Job Search, Job Findings and the Role of Unemployment Insurance History*

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February 13, 2023

PRELIMINARY

Abstract

Standard search theory suggests that (1) job search intensity increases with the relative gain from searching, and that (2) job search intensity increases the job finding probability. Firstly, this paper presents new empirical findings that challenge these predictions when workers are categorised by their unemployment insurance (UI) history. Both current and former UI recipients search harder than those that never take up UI. Furthermore, they find jobs at a slower rate despite their higher search intensity. To be consistent with these empirical findings, I introduce interview/job censoring and inefficient job search to an otherwise standard equilibrium search and matching model with endogenous search intensity. These new features dampen the labour market fluctuations and moderate the effects of UI extensions. They also improve the model's ability to match the persistence of unemployment. Finally, I found that removing all UI extensions during the Great Recession improves welfare but the gain subsides as the economy recovers.

JEL Classification. E24, E32, J24, J64, J65.

Keywords. Business cycles, job search, unemployment insurance, unemployment dynamics

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*I would like to thank Morten Ravn, Wei Cui, Ludo Visschers, Ran Gu, and seminar participants at Keio University, Search Theory Workshop at Nagoya University, the AASLE conference in Singapore and the World Congress of the Econometric Society.

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1 Introduction/Motivation

The effects of unemployment insurance (UI) extensions on unemployment and its duration structure have long been studied from both theoretical and empirical perspectives.[1] The generous UI extensions and the unprecedented rise in unemployment duration during the Great Recession in the US have sparked a greater interest in quantifying the effect of UI extensions. This question becomes more complicated since the extensions themselves were triggered by the state unemployment rate. Some studies find a limited role of UI extensions on unemployment and its duration structure. For example, Rothstein (2011) finds that UI extensions contributes to 0.1-0.5 percentage point increase in the unemployment rate while Fujita (2011) estimates the UI effect to be around 0.5-1.25 percentage point increase.[2] At the same time, other studies find a more substantial effect of the UI extensions. For example, Hagedorn, Karahan, Manovskii, and Mitman (2015) find that without UI extensions the unemployment rate would have been 2.5 percentage points lower. Mitman and Rabinovich (2014) link the emergence of jobless recoveries in the past three recessions to UI extensions.

Rujiwattanapong (2022) develops a framework which helps reconcile these mixed results by studying a general equilibrium search and matching model that distinguishes between the microeconomic and macroeconomic effects of UI extensions. It was found that the extensions can account for a large part of the increase in the average unemployment duration and long-term unemployment (those unemployed longer than six months) during the Great Recession. However, the model overstate the size of the changes of these labour market variables, and also understate their persistence.

The purpose of this paper is to address these issues by exploiting the fact that there are further heterogeneities the job finding rates of unemployed workers. By distinguishing unemployed workers into three categories: currently receiving UI benefits (henceforth insured unemployed), having exhausted UI benefits in the current unemployment spell (formerly insured unemployed), and having never collected benefits in the current spell (uninsured unemployed), I show that in the US data the job finding rate of the formerly insured is significantly lower than that of the uninsured. This finding is at odds with models that incorporate job search intensity including Rujiwattanapong (2022) since they predict that both the formerly insured and the uninsured exert the same search effort (due to having the same outside option), and, therefore, have the same job finding rate. Following Shimer (2004), I measure

[1]For example, see Shavell and Weiss (1979), Moffitt and Nicholson (1982), Moffitt (1985), and Katz and Meyer (1990), Wang and Williamson (1996), Hopenhayn and Nicolini (1997), Chetty (2008), Shimer and Werning (2008), and Krueger and Mueller (2010, 2011).

[2]Other studies that find a small but significant impact of UI extensions within the range of 0.1-1.8 percentage point increase in unemployment include Aaronson, Mazumder, and Schechter (2010), Valletta and Kuang (2010), Farber and Valletta (2011), Mazumder (2011), Nakajima (2012), and Barnichon and Figura (2014).

the search effort based on the number of job search methods, and find that both types of unemployed workers (formerly insured and uninsured) do exert similar job search intensities.

Motivated by these empirical findings, I extend an equilibrium search and matching model with variable job search intensity by introducing a drop in job search efficiency during an unemployment spell of insured unemployed workers. I argue that this drop in search efficiency can be interpreted as a loss of career network or a loss of skills/tools to conduct job search efficiently after a period of less activity (whilst being insured). This feature allows the formerly insured, whose search efficiency has fallen, to exert similar search efforts to the uninsured, and at the same time find a job at a slower rate than do the uninsured. Because of the fall in the formerly insured workers' job finding rate, the model can potentially increase the persistence of unemployment duration and long-term unemployment. Furthermore, the drop in job search efficiency lowers the value of being insured unemployed which has two implications. First, it lowers the job separations of employed workers who are on the margin of returning to unemployment. Second, it increases the job search intensity of the insured (to avoid losing the search efficiency), and thereby shortens the unemployment spells. This means that the response of insured unemployment to UI extensions is expected to be more moderated.

This paper is also related to the literature studying the dynamics of unemployment and its duration structure by exploring worker heterogeneities. Ahn and Hamilton (2016), Ahn (2016), Hornstein (2012), and Ravn and Sterk (2013) study the role of unobserved heterogeneity of workers that affects the unemployment exit probabilities. Kroft, Lange, Notowidigdo and Katz (2014) study the roles of the genuine duration dependence in the job finding rate together with the non participation margin. Elsby, Hobijn, Şahin and Valetta (2011) also study the contribution of flows between non-participation and unemployment. Carrillo-Tudela and Visschers (2014) study the role of occupational choices of unemployed workers on aggregate unemployment and its duration distribution. This paper contributes to this literature by focussing on the roles of worker's UI history and how this affects the effects of UI extensions on the unemployment duration distribution over the business cycles.

The main contributions of this paper is two folds. Empirically, I show that the worker's UI history is an important determinant for the labour market outcomes. I then present an equilibrium model that is made consistent with the empirical findings by introducing a drop in job search efficiency for unemployed workers who have received UI benefits, and study the impact of UI extensions on unemployment and its duration structure from both positive and normative aspects.

I find that the introduction of a search efficiency drop for the formerly insured unemployed improves the persistence of unemployment, average unemployment duration and long-term unemployment by at least 14, 5 and 7 percent respectively (as measured by the autocorrelation coefficients up to 2-year lags) when compared to a model without a search efficiency drop. At the same time, the effect of UI extensions is also revised downwards where the elasticity of unemployment duration is 5 percentage points lower, and a 1-week increase in maximum UI duration implies a [0.33, 0.38] week increase in average unemployment duration. However, the effect on total unemployment is hardly affected by this drop in search efficiency. Additionally, I find that on average there is a welfare gain from eliminating all UI extensions during the Great Recession of 0.14 percent, which is a combination of 0.27 percent welfare increase for the employed and 1.27 percent welfare drop for the unemployed. Consistent with the results From Mitman and Rabinovich (2015) who study the optimal UI policy over the business cycles, I find that the welfare gain subsides as the economy recovers.

The paper is organised as follows. Section 2 presents empirical findings related to worker's UI history. Section 3 describes the model. Section 4 discusses the calibration exercise. Section 5 discusses the results including the welfare analysis. Section 6 concludes.

2 Empirical Evidence

To motivate the main assumption of this paper that there is a drop in search efficiency for unemployed workers who have received UI benefits, I present two empirical findings in this section. First, unemployed workers who have exhausted their UI benefits (the formerly insured) have a significantly lower job finding rate than that of unemployed workers who never received the benefits (the uninsured). Second, despite the smaller job finding rate, the formerly insured exert a similar job search effort to the uninsured. This second finding rules out the possibility that the lower job finding rate of the formerly insured is simply due to a lower job search effort.[3]

Job Findings I use the CPS Basic Monthly Data and CPS Displaced Worker, Employee Tenure, and Occupational Mobility Supplement from 2006 to 2014 to construct monthly transition rates from unemployment to employment, unemployment and out of labour force similar to Rujiwattanapong (2022). Additionally, I consider 3 UI statuses amongst unemployed workers: current UI recipients (insured), non-UI recipients (uninsured), and exhausted-UI recipients (formerly insured). Figure 1 plots the unemployment-to-employment transition (job

[3]Another possible explanation would be unobserved heterogeneity where workers with inherently lower job finding rates are more likely to take up and exhaust UI benefits. Those with lower finding rates should also exert less search efforts; however, the data does not suggest the search efforts are significantly different between the formerly insured (with lower finding rates) and the uninsured (with higher finding rates).

Figure 1: Unemployment-to-Employment Monthly Transition Rate (%) by UI History (Data source: CPS)

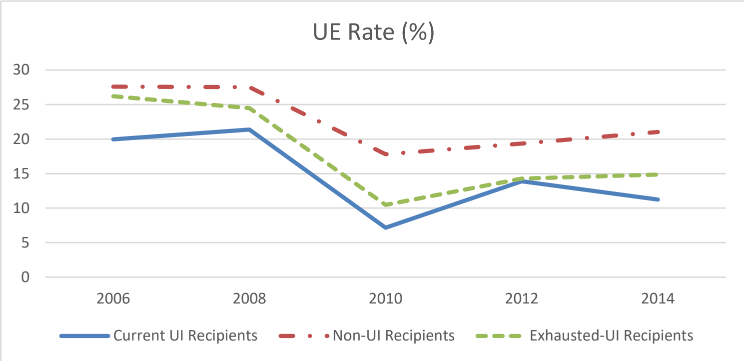
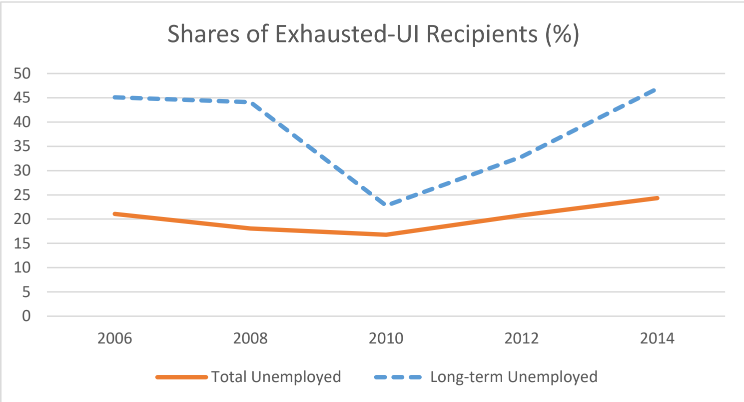


Figure 2: Shares of Formerly Insured Unemployed Workers amongst Total Unemployed Workers and Long-term Unemployed Workers ($>$ 6 months duration) (Data source: CPS)



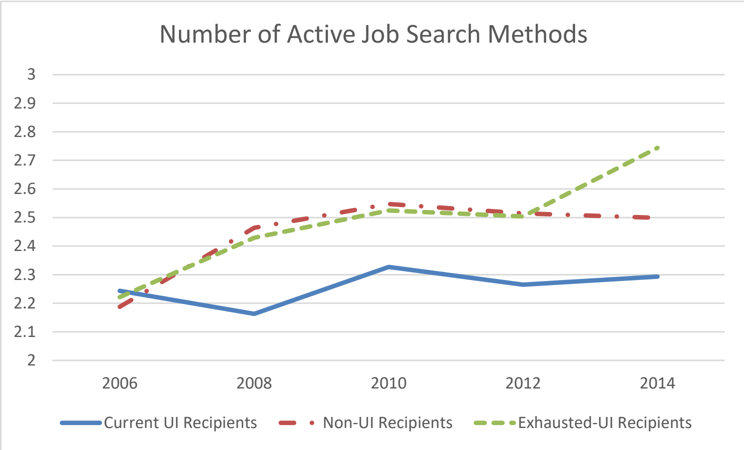
finding) rates. It shows that the formerly insured find a job at a slower rate than the uninsured, especially during the Great Recession when the rate becomes lower and much closer to that of the insured. Table 8 in Appendix C shows that this finding still holds when I control for several observable characteristics that may influence the UI take-up decision, and that adverse selection could be ruled out.[4] Lastly, Figure 2 shows that the formerly insured represent a large fraction of the long-term unemployed (those unemployed longer than 6 months) and therefore acknowledging the difference in the job finding rates between the formerly insured and the uninsured can be important in explaining the unemployment duration structure and its persistence that this paper aims to address.

