be emphasized that in the calibration, the wage distribution and the UI replacement rate, τ are exogenous. However, the distribution of skills over employment and unemployment as well as the earnings of unemployed with no UI, that is, $\tilde{b}$, are endogenous. For a given distribution of skills over employment and unemployment, the result may

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suggest that the $\tilde{b}$ is overestimated. However, it should be noted that $\tilde{b}$ is estimated jointly with other parameters in Θ. This implies that aside from average earnings drop, $\tilde{b}$ also controls for other targets, in particular NU transition rate and long-term unemployment rate.

29 See Auray et al. (2019) or Birinci and See (2019) or Rothstein (2011), for instance.

30 Computed as share of unemployed with spells less than 3 months.

31 Computed as share of unemployed with spells greater than 6 months.

32 The literature includes types of unemployment and distinguishes between the reason for unemployment, for example, job leavers, re-entrants, new-entrants, job losers on temporary layoff as workers' heterogeneity.

33 See Hornstein (2012), for instance for the findings using CPS.

34 This is also discussed in Katz and Meyer (1990) and Katz (1986).

35 See, for instance, Hamermesh (1977), Moffitt (1985), Meyer (1990).

36 In unreported results, I have followed an alternative approach for this experiment in which I allow two margins to respond to the policy while one is remained unresponsive. I find that although the magnitude of the results may change, the interpretation remains unchanged.

37 Columns show changes in each outcome associated with a change in the given decision margin.

38 A decrease in the UN transition rate is consistent with Rothstein (2011) and Farber et al. (2015) among others who show that the extended benefits during the periods of the Great Recession caused a decline in the labor force exit rate.

39 Similar to Table 4, it should be emphasized that the sum of the counterfactual changes associated with each decision margin may not equal the total change due to the non-linearity of interaction between the decision margins.

40 The rest of the parameters are held unchanged.

41 This implies a decrease in the job offer meeting rate, λ, of around 0.38% relative to the baseline value.

42 I choose this extension period so that the response of the average duration of unemployment to UI be close to the estimated response in Valletta (2014) for the period of 2007–2011.

43 The shock and the UI extension occur at time period two. During the extension period, the laid-off workers may receive up to 3 additional months of benefits on top of their regular 6 months of benefits. The rest of the parameters are held unchanged.

44 The states were Arkansas, Florida, Georgia, Kansas, Michigan, Missouri, North Carolina, and South Carolina. The length of new UI duration among these states varies from 8 to 20 weeks. See, United States General Accountability Office, "Unemployment Insurance, State' Reductions in Maximum Benefit Durations Have Implications for Federal Costs," April 2015, http://www.gao.gov/assets/670/669802.pdf.

45 In fact, the state reduced the regular benefits program by 6 weeks, but the reduction triggered an additional 10 weeks reduction by the federEUC program, see Johnston and Mas (2018)

46 The state-level data are taken from Local Area Unemployment Statistics (LAUS). I discard the seven states that reduced the duration of UI following the Great Recession from the comparison states.

47 The estimated weights in Synthetic Missouri are 14.9% to Alabama, 5.2% to Alaska, 3.5% to Arizona, 15.5% to Colorado, 12.7% to Nebraska, 6.7% to New Hampshire, 27% to Oregon, 1.4% to Rhode Island, 7.8% to Texas, 5.4% to West Virginia, and nearly zero to rest of states.

48 In unreported results, I assess the robustness of this result by evaluating the impact of the UI policy in Missouri using both a simple average and a synthetic method including only the neighboring states of Missouri. In doing so, I discard Arkansas and Kansas from the list of neighboring states since they also implemented a similar UI policy following the Great Recession. The synthetic weights of this robustness analysis are 30% for Illinois, 23% for Nebraska, 0.3% for Oklahoma, 47% for Tennessee, and nearly zero for other states.

49 The UN and NU transition rates for each state are estimated in the same way as the "unadjusted" series in Figure 1. I find similar results after adjusting the transitions by "deNUNify"ing the NUN and "deUNUify"ing the NUN transitions, following Elsby et al. (2015), Rothstein (2011), Farber and Valletta (2015).

