# Unemployment Insurance and Job Polarization

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**Abstract**

This paper considers how the structure of the UI system interacts with the observed profile of separations to generate "job-polarization" – wage and separation rate persistence. We extend a standard on-the-job labor search model to include an initial period of high separation rates until the job stochastically becomes more stable. Meanwhile a worker's UI entitlement varies in generosity (based on their former wage) and duration (based on their employment history). The separation structure means that some workers have extended periods of frequent job loss. The UI system amplifies these effects because workers with low benefit eligibility apply for low wage jobs. Their subsequent applications then leave them more highly susceptible to future job loss. Our calibration suggests that this effect accounts for around 1% lower lifetime average wages.

## 1 Introduction

There is an increasing literature (see e.g. Jarosch (2023)) that attempts to understand the "slippery" lower rungs of the job ladder that lead to job polarization. When the lower rungs of the job ladder are slippery, unlucky workers cycle in and out of low wage jobs while otherwise similar but luckier workers are able to obtain relatively stable higher wage jobs. This paper examines the extent to which such job polarization can emerge out of the interaction of the UI system and the observed pattern of match dissolution.

The rate of match dissolution varies considerably with match duration. Consistent with job-worker matches being an experience good, we observe that separation rates decay very

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quickly after initial match formation (see Figure 1). We model this as an initial period of high separation rates until the job stochastically becomes more stable which we call two-stage separations. We attempt to quantify the extent to which the re-entitlement requirement of unemployment insurance (UI) interacts with two-stage separations to cause job polarization. Unlike wage dispersion per se, job polarization is a characterization of wage dynamics in which some workers experience persistently low wages and high realized separation rates while others, who are ex ante identical, experience the opposite.

In the US, a worker is typically eligible for one month of UI for every two months of employment in addition to any remaining eligibility from previous employment spells. Among the many byzantine requirements to receive UI in the United States, such a requirement appears relatively innocuous and sensible. Indeed, in the absence of two-stage separations, the policy promotes employment and equity (see Coles and Masters (2007)). However, when the labor market features skewed employment durations, as our separations pattern creates, a re-entitlement requirement causes workers to cycle through poor job placement repeatedly. This occurs because they gain employment at low-wage jobs and make repeated job-to-job moves, which entail uncertainty about their suitability for each position. Unless they fortuitously navigate this job ladder, these workers face fewer months of UI benefits and as a consequence, regain employment near the bottom of the ladder, and are destined to restart this Sisyphean task.

We present an otherwise standard Diamond-Mortensen-Pissarides (DMP) model of directed on-the-job search, building on the work of Menzio and Shi (2011). Jobs are ex-ante identical as are workers, and firms post vacancies for which unemployed and employed workers search. We depart from the standard formulation by adjusting the separation environment and by incorporating a UI structure that depends on employment history like the system in the US. In the model, workers experience a high separation rate stage when they first find a job with a new employer. They subsequently transition to a lower separation rate calibrated to the tenure-separation profile in the US. We also embed the typical structure of UI systems across the US: generosity of benefits is determined by the worker's prior wage while the duration of entitlement is determined by the length of their prior employment spell. Consequently, markets are indexed by the workers' employment status, their remaining duration of UI entitlement, and the wage payable to the worker. The equilibrium is block recursive as highlighted by Menzio and Shi (2011). We calibrate the model using simulated method of moments to Survey of Income and Program Participation (SIPP) data from 1996 to 2017.

In the model, the structure of separations interacts with UI re-entitlement to create job polarization. Although new matches are prone to a high degree of instability, 92% of matches become stable within one month of initial employment. This results in a skewed distribution of employment duration, in which the majority of workers remain with their employer for long periods of time, but a small subset lose their job almost immediately. Crucially, unlucky workers who lose their jobs face additional periods of instability because they must rejoin and re-climb the job ladder, both of which cause repeated periods of high separation probability. In principle, the UI system would mitigate some of the drop associated with job loss; however, in our context re-entitlement requirements severely hamper these unlucky frequent separators. Because they separate frequently and often immediately after regaining employment, they are entitled to fewer months of unemployment benefits than their luckier peers. The result is amplification of inequality and endogenous job polarization.

This interaction that generates job polarization is quantitatively important. In our baseline model, workers with higher than average frequency of separations, those who bear brunt of job polarization in our model, receive wages that are 1.62% lower on average during employment. Eliminating UI re-entitlement requirements reduces this impact by nearly half, to 0.89%. This occurs because eliminating re-entitlement gives unlucky workers more opportunities to rejoin the job ladder at higher rungs, which in turn causes fewer repeated separations because workers make fewer subsequent job-to-job moves. In the baseline, the movement up the job ladder accounts for 84.5% of of overall wage dispersion, with differences in initial placement created by UI generosity and duration accounting for the complementary 25.5%. When workers are immediately and permanently re-entitled to UI, job-to-job mobility only accounts for 26.4% of the overall dispersion, while the remaining 83.6% results from heterogeneity in initial placement. This allows workers who have partially climbed the job ladder to regain employment without having to re-ascend the job ladder.

The remainder of the paper is organized as follows. Section 2 reviews the related literature. Section 3 provides a summary of the relevant data along with a reduced form analysis of the re-entitlement effect. Section 4 lays out the theoretical model. Section 5 describes our calibration and model estimation strategy. The outcomes from the baseline model calibration are summarized in Section 6. We devote Section 7 to explorations of the general equilibrium impact of aspects of the model. We consider the mechanisms that drive the dynamics of our model in Section 8. Then, in Section 9, we explore how our model endogenously generates job polarization in equilibrium. Section 10 concludes.

## 2 Literature

Our paper relates to two broad strands of literature. First, several prior papers have highlighted the role of UI re-entitlement as a vehicle for wage and employment effects. The closest among these is Coles and Masters (2007) who identify the role of finite duration benefit payments in helping stabilize labor demand over the business cycle. Essentially, by lowering hiring wages more in recessions than in booms, the re-entitlement effect induces inter-temporal transfers from firms that hire in future booms to firms that hire in current recessions. On that basis, it is important to quantify the re-entitlement effect. However, in Coles and Masters (2007) workers become fully re-entitled to benefits as soon as they get hired. Our environment allows for rebuilding re-entitlement through longer employment durations, which better reflects the US UI system in which full re-entitlement typically takes a year or more.[1] Ortega and Rioux (2010) recognizes that benefits take time to accrue and provides a simple model in which workers can either be receiving UI, which is subject to termination, or a less generous unemployment assistance that can be received indefinitely. A distinction between our environment and their environment is that there, termination of UI benefits for the unemployed and re-entitlement to UI for the employed are assumed to follow Poisson processes. Andersen et al. (2018) extends Ortega and Rioux (2010) to incorporate endogenous search intensity. As such it exhibits both sources of moral hazard associated with the UI system: the policy maker is unable to make benefit payments contingent on either the worker's search effort or his propensity to reject job offers. In both papers, the simplicity of the UI system implies a 2-point equilibrium wage distribution which could be used to provide a simple measure of the re-entitlement effect. By comparison, our model provides for a much richer set of labor market histories from which to impute the effect.

Andersen and Ellermann-Aarslev (2020) considers how the rules governing re-entitlement to UI shape the distribution of employment durations. Their paper features a random search model in which all jobs offer the same wage but differ according to their expected duration. They show that when re-entitlement to UI depends on prior employment history, the labor market endogenously moves towards a "dual-market" (see e.g. Dickens and Lang (1985)) in which those with a weak employment history take short duration jobs and those with strong histories take longer duration jobs. A re-entitlement effect therefore emerges in the model along the employment duration dimension. As such we see this paper as complementary to our own. Chao et al. (2024) and Birinci and See (2023) both explore the role of the UI system in creating wage dispersion. Differences in job placement that result from differences in UI is an important mechanism in our paper, but Chao et al. (2024) focus on the role of monetary eligibility requirements rather than explicit re-entitlement, while Birinci and See (2023) focus on the role of household heterogeneity in rationalizing the impact of UI on labor market outcomes. Both provide additional margins through which the UI system affects the labor market, which appears complementary to our exploration, as our mechanism is

[1] Indeed, we have consciously abstracted from certain common features of the US system such as delayed benefit collection, the implications of which are analysed in Xie (2019).

likely to occur in the presence of the additional features they explore. Another related paper that considers eligibility is De Souza and Doherty Luduvice (2023), who explore both the monetary and tenure requirements of UI systems. They focus on the relative importance of these policy dimensions for re-employment outcomes, while our focus is on the interaction with our separation environment.

The paper perhaps closest to ours in structure, is Chaumont and Shi (2022), who provide a directed on-the-job search model of the labor market. Workers are ex ante homogeneous but can differ ex post through accumulation of wealth. UI benefits expire stochastically as in Ortega and Rioux (2010) but, as wealthier workers search for higher wages, wealth provides an additional source of wage dispersion. They focus on the impact of the interaction between search and wealth on wage inequality, while our focus is primarily on how the UI system interacts with job instability to amplify job polarization.

Our paper also relates to the literature on job polarization that results from differences in separation propensity. Two papers that directly address a higher propensity to separate near the bottom of the job ladder are Jarosch (2023) and Krolikowski (2017). In Jarosch (2023), jobs are characterized by (among other things), their degree of stability, which changes as workers climb the job ladder. This causes persistence at the bottom of the job ladder, as workers get unlucky, separate, then return to unstable employment. Our mechanism is similar, but occurs endogenously along the job ladder, and our focus is on the interaction with UI. Krolikowski (2017) presents a model in which a stochastic component determines job stability, similar to our environment, but focuses on the scarring effects generated by unstable employment. We focus on an additional margin, UI requirements, which we believe is complementary to his findings. His paper also provides additional corroborating evidence for an increased likelihood of separating from future jobs in the event of a current job separation, which both models generates endogenously. Gregory et al. (2021) also find corroborating evidence evidence that some workers experience persistently higher rates of unemployment, although they attribute these differences to differences in worker types. Our analysis considers a single worker type and would operate as an extra amplification mechanism in such an environment. Similarly Warren and Wiczer (2024) note a downward slope in job churn along as wages increase, and find that this is primarily explained by worker sorting by type along the wage dimension. Our model features ex-post job heterogeneity in terms of separation risk, and provides one potential explanation for this correlation.

## 3 Data and Reduced-Form Quantification

We start by exploring the effects of re-entitlement and separations. We are interested in job polarization as an endogenous equilibrium outcome, so the extent to which reduced-form approaches can provide a comprehensive perspective is limited. Still it is helpful to identify the extent to which the effect is apparent in the data. These results will then be used to discipline the theory.

We focus on two dimensions of labor market dynamics. We estimate a logistic regression of UI and months of eligibility on whether a worker regains employment. Then, we estimate the re-employment elasticity of UI and months of eligibility on re-employment wages. We use the Survey of Income and Program Participation (SIPP) as the main data source. In the SIPP each respondent is surveyed for up to 48 consecutive months. This longitudinal feature enables us to track labor force activities at the individual level. Because most states condition eligibility and amounts on wages and employment history, we need both the worker's last wage and duration of entitlement when laid-off. Data on wages is readily available in the SIPP but UI entitlement is not. We calculate this value by using UI policy rules across states and time. We use this proxy as the key independent variable and control for benefit amounts, states, time, and other demographic variables.

We first run a logistic regression of the indicator variable UE (which takes a value of one if the worker finds a job in the month) on $\log(UI)$, and the number of months before UI benefits expire ($MtoE$). For this specification, we restrict the sample to white, prime-age males, and assess the impact of UI on job-finding. We select this sample because they are highly attached to the labor market and this helps ensure that our findings are not purely artifacts of phenomena outside the scope of what we can easily measure with our available data, e.g. latent participation.[2] We use 1996-2017 data, and reduce the sample to unemployed workers who are receiving UI benefits and not on layoff expecting a recall and, include other controls including high quarterly wage during the previous employment spell, individual age, education, state, year, and month. Equation 3.1 presents our specification.

$$log(\frac{p_{UE}}{1-p_{UE}}) = \beta_0 + \beta_1 \times log(UI) + \beta_2 \times \text{MtoE} + X\beta + \epsilon. \tag{3.1}$$

where $MtoE$ denotes the months remaining until benefit expiry. We make one adjustment: because the logistic specification is non-linear, we normalize UI benefits by the mean. The unemployed workers with zero or missing UI benefit amounts are excluded. We present the findings in Table 1.

[2] To show that this phenomenon is present throughout the labor market, we include less restrictive specifications in Appendix A.

Table 1: Logistic Regression Results

| | Est. | Std. Err. |
|---|---|---|
| $\log(UI)$ (normalized) | -0.165* | 0.0876 |
| 1 Month to Expiry | -0.0389 | 0.191 |
| 2 Months to Expiry | -0.00499 | 0.171 |
| 3 Months to Expiry | -0.535*** | 0.181 |
| 4 Months to Expiry | -0.287* | 0.171 |
| 5 Months to Expiry | -0.432** | 0.183 |
| 6 Months to Expiry | -0.800 | 0.815 |
| Observations | 2,461 | |

*** p<0.01, ** p<0.05, * p<0.1

This means that for a one percent increase in UI, the odds of the a worker returning to employment are about 15.2% lower (a log-odds ratio of 0.848). In our calibration, this means a reduction in the job-finding rate from an average of 31.6% for the unemployed to 26.7% resulting directly from an increase in UI. These findings are not shocking: a number of papers show that an increase in UI benefits reduces the job-finding rate. We also find that additional months until expiry is associated with a reduction in the job-finding rate. While our coefficients on one or two months to expiry do not show significance, the qualitative pattern remains. In addition, the difference in effect between the coefficients on either two and three months remaining is significant at the 5 percent level (p-value of 0.033) and between one and three at the 10 percent level (p-value of 0.0594). In Appendix A, we consider three alternative specifications: first, we include occupational fixed effects for the occupation of previous employment. Second, we include individuals of all races, while retaining the restriction that they be prime-age and male. Third, we estimate a linear probability model, rather than a logistic regression. While including all races eliminates the significance of the UI benefit amount, each shows qualitatively, and to a large extent quantitatively, the same pattern we observe in our main specification.