Job Search Intensity Following Shimer (2004) and Mukoyama, Patterson and Şahin (2017), I use the number of active job search methods as a proxy for job search intensity.[5] Figure 3

[4]The only exception is for unemployed workers who are expecting to be recalled and/or are on temporary layoff whose job finding rates remain quite high which is consistent with findings in Fujita and Moscarini (2015). However, the share of these workers did not go up during the Great Recession.

[5]Mukoyama et al (2017) also use another measure of search intensity based on information from the American Time Use Survey. However, this survey does not report the UI status of the respondents. Existing literature

Figure 3: Average Number of Active Job Search Methods (Data source: CPS)



plots the average number of active job search methods for unemployed workers with different UI histories over the 2006-2014 period.[6] On average, the formerly insured use 2.48 methods in job searching which is very close to the uninsured who use 2.44 methods whilst the insured use less at 2.25 methods.

This finding is not surprising given that both the formerly insured and the uninsured are supposed to have similar outside options (without UI benefits) they should exert similar job search intensities. What is interesting, however, is when we consider this with the fact that the job finding rate for the formerly insured is significantly lower than that of the uninsured. To reconcile these two findings, I impose an assumption that insured unemployed workers experience a drop in job search efficiency during their unemployment spells. As an intuition, this can be the case when they lose the career/professional network, and/or skills and tools to conduct job search efficiently after having not been searching as actively for some time whilst on the benefits. Therefore, even if the formerly insured exert the same search effort as the uninsured, they will have a lower probability of meeting a potential employer due to having a lower search efficiency.

using this survey such as Krueger and Mueller (2010), Rothstein (2011) and Mukoyama et al (2017) use the UI eligibility criteria (unemployed workers who are job losers or temporary job enders) as a proxy for UI recipients but this paper is the first to report the search intensity based on the reported receipt of UI which is a more accurate measurement.

[6]Active methods are the following: (1) contacted employer directly/interview, (2) contacted public employment agency, (3) contacted private employment agency, (4) contacted friends or relatives, (5) contacted school/university employment center, (6) sent out resumes/filled out application, (7) checked union/professional registers, (8) placed or answered ads, and (9) other active. The survey also lets the respondents answer the following passive methods: (1) looked at ads, (2) attended job training programs/courses, (3) nothing, and (4) other passive.

3 Model

In this section, I describe a Diamond-Mortensen-Pissarides search and matching model with endogenous job separation, variable job search intensity with on-the-job search, endogenous UI extensions and a degree of worker heterogeneity. The model is built upon Rujiwattanapong (2022) with an additional unemployment state, namely, formerly insured unemployment. Based on empirical findings in the previous section, I introduce a drop in job search efficiency for unemployed workers who have collected UI benefits. I purposefully retain all features in Rujiwattanapong (2022) so that the results can be compared straightforwardly.

3.1 Technology and Preferences

Time is discrete and goes on forever. The economy is populated by workers and firms. Workers are ex-ante heterogeneous with respect to their productivity which is either high (H) or low (L) whilst firms are ex-ante identical. A match consists of one worker and one firm. It produces output whose price is normalised to one. The output of a match is a function of the aggregate productivity (z), the match-specific productivity (m), and the worker-specific productivity (η_i; $i \in \{H,L\}$). Namely,

$$y_{it}(m) \quad = \quad z_t \times m \times \eta_i$$

The aggregate productivity (z) evolves according to an AR(1) process: $\ln z_t = \rho_z \ln z_{t-1} + \varepsilon_t$ where $\varepsilon_t \sim N(0, \sigma_z)$. The match-specific productivity (m) is drawn at the start of a worker-firm match from a distribution $F(m)$, and may be redrawn in each subsequent period at the rate λ from the same distribution $F(m)$. Worker's productivity (η_i) is permanent and therefore remains the same throughout the duration of a match. I normalise the productivity of type-H workers such that $(\eta_L <)\eta_H \equiv 1$. A given match is exogenously separated at rate δ and may be endogenously separated whenever the value of workers and/or firms becoming unmatched is higher than the value of being in production.

3.1.1 Workers

Workers are risk neutral and infinitely-lived. They discount future payoffs by the factor β. As previously mentioned, there are two types of workers distinguished by their productivity which can either be high or low. A worker can either be employed (e), insured unemployed with higher search efficiency (u^{UI1}), insured unemployed with lower search efficiency (u^{UI0}), formerly insured unemployed with higher search efficiency (u^{UIx1}), formerly insured unemployed with lower search efficiency (u^{UIx0}), or uninsured unemployed (u^{UU}). I assume that unemployed workers who have collected UI benefits experience a drop in job search efficiency at rate γ in each period during their unemployment spells. Workers are formerly insured unemployed if and only if they were insured unemployed and have exhausted their UI benefits. The worker's UI history is important because the formerly insured and the uninsured are made different due to different search efficiencies.

Both employed and unemployed workers decide each period how much effort they exert in searching for a job (particularly, a new one in case of employed workers). The search effort increases a worker's probability of meeting a firm, and gives a disutility to the worker. The search cost function is strictly concave so a unique search effort is determined for all states. Specifically, the disutility from exerting search effort s of workers with status $k \in \{e, u1, u0\}$

$$\nu_k(s) \quad = \quad a_k s^{d_k};\ a_k, d_k > 0,$$

I distinguish between the search cost of employed workers $-\nu_e(\cdot)$, insured and formerly insured with higher search efficiency as well as uninsured unemployed workers $-\nu_{u1}(\cdot)$, and, lastly, insured and formerly insured workers with low search efficiency $-\nu_{u0}(\cdot)$ where $a_{u0} > a_{u1}$ and/or $d_{u0} > d_{u1}$. Therefore, one unit of search effort yields the insured and formerly insured with higher search efficiency as well as uninsured unemployed workers the same probability of meeting a firm, whilst the insured and formerly insured with lower search efficiency have a lower probability. The search cost for the employed is separated from the unemployed only to discipline the job-to-job transition rate. It is useful to note that workers of different productivity types (H or L) face the same search cost function.

All unemployed workers receive a utility flow h in each period which can be interpreted as home production or leisure flow from not working. Insured unemployed workers further receive unemployment benefits $b_i(\tilde{m});\ i \in \{H, L\}$ that depend on the worker's type (i) and the match-specific productivity in the most recent employment ($\tilde{m}$).[7] Employed workers receive a wage $w_i^j(m)$ where $i \in \{H, L\}$ and $j \in \{e(\tilde{m}), UI1(\tilde{m}), UI0(\tilde{m}), UIx1, UIx0, UU\}$. The wage depends on the worker's type (i), previous employment status and associated unemployment benefits (j), and the current match-specific productivity (m).

UI Duration Policy and UI Eligibility I assume that any employed worker returning to unemployment becomes insured unemployed at rate $1-\psi$, and become uninsured unemployed at rate ψ, so that I can target the UI take-up rate and the size of insured unemployment.

I follow Rujiwattanapong (2022) in modelling the UI duration policy to be a function of the unemployment rate as observed in the US economy. In particular, the maximum UI dura-

[7]As unemployment benefits are calculated as a fraction of a worker's past wage, I use the worker's type along with the match-specific productivity as a proxy for their wages.

tion is extended when the unemployment rate in the economy reaches a threshold $\bar{u}$. Similar to Frediksson and Holmlund (2001), I do not explicitly model the length of an unemployment spell of a worker and instead use a UI exhaustion rate to govern the number of insured unemployed workers losing UI eligibility each period. Additionally, I allow this UI exhaustion rate to vary with total unemployment (u). Namely, the rate an insured unemployed worker loses their UI benefit given the unemployment rate is u_t is

$$\phi(u_t) \equiv \phi_L \mathbb{1}\{u_t \geq \bar{u}\} + \phi_H \mathbb{1}\{u_t < \bar{u}\}$$

where $\phi_L < \phi_H$. Whenever the unemployment rate goes above the threshold $\bar{u}$ the exhaustion rate becomes smaller and therefore the expected maximum UI duration, which equals the inverse of the exhaustion rate, becomes longer/extended.

I assume that, on top of the UI exhaustion rate, insured unemployed workers face an additional probability of losing UI eligibility at rate ξ when they meet a firm but do not proceed to employment.

Workers' Value Functions I define the set of state variables as $\omega \equiv \{z, u, u_i, u_i^{UI1}(\tilde{m}), u_i^{UI0}(\tilde{m}), u_i^{UIx1}, u_i^{UIx0}, u_i^{UU}, e_i(m); \forall m, \tilde{m}$ and $i \in \{H, L\}\}$ where u_i is the measure of type-i unemployed workers, $u_i^{UI1}(\tilde{m})$ is the measure of type-i insured unemployed workers with higher search efficiency whose match quality in the most recent employment was $\tilde{m}$, u_i^{UIx1} is the measure of type-i formerly insured unemployed workers with higher search efficiency, u_i^{UU} is the measure of type-i uninsured unemployed workers, and $e_i(m)$ is the measure of type-i employed workers with current match quality m. $u_i^{UI0}(\tilde{m})$ and u_i^{UIx0} are defined analogously but for workers with lower search efficiency.

Given this setup, I can write the Bellman equation for type-i insured unemployed workers with unemployment benefits $b_i(\tilde{m})$ and higher search efficiency as

$$\begin{aligned} U_i^{UI1}(\tilde{m};\omega) = \max_{s_i^{UI1}(\tilde{m};\omega)} \quad & b_i(\tilde{m}) + h - \nu_{u1}(s_i^{UI1}(\tilde{m};\omega)) \\ & + \beta E_{m'\omega'|\omega}\Big[p_i^{UI1}(\tilde{m};\omega) \max\Big\{ W_i^{UI1(\tilde{m})}(m';\omega'), \ldots \\ & \underbrace{(1-\phi(u))(1-\xi)}_{\text{Pr(keep UI | meeting a firm)}} \bar{U}_i^{UI}(\tilde{m};\omega') + \underbrace{(\phi(u) + (1-\phi(u))\xi)}_{\text{Pr(lose UI | meeting a firm)}} \bar{U}_i^{UIx}(\omega') \Big\} \\ & + (1 - p_i^{UI1}(\tilde{m};\omega)) \Big((1-\phi(u)) \bar{U}_i^{UI}(\tilde{m};\omega') + \phi(u) \bar{U}_i^{UIx}(\omega') \Big) \Big] \end{aligned} \tag{1}$$

where $\bar{U}_i^{UI}(\cdot;\cdot) \equiv (1-\gamma)U_i^{UI1}(\cdot;\cdot) + \gamma U_i^{UI0}(\cdot;\cdot)$ and $\bar{U}_i^{UIx}(\cdot) \equiv (1-\gamma)U_i^{UIx1}(\cdot) + \gamma U_i^{UIx0}(\cdot)$. $p_i^{UI1}(\tilde{m};\cdot)$ is the probability that type-i insured unemployed workers with benefit $b_i(\tilde{m})$ and higher search efficiency meets a firm which is increasing in their job search intensity $s_i^{UI1}(\tilde{m};\cdot)$.

This job finding probability is explained in detail in the next subsection. Once these workers meet a firm, they draw a match-specific productivity m, and decide whether to stay unemployed (with some probability of losing UI eligibility) or start working for that firm. If they lose UI eligibility, they become formerly insured unemployed whose value is $U_i^{UIx1}(\cdot)$ ($U_i^{UIx0}(\cdot)$) for higher (lower) efficiency searchers. The Bellman equation for type-i insured unemployed workers with unemployment benefits $b_i(\tilde{m})$ and lower search efficiency can be written as

$$
\begin{aligned}
U_i^{UI0}(\tilde{m};\omega) \quad = \quad & \max_{s_i^{UI0}(\tilde{m};\omega)} \quad b_i(\tilde{m}) + h - \nu_{u0}(s_i^{UI0}(\tilde{m};\omega)) \\
& +\beta E_{m'\omega'|\omega}\Bigg[p_i^{UI0}(\tilde{m};\omega)\max\Big\{W_i^{UI0(\tilde{m})}(m';\omega'),\ldots \\
& \underbrace{(1-\phi(u))(1-\xi)}_{\text{Pr(keep UI | meeting a firm)}} U_i^{UI0}(\tilde{m};\omega') + \underbrace{(\phi(u)+(1-\phi(u))\xi)}_{\text{Pr(lose UI | meeting a firm)}} U_i^{UIx0}(\omega')\Big\} \\
& +(1-p_i^{UI0}(\tilde{m};\omega))\Big((1-\phi(u))U_i^{UI0}(\tilde{m};\omega') + \phi(u)U_i^{UIx0}(\omega')\Big)\Bigg] \qquad (2)
\end{aligned}
$$

It is useful to note that the search cost function of these workers, $\nu_{u0}(\cdot)$, is the only reason why $U_i^{UI1}(\cdot;\cdot)$ is different from $U_i^{UI0}(\cdot;\cdot)$.