50 For instance, Farber and Valletta (2015), Farber et al. (2015), Rothstein (2011) among others.

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A. Response of the participation margin to UI—An empirical motivation

Background. The unemployment insurance system in the USA is a form of public social insurance which provides benefits to eligible workers who have lost their jobs, for a limited period of time. This system is a partnership between the federal government and states with states mainly funding the UI benefits by collecting the UI taxes from employers and maintaining an adequate trust fund. Since the 1960s, typically, eligible workers who have lost their jobs were entitled to collect benefits up to six months after job loss. However, following the Great Recession and motivated by political reasons and a reduction in the state's UI trust fund, eight states reduced the duration of regular UI program to below 26 weeks.[44] Reduction in UI duration resulted in eligible workers receiving markedly fewer weeks of benefits. For instance, changes in the political environment and decline in financial resources resulted in a 16-week reduction in the duration of UI benefits in Missouri in April 2011.[45] I exploit this sharp and unexpected decline in the duration of UI in Missouri to estimate the impact of UI duration on the labor market participation rate, the transition rate of workers from non-participation to unemployment (NU), and the transition rate from unemployment to non-participation (UN).

To this end, I use the synthetic control method developed by Abadie and Gardeazabal (2003) and Abadie, Diamond, et al., (2010), to estimate the counterfactual labor market participation, UN and NU transition rates that Missouri would have experienced in the absence of the policy change. In doing so, I use percent quarterly growth in the average weekly wages, percent quarterly growth in the housing price index for the period of 2007–2010, percent monthly growth in population (civilian non-institutional), and monthly labor market participation rate at the state level as control variables to construct weights for the comparison states (control groups).[46] Figure 4c shows the impact of the policy change on the labor market participation rate in Missouri. The blue line (Missouri) displays the actual labor market participation rate in Missouri and the dashed red line (Synthetic Missouri) displays the counterfactual labor market participation rate in Missouri in the absence of the policy change.[47] For the periods prior to the policy change, it is shown that the red line (Synthetic Missouri) follows the actual labor market participation rate in Missouri quite closely. This indicates that the Synthetic Missouri provides a fine approximation of the labor market participation rate in the absence of UI reduction, following the UI policy in Missouri.

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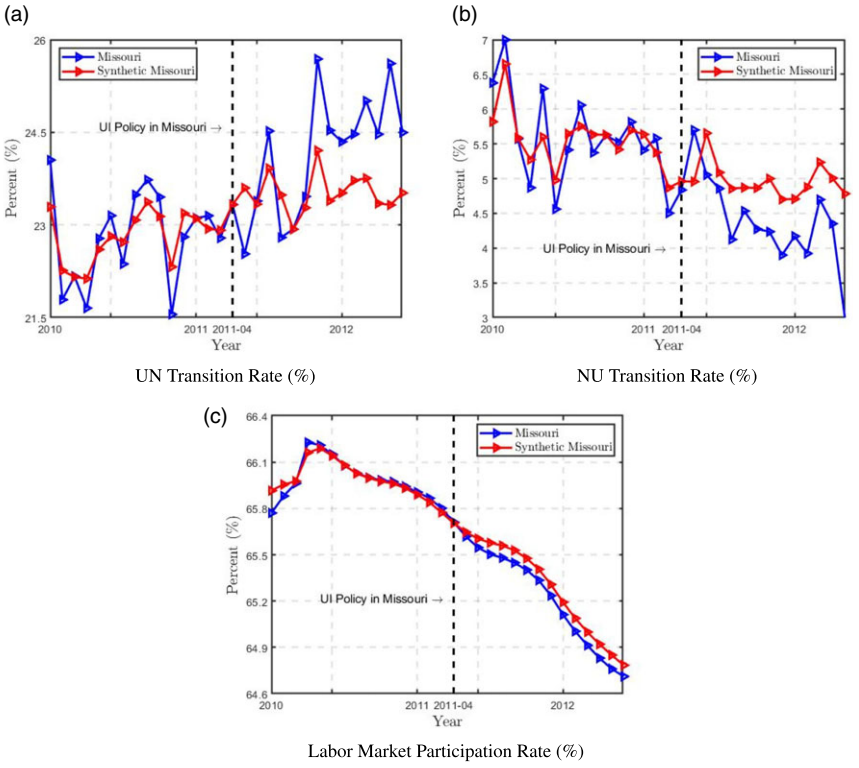

Figure 4. Empirical evidence on the response of participation margin to UI.