Next, we turn to re-employment wages. We follow a similar specification to Griffy (2021), but include months of UI eligibility remaining. We regress the logarithm of monthly earnings for those unemployed workers who find a job during the month ($\log UEwage$) on the logarithm of benefit amounts ($\log(UI)$), the number of months before UI benefits expire ($MonthstoExpiry$), and other controls including high quarterly wage during the previous employment spell, individual age, education, state, year, and month. We also adjust the sample to include re-employment outcomes from all races, because re-employment alleviates the concern about latent participation and because we have very few spells for which we

Table 2: Re-Employment Wage Elasticity on Unemployment Insurance Benefits

| | Est. | Std. Err. |
|---|---|---|
| $\log(UI)$ | 0.201** | 0.0997 |
| 1 Month to Expiry | 0.430*** | 0.145 |
| 2 Months to Expiry | 0.477*** | 0.141 |
| 3 Months to Expiry | 0.415*** | 0.156 |
| 4 Months to Expiry | 0.524*** | 0.171 |
| 5 Months to Expiry | 0.402** | 0.184 |
| 6 Months to Expiry | 2.633** | 1.312 |
| Constant | 2.372* | 1.437 |
| Observations | 714 | |

*** p<0.01, ** p<0.05, * p<0.1

observe both unemployment, UI receipt amounts, and re-employment together.[3] With the same variable definitions as in Equation 3.1 we estimate the specification in Equation 3.2 and present the findings in Table 2.

$$log(UEwage) = \beta_0 + \beta_1 \times log(UI) + \beta_2 \times \text{MtoE} + X\beta + \epsilon \tag{3.2}$$

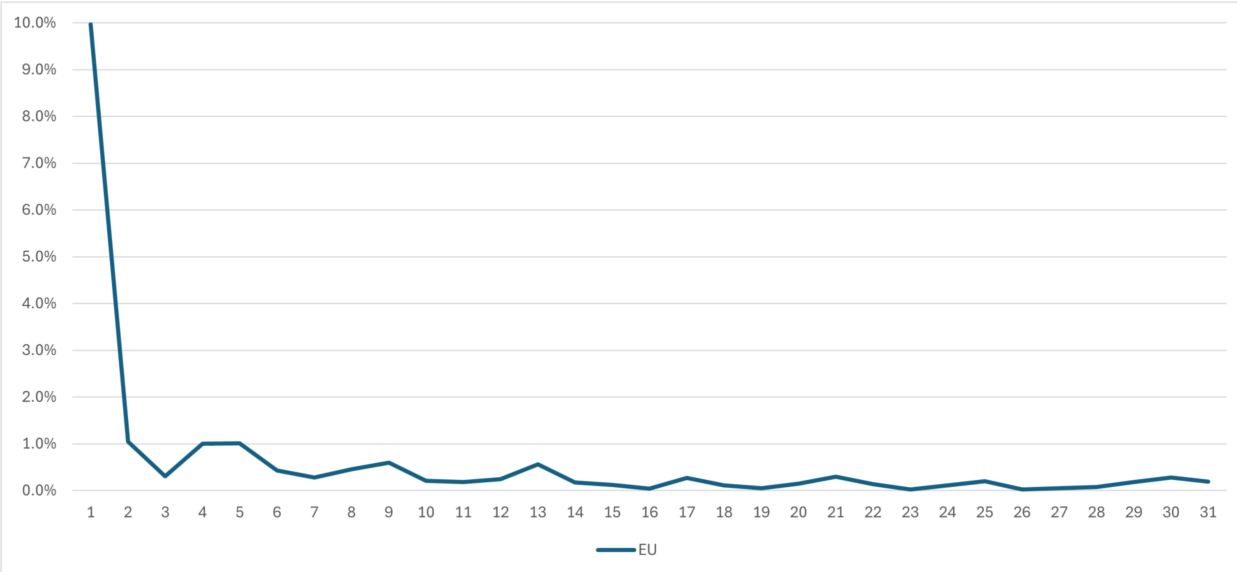
The coefficient on the $\log(UI)$, 0.2, represents the wage elasticity. The coefficient on the numbers of months before UI expiry is positive. This result reveals that the unemployed workers with more remaining generous benefits are pickier than those who almost exhaust the benefits. Combining the 6 month dummies, one more month of eligibility increases the re-employment wage by 1.6%. We also show in Appendix A, that our results are largely robust to sample selection and controls for other job characteristics, although restricting the sample to white prime-age males causes the coefficient on UI benefits to become insignificant. The point estimate is nearly identical, so we attribute this to a smaller sample.

Importantly, we also find that workers who have been with their current firm for a short period of time face a higher likelihood of separating to unemployment. Figure 1 depicts the separation rates for employed males in prime working ages over the horizon of the number of months of being employed with the same employer.

The separation rate is around 10% in the first month, drops rapidly down to 1% in the second month, and exhibits a gradual decline after that. The stark divide between the initial month of employment and longer tenures suggest that some workers and employers find the match is not suitable early in the employment relationship. After the first few months, there

[3]We include the sample restricted to White workers only in our robustness checks in Appendix A. We also use the sample restricted to white, prime-age males in our calibration to ensure that the sample is consistent across all moments.

Figure 1: Separation Rate by Tenure at Current Employer




is virtually no change in the separation rate, suggesting that the sample is highly attached to their current employer. We use these findings as motivation for the construction of our model in the next section, as well as targets for model calibration.

# 4 Model

## 4.1 Environment

The model is set in discrete time with an infinite horizon. There is a mass 1 of workers who are ex ante identical and live forever. There is a large mass of firms that create ex ante identical individual jobs that start out as vacancies. The number of jobs will be controlled by a free entry condition. Each period, jobs are subject to destruction with probability $\lambda$. Both workers and firms are risk-neutral and discount the future at the rate $r$ per period. All unemployed workers receive $z$ units of the consumption good per period from non-market activities. Vacancies cost $c$ units of the consumption good per period to maintain.

In addition to their non-market activities, unemployed workers may be entitled to UI benefits, $b(w) = \min\{\phi w, \bar{b}\}$, per period where $w$ is the worker's prior wage. The parameter $\phi \in [0, 1]$ is referred to as the replacement rate and $\bar{b}$ is the maximum benefit. The benefit is constant throughout the worker's entitlement term. The length of the term depends on the length of the last employment spell and the amount of unused time from the previous unemployment spell.

The earlier literature (e.g., Coles and Masters (2007)) found that the non-stationary nature of the unemployed worker's search problem had important implications for the path of their reservation wage over the unemployment spell. Consequently, we do not allow the benefits to expire according to a Poisson process. Instead, we expand the state space to incorporate the exact time to benefit expiry for the unemployed and the duration of eligibility for the employed.

Thus, we let $i \in \mathcal{I} = \{0, 1, .., I\}$ represent the number of periods of a worker's UI entitlement. Then, while unemployed, $i_{t+1} = \max\{i_t - 1, 0\}$ where $t$ represents calendar time. Analogously, while employed, $i_{t+1} = \min\{i_t + 0.5, I\}$. An employed worker who loses his job becomes unemployed (or, if lucky, re-employed) next period with an entitlement of $i_{t+1} = i_t$. The UI system is paid for by a proportional pay-roll tax, $\tau$, on wages that is nominally paid by the firms.

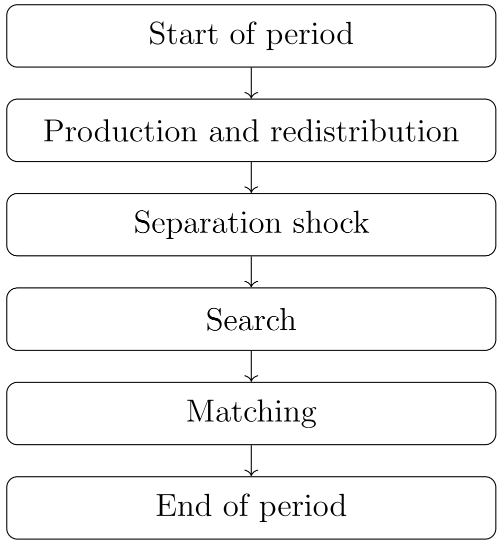
A matched pair of job and worker produces output $p$ per period. Vacant jobs and workers meet in a large number of submarkets indexed by the wage posted by the firm, $w$, the level of worker entitlement, $i$, and the ratio, $\theta$, of vacancies to job seekers in that submarket – the market tightness. Job seekers in any submarket with tightness $\theta$ contact a vacancy with probability $m(\theta)$. Unemployed workers get to look for work with probability 1 while employed workers in that submarket get to look for work with probability $\gamma \leq 1$. [4] The function $m$ is twice continuously differentiable, increasing and concave with $m(0) = 0$, and $\lim_{\theta\to\infty} m(\theta) = 1$. Consequently, vacancies meet with workers in the market with probability $m(\theta)/\theta$ which is assumed to be decreasing. To ensure that $m(\theta)/\theta \leq 1$, we require that $\lim_{\theta\to 0} m'(\theta) = 1$.

Separations can be caused by on-the-job search and by exogenous separation shocks. To capture the nature of the separation hazard observed in the SIPP data we incorporate two separations rates. Whether from on-the-job search or from unemployment, all newly formed jobs are subject to a high separation rate, $\lambda_h$. These jobs are also subject to a separation rate shock: with probability $q_\lambda$ the separation rate drops indefinitely to $\lambda_l$. Whenever it is important to distinguish between employed workers subject to a high separation rate from those subject to a low separation rate, we will use the index, $h$ or $l$ to make that distinction. The index $e$ will signify a generic employed person.

Each period is divided into five stages: production, entitlement, separation, search and matching (see Figure 2). In the production stage, all output is produced, taxes are levied and benefit payments are made. In the entitlement stage, workers' entitlement shocks are realized.

[4] Job seeking workers are heterogeneous in terms of their "wage" (current wage for employed and former wage for unemployed), their employment status, and their current entitlement period. However, all that maters to firms, given the wage being offered, is their entitlement level.

Figure 2: Timing within a Period




Separations due to exogenous shocks occur in the separation stage. In the search stage, depending on their current employment status, wage (or benefit) and benefit entitlement status, workers decide which market to enter. Unlike Menzio and Shi (2011), we do permit those laid-off this period to search. Of course, for such individuals, their search strategy will reflect the fact that they are destined to be unemployed next period if they do not get a job. In the matching stage, new matches for next period are realized. In the case of currently employed workers, matching means their existing employment relationships are dissolved. As it does not affect production or redistribution, the one-time (per employment spell) separation rate shock can be realized at any point before the separation stage. For ease of exposition we allow it to occur at the very beginning of the period.

We seek a block-recursive directed search equilibrium. Firms enter markets in such numbers as to ensure that no vacancy makes positive profits ex ante. The focus throughout is on steady-state.

## 4.2 Value Functions

### 4.2.1 Workers

Workers take the wages and associated levels of market tightness as given and enter the market that is optimal for them based on their current state, $(y, i, w)$ where $y \in \{h, l, u\}$ is employment status, $i \in \mathcal{I}$ is UI benefits entitlement status and $w \in [\underline{w}, p]$ is their current wage if employed or their former wage if unemployed. Here $\underline{w}$ represents the finite lower bound on wage offers.[5]

Let $V_y^i(w)$ represent the value to being a worker of type $(y, i, w)$. And, let

$$R(y', y, i, w, \hat{\gamma}) = \max_{\tilde{w}, \tilde{\theta}} \left\{ \hat{\gamma} m(\tilde{\theta}) V_{y'}^i(\tilde{w}) + (1 - \hat{\gamma} m(\tilde{\theta})) V_y^i(w) \right\}$$

where $\hat{\gamma} \in \{\gamma, 1\}$ is the matching effectiveness. Then, for the unemployed workers with some remaining entitlement $(i \geq 1)$,

$$V_u^i(w) = \frac{1}{1+r} \{b(w) + z + R(h, u, i-1, w, 1)\}. \tag{4.1}$$

For unemployed workers with expired benefits $(i = 0)$ any dependence on their old wage is lost. So that

$$V_u^0 = \frac{1}{1+r} \{z + R(h, u, 0, z, 1)\}. \tag{4.2}$$

For high separation rate workers with less than full entitlement $(i \leq I - 1)$,

$$V_h^i(w) = (1 - q_\lambda) \frac{1}{1+r} \{w + [\lambda_h R(h, u, i + 0.5, w, 1) + (1 - \lambda_h) R(h, h, i + 0.5, w, \gamma)]\} + q_\lambda V_l^i(w) \tag{4.3}$$

For high separation rate workers with full entitlement,

$$V_h^I(w) = (1 - q_\lambda) \frac{1}{1+r} \{w + \lambda_h R(h, u, I, w, 1) + (1 - \lambda_h) R(h, h, I, w, \gamma)\} + q_\lambda V_l^I(w) \tag{4.4}$$

For low separation rate workers with less than full entitlement, $i = 0, ..., I - 1$

$$V_l^i(w) = \frac{1}{1+r} \{w + [\lambda_l R(h, u, i + 0.5, w, 1) + (1 - \lambda_l) R(h, l, i + 0.5, w, \gamma)]\} \tag{4.5}$$

For low separation rate workers with full entitlement,

$$V_l^I(w) = \frac{1}{1+r} \{w + \lambda_l R(h, u, I, 1) + (1 - \lambda_l) R(h, l, I, w, \gamma)\} \tag{4.6}$$

[5] Clearly, the wage is bounded above by $p$. However, if workers are desperate enough to get on the first rung of the wage ladder, the lowest search wage, $\underline{w}$, could be negative. It must, however, be finite. When employed, the highest probability with which a worker can find a new job is $\gamma$ and the highest possible wage is $p$. So, the maximum amount of utility that any worker could be willing to forgo to get on the first rung of the job ladder is $\gamma p / r$.