As for type-i formerly insured unemployed workers with higher and lower search efficiency, I can write their Bellman equations respectively as

$$
\begin{aligned}
U_i^{UIx1}(\omega) \quad = \quad & \max_{s_i^{UIx1}(\omega)} \quad h - \nu_{u1}(s_i^{UIx1}(\omega)) + \beta E_{m'\omega'|\omega}\Big[\ldots \\
& p_i^{UIx1}(\omega)\max\{W_i^{UIx1}(m';\omega'),\bar{U}_i^{UIx}(\omega')\} + (1-p_i^{UIx1}(\omega))\bar{U}_i^{UIx}(\omega')\Big] \qquad (3) \\
U_i^{UIx0}(\omega) \quad = \quad & \max_{s_i^{UIx0}(\omega)} \quad h - \nu_{u0}(s_i^{UIx0}(\omega)) + \beta E_{m'\omega'|\omega}\Big[\ldots \\
& p_i^{UIx0}(\omega)\max\{W_i^{UIx0}(m';\omega'),U_i^{UIx0}(\omega')\} + (1-p_i^{UIx0}(\omega))U_i^{UIx0}(\omega')\Big] \qquad (4)
\end{aligned}
$$

Analogous to the insured unemployed, $p_i^{UIx1}(\cdot)$ is the probability that type-i formerly insured unemployed workers with higher search efficiency meets a firm, and it is increasing in $s_i^{UIx1}(\cdot)$. After the meeting takes place, a match-specific productivity m is drawn and these workers decide whether to stay formerly insured unemployed or start working for that firm. The notations for the formerly insured with lower search efficiency can be similarly defined.

I can write the Bellman equation for type-i uninsured unemployed workers as

$$\begin{aligned} U_i^{UU}(\omega) &= \max_{s_i^{UU}(\omega)} \quad h - \nu_{u1}(s_i^{UU}(\omega)) + \beta E_{m'\omega'|\omega}\Big[\cdots \\ & p_i^{UU}(\omega)\max\{W_i^{UU}(m';\omega'), U_i^{UU}(\omega')\} + (1-p_i^{UU}(\omega))U_i^{UU}(\omega')\Big] \end{aligned} \tag{5}$$

It is useful to note that the values of uninsured unemployed workers are different from formerly insured unemployed workers only because of the possibility that the latter type face a drop in search efficiency.

Lastly, I can write the Bellman equation for type-i employed workers with current match quality m, and previous employment status and associated unemployment benefits $j \in \{e(\tilde{m}), UI1(\tilde{m}), UI0(\tilde{m}), UIx1, UIx0, UU\}$ as

$$\begin{aligned} W_i^j(m;\omega) &= \max_{s_i^e(m;\omega)} \quad w_i^j(m;\omega) - \nu_e(s_i^e(m;\omega)) + \beta E_{\omega'|\omega}\Bigg[\\ & \underbrace{(1-\delta)(1-\lambda)}_{\text{Pr(stay matched, keep } m)}\Big[\underbrace{(1-p_i^e(m;\omega)(1-F(m)))}_{\text{Pr(stay with current firm)}} W_i^{e(m)+}(m;\omega') \\ & + \underbrace{p_i^e(m;\omega)(1-F(m))}_{\text{Pr(move to new firm)}} E_{m'|m'>m}[W_i^{e(m)+}(m';\omega')]\Big] \\ & + \underbrace{(1-\delta)\lambda}_{\text{Pr(stay matched, new } m)} E_{m'}\Big[\underbrace{(1-p_i^e(m;\omega)(1-F(m')))}_{\text{Pr(stay with current firm)}} W_i^{e(m)+}(m';\omega') \\ & + \underbrace{p_i^e(m;\omega)(1-F(m'))}_{\text{Pr(move to new firm)}} E_{m''|m''>m'}[W_i^{e(m)+}(m'';\omega')]\Big] \\ & + \underbrace{\delta}_{\text{Pr(match exogenously separated)}} \Big((1-\psi)U_i^{UI1}(m,\omega') + \psi U_i^{UU}(\omega')\Big)\Bigg] \end{aligned} \tag{6}$$

where $W_i^{e(m)+}(m';\omega') \equiv \max\{W_i^{e(m)}(m';\omega'), (1-\psi)U_i^{UI1}(m,\omega') + \psi U_i^{UU}(\omega')\}$ showing that employed workers are free to return to unemployment in which case they become insured at rate $1-\psi$ and uninsured at rate ψ. The expressions for optimal job search intensities for all types of workers can be found in Appendix A.

3.1.2 Firms

Similar to workers, firms are risk neutral and infinitely-lived. They also discount future payoffs by the factor β. Firms are ex-ante identical, and either matched with one worker or unmatched. Matched firms are only made different by the type of workers they are matched with and the match-specific productivity they have drawn together. Matched firms produce and sell output, pay wage to their workers, and lump-sum tax to finance UI payments. Unmatched firms pay a fixed cost κ to post a job vacancy, and have no ability to direct their search to a certain type of workers.

The Bellman equation for unmatched firms is

$$\begin{aligned} V(\omega) &= -\kappa+\beta q(\omega)E_{\omega'|\omega}\Bigg[\sum_{i\in\{H,L\}}\Big(\sum_m \zeta_i^e(m;\omega)(1-F(m))E_{m'|m'>m}[J_i^{e(m)+}(m';\omega')] \\ &\quad +\sum_m \zeta_i^{UI1}(m,\omega)E_{m'}[J_i^{UI1(m)+}(m';\omega')]+\sum_m \zeta_i^{UI0}(m,\omega)E_{m'}[J_i^{UI0(m)+}(m';\omega')] \\ &\quad +\zeta_i^{UIx1}(\omega)E_{m'}[J_i^{UIx1+}(m';\omega')]+\zeta_i^{UIx0}(\omega)E_{m'}[J_i^{UIx0+}(m';\omega')] \\ &\quad +\zeta_i^{UU}(\omega)E_{m'}[J_i^{UU+}(m';\omega')]\Big)\Bigg] \end{aligned} \tag{7}$$

$$\begin{aligned} \text{where}\quad \zeta_i^e(m) &= \frac{(1-\lambda)s_i^e(m)e_i(m)+\lambda f(m)\sum_m s_i^e(m)e_i(m)}{s} \\ \zeta_i^{UI1}(m) &= \frac{s_i^{UI1}(m)u_i^{UI1}(m)}{s};\quad \zeta_i^{UI0}(m)=\frac{s_i^{UI0}(m)u_i^{UI0}(m)}{s}; \\ \zeta_i^{UIx1} &= \frac{s_i^{UIx1}u_i^{UIx1}}{s};\quad \zeta_i^{UIx0}=\frac{s_i^{UIx0}u_i^{UIx0}}{s};\quad \zeta_i^{UU}=\frac{s_i^{UU}u_i^{UU}}{s}; \\ s &= \sum_{i\in\{H,L\}}\Big(\sum_m\big(s_i^e(m)e_i(m)+s_i^{UI1}(m)u_i^{UI1}(m)+s_i^{UI0}(m)u_i^{UI0}(m)\big) \\ &\quad +s_i^{UIx1}u_i^{UIx1}+s_i^{UIx0}u_i^{UIx0}+s_i^{UU}u_i^{UU}\Big) \end{aligned}$$

$J_i^j(\cdot)$ denotes the value of a firm being matched to a worker of type-i and previous employment status $j\in\{e(\tilde{m}),UI1(\tilde{m}),UI0(\tilde{m}),UIx1,UIx0,UU\}$ and $J_i^{j+}(m;\omega)\equiv\max\{J_i^j(m;\omega),V(\omega)\}$. Since the meeting process between workers and firms is random, unmatched firms must take into account the entire distribution of workers over productivity types, employment statuses and associated (potential) UI benefits to compute the probability they meet a certain type of workers. I also assume that firms can enter and leave the market freely; therefore, the value of being an unmatched firm is always zero, i.e. $V(\omega)=0,\forall\omega$.

Given the free entry condition, I can write the Bellman equation for matched firms as

$$\begin{aligned} J_i^j(m;\omega) &= y_i(m;\omega)-w_i^j(m;\omega)-\tau(\omega)+\beta E_{\omega'|\omega}\Bigg[\ldots \\ &\quad (1-\delta)(1-\lambda)\Big[(1-p_i^e(m;\omega)(1-F(m)))J_i^{e(m)+}(m;\omega')\Big] \\ &\quad +(1-\delta)\lambda E_{m'}\Big[(1-p_i^e(m;\omega)(1-F(m')))J_i^{e(m)+}(m';\omega')\Big]\Bigg] \end{aligned} \tag{8}$$

where $J_i^{e(m)+}(m;\omega)\equiv\max\{J_i^{e(m)}(m;\omega),0\}$ implying that matched firms are free to endogenously separate from their current matched workers.

3.1.3 Search and Matching

A meeting function $M(s,v)$ determines the number of meetings between workers and firms. It is concave in its arguments which are the total job search intensity (s) and the total number of job vacancies (v), and has constant returns to scale. Conventionally, I define the rate a worker meets a firm per unit of job search to be $\frac{M(s,v)}{s} = M(1,\theta) \equiv p(\theta)$; therefore, the rate a worker of type i with history j meets a firm is $s_i^j p(\theta) \equiv p_i^j(\theta)$. The rate a firm meets a worker is $\frac{M(s,v)}{v} = M(1/\theta,1) \equiv q(\theta)$, where $\theta \equiv \frac{v}{s}$ is the market tightness.

3.2 Wage and Surplus

A wage in the model is determined by the generalised Nash bargaining rule. That is, the Nash bargained wage solves

$$w_i^j(m;\omega) \quad = \quad \text{argmax} \left(WS_i^j(m;\omega)\right)^{\mu} \left(J_i^j(m;\omega)\right)^{(1-\mu)} \tag{9}$$

where μ is the worker's bargaining power. The worker's previous employment status $j \in \{e(\tilde{m}), UI1(\tilde{m}), UI0(\tilde{m}), UIx1, UIx0, UU\}$ is important for the determination of wage because workers use their outside options in the bargaining process. Specifically, WS_i^j denotes the surplus of type-i employed workers with history j. It is defined as the difference between the value of being employed and the corresponding outside option. Define the total match surplus as $S_i^j \equiv WS_i^j + J_i^j$. Nash bargaining results in $WS_i^j = \mu S_i^j$ and $J_i^j = (1-\mu)S_i^j$. I can write the surpluses of employed workers as follows

$$\begin{aligned}
WS_i^{e(\tilde{m})}(m;\omega) &\equiv W_i^{e(\tilde{m})}(m;\omega) - (1-\psi)U_i^{UI1}(\tilde{m},\omega) - \psi U_i^{UU}(\omega) \\
WS_i^{UI1(\tilde{m})}(m;\omega) &\equiv W_i^{UI1(\tilde{m})}(m;\omega) - (1-\phi(u))(1-\xi)\bar{U}_i^{UI}(\tilde{m},\omega) \\
&\quad -(\phi(u)+(1-\phi(u))\xi)\bar{U}_i^{UIx}(\omega) \\
WS_i^{UI0(\tilde{m})}(m;\omega) &\equiv W_i^{UI0(\tilde{m})}(m;\omega) - (1-\phi(u))(1-\xi)U_i^{UI0}(\tilde{m},\omega) \\
&\quad -(\phi(u)+(1-\phi(u))\xi)U_i^{UIx0}(\omega) \\
WS_i^{UIx1}(m;\omega) &\equiv W_i^{UIx1}(m;\omega) - \bar{U}_i^{UIx}(\omega) \\
WS_i^{UIx0}(m;\omega) &\equiv W_i^{UIx0}(m;\omega) - U_i^{UIx0}(\omega) \\
WS_i^{UU}(m;\omega) &\equiv W_i^{UU}(m;\omega) - U_i^{UU}(\omega)
\end{aligned}$$

where $\bar{U}_i^{UI}(\tilde{m},\omega) = (1-\gamma)U_i^{UI1}(\tilde{m},\omega) + \gamma U_i^{UI0}(\tilde{m},\omega)$. $\bar{U}_i^{UIx}(\omega)$ is analogously defined. The expressions for total match surpluses can be found in Appendix A.