The impact of the UI policy can be seen by the difference between the labor market participation rate of Missouri and Synthetic Missouri for the period after the UI policy date (April 2011). Consistent with the findings of Johnston and Mas (2018), I find that the 16 weeks reduction in the duration of UI caused a decrease in the labor market participation rate in Missouri. Specifically, I find that, on average, the labor market participation declines by about 0.078 percentage points within a year following the policy change in Missouri.[48]

To further investigate this policy impact, I dig deeper into CPS to examine how the UI policy affects the transitions of workers in and out of the labor market. In doing so, I exploit the longitudinal dimension of the CPS to match individuals across all the months that are being surveyed (8 months) and compute the UN (unemployment to non-participation) and NU (non-participation to unemployment) transition rates for all the states. I then estimate the impact of the policy on UN and NU transition rates in Missouri using the synthetic control approach.[49]

Figures 4a and 4b show the impact of UI policy on UN and NU transitions in Missouri, respectively. Similar to Figure 4c, Figure 4a and 4b show that Synthetic Missouri (control group) provided a fine approximation of the transition rates prior to the UI policy in Missouri. This implies that Synthetic Missouri provides a fine approximation of the UN and NU transitions in the post-treatment (the period after the policy) period in the absence of UI policy in Missouri. Consistent with the existing empirical findings, I find that the reduction in the duration of UI results in a decrease in the NU and an increase in the UN transition rates.[50] This is shown by the difference between the transitions rates in Missouri and Synthetic Missouri in the periods after the UI policy.

https://doi.org/10.1017/S1365100522000293 Published online by Cambridge University Press

B. Characterizing the decision margins

The search intensity $s(b,h,j)$ for UI-eligible and UI-ineligible workers $s_{ne}(h)$ are the result of the maximization problem of the workers. The job selectivity, which is characterized by reservation wage $\tilde{w}(b,h,j)$ for UI-eligible and $\tilde{w}_{ne}(h)$ for UI-ineligible workers, are defined by

$$\left\{w \in G(w) \mid V^e(w,h) \geq V^u(b,h,j)\right\} \quad \forall h \ \ \forall j \leq \mathbf{T},$$

$$\left\{w \in G(w) \mid V^e(w,h) \geq V^u_{ne}(h)\right\} \quad \forall h.$$

Similarly the labor market participation is characterized by a participation cutoff $\tilde{x}(b,h,j)$ for UI eligible and $\tilde{x}_{ne}(h)$ for UI ineligible, which are defined as following

$$\left\{x \in F(x) \mid V^n(x,h) \geq V^u(b,h,j)\right\} \quad \forall h \ \ \forall j \leq \mathbf{T},$$

$$\left\{x \in F(x) \mid V^n(x,h) \geq V^u_{ne}(h)\right\} \quad \forall h.$$

The decision margins jointly determine the behavior of workers in the labor market. Given the optimal search intensity for unemployed individuals whose value is defined by equations (2) and (3), the optimal decisions regarding participation/dropping out of the labor market is determined by reservation participation $\tilde{x}$. The decision regarding accepting/rejecting the job offers can also be defined with a set of reservation wages, $\tilde{w}$ that makes individuals indifferent between accepting/rejecting job offers depending on the duration of receiving benefits.

The first order necessary conditions of the search intensities given equations (2) and (3) imply the optimal search intensity of unemployed workers as following:

$$s(b,h,j) = \Psi^{-1}\left[\beta \sum_{h'} p_u(h,h')\left(\iint \max\left\{V^e(w',h'), V^u(b,h',j+1), V^n(x')\right\} dF(x')\, dG(w') - \int \max\{V^u(b,h',j+1), V^n(x'))\} dF(x')\right)\right] \tag{5}$$

where $\Psi(.) = \dfrac{c'(s)}{f'(s)}$.

This optimality condition simply states that the marginal cost associated with searching is equal to its benefit which is the differential value of participation, accepting the job, and dropping out of the labor market, discounted by the marginal increase in the probability of facing the wage distribution in the next period.