A further concern here might be that if someone who was earning a negative wage loses her job, she will receive negative benefits. We ignore this possibility as $w < 0$ never happens in any of the simulations below.

It will be convenient to use $(\tilde{\theta}^i_y(w), \tilde{w}^i_y(w))$ as the market tightness and wage that solves the preceding problems for the worker with employment status $y \in \{h, l, u\}$, entitlement level, $i$, and current (or former) wage $w$.

As $\gamma < 1$, the unemployed search more effectively than the employed which raises the possibility that workers might want to quit a low wage job once their entitlement for benefits is fully restored. We assume, however, that, consistent with all the UI systems we explored, people who quit are ineligible for benefits. Once they quit, they face the same problem as anyone who has zero entitlement to benefits. Those workers always choose the lowest wage that has positive density – quitting makes no one better off.

### 4.2.2 Firms

Firms take the search strategies of the workers as given and create vacancies to target those workers. Because firms do not care about their current worker's former employment status, filled jobs are characterized by the triple $(\tilde{y}, i, w)$, where $\tilde{y} \in \{h, l\}$ is the separation status of the worker, $i$ is the UI entitlement status of the worker and $w$ is the wage paid to that worker. Let $V^i_{f,\tilde{y}}(w)$ represent the present expected discounted profits accruing from employing a worker with separation rate $\tilde{y}$. As free-entry drives the value to holding a vacancy in every active market to zero, for the job occupied by a high separation rate worker with less than full entitlement, $i = 0..I - 1$,

$$V^i_{f,h}(w) = (1 - q_\lambda)\frac{1}{1+r}\left\{p - w(1+\tau) + (1-\lambda_h)(1 - \gamma m(\tilde{\theta}^{i+0.5}_h(w))V^{i+0.5}_{f,h}(w)\right\} + q_\lambda V^i_{f,l}(w).$$

For a job occupied by a high separation rate worker with full entitlement, $i = I$,

$$V^I_{f,h}(w) = (1 - q_\lambda)\frac{1}{1+r}\left\{p - w(1+\tau) + (1-\lambda_h)(1 - \gamma m(\tilde{\theta}^I_h(w))V^I_{f,h}(w)\right\} + q_\lambda V^I_{f,l}(w).$$

For the job occupied by a low separation rate worker with less than full entitlement, $i = 0..I-1$,

$$V^i_{f,l}(w) = \frac{1}{1+r}\left\{p - w(1+\tau)(1-\lambda_l)(1 - \gamma m(\tilde{\theta}^{i+0.5}_l(w))V^{i+0.5}_{f,l}(w)\right\}.$$

For a job occupied by a low separation rate worker with full entitlement, $i = I$,

$$V^I_{f,l}(w) = \frac{1}{1+r}\left\{p - w(1+\tau) + (1-\lambda_l)(1 - \gamma m(\tilde{\theta}^I_l(w))V^I_{f,l}(w)\right\}.$$

Free-entry of vacancies determines the tightness in each submarket so that

$$\frac{m(\theta)}{\theta} V_{f,h}^{i}(w) \leq c \text{ and } \theta \geq 0 \tag{4.7}$$

with complementary slackness. We will focus on equilibria in which there is a unique value of the market tightness, $\theta(i, w)$ that solves equation (4.7) for each entitlement and wage level.

Notice that while employment status, $y \in \{h, l, u\}$, does matter for which market the worker enters, the market tightness function, $\theta(i, w)$, is not indexed by $y$. This is because all new hires have status $h$, so the hiring firms do not care about a worker's current employment status. They only care about UI entitlement and the wage they will pay. In general, for a given level of worker entitlement, $i$, firms offering higher wages will attract employed workers while those offering low wages attract unemployed workers. That latter set of markets will have commensurately higher market tightnesses.

## 4.3 Steady State

Worker optimal search policies, $(\tilde{\theta}_y^i(w), \tilde{w}_y^i(w))$, imply Markovian transition dynamics which further imply an ergodic distribution of workers across states. We denote by $e^i(w)$ the steady state measures of employed workers whose current eligibility status is $i$ and whose current wage is $w$. We similarly denote by $u^i(w)$ the steady state measures of unemployed workers whose current eligibility status is $i$ and whose previous wage was $w$. So that

$$e = \sum_{i \in \mathcal{I}} \int_{\underline{w}}^{p} e^i(w) dw \quad \text{and} \quad u = \sum_{i \in \mathcal{I}} \int_{\underline{w}}^{p} u^i(w) dw \tag{4.8}$$

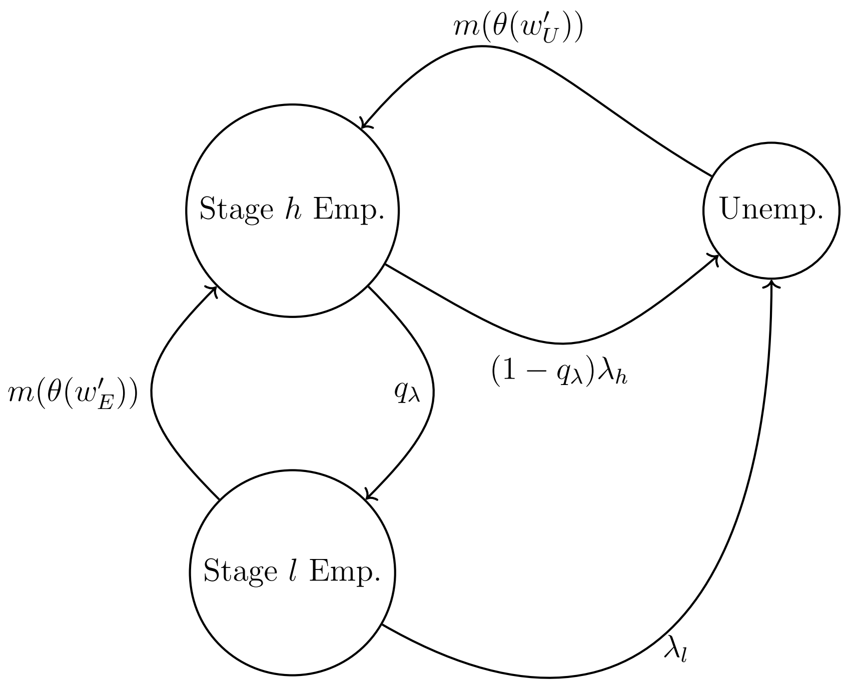
are the aggregate steady state measures of employed and unemployed workers respectively. As the total population is normalized to 1, they also represent the employment and unemployment rates. These flows are depicted in Figure 3.

## 4.4 Government Budget Constraint

Because we focus on steady states, the government budget constraint is always balanced,

$$\sum_{i \in \mathcal{I}} \int_{\underline{w}}^{p} \tau w e^i(w) dw = \sum_{i \in \mathcal{I} \setminus \{0\}} \int_{\underline{w}}^{p} b(w) u^i(w) dw. \tag{4.9}$$

Figure 3: A Graphical Depiction of Endogenous Flows in the Model.



### 4.5 Equilibrium

**Definition 1.** *A balanced-budget, steady state equilibrium consists of a pair of worker policy functions,* $(\tilde{w}_y^i, \tilde{\theta}_y^i) : \mathcal{I} \times \{l, h, u\} \times [\underline{w}, p] \to [\underline{w}, p] \times \mathbb{R}_+$*, a set of active submarkets,* $\mathcal{A} \subset \mathcal{I} \times [\underline{w}, p]$*, a market tightness function,* $\theta : \mathcal{A} \to \mathbb{R}_+$*, the steady state population measures,* $e^i(w)$ *and* $u^i(w)$*, and a pay-roll tax rate,* $\tau$ *such that:*

1. *Given the set of active markets, the market tightness function and pay-roll tax rate, the worker policy functions emerge from optimal search and matching: equations (4.1), (4.2), (4.3), (4.4), (4.5) and (4.6).*
2. *The set of active markets,* $\mathcal{A}$*, is determined where* $\frac{m(\theta)}{\theta} V_f^i(w) = c$ *and* $\theta > 0$
3. *The tightness function,* $\theta(i, w)$*, is determined from (4.7) for all* $(i, w) \in \mathcal{A}$*.*
4. *The steady state population measures,* $e^i(w)$ *and* $u^i(w)$ *represent the ergodic distribution that emerges from the worker policy functions.*
5. *The balanced budget condition, (4.9), holds.*

For a given UI structure, $\{b(w), \mathcal{I}\}$ and pay-roll tax rate, $\tau$, this equilibrium is block-recursive (see Menzio and Shi (2011)). This is due to two key modeling choices. The first is the use of directed search. In a directed search setup, firms and workers do not need to forecast wages because they are determined by the market they choose to enter and not on which particular firm they meet (c.f. Burdett and Mortensen (1998)). However, in such an environment, workers and firms might still need to forecast the market tightness in each market. The second modelling choice is free-entry of vacancies into any submarket. It implies that each submarket is self-contained. Since the cost of opening a vacancy is constant, the free-entry condition pins down the value of the market tightness as a function of the value of a new job independently from the distribution of firms across those markets. It is, therefore, possible to construct a block-recursive equilibrium in which neither the value functions nor the market tightnesses depend on the distribution of firms or workers across wage levels. Notice here, though, that we seek a steady state equilibrium. In steady state there is never any forecasting required. Both the wage and workforce composition are known to all participants in the economy. The modeling choices that ensure block-recursivity are made here for computational simplicity.

**Proposition 1.** *For any finite wage grid, and sufficiently small replacement ratio,* $\phi$*, a balanced budget steady-state equilibrium exists.*

*Proof.* See Appendix B. ∎

The restriction to a finite wage grid is necessary because we have to invoke Kakutani's fixed-point theorem to guarantee the existence of the fixed-point in the space of market tightness functions. Kakutani's theorem, however, only applies to finite dimensional spaces while the space of market tightness functions is of infinite dimension. To apply Kakutani, then, requires evaluation of the market tightness function on a finite grid. By comparison, Menzio and Shi (2010) invoke Schauder's fixed point theorem which can be used to establish existence of a fixed point in a space of functions. However, the required restrictions on the market tightness function, $\theta(i, w)$ are not satisfied here. Those restrictions require that the workers' objective functions are always concave which we were unable to establish given our assumptions on the matching function. However, as we use a finite wage grid to simulate the equilibrium, our result is sufficient for the purposes of this paper.

While Proposition 1 ensures existence of a steady state equilibrium, it is moot on the number of such equilibria that can emerge for any given parameter arrangement. Indeed, even in the simple DMP model of Pissarides (2000) whenever a payroll tax is introduced to cover the cost of benefits, the implied Laffer curve will generate two steady state equilibria. There is a low-tax high employment equilibrium and a high-tax low employment equilibrium. That phenomenon exists in this model too putting an upper bound on the generosity of benefits. Here, though, even among the class of low-tax high employment equilibria we cannot guarantee uniqueness. Non-uniqueness is typically a problem for comparative statics as carried out in this paper because the model can be switching from one equilibrium to another as parameters change. In the simulations, however, equilibrium switching does not affect the results. Either no such switching is happening, or the equilibria are sufficiently similar that the impact of switching on aggregate outcomes is negligible. [6]

# 5 Calibration

The model is calibrated to match key features of the labor market in two steps. The first step consists of: presetting common parameters; external calibration of the UI system to the generosity and expiry of the US system; setting the dual separation rates to match the empirical worker's survival probability over various horizons at a single firm; and making standard functional form assumptions. The second step targets a set of appropriate labor market moments to discipline key aspects of the model. These are: the response to changes in

[6] Any simulation has to use a finite grid of possible wages (we use a 240 wage grid) by providing focal points for the locations of rungs on the wage ladder, this may also be reducing the likelihood of equilibrium switching.

UI generosity; the impact of UI on the job-finding rate; the average unemployment rate; and the job-finding rates of highly attached workers. Section 5.1 details the external calibration strategy while Section 5.2 discusses how our targeted moments yield identification of the estimated parameters. We then provide the moments and parameters that best fit the data in Section 5.3

## 5.1 External Calibration

We first preset appropriate parameters and functional forms. The time period is set to one month. Our only externally obtained structural model parameter is the discount rate, $\beta = 0.996$, which is based on an annual risk-free interest rate of 5% and implies $r = 0.004$. The matching function is chosen to be Cobb-Douglas, $m(\theta) = \min\{\bar{m}\theta^{\eta}, 1\}$. Because the parameter $m$ moves one-to-one with the cost of holding a vacancy, $c$, it can be chosen to avoid the matching rate hitting it's upper value of 1 without otherwise impacting the results. We ultimately use this parameter to adjust the job-finding rate without affecting vacancy creation, which yields a value of $\bar{m} = 0.0979$.[7] The match productivity, $p$, is normalized to 1.

We use features of the US unemployment insurance system to calibrate the UI replacement rate, months of eligibility, and the maximum benefit allowed. While the specific details of UI policy vary across states, some features as reported by the US Department of Labor (DoL) are essentially uniform across the country. Standard UI eligibility extends to 26 weeks which implies $I = 6$. However, it takes a full year of working to restore full eligibility for a worker who had exhausted benefits prior to getting hired. Hence, it requires 12 months for an employed work to regain full entitlement. Our replacement ratio, $\phi = 0.5$, reflects a consensus across state rules and is common in the literature (see e.g. Chao et al. (2024)). The benefit cap, $\bar{b}$, varies more widely across states but here will be moot. With ex ante homogeneous workers, the wage dispersion that emerges in the model is insufficient to warrant its use. Depending on the group we are trying to capture, the cap would typically either bind on all of them or none of them. Because our focus is on lower income workers we assume $\bar{b} > p$ so that it does not bind on anyone.