3.3 Recursive Competitive Equilibrium

A recursive competitive equilibrium is characterised by

- Value functions: $W_i^{e(\tilde{m})}(m;\omega)$, $W_i^{UI1(\tilde{m})}(m;\omega)$, $W_i^{UI0(\tilde{m})}(m;\omega)$, $W_i^{UIx1}(m;\omega)$, $W_i^{UIx0}(m;\omega)$, $W_i^{UU}(m;\omega)$, $U_i^{UI1}(\tilde{m};\omega)$, $U_i^{UI0}(\tilde{m};\omega)$, $U_i^{UIx1}(\omega)$, $U_i^{UIx0}(\omega)$, $U_i^{UU}(\omega)$, $J_i^{e(\tilde{m})}(m;\omega)$, $J_i^{UI1(\tilde{m})}(m;\omega)$, $J_i^{UI0(\tilde{m})}(m;\omega)$, $J_i^{UIx1}(m;\omega)$, $J_i^{UIx0}(m;\omega)$, $J_i^{UU}(m;\omega)$, and $V(\omega)$;

- Market tightness $\theta(\omega)$;

- Search policy: $s_i^e(m;\omega)$, $s_i^{UI1}(m,\omega)$, $s_i^{UI0}(m,\omega)$, $s_i^{UIx1}(\omega)$, $s_i^{UIx0}(\omega)$ and $s_i^{UU}(\omega)$; and

- Wage functions: $w_i^{e(\tilde{m})}(m;\omega)$, $w_i^{UI1(\tilde{m})}(m;\omega)$, $w_i^{UI0(\tilde{m})}(m;\omega)$, $w_i^{UIx1}(m;\omega)$, $w_i^{UIx0}(m;\omega)$ and $w_i^{UU}(m;\omega)$,

such that, given the initial distribution of workers over productivity level, employment status, UI status, benefit level and match productivity, the government's policy $\tau(\omega)$ and $\phi(\omega)$, and the law of motion for z:

1. The value functions and the market tightness satisfy the Bellman equations for workers and firms, and the free entry condition, namely, equations (1), (2), (3), (4), (5), (6), (7) and (8)

2. The search decisions satisfy the FOCs for optimal search intensity, which are equations (10), (11), (12), (13), (14) and (15)

3. The wage functions satisfy the FOCs for the generalised Nash bargaining rule (equation (9))

4. The government's budget constraint is satisfied each period

5. The distribution of workers evolves according to the transition equations (16), (18), (19), (20), (21) and (22), which can be found in Appendix B, consistent with the maximising behaviour of agents

4 Calibration

For simplicity, I assume that the rate the insured unemployed workers experience a drop in their search efficiency is the same as the rate they exhaust their UI benefits, i.e. γ coincides with $\phi(u)$; $\forall u$. This implies that the employment statuses reduce to a set of $\{e(\tilde{m}), UI(\tilde{m}), UIx, UU\}$. Therefore, only the formerly insured unemployed (those with status UIx) have a lower search efficiency.

The calibration strategy follows Rujiwattanapong (2022) with the exception of an additional parameter to be calibrated and an additional target. Namely, the relative search efficiency of the formerly insured unemployed, $\frac{a_{u0}}{a_{u1}}$, is calibrated to match the average ratio of the job finding rates between the insured unemployed and the formerly insured unemployed.[8] Therefore, there are in total 13 targeted moments and 13 parameters to be calibrated using the Simulated Method of Moments (SMM). Table 1 summarises the targeted moments used in the calibration exercise, and also compares the baseline model's performance to that of the model without a drop in search efficiency of the formerly insured unemployed. Non-targeted moments are reported in Table 2. Table 3 reports the calibrated parameters whilst Table 4 summarises the pre-specified parameters.

Table 1: **Targeted Moments**

Moment	Data	Baseline	Without UIx
E(u)	0.0583	0.0569	0.0577
E(ρ_{UE})	0.4194	0.4414	0.4286
E(ρ_{EU})	0.0248	0.0259	0.0251
E(ρ_{EE})	0.0320	0.0316	0.0320
E(u_{dur})	15.416	12.251	13.063
E(u^{UI})	0.0290	0.0314	0.0327
std(u)	0.1454	0.1449	0.1453
std(ρ_{UE})	0.0999	0.1221	0.1402
std(ρ_{EU})	0.0890	0.0617	0.0641
std(u_{dur})	6.9327	5.6412	6.1954
std(LP)	0.0131	0.0106	0.0104
corr(LP, LP_{-1})	0.7612	0.7609	0.7593
E($\rho^{UI}_{UE}/\rho^{UIx}_{UE}$)	0.8009	0.8018	0.5508

- ρ_{UE}: job finding rate // ρ_{EU}: job separation rate // ρ_{EE}: job-to-job transition rate
  u_{dur}: mean unemployment duration (weeks) // $LP = y/(1-u)$: labour productivity
  Data source: CPS

I continue to assume that the match-specific productivity m follows a Beta distribution with three parameters $\{\underline{m}, \beta_1, \beta_2\}$. Specifically, $F(m) = \underline{m} + \text{betacdf}(m - \underline{m}, \beta_1, \beta_2)$. The meeting function between workers and firms is similar to den Haan, Ramey and Watson (2000) but the number of job searchers is augmented by their search intensities, namely, $M(s,v) = (sv)/(s^l + v^l)^{\frac{1}{l}}$. I choose the same pre-specified parameters as in Rujiwattanapong (2022) including UI exhaustion rates during recessionary periods (ϕ_L) that vary to match the observed extended UI durations over the 1948-2007 period. It is useful to note that the UI extensions in the simulations are still endogenous and triggered when the unemployment rate is above the threshold.

[8] Despite this additional parameter directly affects the relative job finding rates between unemployed workers with and without UI benefits, it inevitably affects other moments in the calibration exercise.

Table 2: **Moments Not Targeted**

Moment	Data	Model	Wihtout UIx
E($U1$)	0.0233	0.0243	0.0237
E($U2$)	0.0172	0.0183	0.0180
E($U4$)	0.0080	0.0075	0.0085
E(LTU)	0.0098	0.0066	0.0076
std($U1$)	0.0048	0.0015	0.0017
std($U2$)	0.0046	0.0027	0.0030
std($U4$)	0.0035	0.0033	0.0035
std(LTU)	0.0085	0.0090	0.0107
std(u^{UI})	0.1780	0.2059	0.2523
std(v)	0.1226	0.0436	0.0327
corr(u,v)	-0.6682	-0.2077	-0.1906

- $U1$: Unemployed less than 1 month // $U2$: Unemployed with 2-3 month duration
  $U4$: Unemployed with 4-6 month duration // LTU: Unemployed longer 6 months
  u_{dur}: mean unemployment duration (weeks)
  Data source: CPS

Table 3: **Calibrated Parameters For Baseline Model**

Parameter	Description	Baseline	No UIx
l	Meeting function	0.50	0.51
δ	Exogenous separation rate	0.025	0.023
λ	Pr(redrawing new m)	0.50	0.50
ψ	Pr(losing UI after becoming unemployed)	0.49	0.49
ξ	Pr(losing UI after meeting firm)	0.50	0.50
a_e	Search cost function	0.20	0.15
$\underline{m}$	Lowest match-specific productivity	0.384	0.396
β_1	Match-specific prod. distribution	2.57	2.55
β_2	Match-specific prod. distribution	5.39	5.26
ρ_z	Persistence of TFP	0.9581	0.9562
σ_z	Standard deviation of TFP shocks	0.0086	0.0075
η_L	Productivity of type-L	0.985	0.985
a_{ux}/a_u	Search cost for u^{UIx} compared to u^{UI}	1.351	1

Overall, the model performs well in matching the targets. It matches the average ratio of the job finding rates between insured and formerly insured unemployed workers unlike the model without a drop in search efficiency in Rujiwattanapong (2022) where this statistic is not targeted. It also improves on the average share of insured unemployment, and performs much better in producing the volatility of the job finding rates. With respect to the non-

Table 4: **Fixed Parameters For Baseline Model** (From Rujiwattanapong (2022))

Parameter	Description	Value	Sources/Remarks
β	Discount factor	0.9967	Annual interest rate of 4%
κ	Vacancy posting cost	0.0392	Fujita & Ramey (2012)
μ	Worker's bargaining power	0.5	Den Haan, Ramey & Watson (2000)
ϕ_H	UI exhaustion rate	1/6	6 months max UI duration, ETA
ϕ_{L1}	UI exhaustion rate	1/9	9 months max UI duration, ETA
ϕ_{L2}	UI exhaustion rate	1/12	12 months max UI duration, ETA
ϕ_{L3}	UI exhaustion rate	1/16	16 months max UI duration, ETA
ϕ_{L4}	UI exhaustion rate	1/21	21 months max UI duration, ETA
$\bar{u}$	UI policy threshold	0.065	ETA
a_u	Search cost function	0.1180	Normalisation
d_u, d_e, d_{ux}	Search cost function	1	Christensen et al (2004), Yashiv (2000)
h	Leisure flow	0.5695	Gruber (1997)

targeted moments, since the model delivers a more moderated insured unemployment series, it produces a much more realistic volatility of the series. In effect, this makes total unemployment more moderated and improves on the Beveridge curve as measured by the correlation between unemployment and vacancies. The volatilty of the vacancies also improves despite being somewhat far from the data.

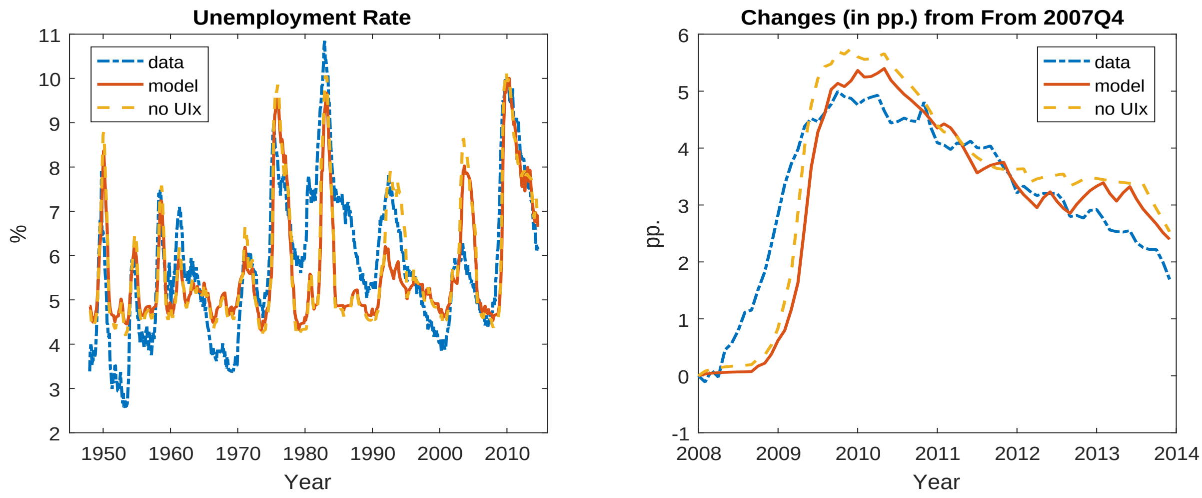
5 Results

I obtain the results in this section by feeding in (1) the observed extended maximum UI durations between 1948 and 2014, and (2) the path of aggregate productivity z such that the model delivers the same series of deviations of output (GDP per capita) from its HP trend exactly as in the data. I then evaluate the performance of the baseline model with respect to the model without formerly insured unemployment in terms of how well it can account for the labour market activities over the business cycles as well as the increase in the persistence of unemployment. I show how the increased persistence affects the previously reported results regarding the effects of UI extensions during the Great Recession. Lastly, I report the welfare gains and losses from eliminating UI extensions during the recent recession.

5.1 Performance

Unemployment Firstly, Figure 4 shows how well the model can account for the total unemployment series in the data. Since UI extensions are a function of unemployment, it is expected that the model generated UI extensions are similar to the ones observed in the data.