Proof.

PROPOSITION 1.

The proof of this result is by induction and is similar to Rothstein (2011). To see that $V^u(j)$ decreases with j let

$$V^u(j) = \left\{u(b) - c(s_j) + \beta\left[f(s_j)\iint \max\left\{V^e(w'), V^u(j+1), V^n(x')\right\} dF(x') dG(w') + (1-f(s_j))\left[\int \max\{V^u(j+1), V^n(x')\}\, dF(x')\right]\right]\right\}$$

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Take j' such that $j' = j + 1 < \mathbf{T}$ and assume that $V^u(j) \geq V^u(j')$, then we have

$$V^u(j-1) - V^u(j'-1) \geq V^u(s_{j'-1}, j-1) - V^u(j'-1) =$$

$$\beta f\left(s_{j'-1}\right)\left[\iint \max\left\{V^e(w'), V^u(j), V^n(x')\right\} dF(x')dG(w') - \iint \max\left\{V^e(w'), V^u(j'), V^n(x')\right\} dF(x')dG(w')\right] +$$

$$\beta\left(1 - f(s_{j'-1})\right)\left[\int \max\{V^u(j), V^n(x')\}\, dF(x') - \int \max\{V^u(j'), V^n(x')\}\, dF(x')\right] \geq 0$$

By induction this holds for every j, thus $V^u(j)$ decreases with j □

Proof.

PROPOSITION 2.

The first order condition $\forall j \leq \mathbf{T}$ implies

$$c'(s) = \beta f'(s)\left[\iint \max\left\{V^e(w'), V^u(j+1), V^n(x')\right\} dF(x')dG(w') - \int \max\{V^u(j+1), V^n(x')\}\, dF(x')\right]$$

Which can be re-written as

$$c'(s) = \beta f'(s) F(\tilde{x}_{j+1})\left[\int \max\{\, V^e(w') - V^u(j+1), 0\,\}\, dG(w')\right]$$

The left-hand side is the cost of searching. The right-hand side is the discounted expected continuation value of searching adjusted by the probability that workers participate in job search. Assuming that $c(s)$ is a strictly convex function and $f(s)$ is a concave function, then I can show that the $\frac{c'(s)}{f'(s)}$ is increasing with respect to s. The right-hand side is a increasing function of j since the return to unemployment declines with j. Therefore, it can then be seen that the optimal search intensity increases with j. □

Proof.

PROPOSITION 3.

The job selectivity is characterized by a reservation wage $\tilde{w}$ that satisfies $V^e(\tilde{w}) = V^u(b, j)$ for $j \leq \mathbf{T}$. To characterize the job selectivity, without loss of generality, I assume that $\delta_{en} = 0$ and $\mathcal{E} = 1$, that is, no EN transition and full take-up rate of UI. This helps to simplify the value of employment to

$$V^e(w) = u(w) + \beta\left[(1 - \delta_{eu})V^e(w) + \delta_{eu}V^u(b, j=1)\right]$$

$$= \frac{u(w)}{1 - \beta(1 - \delta_{eu})} + \frac{\delta_{eu}}{1 - \beta(1 - \delta_{eu})}V^u(b, j=1)$$

The value of unemployment after some simplification becomes as following.

$$V^u(j) = \left\{u(b) - c(s) + \beta F(\tilde{x}_{j+1})\left[f(s)\int \max\left\{\, V^e(w') - V^u(j+1), 0\,\right\} dG(w') + V^u(j+1)\right] + \beta\int_{\tilde{x}_{j+1}} V^n(x')dF(x')\right\} \quad \forall\, j \leq \mathbf{T}$$

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which is

$$V^u(j) = \Bigg\{ u(b) - c(s) + \beta F(\tilde{x}_{j+1}) \Bigg[f(s) \int_{\tilde{w}_{j+1}} \{ V^e(w') - V^u(j+1) \} dG(w') + V^u(j+1) \Bigg] + \beta \int_{\tilde{x}_{j+1}} V^n(x') dF(x') \Bigg\} \ \forall j \leq \mathbf{T}$$