We use the profile of separation rates to unemployment by worker tenure to discipline the dual separation rates, $\lambda_h$ and $\lambda_l$, along with the switching rate from the high separation stage to the low separation stage of a job, $q_\lambda$, in our model. We do this by constructing the separation probabilities at one (9.971%), two (1.046%) and six (0.425.%) months of tenure using the targets from Figure 1. These yield $\lambda_h = 0.2351$, $\lambda_l = 0.0042$, and $q_\lambda = 0.9181$. We

[7]We do this because in the absence of wage node precisely on $m(\theta(w)) = 0$, approximation error within the model propagates. Our approach allows us to ensure that a node is placed at precisely this location under any parameterization, but requires re-scaling of $\bar{m}$ and $c$.

provide a complete description of the methodology is in Appendix C.

## 5.2 Calibration Strategy

Our calibration strategy exploits the impact of variation in unemployment insurance on wages and job-finding rates. When applying for a wage, an unemployed worker's outside option depends on their previous wage and their direct value of leisure, $z$, along with their future employment prospects. We account for the impact of their previous wage by embedding a UI system that directly replicates the US unemployment insurance system. Then, we target the elasticity of re-employment wages with respect to changes in UI benefits, similar to the strategy in Griffy (2021). Intuitively, as $z$ increases, it becomes a larger share of a worker's outside option, reducing the impact that differences in UI have on future wages. By contrast, a smaller $z$ value increases the relative importance of UI in determining future wages. Specifically, we target $\beta_1$ from the following specification:

$$ln(y_{j+1}) = \beta_0 + \beta_1 \times ln(UI) + X\beta + \epsilon \tag{5.1}$$

which closely mirrors our specification in Section 3.

We follow a similar strategy to identify the elasticity of the matching function. Targeting the wage-elasticity allowed us to exploit the idea that a change in a worker's outside option entails a change in their expected re-employment wage; however, it comes with an associated change in the job-finding rate. Because a higher wage reduces the value of a match to the firm, they reduce the number of vacancies they create. The extent to which this results in differences in job-finding rates depends upon the elasticity of the matching function, $\eta$. As higher values of $\eta$ generate higher differential matching rates between workers searching for high and low wages, identification comes from the relative matching rates across submarkets. We include this formally in our set of moments by targeting the semi-elasticity of the job-finding rate using a logistic regression on a binary variable that denotes whether an unemployed individual finds a job during the period (UE = 1) or not (UE = 0):

$$ln(\frac{p_{UE}}{1-p_{UE}}) = \beta_0 + \beta_1 \times ln(UI) + X\beta + \epsilon. \tag{5.2}$$

As noted by Griffy and Rabinovich (2023), there is a direct link between the response of re-employment outcomes, like the job-finding rate and wage, and the generosity of UI. For a given degree of dispersion, a larger response of the job-finding rate translates into a larger wage elasticity, and vice-versa. Although our model setting is quite different, the basic intuition is still present. In combination with the wage elasticity, the semi-elasticity of the job-finding rate allows us to use variation in application strategies resulting from changes in the outside option (used to identify $z$) along with the impact on the job-finding rate to identify $\eta$.

The strategy used to identify our remaining parameters, the vacancy creation cost, $c$, and on-the-job search efficiency, $\gamma$, is standard. An increase in $c$ reduces vacancies posted in every submarket, which reduces the job-finding rate in every wage submarket in equilibrium. We then include the employed job-finding rate which, given our argument for identifying application strategies above, identifies $\gamma$ from the relative speed with which the employed and the unemployed find jobs. Finally, we also target the average unemployment rate for our sample, which ensures consistency between our model and our external calibration of the separation rates described in Appendix C, as well as provides an additional source of identification of the vacancy creation cost, $c$.

While the foregoing describes the primary sources of identification, the model estimation targets all of these moments simultaneously using simulated method of moments. We average our simulated moments after allowing the simulation to reach an ergodic distribution across 20 cohorts of different shocks and initial conditions. For each of our moments, we restrict the sample to prime-age white males. This is a common restriction and is important in our context because this sample is highly attached to the labor market and the model does not incorporate non-participation.

## 5.3 Calibration Results

The best fit produced by our model yields parameters similar to previous estimates. We find an elasticity of the matching function of 0.465, nearly at the midpoint of the range from 0.3 to 0.7 reported by Petrongolo and Pissarides (2001) in their survey on matching functions and their estimation. Our estimate of on-the-job search efficiency is high ($\gamma = 0.299$) relative to related work (for example, Hornstein et al. (2011), who find an estimate of closer to 0.15), but we focus on a particularly attached group in the labor market, prime-age white males. Despite this high value of $\gamma$, our targeted job-to-job data estimate falls below other estimates from the literature. This suggests that our directed search approach may be central to the higher frequency of opportunities to search among the employed. Under directed search the already employed worker targets a particular higher wage market. Recall, though, that firms face a trade off between wages and matching rates. The worker who meets a firm gets hired with probability one, but such meetings are relatively infrequent. We estimate a leisure utility, $z = 0.142$, which when added to our average UI ($E[b] = 0.4343$), falls within the range of 0.4 to 0.9 of Shimer (2005) and Hagedorn and Manovskii (2008), respectively. We report

Table 3: Parameter Values

| | Symbol | Values | Comment |
|---|---|---|---|
| Replacement rate | $\phi$ | 0.5 | US average |
| Months of eligibility | $I$ | 6 | US maximum |
| Discount factor | $\beta$ | 0.996 | $\frac{1}{1+r}$, annual 5% |
| Low separation probability | $\lambda_l$ | 0.004 | External |
| High separation probability | $\lambda_h$ | 0.235 | External |
| High-to-low transition prob. | $q_\lambda$ | 0.918 | External |
| Elasticity of the Matching Function | $\eta$ | 0.465 | Estimated |
| OTJ Search Efficiency | $\gamma$ | 0.299 | Estimated |
| Leisure utility (subsistence benefits) | $z$ | 0.142 | Estimated |
| Vacancy creation cost | $c$ | 0.182 | Estimated |
| Tax-rate | $\tau$ | 0.0206 | Gov't budget |
| Matching efficiency | $m$ | 0.098 | Re-scaled |

Table 4: Moments Calibration results

| | Data | Model |
|---|---|---|
| Unemployment rate | 4.84% | 4.77% |
| Unemployed job-finding rate | 31.6% | 33.3% |
| Employed job-finding rate | 0.96% | 0.96% |
| $\epsilon_{w,b}$ | 0.194 | 0.195 |
| $\frac{\partial UE}{\partial ln(b)}$ | $-0.161$ | $-0.161$ |

our preset and estimated parameters in Table 3.

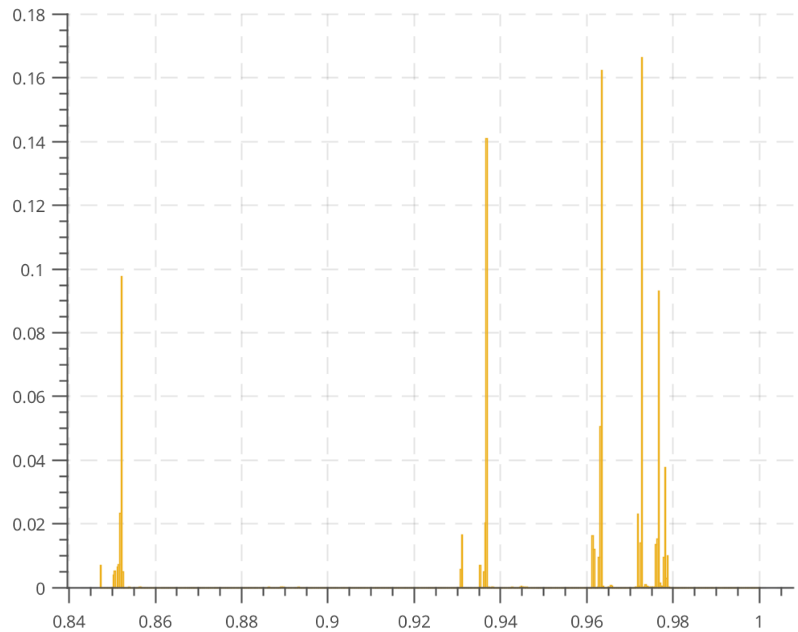
Despite its parsimonious nature, this parameterization allows our model to match our moments well. Notably, we nearly precisely match each of the elasticity moments (wage and UE probability). Our model, therefore, replicates both the impact of UI on reservation strategies and the impact of changes in wages on the job-finding probability. The target moments are reported in Table 4.

# 6 Baseline Model Outcomes

Having calibrated the model, we start by exploring characteristics of the equilibrium in our baseline model.

Figure 4 shows the equilibrium wage distribution for the baseline model. An implication of directed search is that wages emerge in clusters (see Delacroix and Shi (2006)). For any given

Figure 4: Baseline wage distribution



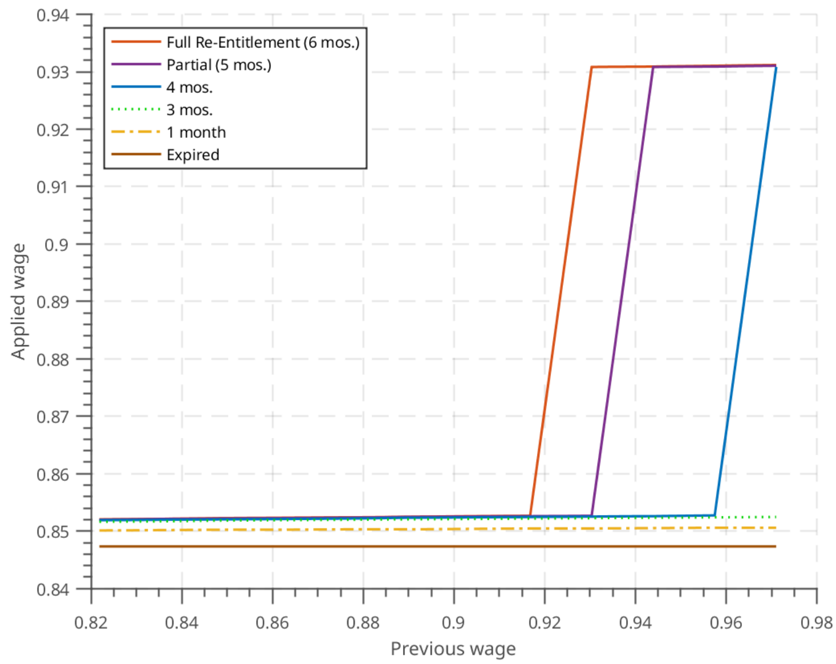

employment status, $(y, i, w)$, firms make a market at the constrained efficient wage for those workers. Through on-the-job search, workers then make their way up the associated wage ladder. Of course, when their employment status changes due to a change in entitlement level or separation rate, the worker switches to a different ladder. The aggregate wage distribution reflects a conflation of all of those ladders. Unemployed workers apply for jobs up to a wage of 0.931. Submarkets above this value are only visited by workers presently employed.

While firms are indifferent across which of the active markets to enter, their realized profits from hiring a worker decrease in the wage. This is offset for the newly created vacancies by the increased matching rates in higher wage markets. The highest conceivable wage in this economy is $\bar{w} = 0.9783$. A firm that offers this wage meets a worker with probability 1 but the discounted value of their share of the output is only just equal to the vacancy cost, $c$.

Figure 5 shows how worker application wages differ by their prior wage and remaining entitlement. As the prior wage is no longer relevant for those without benefits, their application wage is invariant to it. The prior wage becomes more determinative of application wages as the entitlement period increases. A consequence of this is that workers with more remaining UI entitlement exhibit more wage dispersion. As one might infer, these interact in equilibrium.

On average, one-month closer to UI expiration causes unemployed workers who receive benfits to search for wages 0.6% lower. This measure, which we term the Wage-Duration Index (WDI), provides insight into the magnitude of the re-entitlement effect in our baseline

Figure 5: Application Wages of the Unemployed by Prior Wage and Remaining Entitlement




model. The reason is that although there is a large effect of UI entitlement on application strategies, it is primarily through indirect effects: only 4% of our workers allow their benefits to expire, meaning that the effective replacement rate in our model is around 45.4% of a workers previous wage.

What determines the application strategy of the employed are their current wage, their separation rate, and their current entitlement level. Figure 6 shows how important their current wage is and how little their separation rate matters for application strategies. While workers with low separation rates are pickier than those with high separation rates, the difference is dwarfed by the current wage effect. This is because those with high separation rates only expect to be in that state for a brief period of time – a change in their separation rate is 4 times more likely than losing their job. When looking for a new job, all workers can expect to be in that job for some time and are therefore similarly selective. Differences in equilibrium separation rates, however, will play a sizable role in determining the wage dynamics of the model.

Figure 7 shows the Current wage distributions of high- and low-separation rate workers superimposed on the same axes. [8] What it shows is that while the application wage as a function of their current wage is similar between these groups, the wage ladder rungs they

[8]The bar heights for each separation rate add to 1 so they are not directly comparable. The figure is shown this way because high separation rate workers are only 0.4% of the employed work force.

Figure 6: Application Wages of the Employed (with One Month of Entitlement) by Current Wage and Separation Rate.