Figure 4: Unemployment Rate (%): Data and Models (Data source: CPS)



However, the model's unemployment series does not reach the threshold to trigger UI extension during the 90s recession. Overall, the model's series is more moderated than in the model without formerly insured unemployment. The right panel of Figure 4 shows that the series exhibits a slightly more persistent and subdued response during the Great Recession than does the series from the previous model without u^{UIx}. From Table 5, we can see that the baseline model does a better job in accounting for total unemployment during the Great Recession (96 percent of the observed series - as measured by percentage deviation) than the previous model (95.4 percent) as the series from the baseline model overshoots by less when UI is extended during a recession.

Table 5: **Performance of the Model During the Great Recession**

x	Data max(x)	Model max(x)	No UIx max(x)	Data mean(x)	Model mean(x)	No UIx mean(x)	mean % dev. from data Model	No UIx
$u(\%)$	10.0%	10.0%	10.1%	8.3%	8.2%	8.3%	4.0%	4.6%
u_{dur} (weeks)	40.6	35.9	38.8	36.3	26.7	28.5	26.5%	23.0%
$LTU(\%)$	4.4%	4.4%	4.9%	3.4%	2.8%	3.1%	17.4%	12.9%

- LTU: Unemployed longer 6 months // u_{dur}: mean unemployment duration (weeks)
  - These statistics are computed between October 2009 (the peak of the US unemployment rate) and June 2014
  - The last 2 columns show the time-average percentage deviation in modulus of each variable from its empirical counterpart
  - Data source: CPS

Figure 5: Average Unemployment Duration (%): Data and Models (Data source: CPS)

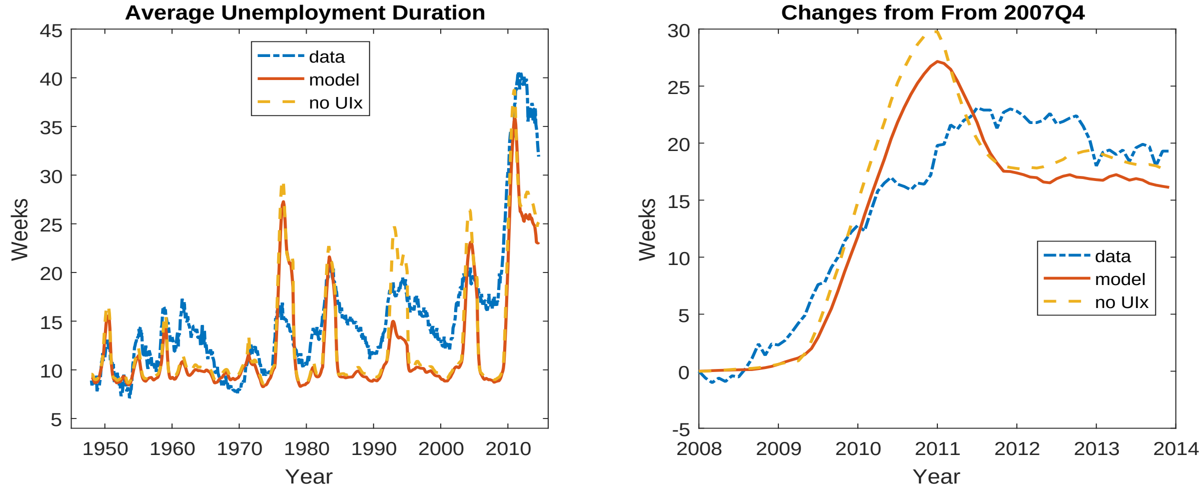
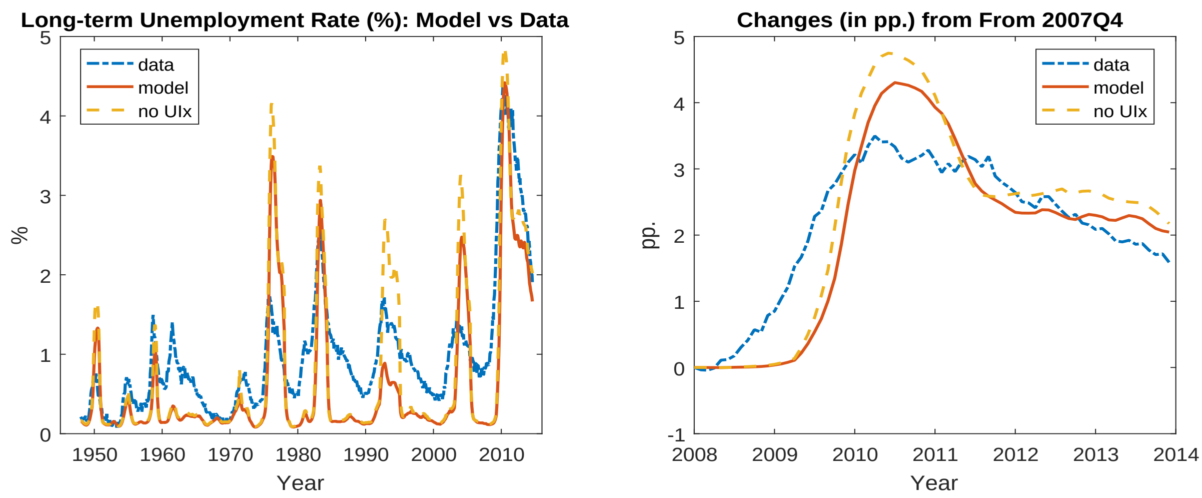


Figure 6: Long-term Unemployment Rate (%): Data and Models (Data source: CPS)



Unemployment Duration Structure The same observation can be made with regards to the average unemployment duration and long-term unemployment series shown in Figures 5 and 6. The persistence of these series are slightly higher than those in the previous model. Both series do improve in terms of their responses to negative aggregate shocks and UI extensions as observed by the significantly smaller spikes during recessionary episodes (i.e., less overshooting). However, both average unemployment duration and long-term unemployment in the baseline model are on average lower than those in the previous model. As a result, the model performs slightly worse in accounting for these two series (despite delivering the observed peak of long-term unemployment that the other model overshoots) as shown in Table 5.

Persistence To quantify the increase in the persistence of unemployment and its duration structure from the introduction of worker's UI history, I show in Figure 7 the autocorrelation coefficients of total unemployment, average unemployment duration and long-term unemployment from the models with and without a search efficiency drop and the empirical counterparts. The baseline model is successful in generating greater persistence for all three variables especially at longer lags (6 to 24 months). It yields higher autocorrelation coefficients on average by 0.03 (14 percent increase) for unemployment, 0.02 (5 percent increase) for average unemployment duration, and 0.03 (7 percent increase) for long-term unemployment in comparison to the previous model. I find similar improvement in the autocorrelation coefficients when I remove the quadratic time trend from the series as shown in Figure 8, but since the coefficients are smaller, the baseline model improves from the previous model by 41 percent for total unemployment, 10 percent for average unemployment duration, and 33 percent for long-term unemployment. Nonetheless, the observed persistence for all series in the data is significantly higher which may suggest that further worker heterogeneities can improve the persistence and match the structure of unemployment duration further.

5.2 Effects of UI Extensions on the Aggregate Labour Market

Now that I have established that the introduction of a drop in search efficiency for insured unemployed workers helps increase the persistence of unemployment that was lacking in the previous model in Rujiwattanapong (2022), I discuss in this section its implication on the revised effects of UI extensions on the aggregate labour market.

Table 6 shows the responses of main labour market variables to a reduction of maximum UI duration from 90 weeks to 26 weeks during the Great Recession, i.e., eliminating all UI extensions. To compare the effectiveness of UI duration policy, I report the responses from the previous model without a drop in search efficiency in the same table.

It can be seen from this table that introducing a drop in job search efficiency for formerly insured workers reduces the effects of UI extensions on the unemployment duration structure (as represented by the average unemployment duration and long-term unemployment) but it hardly affects the effects of UI extensions on total unemployment. This is expected since the formerly insured unemployed represent a small fraction of total unemployment but its (negative) effect on the job finding rates becomes more important for the unemployment duration due to Jensen's inequality, and they represent a larger fraction of long-term unemployment. The reason that the UI effects are smaller in the baseline model is because a drop in job search efficiency lowers the value of being insured unemployed in the first place. Insured unemployed workers then search for jobs more intensively than in the previous model regardless of the level of the benefit. As a result, these workers respond less strongly to UI

Figure 7: Autocorrelation Functions: Data and Models (Data source: CPS)

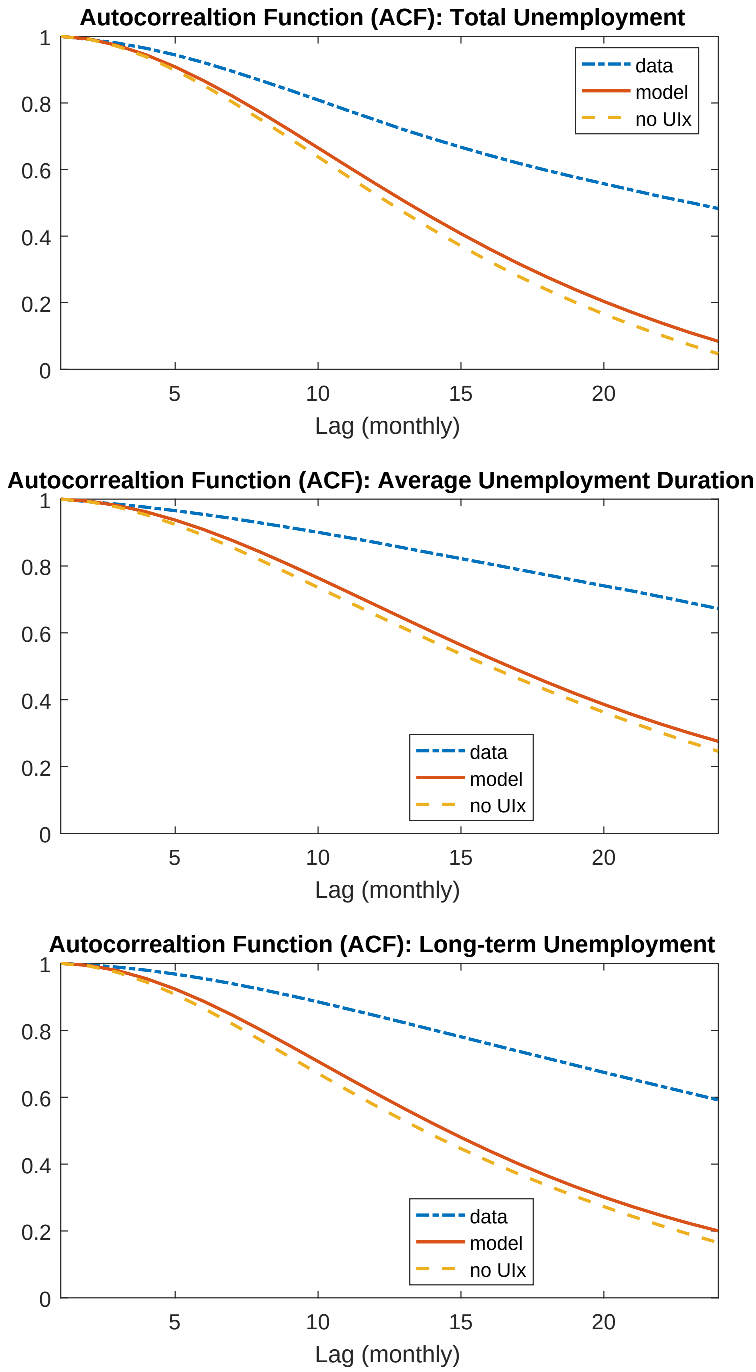


Figure 8: Autocorrelation Functions: Data and Models After Removing the Quadratic Time Trend (Data source: CPS)