In equilibrium $V^e(\tilde{w}_j) = V^u(j)$. Replacing from the value of employment we have

$$\frac{u(\tilde{w}_j)}{1-\beta(1-\delta_{eu})} + \frac{\delta_{eu} V^u(b, j=1)}{1-\beta(1-\delta_{eu})} = \Bigg\{ u(b) - c(s) + \beta F(\tilde{x}_{j+1}) \Bigg[f(s) \int_{\tilde{w}_{j+1}} \{ V^e(w') - V^u(j+1) \} dG(w') + V^u(j+1) \Bigg] + \beta \int_{\tilde{x}_{j+1}} V^n(x') dF(x') \Bigg\} \ \forall j \leq \mathbf{T}$$

Simplifying further,

$$\frac{u(\tilde{w}_j)}{1-\beta(1-\delta_{eu})} + \frac{\delta_{eu} V^u(b, j=1)}{1-\beta(1-\delta_{eu})} = \Bigg\{ u(b) - c(s) + \beta F(\tilde{x}_{j+1}) \Bigg[f(s) \int_{\tilde{w}_{j+1}} V^e(w') dG(w') + (1 - f(s)(1 - G(\tilde{w}_{j+1}))) V^u(j+1) \Bigg] + \beta \int_{\tilde{x}_{j+1}} V^n(x') dF(x') \Bigg\} \ \forall j \leq \mathbf{T}$$

The right-hand side decreases with j since the $V^u(j+1)$ is decreasing from the proposition 1. Therefore $\tilde{w}_j$ decreases with increase in j which implies that workers become less selective in accepting a job offer as their benefits run out. □

Proof.

PROPOSITION 4.

Without loss of generality, I assume that $f_{ne} = 0$ and also $\psi = 0$, that is, no NE transition and the cost of entry into labor market is zero. This helps to simplify the value of non-participation as following

$$\begin{aligned} V^n(x) &= u(x) + \beta \int \max\{V^u_{ne}, V^n(x')\} dF(x') \\ &= u(x) + \beta \int^{\tilde{x}} V^u_{ne} dF(x') + \beta \int_{\tilde{x}} V^n(x') dF(x') \\ &= u(x) + \beta F(x) V^u_{ne} + \beta \int_x V^n(x') dF(x'), \end{aligned}$$

also we have the value of unemployment at duration j as following

$$V^u(j) = \Bigg\{ u(b) - c(s) + \beta F(\tilde{x}_{j+1}) \Bigg[f(s) \int_{\tilde{w}_{j+1}} \{ V^e(w') - V^u(j+1) \} dG(w') + V^u(j+1) \Bigg] + \beta \int_{\tilde{x}_{j+1}} V^n(x') dF(x') \Bigg\} \ \forall j \leq \mathbf{T}.$$

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The participation cutoff can be found from $V^n(\tilde{x}_j) = V^u(j)$, therefore

$$u(\tilde{x}_j)+\beta[F(\tilde{x}_{j+1})V^u_{ne} + \int_{\tilde{x}_{j+1}} V^n(x')dF(x')] = u(b) - c(s)+$$
$$\beta F(\tilde{x}_{j+1})\Big[f(s)\int_{\tilde{w}_{j+1}}\big\{V^e(w') - V^u(j+1)\big\}dG(w') + V^u(j+1)\Big]+$$
$$\beta\int_{\tilde{x}_{j+1}} V^n(x')dF(x') \;\forall j \le \mathbf{T},$$

which simplifies to

$$u(\tilde{x}_j) = u(b) - c(s) + \beta F(\tilde{x}_{j+1})\Big[f(s)\int_{\tilde{w}_{j+1}}\big\{V^e(w') - V^u(j+1)\big\}dG(w') + V^u(j+1) - V^u_{ne}\Big] \;\forall j \le \mathbf{T}.$$

Similarly, as workers' benefits run out, that is the $V^u(j+1) - V^u_{ne}$ decreases, $\tilde{x}_j$ declines which implies that workers chance of participating in the labor market decreases. □

Cite this article: Mousavi O (2023). "Extension of unemployment benefits and changes in job search margins." *Macroeconomic Dynamics* **27**, 1424–1454. https://doi.org/10.1017/S1365100522000293