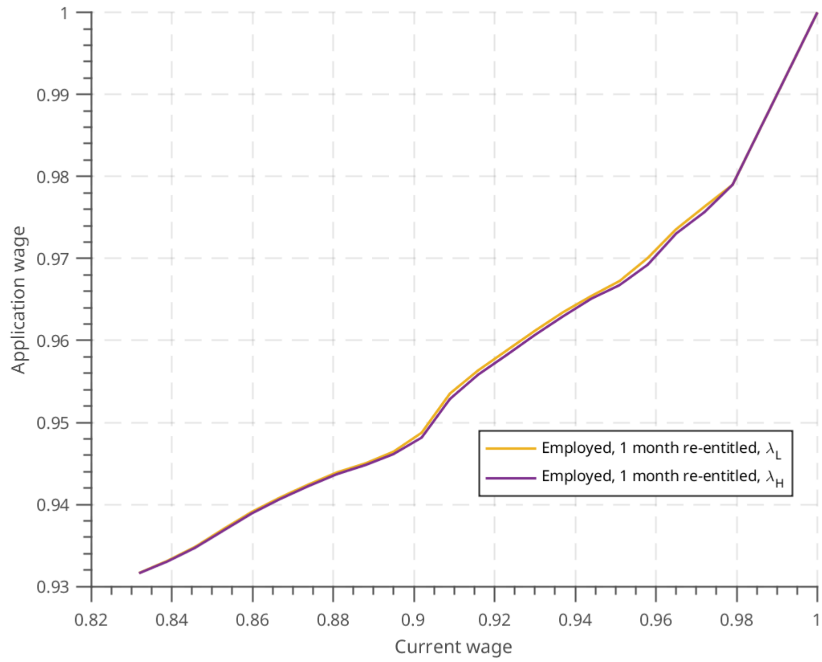
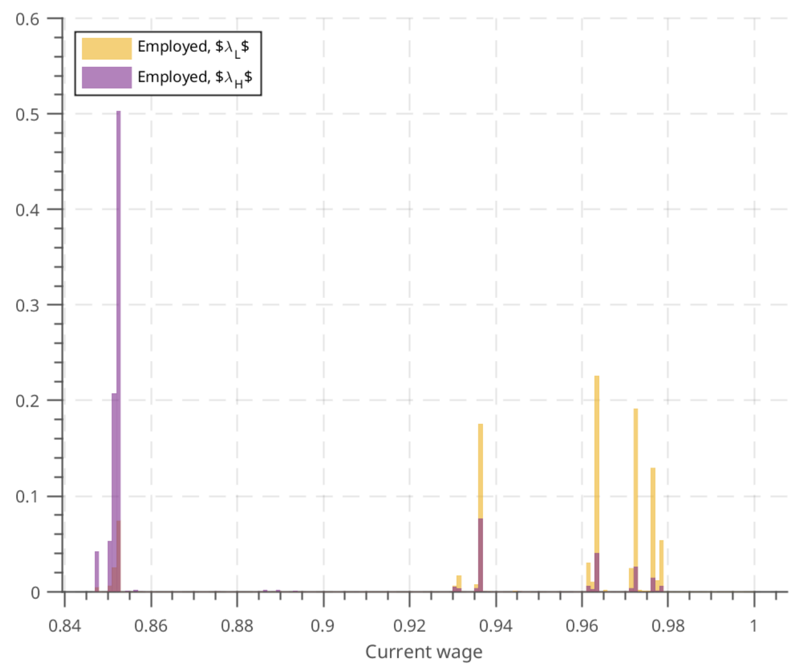



Figure 7: Current Wage Distributions of High- and Low-Separation Rate Workers.



occupy are very different. The difference highlights how the labor market churn is largely among workers moving in and out of low-wage jobs. Consider two individuals, one who gets a low-wage job and one who gets a high wage job. Both are equally likely to lose their jobs and both are equally likely to switch to a low separation rate. But, the high earner is much less likely to move to a higher paid position and is thereby less exposed to future separation. The low wage-worker is, therefore, more likely to be out of work at a given time in the future, say one year hence, than the high-wage worker. In a single separation rate version of the model this cannot happen.

As they face a relatively low chance of separation, the current entitlement level plays a negligible role in employed workers' application strategies. This is why Figure 6 focuses only those with one month of remaining entitlement. On this scale, the curves for different levels of entitlement would be indistinguishable. This does not mean that entitlement is not important in determining the distribution of wages or their dynamics. Figure 5 shows that remaining entitlement matters for application wages and, therefore, indirectly for different separation probabilities.

Taken together, the preceding analysis implies that low-wage workers are more likely to lose their jobs which means they have fewer months of UI entitlement. On finding themselves unemployed those workers then apply for lower wage jobs. So, the model generates low wage and high separation rate persistence. Of course by corollary, it also produces high-wage and low separation rate persistence. We call this endogenous, equilibrium outcome generated by our model "job polarization."

# 7 Equilibrium Wage Dynamics

This section shuts down different components of the model to identify their contribution to wage and separation rate persistence. In each following subsection, we conduct both partial equilibrium (PE) and general equilibrium (GE) experiments. The PE experiments hold both the firms' policy rules (as captured by $\theta(i, w)$,) and the replacement rate, $\phi$ fixed; there is no attempt to re-balance the UI budget. In the GE experiments the firms are permitted to re-optimize and $\phi$ is adjusted to reestablish budget balance. (The tax rate $\tau$ remains at its Baseline model value, 0.0206, throughout to ensure numerical stability that would be impacted by changes to the set of equilibrium wages. See Appendix D for details.)

In each experiment, we compute various statistics to better understand the role of separations and re-entitlement for wage and employment dynamics. We calculate our simulation outcomes from a sample of 10,000 individuals whom we track over 500 months (41.67 years) once the model has reached its ergodic steady state. To measure the extent or

Table 5: On-the-job Search on Re-Entitlement Effects

| | Baseline Model | No OTJS (Base. $\theta$) | No OTJ Search (GE) |
|---|---|---|---|
| Unemployment | 0.0477 | 0.313 | 0.147 |
| Mean wage | 0.945 | 0.930 | 0.935 |
| Wage Mean-Min ratio | 1.115 | 1.099 | 1.045 |
| Wage standard deviation | 0.0425 | 0.00593 | 0.00427 |
| Wage-Duration Index | 0.597 | 0.0358 | 0.0507 |
| Mean Wage of Infrequently Unemployed | 0.956 | 0.930 | 0.935 |
| Mean Wage of Frequently Unemployed | 0.940 | 0.929 | 0.935 |
| % $\Delta$ Wages from Polarization | 1.614 | 0.0365 | 0.0938 |
| Replacement rate, $\phi$ | 0.500 | 0.500 | 0.370 |

impact of job polarization, we divide the sample into those who experienced more than the average number of separations into unemployment (the frequently unemployed), and those who experienced less than average number of separations into unemployment (the infrequently unemployed). Then, for example, the difference between the mean wages received by each group over the course of their working lives is a measure of wage persistence.

## 7.1 Shutting Down OTJ Search

The implications of shutting down OTJ search are reported in Table 5. The second column summarizes the Baseline model outcomes for comparison with the versions without on-the-job search. The results show that in the baseline model, those who experienced fewer than average separations also experienced 1.6% higher wages over the course of their working lives. This comes from the job-polarization dynamics described above.

Comparing the Baseline to the No OTJ Search experiments, we see that in both partial and general equilibrium, unemployment is much higher under sequential search. This happens because absent the possibility of moving up the wage ladder, the workers tend to be much pickier over which job to take out of unemployment. As it happens, though, the minimum wages are not really any higher than in the baseline model. This is because the unemployment is so much higher that the workers' reservation wages are much lower under sequential search. The main difference that shows up between the partial and general equilibrium experiments is that the replacement rate is much lower in the latter. With high unemployment the cost of the UI system in the partial equilibrium scenario exceeds the revenue from taxes so $\phi$ has to fall.

Dispersion and the wage-duration index fall considerably under sequential search. This is

Table 6: Single Separation rate

| | Baseline Model | Single Sep. Rate (Base. $\theta$) | Single Sep. Rate (GE) |
|---|---|---|---|
| Unemployment | 0.0477 | 0.0126 | 0.279 |
| Mean wage | 0.945 | 0.892 | 0.771 |
| Wage mean-min ratio | 1.115 | 1.059 | 1.054 |
| Minimum wage | 0.847 | 0.842 | 0.731 |
| Job-to-job transition rate | 0.00957 | 0.0332 | 0.0148 |
| Mean wage of infrequently unemployed | 0.956 | 0.899 | 0.776 |
| Mean wage of frequently unemployed | 0.940 | 0.891 | 0.767 |
| % $\Delta$ wages from polarization | 1.614 | 0.898 | 1.100 |
| Replacement rate, $\phi$ | 0.500 | 0.500 | 0.131 |

indicative of how simply focusing on wage dispersion can miss much of the story here. From Hornstein et al. (2011) we know that on-the-job search is powerful driver of wage dispersion but our focus is on the labor market dynamics that lead to job-polarization. Under sequential search, in both partial and general equilibrium, the average wages are essentially uncorrelated with the workers' propensity to separate to unemployment. Under both sequential and OTJ search, workers who experience higher than average separations will have fewer average months of benefit entitlement and will generally apply for lower wage jobs. With OTJ search there is an additional effect: lower wage employed workers apply for new jobs that they are more likely to get which leaves them more susceptible to separation. This experiment shows that the latter mechanism linking wages to separation rates is the stronger one.

## 7.2 Imposing a Single Separation Rate

Here we look at the implications imposing a single separation rate on the model. The single separation rate is set to 0.0494 per month which is the average rate of separations in the Baseline model. Beyond that, we use all the same parameter values associated with the baseline calibration of the model. Table 6 presents partial equilibrium (PE) and general equilibrium (GE) variants of the single separation rate model and compares both to the Baseline model.

Comparing the two-separation rate and the PE single separation rate models, what jumps out immediately is that the latter model has less than one third of the unemployment. With two separation rates, workers who move from job to job are subject to the high separation rate for what is effectively their first month on the new job.[9] While brief this period does still

[9]The chance that they transition to the low separation rate after the first month is 92%

account for 50% of the separations to unemployment in the Baseline model. Absent job-to-job moves incurring an increase in separation probability, workers move 3 times more frequently to new jobs. But what it means for unemployment is fewer separations on aggregate. Moving to the GE variant, unemployment jumps up to 28%. Because workers can take a new job with impunity, firm's ex post expected profits fall and they create fewer vacancies.

The move to a single separation rate drops the MMR to a similar extent to that seen with the move to sequential search. This tells us that there is an interaction between these two components of the model. By reducing the opportunity cost of taking a job, OTJS tends to lower the minimum wage in the market. Meanwhile, the job-polarization that emerges from the two-stage separation rates leads to a higher mean wage in the economy. In the general equilibrium version, high unemployment leads to lower reservation wages and, because there is no excess high wage persistence – the mean wage drops accordingly.

The implications of the two separation rates for wage persistence also shows up in the results that distinguish between those experiencing high and low levels of separations. The lifetime earnings differential between the groups is noticeably larger under two separation rates, 1.6%, than under the single separation rate 0.9% or 1.1%. Under a single separation rate, changing jobs does not expose the worker to a period of higher separation rates to unemployment. Lower wage workers are still more likely than higher wage workers to get the jobs they apply to but those transitions have no implications for realized separation rates. Of course, the fact that workers who have more separations will have accumulated fewer months of UI entitlement means that that mechanism driving job-polarization is still present in the single separation rate models.

## 7.3 Allowing Indefinite Benefits

Here we assess the importance of benefit expiry for job-polarization. Table 7 reports the implications of allowing for indefinite benefit payments in both partial equilibrium and general equilibrium experiments alongside the Baseline model results.

Recall that the PE variant does not allow the firms to re-optimize and maintains the same 50% replacement ratio from the Baseline model. With the move to the PE model, unemployment jumps to 32.5% and the MMR rises to 1.13. As the market tightness function, $\theta(i, w)$, does not change, the difference can only come from the unemployed workers' application strategies. Table 7 shows that the average wage they apply for is considerably higher than in the Baseline model. The increased unemployment comes from the fact that the market tightness is much lower in the higher wage markets to which the recipients of indefinite benefits apply than it is in the markets to which workers who expect their benefits

Table 7: Indefinite Benefits

| | Baseline Model | Indefinite UI (Base. $\theta$) | Indefinite UI (GE) |
|---|---|---|---|
| Unemployment | 0.0477 | 0.325 | 0.0475 |
| Mean wage | 0.945 | 0.959 | 0.946 |
| Minimum wage | 0.847 | 0.852 | 0.849 |
| Wage mean-min ratio | 1.115 | 1.126 | 1.114 |
| Replacement rate, $\phi$ | 0.500 | 0.500 | 0.484 |
| Mean wage of infrequently unemp. | 0.955 | 0.964 | 0.956 |
| Mean wage of frequently unemp. | 0.940 | 0.955 | 0.941 |
| % $\Delta$ wages from polarization | 1.615 | 0.888 | 1.625 |
| Average unemp. app. strategy | 0.859 | 0.931 | 0.872 |
| Ave. unemp. of infrequently unemp. | 0.0205 | 0.143 | 0.0261 |
| Ave. unemp. of frequently unemp. | 0.0865 | 0.534 | 0.0785 |

to run out apply. The higher application wages from unemployment then also translate into a higher aggregate mean wage. The lowest (minimum) wage in the market does not rise very much, though, which leads to the observed increase in the MMR. But how does this happen? As shown in Figure 5, there are two channels by which the UI system can affect the wage distribution. The first is through benefit generosity which comes from the worker's previous earnings. The second is through time to benefit expiry. While the experiment conducted here, to extend benefits indefinitely, shuts down the latter channel it strengthens the first. Those workers who have low wages and lose their jobs, get low benefits and apply again to low wages. Because benefits are paid indefinitely, the elasticity of the application wage with respect to benefit payments is higher than in the Baseline model.

When we turn to the the GE variant, the outcomes are remarkably similar to the Baseline model. There, only 4% of the unemployed receive no benefits. [10] Consequently, with a similar unemployment rate, the total expected benefit receipt over any spell of unemployment does not rise much when benefits are paid indefinitely. The replacement rate simply drops by 3% to equate the tax rate across the models. Comparing the frequently and infrequently unemployed across the models, shows that the indefinite benefits model has slightly more wage persistence while the Baseline model has a larger difference in unemployment across the groups.

[10]This is very low compared to the literature which typically suggests a figure closer to 50% – see Auray et al. (2019). Here, though, the workers are very attached to the labor market and so their matching rate is high even though they are liable to lose their jobs again quite quickly. In our model, workers are also immediately enrolled in UI if eligible, but a sizable share never apply for UI (Chao et al., 2024).