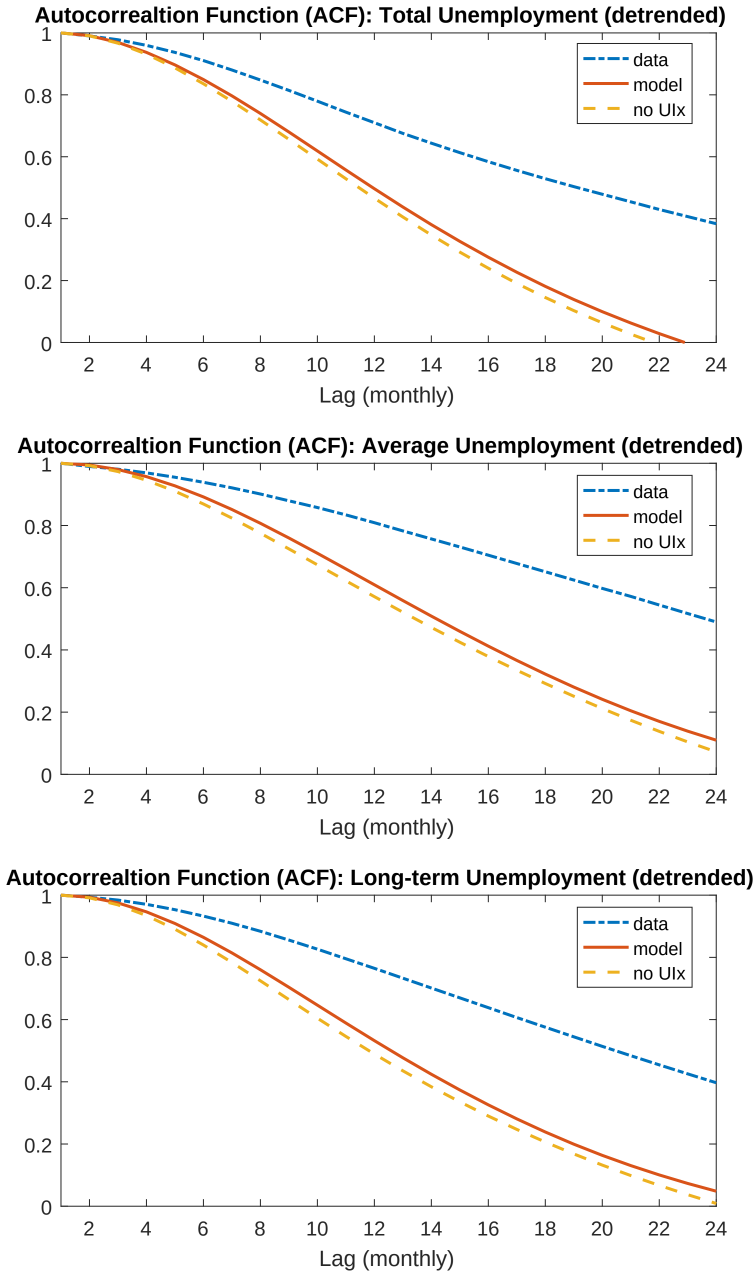


Table 6: **Counterfactual Experiments: Effects of Decreasing Maximum UI Duration from 90 Weeks to 26 Weeks During the Great Recession**: Baseline Model (with Worker's UI History) and Model without Worker's UI History

With UIx	Data	Model	$\Delta\phi$	$\Delta(\phi,s)$	$\Delta(\phi,s,S)$
max(u) (%)	10.0%	10.0%	9.0%	8.1%	6.6%
max(u_{dur}) (weeks)	40.6	35.9	14.57	12.25	11.59
max(LTU) (%)	4.4%	4.4%	1.2%	0.6%	0.5%
Δ max(u)			−1.0pp	−1.9pp	−3.4pp
Δ max(u_{dur})			−21.3	−23.6	−24.3
Δ max(LTU)			−3.2pp	−3.8pp	−4.0pp
Without UIx	**Data**	**Model**	$\Delta\phi$	$\Delta(\phi,s)$	$\Delta(\phi,s,S)$
max(u) (%)	10.0%	10.1%	9.2%	8.4%	6.8%
max(u_{dur}) (weeks)	40.6	38.8	14.8	12.9	12.2
max(LTU) (%)	4.4%	4.9%	1.2%	0.6%	0.5%
Δ max(u)			−0.9pp	−1.7pp	−3.4pp
Δ max(u_{dur})			−24.0	−25.9	−26.6
Δ max(LTU)			−3.7pp	−4.3pp	−4.4pp

- $\Delta\phi$: only maximum UI duration changes
  $\Delta(\phi,s)$: maximum UI duration and job search effort change
  $\Delta(\phi,s,S)$: maximum UI duration, job search effort and match surplus change
  LTU: Unemployed longer 6 months // u_{dur}: mean unemployment duration (weeks)
  Δ max($\cdot$): difference between the model's and counterfactual experiments' maxima
  - These statistics are computed between October 2009 (the peak of the US unemployment rate) and June 2014
  - Data source: CPS

extensions. The elasticity of unemployment duration on changes in the maximum UI duration is also revised downwards from [0.38, 0.41] weeks to [0.33, 0.38] weeks for a one-week increase in maximum UI duration.

5.3 Welfare Implication

Following the revised effects of UI extensions after the introduction of a search efficiency drop amongst insured unemployed workers, I show in this section how it is translated into welfare gains and/or losses for agents in the economy had UI extensions not been implemented during the Great Recession. I also compare this to the case where there is no drop in search efficiency. I summarise the welfare results in Table 7 and plot them in Figure 9 and 10. As in Lucas (1987), I define the welfare gain/loss to be the percentage change in consumption necessary in each period to make agents in the economy to be as satisfied as they would be in a counterfactual economy, which is the economy without UI extensions in this case.

Figure 9: Welfare Gains and Losses from Eliminating All UI Extensions during the Great Recession

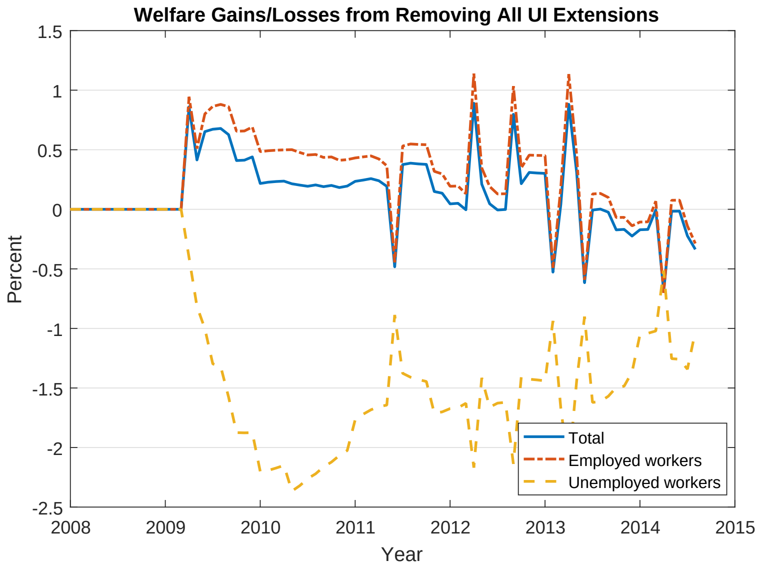


Figure 10: Welfare Gains and Losses from Eliminating All UI Extensions during the Great Recession: Unemployed Workers by UI History

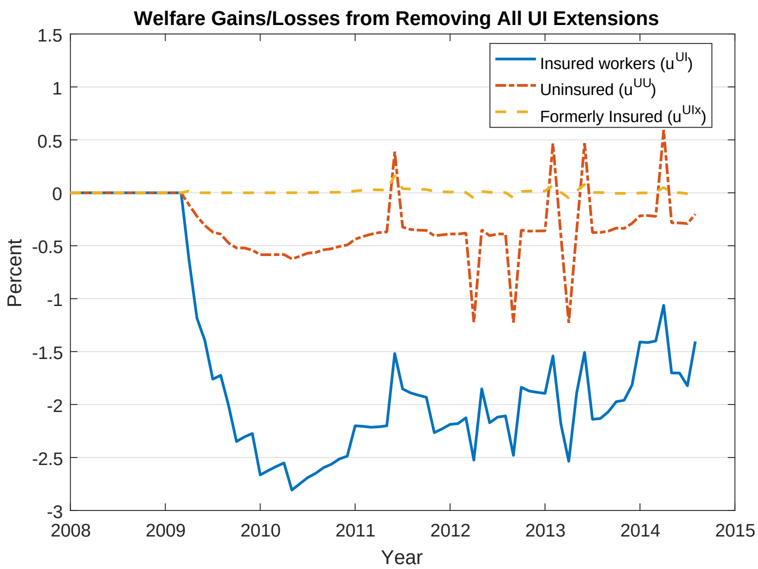


Table 7: **Welfare Gains/Losses From Eliminating All UI Extensions During the Great Recession**

Average Welfare Gains/Losses (%)	Baseline	No UIx
Total	0.14	0.23
Employed	0.27	0.33
Employed: High Productivity	0.25	0.32
Employed: Low Productivity	0.28	0.34
Unemployed	−1.27	−0.93
Unemployed: Insured	−1.64	−1.20
Unemployed: Insured (0−2 months)	−1.67	−1.30
Unemployed: Insured (3 months or longer)	−1.61	−1.16
Unemployed: Formerly Insured	0.00	n/a
Unemployed: Uninsured	−0.31	−0.15
Unemployed: High Productivity	−1.35	−1.00
Unemployed: Low Productivity	−1.21	−0.90

- These statistics are computed between June 2009 (the peak of the Great Recession and when UI extension is triggered in the model) and June 2014
- Welfare gains/losses are defined as in Lucas (1987). It is the percentage change in consumption necessary in each period to make agents in the economy with endogenous UI extensions be as satisfied as they would be in an economy where UI extensions are eliminated during the Great Recession.

I find that eliminating all UI extensions increases the total welfare of the economy by around 0.14 percent. This is expected since given the agents are risk neutral there is no role of UI provision as precautionary savings which may alter the results to be more in favour of UI extensions. However, Mitman and Rabinovich (2015) study the optimal UI policy over the business cycles using a search and matching model similar to this paper except that workers are risk averse. They find that the optimal UI policy should be procyclical in terms of both level and duration.[9] Figure 9 shows that the welfare gain from eliminating UI extensions subsides as the economy recovers (the welfare loss is present from the second half of 2013), which also suggests that UI extensions should be procyclical.

Welfare gains and losses do vary with the types of workers. Only employed workers benefit from the removal of UI extensions (a welfare improvement of 0.27 percent). This is due to the fact that they have to indirectly pay taxes to finance the UI payments for the unemployed each period. The low-productivity employed benefit slightly more than the high-productivity

[9] Landais, Michaillat, and Saez (2013) also study the optimal UI policy over the business cycles and find that the policy should be countercyclical; however, they assume a complete wage rigidity whilst wages in this model and in Mitman and Rabinovich (2015) are determined using Nash bargaining.

type since they inherently earn lower wages and have to pay the same amount of lump-sum taxes.

Unemployed workers suffer a large welfare loss of 1.27 percent when UI extensions are removed, especially the insured unemployed whose welfare goes down by 1.64 percent. As expected, the insured unemployed with shorter unemployment durations (0-2 months) benefit more from UI extensions than those with longer durations since they are more likely to be insured (with a higher search efficiency) in subsequent periods and enjoy the extended benefits. The uninsured unemployed also suffer slightly from the UI extension removal mainly because the insured unemployed would search harder for jobs making the market less tight. As a result, the uninsured would have lower chances to meet a vacant firm unless they also search harder. However, the formerly insured unemployed are barely affected. The larger search cost they face implies that their search intensity varies only slightly in either case. Unemployed workers with a higher productivity suffer a larger welfare loss than those with a lower productivity as higher wages imply higher UI payments.

The welfare gain from eliminating UI extensions is revised downwards when the baseline model is compared to an economy without a drop in job search efficiency (which has a welfare gain of 0.23 percent). In this alternative scenario, insured unemployment respond more strongly to UI extensions than in the baseline model as discussed in previous subsections. Therefore, the tax burden for employed workers is higher and they benefit more from the UI extension removal than in the baseline case. The insured unemployed, on the contrary, suffer less than in the baseline model since their search efficiency now remain the same throughout the unemployment spell making being unemployed less unpleasant.

6 Conclusion

Building on Rujiwattanapong (2022) which studies the general equilibrium impact of UI extensions on unemployment and its duration structure in the US, this paper distinguishes between unemployed workers who never collected UI benefits and those who have exhausted the benefits as they face different labour market outcomes. To make the model consistent with the data, I assume that the job search efficiency falls during an unemployment spell of workers who have collected UI benefits. Given further heterogeneities in the job finding rates, the model can better account for the dynamics of unemployment and its duration structure. In particular, it generates higher persistence (closer to the data) as well as a smaller degree of overshooting in recessionary periods. As a result, the effects of UI extensions on the unemployment duration structure have been revised slightly downwards. I also find that removing all UI extensions during the Great Recession improves the welfare of the economy given that agents are risk neutral. The findings from this paper also suggest that further heterogeneities from either workers or firms that affect the unemployment exit probabilities could create more realistic dynamics of the aggregate labour market, and provide more accurate results from policy experiments.