The upshot is that with both benefit expiry and indefinite benefits, the two-separation rate structure leads to wage and separation rate persistence. A switch to indefinite benefits shuts down the expiry channel that can lead to wage persistence but it exacerbates the generosity channel. In this calibration, the two channels almost exactly offset each other. In the next section, we begin to parse out these effects.

# 8 Understanding Wage Dynamics

Here, we dig deeper into the roles of each of the model components in determining individual wage dynamics within the model. We first consider two restrictions that quantify the role of on-the-job search absent any role in subsequent job placement out of unemployment. In the next subsection, we impose two restrictions that eliminate all heterogeneity except that created by re-entitlement effects. Finally, in the last subsection, we isolate the contribution of the wage ladder and differences in initial placement on the wage ladder to job polarization.

We consider each restriction under partial equilibrium. We hold both the firms' policy rules, $\theta(i, w)$, and the replacement rate, $\phi = 0.5$, fixed. For counterfactuals in which we restrict benefits to a single value, we use the average value of benefits in the baseline model, $E[b] = 0.434$. Under either set of restrictions, we do not attempt to re-balance the UI budget.

## 8.1 The On-the-Job Wage Ladder

The presence of a job ladder affects equilibrium job placement out of unemployment. As a byproduct of increasing wage dispersion and mobility, on-the-job search creates additional dispersion in UI benefit amounts, because entitled unemployed workers are paid a fixed replacement of their previous wage. As the application strategies in our baseline model show (Figure 5), this dispersion in benefits leads to differences in average job placement for fully and near-fully re-entitled job losers. However, this figure also shows that months of re-entitlement to UI benefits, a complicated object in our model with different stages of separation rates, impacts job placement and interacts with benefit amounts.

In this section, we consider two restrictions that sequentially remove the impact of the job ladder from either benefit amounts or months of re-entitlement. We start by restricting benefits to be fixed at the average amount in the baseline ($E[b] = 0.434$), which eliminates the heterogeneity in benefits created by separating at different rungs of the job ladder. This leaves employment history as the only channel through which on-the-job search affects job placement. We then extend this counterfactual so that individuals are permanently entitled to benefits. Our second restriction limits the impact of differences in employment history

Table 8: The Job Ladder and UI

| | Baseline Model | Fixed UI (Base $\theta$) | Fixed and Indef. UI (Base $\theta$) |
|---|---|---|---|
| Unemployment | 0.0477 | 0.0254 | 0.0261 |
| Mean wage | 0.945 | 0.946 | 0.946 |
| Wage mean-min ratio | 1.115 | 1.116 | 1.109 |
| Average unemployed application strategy | 0.859 | 0.852 | 0.852 |
| Minimum wage | 0.847 | 0.847 | 0.852 |
| Wage-Duration Index (recipients) | 0.597 | 0.0226 | 0.00000 |
| Wage standard deviation | 0.0425 | 0.0420 | 0.0419 |
| Job-to-Job transition Rate | 0.00957 | 0.00986 | 0.00986 |
| $b_{lump}$ | 0.00000 | 0.434 | 0.434 |
| Mean wage of infrequently unemployed | 0.955 | 0.953 | 0.953 |
| Mean wage of frequently unemployed | 0.940 | 0.940 | 0.940 |
| % $\Delta$ wages from polarization | 1.615 | 1.365 | 1.359 |

that occur as a result of on-the-job search. Any residual wage dispersion results purely from the interaction between the separation structure and on-the-job search in our model. We report our findings in Table 8, as well as a comparison with the baseline model.

Our findings show that both channels appear to impact job placement. Removing benefit heterogeneity leads to a reduction in the unemployment rate, as previously high-wage workers start lower on the job ladder. This occurs because of a reduction in their outside option. The second restriction shows that removing the role of employment history in outside options reduces wage dispersion by increasing average job placement out of unemployment. Notably, both restrictions increase job-to-job mobility, as the average worker starts on a lower rung of on the job ladder.

The results suggest that the job ladder indirectly affects wage dynamics primarily through differences in employment history rather than wage heterogeneity. The wage distribution again provides insight: in our baseline model, long-tenured workers at the top rungs of the job ladder used their re-entitlement to replace income until they found employment near the middle of the job ladder. Here, job loss entails a complete reset of one's employment history. This amplifies the inequality created by on-the-job search in our baseline model.

The final three lines may appear precarious for any quantitatively meaningful interaction between our two-stage separation environment and re-entitlement. Indeed, the difference between the first and third columns yields the cumulative impact of re-entitlement on workers in our baseline economy. However, the equilibrium effects on wages and benefits mask the role of re-entitlement, although the impact on employment is readily apparent. A key insight

Table 9: Re-Entitlement Effects

| | Baseline Model | No OTJS, Fixed UI (Base $\theta$) | No OTJS, Fixed, Indef. UI (Base $\theta$) |
|---|---|---|---|
| Unemployment | 0.0477 | 0.313 | 0.378 |
| Mean wage | 0.945 | 0.930 | 0.944 |
| Wage mean-min ratio | 1.115 | 1.099 | 1.000 |
| Average unemp. app. strategy | 0.859 | 0.929 | 0.944 |
| Minimum wage | 0.847 | 0.846 | 0.944 |
| Wage-Duration Index | 0.597 | 0.0331 | 0.00000 |
| Wage standard deviation | 0.0425 | 0.00591 | 0.00336 |
| $b_{lump}$ | 0.00000 | 0.434 | 0.434 |

is that workers with relatively low wages experience higher expected separation rates because each job transition entails a period of job instability. As we demonstrate in the next section, these dynamics have a sizable impact through their role in job placement.

## 8.2 Re-Entitlement and Initial Job Placement

One of the key questions we address in this paper is the role that employment requirements for UI receipt, often absent in models of the labor market, has for labor market dynamics. In our model, workers must find and maintain employment to become fully re-entitled to unemployment benefits. With each additional two months of employment, they regain one month of eligibility. This creates an implicit re-entitlement ladder, whose rungs lead to sequentially better placement on the job ladder. The cumulative impact, while muted in our baseline environment by the small share of unemployed in the economy, affects wage dynamics.

We isolate the role of re-entitlement in our model using two restriction on job mobility in partial equilibrium. First, we consider an environment without on-the-job search in which individuals receive the average UI benefit during unemployment. This limits the channels through which employment history affects job placement to months of re-entitlement. Second, we extend this counterfactual so that individuals are permanently entitled to benefits, regardless of employment history. The difference between these two restrictions is the impact of UI re-entitlement, absent interactions with other features of our model. We present the results in Table 9.

Our findings show that the direct impact of UI re-entitlement and expiration is sizable, particularly for employment. Unlike our restriction on expiry in Section 7.3, expiration in this environment raises the unemployment rate by 6.5 percentage points. We also see that much of the impact of on-the-job search on wage dispersion is caused by its interaction with the UI system: eliminating re-entitlement and expiry reduces wage dispersion by 10 percentage points. This occurs because when other sources of dynamics are restricted, introducing benefit expiry lowers unemployment at the expense of lower initial hiring wages. This is consistent with the intuition in Coles and Masters (2007) that benefit expiry can provide maintained income while incentivizing job search.

How these gains and losses are distributed in our baseline model is crucial for understanding the role of UI re-entitlement in creating job polarization. The gains accrued by removing expiration occur at the bottom of the ladder: initial job placement as indicated by the minimum wage rises from a piece-rate of about 85% to nearly 95%. The reason is two-fold: first, in our baseline model, unlucky workers are likely to have limited months of entitlement when unemployed. Second, these workers regain employment closer to the bottom of the job ladder, and thus face the spectre of higher expected separation rates before achieving stable employment. This interaction is important: indirect effects that occur because of differences employment history account for 86% of the dispersion in the baseline model (1.099 versus 1.115), but these effects are masked in equilibrium by the job polarization that occurs endogenously in our baseline model. This is because a small fraction of workers repeatedly experience low wages, while their luckier peers find stable jobs further up the job ladder, a consequence of our separation environment.

## 8.3 High and Low Separation Stages

Although our partial and general equilibrium exploration in Section 7.2 suggest a tepid response of wage dispersion to differences in job stability, this has important implications for wage dynamics. In our model, high-separation stage workers fall off the employment ladder frequently. When they are re-employed, they again face a high likelihood of separating. And further, they expose themselves to this high likelihood of separation each time they move up the job ladder. This is partially responsible for endogenously creating "job polarization," in which an unlucky worker remains multiple rungs below their ex-ante identical, but ex-post luckier peers, on the job ladder. Crucially, absent any persistence of separation type, this polarization would be a misnomer, and any resulting wage scarring would only exist in transition.

We first assess the extent to which an individual in the high separation stage is likely to remain in the high separation stage over various horizons. While workers expect to face identical separation rates ex-ante, unlucky workers may be exposed to a series of high separation jobs, simply by virtue of their higher rates of job-to-job moves and separations to unemployment before finding a high-pay, highly stable job. We document the presence of substantial persistence in two ways: first, we calculate the probability that a worker in a high separation job today will be in a high separation rate job in the future. Second, we compute the forward-looking expected separation probability of high and low-separation stage workers in each decile of the wage distribution. This includes both a worker's current separation probability and the separation probability induced by subsequent job-to-job moves. We present these results in the right and left panel of Figure 8. The left panel shows that even 100 months after being in a "high" separation stage, a worker has a 10 percent likelihood of being in the high separation stage of job. The right panel shows that across every wage decile, high separation stage workers are more likely to separate. The reason is that these workers take smaller steps on the job ladder, exposing themselves to more frequent periods of high likelihood of job loss.

Figure 8: Separation-Type Persistence

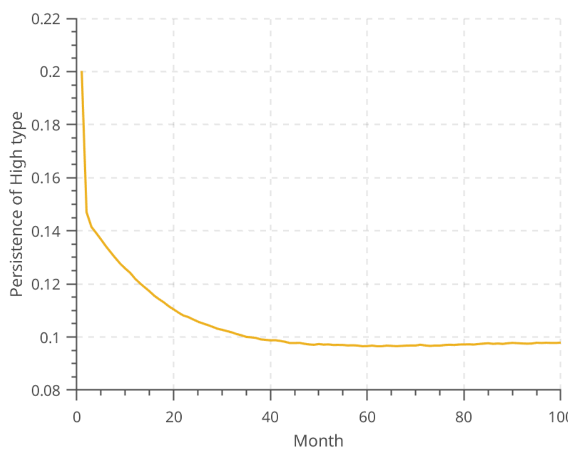



Figure 9: Persistence

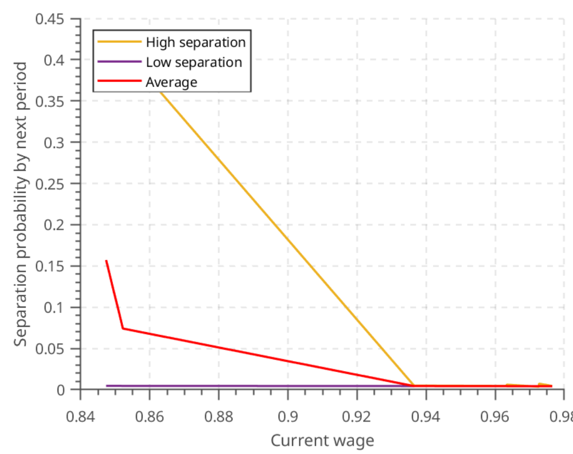



Figure 10: Separation by Wage

Both figures show how the two-tiered separation structure of a job creates polarization within the job ladder, in which the majority of workers are employed in high wage, stable jobs, but a small subset experience low wages and a high frequency of separations to unemployment. This effect emanates from two sources: heterogeneity in initial placement, which dictates the number of rungs on the job ladder a worker expects to climb when they regain employment, and differences in ex-post realizations of separation shocks. Absent the presence of jobs as experience goods in our model, and hence variable job stability upon first arrival, there is limited scope for unemployment to persist and "scar" earnings. A separation would yield a transitory disruption in climbing the job ladder, but there would be no impediment to regaining their previous ledge. Here, a separation entails potentially many periods of job instability.

We explore these two effects by placing two restrictions on the model. First, we alter the UI system so that benefits are fixed, and offered to the unemployed indefinitely, like our second restriction in Section 8.1. This removes any ex-ante heterogeneity in placements, thus eliminating differences in separation rates from differences in job-to-job transitions. Second, we compare the model to the single separation rate model discussed in the previous section (Section 7.2), in which the separation rate is set to the sample average generated by our baseline model. This second restriction ensures that all workers, regardless of employment history, face the same expected separation rate.

We start by comparing the average lifetime separation rates of any individuals who are high or low type during any given period. Importantly, there is no notion of persistence embedded in this definition, outside of any that is generated endogenously. Then we focus on the performance of two groups: individuals who separate to unemployment more frequently than the average in their respective counterfactual, and those who separate to unemployment with below average frequency. Then we compare the average unemployment duration while individuals from each group are unemployed, and the average lifetime earnings (at a monthly frequency) while individuals from each group are employed. Comparing separation rates provides insight into the role of on-the-job search in generating ex-post heterogeneity. Given differences in separation rates, resulting differences in unemployment accrue from the job-finding rate heterogeneity across the models. Finally, exploring average earnings of the employed means that the frequency of unemployment, while it may play a role in placement and subsequent likelihood of unemployment, has no direct effect on wages. We present the results in Table 10.

The first two rows show the importance of initial placement on the job-ladder in generating separation heterogeneity. Under the fixed and indefinite restriction, in which newly-employed workers exhibit no heterogeneity, separation probabilities fall for both high and low types relative to the baseline. The reason is that in the baseline model, fewer workers at any one period in time are employed in high separation jobs. Heterogeneity in placement allows a sizable subset of workers to search for jobs high-pay, low-availability jobs, leading to a larger mass of workers employed at low separation rates. In the fixed and indefinite restriction, the majority of workers employed in stable jobs are nearly all on the upper rungs of the job ladder. The reason is that employment history no longer plays a role in job stability, meaning that only job-to-job moves during the current employment spell lead to differences between workers. This is borne out by differences in unemployment: the infrequently unemployed virtually never separate, leading to an unemployment rate of 0.63%, while the frequently

Table 10: Single Separation Rate

| | Baseline Model | Fixed, Indef. UI (Base $\theta$) | Single Sep. Rate (Base $\theta$) |
|---|---|---|---|
| Separation frequency of low type | 0.0452 | 0.0280 | 0.0494 |
| Separation frequency of high type | 0.0714 | 0.0534 | 0.0494 |
| Job-to-job transition rate | 0.00957 | 0.00986 | 0.0332 |
| Unemployment | 0.0477 | 0.0261 | 0.0126 |
| Ave. unemp. of infrequently unemp. | 0.0205 | 0.00630 | 0.0108 |
| Ave. unemp. of frequently unemp. | 0.0865 | 0.0601 | 0.0144 |
| Mean wage | 0.945 | 0.946 | 0.892 |
| Mean wage of infrequently unemp. | 0.955 | 0.953 | 0.899 |
| Mean wage of frequently unemp. | 0.940 | 0.940 | 0.891 |
| % $\Delta$ wages from polarization | 1.615 | 1.359 | 0.897 |
| $\phi$ | 0.500 | 0.0 | 0.500 |
| $b_{lump}$ | 0.0 | 0.434 | 0.0 |

unemployed have an unemployment rate nearly 10 times higher (6.01%). These are both reductions from the baseline model, in which heterogeneity in job placement can lead to longer unemployment spells. The single separation restriction shows that the interaction between job placement and separation probabilities are crucial for employment, as nearly all dispersion in job-finding outcomes are eliminated.

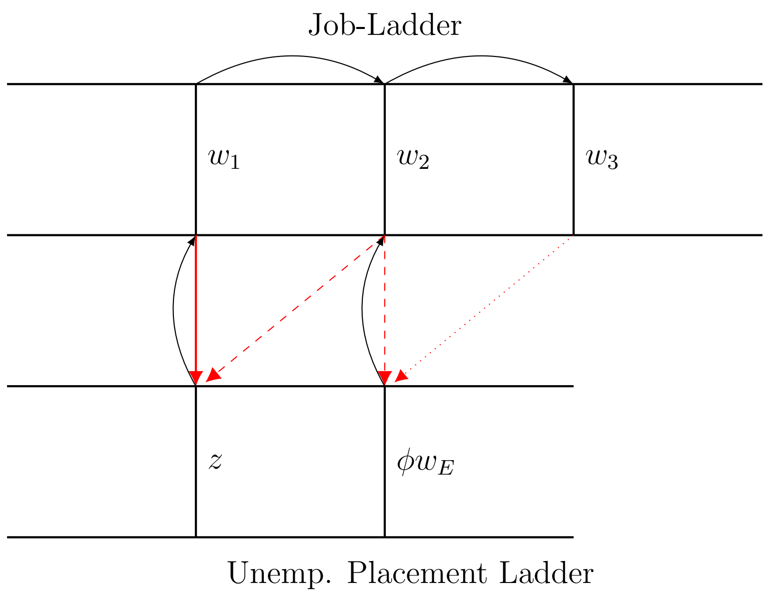
The wage results do, however, demonstrate that both channels are important: eliminating ex-ante heterogeneity in job placement reduces the degree of job polarization on wages by 0.26pp, obtained by comparing the difference in wages between groups across the baseline and, the fixed and indefinite restriction. Eliminating differences in job stability, however, leaves a sizable difference in wage outcomes by group. This suggests that while the dynamics of the labor market in our model may be primarily driven by job search and job instability, job placement, the residual of this last restriction, remains an important driver of wage inequality. In our model, differences in job placement occur as a result of differences in employment history, fed through a UI system that yields variation based on worker re-entitlement. We explore how these forces endogenously create job polarization in the next section.

# 9 Sources of Job Polarization

Here, we address the main question posed by the paper: to what extent is job polarization driven by the interaction between the two-stage separation rates and the re-entitlement structure of the unemployment insurance system? Our findings in the previous two sections show that both mechanisms impact wage dynamics. Moving to a single separation rate causes a more even distribution of workers across the wage distribution (Section 7.2), while moving to indefinite benefit payments reduces the importance of employment history (Section 7.3) and reduces heterogeneity in re-employment outcomes (Section 8.2). Moreover, these results show that both generate feedback loops between employment history and job placement.

Each feedback loop changes the likelihood that a worker retains any prior successful moves up the job ladder. To provide some insight into what is going on consider a simplified job ladder with just three wages as depicted in Figure 11. The upper portion of the figure depicts each rung of the job-ladder that employed workers can inhabit while they attempt to climb to the top. The ladder shown in the lower portion represents the workers' possible outside options should they experience unemployment. These outside options dictate an unemployed worker's placement once they regain employment. At each rung of each ladder, the solid black lines with arrows depict the workers application strategy: while unemployed, workers with the lowest outside option apply for the lowest equilibrium wage, while those with higher outside options from re-entitlement and benefits apply for the "middle" rung. Once employed, they move sequentially up the job ladder as denoted by the arrows at the top of the figure. Thus far, the dynamics largely mirror a standard labor search model with on-the-job search.

Figure 11: Placement and Separation Dynamics




What differentiates our model lies in the red lines, which denote separations. First, the solid red line and arrow from $w_1$ occurs at a frequency close to $\lambda_h$ in equilibrium. This occurs because the only workers on the bottom rung of the job ladder are newly employed and either move quickly to a new job or separate to unemployment; relatively few become a low separation type at this rung. Second, the dotted red line and arrow from $w_3$ occurs at a frequency close to $\lambda_l$ in equilibrium. This is because workers at top rung are no longer moving job-to-job and thus no longer exposing themselves to high separation probabilities associated with new employment. The dashed lines emanating from $w_2$ crucially determine the the extent of job polarization in the model: unlucky workers in our model face frequent separations as they attempt to climb the job ladder. However, if they are re-entitled to a sufficient period of UI eligibility, they could regain employment at $w_2$, their prior rung on the job ladder. This is what occurs when separations follow the vertical dashed line from $w_2$. In equilibrium, because of repeated job loss, the bulk of these workers have limited or no re-entitlement. The result is that they follow the dashed line back to the outside option ladder that results in re-employment at the bottom of the job ladder.

With this in mind, we provide a geometric decomposition of our standard measure of dispersion, the mean-min ratio. The first component is the ratio of mean wage that the unemployed apply to, $w'_U$, to the lowest wage they apply to, $w_{min}$. The second is the ratio of the mean of the realized wage distribution, $w_{mean}$ to $w'_U$ in the economy to the mean application wage of the unemployed. The first component represents the dispersion in application wages which reflects the dispersion in unemployed outside options. The second component measures the dispersion in wage gains during employment.

To explore the interaction between the UI system and two-stage separations, we calculate the impact of changing the relative values of $\lambda_h$ and $\lambda_l$ in our baseline model. First, we double the separation rate of the "high" separation type jobs, from $\lambda_h = 0.2356$ to $\tilde{\lambda}_H = 2 \times \lambda_h = 0.47$, while simultaneously halving the separation rate of those in "low"-type jobs: $\tilde{\lambda}_L = 0.5 \times \lambda_l = 0.0024$. This results is a much more skewed distribution of employment duration, with unlucky high-separation workers frequently losing their jobs, and the lucky low-separation workers maintaining nearly permanent employment. To understand the symmetry of any effects, we repeat this exercise with opposite restrictions $\tilde{\lambda}_H = 0.5 \times \lambda_h = 0.1175$, and $\tilde{\lambda}_L = 2 \times \lambda_l = 0.0096$. This allows us to examine the impact of a less-skewed distribution of job stability.

We explore the interaction by revisiting three restrictions under these new separation environments. First, we examine the cumulative impact of re-entitlement by computing key quantities under the indefinite benefit restriction described in Section 7.3. The cumulative difference under each counterfactual separation environment is the impact of removing UI expiry. Next, we assess the impact of restricting separation to a single type, calibrated to the average for each new baseline separation environment. This provides the cumulative impact of dual separation rates. Finally, we compare these restrictions to a model with a single separation rate and indefinite UI, effectively eliminating any re-entitlement role of employment history on job placement as well as any impact of differences in job stability. Comparing across these different settings as well as across separation rate environments yields insight into the interaction between separation rates and re-entitlement. We present a comparison between these counterfactuals and our baseline model in Table 11.

Our decomposition of the MMR reveals that elimination of benefit expiry raises the relative importance of initial placement and reduces the relative importance of climbing the job ladder during employment for wage dispersion. While overall wage dispersion is similar with and without benefit expiry, in the former scenario the unemployed are more likely to end up at the bottom of the outside option ladder and apply for low wage jobs leading to job polarization. Meanwhile, imposing identical separation regardless of job history yields almost no impact of employment history on outcomes: initial placement accounts for 10-15% of overall wage dispersion, and none once expiry is eliminated. This is because employed workers have no reason for any reluctance to apply for new jobs. Anticipating a quick rise up the employed job ladder means that, regardless of their UI status, the unemployed apply for essentially the same low wage where the matching rate is high.

Looking across the panels in Table 11 reveals that job placement does get more important as we move from the second to the first and then to the third panel. This a consequence of a rising average separation rate. The bottom two rows of each panel report the average separation frequency over the 500 months for those who started out as and high and low separation stage workers respectively. For the experiments with a single separation rate, the single rate is set to the mean rate in the two stage model and reported in the bottom row. There it is clear that the mean separation rate is rising from panel 2 to panel 1 and then to panel 3. A higher mean separation rate leads to longer periods of unemployment, increases the importance of benefit entitlement for the outside option ladder, and the dispersion of application wages among the unemployed.

The upshot is that to generate the kind of job polarization that emerges in our baseline model requires both benefit expiry and two-stage separations. Higher mean separation rates reduce the degree of interaction between those components of the model by increasing the direct effect of re-entitlement in creating job-polarization.

Table 11: Separation Environment and Re-Entitlement Effects

| | Baseline model | Indef. UI (Base $\theta$) | Single sep. (Base $\theta$) | Single sep., indef. UI (Base $\theta$) |
|---|---|---|---|---|
| Baseline Separations ($\tilde{\lambda}_H = \lambda_h, \tilde{\lambda}_L = \lambda_l$) | | | | |
| Wage mean-min ratio | 1.115 | 1.126 | 1.059 | 1.050 |
| Wage mean-mean ratio ($w_{mean}/w'_U$) | 1.1001 | 1.0301 | 1.0494 | 1.0494 |
| Wage mean-min ratio ($w'_U/w_{min}$) | 1.0178 | 1.0927 | 1.0095 | 1.0000 |
| % $\Delta$ wages from Ppolarization | 1.615 | 0.888 | 0.897 | 0.897 |
| Job-to-job transition Rate | 0.00957 | 0.00721 | 0.0332 | 0.0332 |
| Unemployment | 0.0477 | 0.325 | 0.0126 | 0.0127 |
| Sep. freq. of low type | 0.0452 | 0.0338 | NA | NA |
| Sep. freq. of high type | 0.0714 | 0.0791 | 0.0494 | 0.0494 |
| Highly-Skewed Separations ($2 \times \lambda_h, 0.5 \times \lambda_l$) | | | | |
| Wage mean-min ratio | 1.129 | 1.133 | 1.068 | 1.060 |
| Wage mean-mean ratio ($w_{mean}/w'_U$) | 1.1115 | 1.0365 | 1.0599 | 1.0599 |
| Wage mean-min ratio ($w'_U/w_{min}$) | 1.0153 | 1.0939 | 1.0083 | 1.0000 |
| % $\Delta$ wages from polarization | 1.699 | 0.959 | 1.171 | 1.171 |
| Unemployment | 0.0300 | 0.257 | 0.0144 | 0.0144 |
| Job-to-job transition rate | 0.00669 | 0.00513 | 0.0267 | 0.0267 |
| Sep. freq. of low type | 0.0293 | 0.0253 | NA | NA |
| Sep. freq. of high type | 0.0667 | 0.117 | 0.0318 | 0.0318 |
| Less-Variable Separations ($0.5 \times \lambda_h, 2 \times \lambda_l$) | | | | |
| Wage mean-min ratio | 1.111 | 1.027 | 1.061 | 1.035 |
| Wage mean-mean ratio ($w_{mean}/w'_U$) | 1.0680 | 1.0268 | 1.0342 | 1.0342 |
| Wage mean-min ratio ($w'_U/w_{min}$) | 1.0401 | 1.000 | 1.0253 | 1.0011 |
| % $\Delta$ wages from polarization | 1.184 | 0.629 | 0.629 | 0.629 |
| Unemployment | 0.0465 | 0.298 | 0.0245 | 0.0245 |
| Job-to-job transition rate | 0.0167 | 0.0128 | 0.0340 | 0.0340 |
| Sep. freq. of low type | 0.0702 | 0.0576 | NA | NA |
| Sep. freq. of high type | 0.0886 | 0.0849 | 0.0749 | 0.0749 |

# 10 Conclusion

In this paper, we explore the impact of UI re-entitlement requirements on job polarization in an environment where the propensity to separate decreases with employment duration. We show that while UI re-entitlement may have positive employment effects, it amplifies the degree of job polarization, the consequences of which are permanent differences in wages for purely unlucky workers. This is because jobs initially exhibit a higher probability of dissolving, leaving unlucky workers with shorter employment durations and degrees of re-entitlement. These unlucky workers experience worse subsequent job placement and are again exposed to higher separation probabilities generating additional job polarization.