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A Expressions for Optimal Search Intensity and Match Surplus

Given the worker's value functions when employed, insured unemployed and uninsured unemployed, we can take the first derivative to find the optimal search effort. The first order conditions for type-i workers are as follows

$$
\begin{aligned}
v_e'(s_i^e(m;\omega)) &= -\beta(1-\delta)M(\theta(\omega))E_{\omega'|\omega}\Big[\dots \\
&\quad (1-\lambda)(1-F(m))\Big(WS_i^{e(m)+}(m;\omega') - E_{m'|m'>m}[WS_i^{e(m)+}(m';\omega')]\Big) \\
&+ \lambda E_{m'}\Big[(1-F(m'))(WS_i^{e(m)+}(m';\omega') - E_{m''|m''>m'}[WS_i^{e(m)+}(m'';\omega')])\Big]\Big] \quad (10)
\end{aligned}
$$

$$
v_u'(s_i^{UI1}(m,\omega)) = \beta M(\theta(\omega))E_{m'\omega'|\omega}\Big[\max\{WS_i^{UI1(m)}(m';\omega'),0\} - \xi(1-\phi(u))\bar{US}_i^x(m,\omega')\Big] \quad (11)
$$

$$
v_u'(s_i^{UI0}(m,\omega)) = \beta M(\theta(\omega))E_{m'\omega'|\omega}\Big[\max\{WS_i^{UI0(m)}(m';\omega'),0\} - \xi(1-\phi(u))US_i^{x0}(m,\omega')\Big] \quad (12)
$$

$$
v_u'(s_i^{UIx1}(\omega)) = \beta M(\theta(\omega))E_{m'\omega'|\omega}\Big[\max\{WS_i^{UIx1}(m';\omega'),0\}\Big] \quad (13)
$$

$$
v_u'(s_i^{UIx0}(\omega)) = \beta M(\theta(\omega))E_{m'\omega'|\omega}\Big[\max\{WS_i^{UIx0}(m';\omega'),0\}\Big] \quad (14)
$$

$$
v_u'(s_i^{UU}(\omega)) = \beta M(\theta(\omega))E_{m'\omega'|\omega}\Big[\max\{WS_i^{UU}(m';\omega'),0\}\Big] \quad (15)
$$

where

$$
\begin{aligned}
\bar{US}_i^x(m,\omega') &\equiv (1-\gamma)US_i^{x1}(m,\omega') + \gamma US_i^{x0}(m,\omega') \\
US_i^{x1}(m,\omega') &\equiv U_i^{UI1}(m,\omega') - U_i^{UIx1}(\omega') \\
US_i^{x0}(m,\omega') &\equiv U_i^{UI0}(m,\omega') - U_i^{UIx0}(\omega')
\end{aligned}
$$

Total match surpluses and unemployed worker's surplus are as follows (note that the expressions below are under the assumption that the rate an insured unemployed worker loses UI eligibility is the same as the rate she experiences a drop in her job search efficiency):

$$
\begin{aligned}
S_i^{e(\tilde{m})}(m;\omega) \quad = \quad & y_i(m,\omega) - \nu_e(s_i^e(m;\omega)) - \tau(\omega) - (1-\psi)(b_i(\tilde{m}) + h - \nu_u(s_i^{UI(\tilde{m})}(\omega))) \\
& -\psi(h - \nu_u(s_i^{UU}(\omega))) + \beta E_{\omega'|\omega}\Big[\ldots \\
& (1-\delta)(1-\lambda)\Big((1 - p_i^e(m;\omega)(1-F(m)))S_i^{e(m)+}(m;\omega')\ldots \\
& +p_i^e(m;\omega)(1-F(m))E_{m'|m'>m}[\mu S_i^{e(m)+}(m';\omega')]\Big) \\
& +(1-\delta)\lambda E_{m'}\Big[(1 - p_i^e(m;\omega)(1-F(m')))S_i^{e(m)+}(m';\omega')\ldots \\
& +p_i^e(m;\omega)(1-F(m'))E_{m''|m''>m'}[\mu S_i^{e(m)+}(m'';\omega')]\Big] \\
& -(1-\psi)p_i^{UI(\tilde{m})}(\omega)E_{m'}[\mu S_i^{UI(\tilde{m})+}(m';\omega')] \\
& -\psi p_i^{UU}(\omega)E_{m'}[\mu S_i^{UU+}(m';\omega')] \\
& +(1-\psi)\Big(US_i^x(m,\omega') - (1-\phi(u))\big(1-\xi p_i^{UI(\tilde{m})}(\omega)\big)US_i^x(\tilde{m};\omega')\Big)\Big]
\end{aligned}
$$

$$
\begin{aligned}
S_i^{UI(\tilde{m})}(m;\omega) \quad = \quad & y_i(m,\omega) - \nu_e(s_i^e(m;\omega)) - \tau \\
& -(1-\phi)(1-\xi)(b(\tilde{m}) + h - \nu_u(s_i^{UI(\tilde{m})}(\omega))) \\
& -(\phi + (1-\phi)\xi)(h - \nu_{ux}(s^{UIx}(\omega))) + \beta E_{\omega'|\omega}\Big[\ldots \\
& (1-\delta)(1-\lambda)\Big((1 - p_i^e(m;\omega)(1-F(m)))S_i^{e(m)+}(m;\omega')\ldots \\
& +p_i^e(m;\omega)(1-F(m))E_{m'|m'>m}[\mu S_i^{e(m)+}(m';\omega')]\Big) \\
& +(1-\delta)\lambda E_{m'}\Big[(1 - p_i^e(m;\omega)(1-F(m')))S_i^{e(m)+}(m';\omega')\ldots \\
& +p_i^e(m;\omega)(1-F(m'))E_{m''|m''>m'}[\mu S_i^{e(m)+}(m'';\omega')]\Big] \\
& -(1-\phi)(1-\xi)p_i^{UI(\tilde{m})}(\omega)E_{m'}[\mu S_i^{UI(\tilde{m})+}(m';\omega')] \\
& -(\phi + (1-\phi)\xi)p_i^{UIx}(\omega)E_{m'}[\mu S_i^{UIx+}(m';\omega')] \\
& +US_i^x(m,\omega') - \psi US_i(m,\omega') \\
& -(1-\phi)^2(1-\xi)\Big(1-\xi p_i^{UI(\tilde{m})}(\omega)\Big)US_i^x(\tilde{m};\omega')\Big]
\end{aligned}
$$

$$
\begin{aligned}
S_i^{UU}(m;\omega) &= y_i(m,\omega) - \nu_e(s_i^e(m;\omega)) - \tau - (h - \nu_u(s_i^{UU}(\omega))) + \beta E_{\omega'|\omega}\Big[\ldots \\
&(1-\delta)(1-\lambda)\Big((1-p_i^e(m;\omega)(1-F(m)))S_i^{e(m)+}(m;\omega')\ldots \\
&+p_i^e(m;\omega)(1-F(m))E_{m'|m'>m}[\mu S_i^{e(m)+}(m';\omega')]\Big) \\
&+(1-\delta)\lambda E_{m'}\Big[(1-p_i^e(m;\omega)(1-F(m')))S_i^{e(m)+}(m';\omega')\ldots \\
&+p_i^e(m;\omega)(1-F(m'))E_{m''|m''>m'}[\mu S_i^{e(m)+}(m'';\omega')]\Big] \\
&-p_i^{UU}(\omega)E_{m'}[\mu S_i^{UU+}(m';\omega')] \\
&+(1-\psi)US_i(m,\omega')\Big]
\end{aligned}
$$

$$
\begin{aligned}
S_i^{UIx}(m;\omega) &= y_i(m,\omega) - \nu_e(s_i^e(m;\omega)) - \tau - (h - \nu_{ux}(s_i^{UIx}(\omega))) + \beta E_{\omega'|\omega}\Big[\ldots \\
&(1-\delta)(1-\lambda)\Big((1-p_i^e(m;\omega)(1-F(m)))S_i^{e(m)+}(m;\omega')\ldots \\
&+p_i^e(m;\omega)(1-F(m))E_{m'|m'>m}[\mu S_i^{e(m)+}(m';\omega')]\Big) \\
&+(1-\delta)\lambda E_{m'}\Big[(1-p_i^e(m;\omega)(1-F(m')))S_i^{e(m)+}(m';\omega')\ldots \\
&+p_i^e(m;\omega)(1-F(m'))E_{m''|m''>m'}[\mu S_i^{e(m)+}(m'';\omega')]\Big] \\
&-p_i^{UIx}(\omega)E_{m'}[\mu S_i^{UIx+}(m';\omega')] \\
&+US_i^x(m,\omega') - \psi US_i(m,\omega')\Big]
\end{aligned}
$$

$$
\begin{aligned}
US_i(m,\omega) &= b(m) - \nu_u(s_i^{UI(m)}(\omega)) + \nu_u(s_i^{UU}(\omega)) \\
&+\beta E_{\omega'|\omega}\Big[p_i^{UI(m)}(\omega)E_{m'}[\mu S_i^{UI(m)+}(m';\omega')]\ldots \\
&-p_i^{UU}(\omega)E_{m'}[\mu S_i^{UU+}(m';\omega')] \\
&+US_i(m,\omega') - \Big(\phi + (1-\phi)\xi p_i^{UI(m)}(\omega)\Big)US_i^x(m,\omega')\Big]
\end{aligned}
$$

$$
\begin{aligned}
US_i^x(m,\omega) &= b(m) - \nu_u(s_i^{UI(m)}(\omega)) + \nu_{ux}(s_i^{UIx}(\omega)) \\
&+\beta E_{\omega'|\omega}\Big[p_i^{UI(m)}(\omega)E_{m'}[\mu S_i^{UI(m)+}(m';\omega')]\ldots \\
&-p_i^{UIx}(\omega)E_{m'}[\mu S_i^{UIx+}(m';\omega')] \\
&+(1-\phi)\Big(1-\xi p_i^{UI(m)}(\omega)\Big)US_i^x(m,\omega')\Big]
\end{aligned}
$$

B Transitions

Employment The mass of type-i employed agents in t with match quality m, $e_{i,t}(m)$, evolves as follows

$$
\begin{aligned}
e_{i,t+1}(m) &= (1-\delta)(1-\lambda)(1-p^e_{i,t}(m)+p^e_{i,t}(m)F(m))e_{i,t}(m)\mathbb{1}\{S^{e(m)}_{i,t+1}(m)>0\} \\
&+(1-\delta)(1-\lambda)f(m)\int_{m'<m} p^e_{i,t}(m')e_{i,t}(m')\mathbb{1}\{S^{e(m')}_{i,t+1}(m)>0\}dm' \\
&+(1-\delta)\lambda f(m)\int_{m'}(1-p^e_{i,t}(m')+p^e_{i,t}(m')F(m))e_{i,t}(m')\mathbb{1}\{S^{e(m')}_{i,t+1}(m)>0\}dm' \\
&+(1-\delta)\lambda F(m)f(m)\int_{m'} p^e_{i,t}(m')e_{i,t}(m')\mathbb{1}\{S^{e(m')}_{i,t+1}(m)>0\}dm' \\
&+f(m)\int_{\tilde{m}} u^{UI1}_{i,t}(\tilde{m})p^{UI1}_{i,t}(\tilde{m})\mathbb{1}\{S^{UI1(\tilde{m})}_{i,t+1}(m)>0\}d\tilde{m} \\
&+f(m)\int_{\tilde{m}} u^{UI0}_{i,t}(\tilde{m})p^{UI0}_{i,t}(\tilde{m})\mathbb{1}\{S^{UI0(\tilde{m})}_{i,t+1}(m)>0\}d\tilde{m} \\
&+f(m)u^{UIx1}_{i,t}p^{Uix1}_{i,t}\mathbb{1}\{S^{UIx1}_{i,t+1}(m)>0\} \\
&+f(m)u^{UIx0}_{i,t}p^{Uix0}_{i,t}\mathbb{1}\{S^{UIx0}_{i,t+1}(m)>0\} \\
&+f(m)u^{UU}_{i,t}p^{UU}_{i,t}\mathbb{1}\{S^{UU}_{i,t+1}(m)>0\} \qquad (16)
\end{aligned}
$$

where $\mathbb{1}\{\cdot\}$ is an indicator function. The total employment is the sum of all employed workers over productivity types and match qualities $e_t = \sum_{i=H,L}\int e_{i,t}(m)\, dm$ and the aggregate output can be computed as $y_t = z_t \sum_{i=H,L}\int m \cdot e_{i,t}(m)\, dm$.

Job Destructions The job destruction rate of type-i employed workers with match quality m at the beginning of period t and m' at the end of period t, and the average job destruction rate are respectively

$$
\begin{aligned}
\rho_{x,it}(m,m') &= \begin{cases} \delta & \text{if } S^{e(m)}_{i,t+1}(m')>0, \\ 1 & \text{otherwise} \end{cases} \\
\rho_{x,it} &= \left(\delta \int\int_{\{(m,m'):S^{e(m)}_{i,t+1}(m')>0\}} e^{post}_{i,t}(m,m')dm\, dm' \right. \\
&\left. + \int\int_{\{(m,m'):S^{e(m)}_{i,t+1}(m')\leq 0\}} e^{post}_{i,t}(m,m')dm\, dm' \right)/e_t \qquad (17)
\end{aligned}
$$

$$
\begin{aligned}
\text{where } e^{post}_{i,t}(m,m') &= (1-\lambda)(1-p^e_{i,t}(m')+p^e_{i,t}(m')F(m'))e_{i,t}(m') \\
&+(1-\lambda)f(m')p^e_{i,t}(m)e_{i,t}(m)\mathbb{1}\{m<m'\} \\
&+\lambda f(m')(1-p^e_{i,t}(m)+p^e_{i,t}(m)F(m'))e_{i,t}(m) \\
&+\lambda F(m')f(m')p^e_{i,t}(m)e_{i,t}(m)
\end{aligned}
$$

denotes employed workers with match productivity m at the beginning of period t and m' at the end of the period t.

Job Findings The job finding rate for a type-i unemployed worker of status $j = \{UI1(\tilde{m}), UI0(\tilde{m}), UIx1, UIx0, UU\}$ and the average job finding rate are respectively

$$\rho^{j}_{f,it} = \int \rho^{j}_{f,it}(m) f(m) dm$$

$$\rho_{f,t} = \frac{\int_{\tilde{m}} u^{UI1}_{i,t}(\tilde{m}) \rho^{UI1(\tilde{m})}_{f,it} d\tilde{m} + \int_{\tilde{m}} u^{UI0}_{i,t}(\tilde{m}) \rho^{UI0(\tilde{m})}_{f,it} d\tilde{m} + u^{UIx1}_{i,t} \rho^{UIx1}_{f,it} + u^{UIx0}_{i,t} \rho^{UIx0}_{f,it} + u^{UU}_{i,t} \rho^{UU}_{f,it}}{\int_{\tilde{m}} u^{UI1}_{t}(\tilde{m}) d\tilde{m} + \int_{\tilde{m}} u^{UI0}_{t}(\tilde{m}) d\tilde{m} + u^{UIx1}_{t} + u^{UIx0}_{t} + u^{UU}_{t}}$$

$$\text{where } \rho^{j}_{f,it}(m) = \begin{cases} p^{j}_{i,t} & \text{if } S^{j}_{i,t+1}(m) > 0, \\ 0 & \text{otherwise} \end{cases}$$

Job-to-job Transitions The match-specific and the average job-to-job transition rates are respectively

$$\begin{aligned} \rho^{ee}_{i,t}(m) &= (1-\delta)\Big((1-\lambda) p^{e}_{i,t}(m)(1-F(m)) E_{m'>m}[\mathbf{1}\{S^{e}_{i,t+1}(m,m') > 0\}] \\ &\quad + \lambda \int_{m'} p^{e}_{i,t}(m) f(m')(1-F(m')) E_{m''>m'}[\mathbf{1}\{S^{e}_{i,t+1}(m,m'') > 0\}] dm'\Big) \\ \rho^{ee}_{i,t} &= \frac{\int_m \rho^{ee}_{i,t}(m) e_{i,t}(m) dm}{e_t} \end{aligned}$$

Unemployment The mass of type-i unemployed workers with and without UI benefits as well as the total unemployment evolve respectively as follows

$$
\begin{aligned}
u^{UI1}_{i,t+1}(\tilde{m}) &= (1-\gamma)\Big(\underbrace{(1-\phi_t)(1-p^{UI1}_{i,t}(\tilde{m}))u^{UI1}_{i,t}(\tilde{m})}_{\text{unmatched, not losing UI}} + \underbrace{\chi^{UI1}_{i,t}(\tilde{m})(1-\phi_t)(1-\xi)p^{UI1}_{i,t}(\tilde{m})u^{UI1}_{i,t}(\tilde{m})}_{\text{bad match, not losing UI}}\Big) \\
&\quad + \underbrace{(1-\psi)\int_{m'}\rho_{x,it}(\tilde{m},m')e_{i,t}(\tilde{m},m')dm'}_{\text{destroyed match, not losing UI}} \qquad (18) \\
u^{UI0}_{i,t+1}(\tilde{m}) &= \underbrace{(1-\phi_t)(1-p^{UI0}_{i,t}(\tilde{m}))u^{UI0}_{i,t}(\tilde{m})}_{\text{unmatched, not losing UI}} + \underbrace{\chi^{UI0}_{i,t}(\tilde{m})(1-\phi_t)(1-\xi)p^{UI0}_{i,t}(\tilde{m})u^{UI0}_{i,t}(\tilde{m})}_{\text{bad match, not losing UI}} \\
&\quad + \gamma\Big(\underbrace{(1-\phi_t)(1-p^{UI1}_{i,t}(\tilde{m}))u^{UI1}_{i,t}(\tilde{m}) + \chi^{UI1}_{i,t}(\tilde{m})(1-\phi_t)(1-\xi)p^{UI1}_{i,t}(\tilde{m})u^{UI1}_{i,t}(\tilde{m})}_{\text{losing search efficiency}}\Big) \qquad (19) \\
u^{UIx1}_{i,t+1} &= (1-\gamma)\int_{\tilde{m}}\Big(\underbrace{\phi_t(1-p^{UI1}_{i,t}(\tilde{m}))u^{UI1}_{i,t}(\tilde{m})}_{\text{unmatched, losing UI}} + \underbrace{\chi^{UI1}_{i,t}(\tilde{m})\Big(\phi_t+(1-\phi_t)\xi\Big)p^{UI1}_{i,t}(\tilde{m})u^{UI1}_{i,t}(\tilde{m})}_{\text{bad match, losing UI}}\Big)d\tilde{m} \\
&\quad + (1-\gamma)(1-\rho^{UIx1}_{f,it})u^{UIx1}_{i,t} \qquad (20) \\
u^{UIx0}_{i,t+1} &= \gamma\int_{\tilde{m}}\Big(\underbrace{\phi_t(1-p^{UI1}_{i,t}(\tilde{m}))u^{UI1}_{i,t}(\tilde{m})}_{\text{unmatched, losing UI}} + \underbrace{\chi^{UI1}_{i,t}(\tilde{m})\Big(\phi_t+(1-\phi_t)\xi\Big)p^{UI1}_{i,t}(\tilde{m})u^{UI1}_{i,t}(\tilde{m})}_{\text{bad match, losing UI}}\Big)d\tilde{m} \\
&\quad + \int_{\tilde{m}}\Big(\underbrace{\phi_t(1-p^{UI0}_{i,t}(\tilde{m}))u^{UI0}_{i,t}(\tilde{m})}_{\text{unmatched, losing UI}} + \underbrace{\chi^{UI0}_{i,t}(\tilde{m})\Big(\phi_t+(1-\phi_t)\xi\Big)p^{UI0}_{i,t}(\tilde{m})u^{UI0}_{i,t}(\tilde{m})}_{\text{bad match, losing UI}}\Big)d\tilde{m} \\
&\quad + (1-\rho^{UIx0}_{f,it})u^{UIx0}_{i,t} + \gamma(1-\rho^{UIx1}_{f,it})u^{UIx1}_{i,t} \qquad (21) \\
u^{UU}_{i,t+1} &= (1-\rho^{UU}_{f,it})u^{UU}_{i,t} + \underbrace{\psi\rho_{x,it}e_{i,t}}_{\text{destroyed match, losing UI}} \qquad (22) \\
u_{t+1} &= \sum_{i=H,L}\Big(\int_{\tilde{m}}u^{UI1}_{i,t+1}(\tilde{m})d\tilde{m} + \int_{\tilde{m}}u^{UI0}_{i,t+1}(\tilde{m})d\tilde{m} + u^{UIx1}_{i,t+1} + u^{UIx0}_{i,t+1} + u^{UU}_{i,t+1}\Big) \qquad (23)
\end{aligned}
$$

where $\chi^{UI1}_{i,t}(\tilde{m}) \equiv \int \mathbf{1}\{S^{UI1}_{i,t+1}(\tilde{m},m) \leq 0\}f(m)dm$ denotes the rate the newly formed matches consisting of $u^{UI1}_{i}(\tilde{m})$ are not viable. $\chi^{UI0}_{i,t}(\tilde{m})$ is analogously defined.

C Additional Table

Table 8: **Unemployment-to-Employment (UE) Monthly Transition Rate (%)**

	Current UI Recipients			Non-UI Recipients			Former UI Recipients		
	Jan-08	Jan-10	Δpp.	Jan-08	Jan-10	Δpp.	Jan-08	Jan-10	Δpp.
Age									
16 years or older	21.4	7.2	−14.2	27.5	17.8	−9.7	24.5	10.5	−14.0
25−54 years	24.3	7.1	−17.1	30.7	19.7	−11.0	27.8	11.8	−16.0
Gender									
Male	24.9	7.2	−17.6	28.4	18.3	−10.1	22.2	12.6	−9.6
Female	16.3	7.2	−9.1	26.3	17.1	−9.2	26.9	6.3	−20.6
Education									
< High School	25.0	4.7	−20.3	25.4	16.2	−9.2	43.4	10.3	−33.1
High School	9.0	7.5	−1.5	28.9	16.0	−12.9	16.1	8.8	−7.3
Some College	27.4	7.4	−20.0	28.0	20.5	−7.5	26.2	12.0	−14.2
College or higher	26.8	7.4	−19.3	28.4	24.5	−3.9	30.3	8.3	−22.0
Industry									
Manufacturing	22.5	6.5	−16.0	25.6	14.9	−10.7	22.5	6.5	−16.0
Construction	18.3	9.6	−8.7	36.3	21.6	−14.7	n/a	12.1	−n/a
Wholesale & Retail	n/a	6.4	n/a	26.0	16.3	−9.7	34.6	10.2	−24.4
Prof./Business Services	45.9	4.3	−41.6	22.5	19.9	−2.6	39.3	23.6	−15.3
Occupation									
High-skilled	27.4	7.8	−19.5	27.4	24.6	−2.9	13.7	10.6	−3.1
Middle-skilled	18.6	6.6	−12.0	30.1	17.9	−12.2	22.0	10.7	−11.3
Low-skilled	20.6	10.4	−10.2	26.6	17.6	−9.0	43.9	9.1	−36.8
Reasons for Unemployment									
Temporary Layoff	50.7	12.2	−38.5	46.2	40.4	−5.8	27.1	34.5	7.4
Permanent Separation	13.6	6.7	−6.9	25.6	15.6	−10.0	28.0	8.0	−20.0
Recall									
Date Given	56.4	9.9	−46.5	53.9	47.00	−6.9	100.0	64.3	−35.7
No Date Given	22.4	7.7	−14.7	29.4	22.9	−6.5	32.2	10.0	−22.2
Some indication	48.3	13.3	−35.0	36.6	33.8	−2.8	18.0	18.8	0.8
No indication	16.5	7.0	−9.5	22.2	17.5	−4.7	38.4	8.9	−29.5

- Data source: CPS
  Δpp. ≡ change in UE rate (in percentage points) = $UE_{Jan10} - UE_{Jan08}$
  Occupation skills are defined as in the job polarisation literature (where high-, middle- and low-skilled occupations respectively are abstract, routine and manual jobs)