We find that re-entitlement and benefit expiry accounts for a 0.8% decrease in average earnings for unlucky workers due to its amplification of job polarization through separation persistence. Further, a worker currently facing high separation probabilities maintains a 10% likelihood of facing the same separation stage of their career even after an additional 100 months have passed. This persistence allows job polarization to reduce average wages of the unlucky workers who cycle through frequent separations by 1.61%, which is 14% of the overall dispersion in wages in the model.

Our findings suggest policy requirements meant to increase employment may have adverse effects that persist when they condition on employment history. Although we abstract from savings and as a result have very little to contribute to a discussion of welfare, typical UI recipients are relatively poor, and may face further frictions that amplify the separation structure present in our model. We believe this deserves consideration in policy discussions, and hope that future work expands on this intuition.

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# A Empirical Robustness

To show that our empirical results showing the role of UI amounts and re-entitlement on the job-finding rate is robust, we consider three alternative specifications: first, we include occupational fixed effects for the occupation of previous employment. Second, we include individuals of all races, while retaining the restriction that they be prime-age and male. Third, we estimate a linear probability model, rather than a logistic regression. We present these results in Table 12.

Next, we consider our re-employment wage findings. We consider three alternative specifications: first, we include hours at an individuals new job, to show that there is an impact on the piece-rate. Second, we include an indicator variable for whether the individual has a positive net worth. Third, we include a restriction that individuals are white in addition to our baseline restriction that they are prime-age and male.. We present these results in Table 13.

Table 12: Logistic Regression Results

| | Base Sample | All Races | Base Sample, LPM |
|---|---|---|---|
| log(UI) (normalized) | -0.286* | -0.107 | -0.027* |
| | (0.159) | (0.0754) | (0.0143) |
| 1 Month to Expiry | -0.641* | -0.0273 | -0.0043 |
| | (0.337) | (0.161) | (0.0312) |
| 2 Months to Expiry | -0.766** | 0.0584 | 0.0024 |
| | (0.343) | (0.145) | (.0282) |
| 3 Months to Expiry | -0.852*** | -0.359** | -0.0806*** |
| | (0.312) | (0.149) | (.0277) |
| 4 Months to Expiry | -1.789*** | -0.267* | -0.0433 |
| | (0.309) | (0.145) | (0.0274) |
| 5 Months to Expiry | -2.834*** | -0.291* | -0.0648** |
| | (0.328) | (0.154) | (0.0290) |
| 6 Months to Expiry | | -0.624 | -0.1098 |
| | | (0.808) | (0.1104) |
| Observations | 1,116 | 3,491 | |
| Occ. FEs | Y | N | |

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 13: Re-Employment Earnings

| | Empirical Sample | Empirical Sample | Calibration Sample (White) |
|---|---|---|---|
| log(UI) 0.142* | 0.168* | 0.194 | |
| | (0.0806) | (0.0988) | (0.156) |
| 1 Month to Expiry | 0.213** | 0.304** | 0.630*** |
| | (0.103) | (0.126) | (0.181) |
| 2 Months to Expiry | 0.228** | 0.321*** | 0.561*** |
| | (0.0908) | (0.110) | (0.176) |
| 3 Months to Expiry | 0.171* | 0.220* | 0.460** |
| | (0.0938) | (0.115) | (0.197) |
| 4 Months to Expiry | 0.179* | 0.301*** | 0.605*** |
| | (0.0935) | (0.114) | (0.213) |
| 5 Months to Expiry | 0.203** | 0.136 | 0.432* |
| | (0.0954) | (0.116) | (0.232) |
| 6 Months to Expiry | 1.635 | 2.242* | 2.215 |
| | (1.044) | (1.296) | (1.357) |
| Constant | 0.0687 | 2.555** | 2.967* |
| | (0.960) | (1.190) | (1.646) |
| Observations | 692 | 714 | 517 |
| R-squared | 0.556 | 0.325 | 0.338 |
| Networth FEs | N | Y | N |
| log(hours) | Y | N | N |

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

# B Proof of Proposition 1

*Proof.* This proof follows the algorithm we use to obtain equilibrium values in the simulations. There are three layers of solution. In Step 1, given a UI policy scheme, $(\tau, \phi, \bar{b})$, and the market tightness function $\theta(i, w)$ we show that the operator $T_V$ that maps the space of worker value functions (characterized by $V_y^i(w)$) into itself is a contraction. In Step 2, we show that, given $(\tau, \phi, \bar{b})$, for any finite wage grid, the implied movement probabilities from the worker's solution that determine the firms' value function, $V_{f,h}^i(w; \theta(i, w))$, can be used to obtain an updated market tightness function, $\theta'(i, w) = n^{-1}(c/V_{f,h}^i(w; \theta(i, w)))$ where $n(\theta) \equiv m(\theta)/\theta$. This mapping is shown to satisfy the requirements of Kakutani's fixed point theorem. Step 3 then looks at how the tax rate, $\tau$, is determined.

**Step 1:** For this step we do not impose a wage grid. Blackwell's sufficient conditions for a contraction, (see **Stokey (1989)** Theorem 3.3) are monotonicity and discounting in the operator, $T_V$, that maps the space of continuous and bounded worker value functions into itself. As expressed above in the set of equations, (4.1) to (4.6), $V_y^i(w)$ represents a real valued function on the space $\mathcal{I} \times \{l, h, u\} \times [\underline{w}, p]$. That $V_y^i(w)$ is continuous then follows from from the Theorem of the Maximum (**Stokey (1989)** Theorem 3.6).

Monotonicity of $T_V$ requires that for any two value functions, $W_y^i(w)$ and $V_y^i(w)$, in the space of bounded and continuous functions under the sup norm, $W_y^i(w) \geq V_y^i(w)$ for all $(i, y, w) \in \mathcal{I} \times \{l, h, u\} \times [\underline{w}, p]$ implies $\left(T_V W_y^i\right)(w) \geq \left(T_V V_y^i\right)(w)$ for all $(i, y, w) \in \mathcal{I} \times \{l, h, u\} \times [\underline{w}, p]$. Using (4.1) to demonstrate, compare

$$V_u^i(w) = \frac{1}{1+r}\Big[b(w) + z + \max_{\tilde{w}}\left\{m(\theta(i-1, w))V_h^{i-1}(\tilde{w}) + (1 - m(\theta(i-1, w)))V_u^{i-1}(w)\right\}\Big]$$

with

$$W_u^i(w) = \frac{1}{1+r}\Big[b(w) + z + \max_{\tilde{w}}\left\{m(\theta(i-1, w))W_h^{i-1}(\tilde{w}) + (1 - m(\theta(i-1, w)))W_u^{i-1}(w)\right\}\Big].$$

As all uncertainty is resolved prior to the worker making a job search choice, we can compare each choice contingent on the realized shocks. As the choice set, $[\underline{w}, p]$, for $\tilde{w}$ is compact, the problem is well formulated and a solution exists. Let $\tilde{w}_V(i', w)$ be the optimal choice for the search-wage when the value function is $V$ and $i'$ is the new entitlement duration. We have

$$V_u^{i'}(\tilde{w}_V(i',w)) \leq W_u^{i'}(\tilde{w}_V(i',w)) \leq W_u^{i'}(\tilde{w}_W(i',w))$$

for $i' = i, i-1$. The first inequality is true by hypothesis. The second is true because $\tilde{w}_W(i',w)$ is optimal for the value function $W$. As $V_u^i(w)$ and $W_u^i(w)$ are simply weighted averages of these outcomes we have $V_u^i(w) \leq W_u^i(w)$ for all $(i,y,w) \in \mathcal{I} \times \{l,h,u\} \times [\underline{w},p]$. Clearly this same logic works for each of the other equations in the set (4.1) to (4.6).

Discounting of $T_V$ requires that for any $a \geq 0$ there exists some $\beta \in (0,1)$ such that $T_V(V_y^i(w)+a) \leq T_V(V_y^i(w)) + \beta a$. As the probability of each shock occurring adds to one, this requirement is obvious and the associated value of $\beta = 1/(1+r)$.

**Step 2:** Let $V_{f,h}^i(w;\theta(.,.))$ represent the value function for the firm who hires a worker with UI entitlement level $i$ at wage $w$, given the market tightness function, $\theta(.,.)$. The worker's propensity to quit comes from their optimal search behavior and the updated market tightness function $\theta'(.,.)$ is obtained from

$$\theta'(i,w) = n^{-1}(c/V_{f,h}^i(w;\theta(.,.)))$$

for each $(i,w)$. Thus the mapping $T_\theta(\theta) \equiv n^{-1}(c/V_f^i(w))(\theta)$ maps the space of market tightness functions into itself. To employ Kakutani's fixed point theorem (see Border (1985) §15.3), however, the space mapped into itself needs to be a compact, subset of a finite dimensional real space. Unfortunately, as $\theta(.,.)$ is a function, the space of possible values is not of finite dimension. However, for any finite grid of values for the wage, $\theta(.,.)$ is simply a matrix which, by stacking the the columns, can be expressed as a vector in finite dimensional real space, $\mathbb{R}^{(IN_w)}$, where $N_w$ is the number of points on the wage grid. The analysis of the worker's value function above was not conducted for a wage grid and the fixed point is a continuous function of the wage. Here, we only need the implied moving probabilities associated with each wage on the grid.

Now, the set of permissible values of $\theta(i,w)$, (i.e. each component of the vector) is bounded below by 0. As the lowest possible wage offer is $\underline{w}$, the highest match value a firm can ever expect, $V_{f,h}^0(\underline{w})$, is certainly less than $(p-\underline{w})/r$. That is, we can establish an upper bound for each element of $\theta(.,.)$ as

$$\bar{\theta} = n^{-1}\left(\frac{cr}{p-\underline{w}}\right).$$

A further requirement of Kakutani's theorem is that the mapping $T_\theta$ should be upper hemi-continuous, with non-empty, convex and compact values. From the Theorem of the

Maximum (**Stokey (1989)** Theorem 3.6), the chosen value of the wage (and hence $\theta$) by the searching worker as a function of the current wage is an upper hemi-continuous (uhc), non-empty and compact valued correspondence. It is not, however, necessarily convex valued. For that we need to recognize that whenever a worker's optimal search wage has more than one possible value, the worker is indifferent between those values. This set of optimal wages can be convexified by allowing for lotteries. When a lottery is chosen, the appropriate value of $\theta$ and hence, quitting probability, $\gamma m(\theta)$, is chosen by the lottery. This value of $\theta$ is the $\tilde{\theta}^{i+1}_{\tilde{y}}(w)$ or $\tilde{\theta}^{i}_{\tilde{y}}(w)$, $\tilde{y} = h, l$ that enters the firm's value function and is not bound by the grid. The implied value of $V^i_{f,h}(w; \theta(.,.))$ is continuous in both $\tilde{\theta}^{i+1}_e(w)$ and $\tilde{\theta}^i_e(w)$. Consequently, $\theta'(i, w)$ is continuous in both $\tilde{\theta}^{i+1}_e(w)$ and $\tilde{\theta}^i_e(w)$. Moreover, continuous functions of uhc correspondences are themselves uhc correspondences (see Border (1985) §11.23). We also know that continuous functions map connected sets into connected sets (see Rudin (1953) Theorem 4.22). This may not be sufficient, though, to imply that the mapping $T_\theta$ is convex valued. But, we can identify the components of $T_\theta(\theta(i, w))$, one dimension at a time. In a single dimension the definitions of connectedness and convexity coincide so $T_\theta(\theta(i, w))$ is an $IN_w$ dimensional cuboid which is convex. Bringing these together we can conclude that $T_\theta$ is an upper hemi-continuous correspondence with non-empty, convex and compact values. Hence, there exists a fixed point, $\theta^*(.,.)$, of $T_\theta$.

**Step 3:** Here we establish existence of a tax rate, $\tau$, that balances the budget for a sufficiently small value of the replacement ratio, $\phi$. For any given value of $\phi$, when $\tau = 0$ there is no revenue collected and the budget cannot be in balance. Meanwhile there is also a maximal sustainable tax rate, $\bar{\tau}(\phi) < (p - z)/z$ above which no vacancy will be posted because, in a steady state, firms cannot make any post-match profit. When $\tau = \bar{\tau}(\phi)$ there is also no revenue and the budget is not in balance. In Steps 1 and 2, we have established that for some finite values of $\phi$ and $\tau$ the block recursive equilibrium exists. In particular it will exist for $\tau = 0$. By inspection of (4.9), regardless of what happens to the wage distribution, on the margin at $\tau = 0$, increasing $\tau$ will increase revenue. So, we know that there is some revenue maximizing value of $\tau$ in $(0, \bar{\tau}(\phi))$ and that the maximal revenue is strictly positive. For large enough values of $\phi$, the UI system will be too generous in that RHS of (4.9) will exceed LHS of (4.9) evaluated at the revenue maximizing value of $\tau$. In that case, a balanced budget equilibrium does not exist. For strictly positive values of $\phi$ sufficiently close to 0 that the cost of the UI system does not exceed the maximal revenue, the existence of a value of $\tau$ that balances the budget follows from the intermediate value theorem. ∎

# C Obtaining Job Separation Parameters

Rather than jointly estimate the parameters $\lambda_h$, $\lambda_l$ and $q_\lambda$ that control the process of exogenous separations into the main estimation with our moments described in the next section, we calibrate them from measured separations in the data. Let $\mu_{\tilde{y}}(t)$, $\tilde{y} \in (h,l)$ represent the remaining measure of workers employed in a job that began $t$ time units ago for each worker type. If we shutdown job-to-job transitions, it is straight forward to show that $\mu_h(t) = \exp -(\lambda_h^* + q_\lambda^*)t$ and,

$$\mu_l(t) = \frac{q_\lambda^*(\exp(-\lambda_l^* t) - \exp(-(\lambda_h^* + q_\lambda^*)t))}{\lambda_h^* + q_\lambda^* - \lambda_l^*}. \tag{C.1}$$

Here, the asterisk, $^*$, is used to designate the continuous time counterpart of the original parameter. Now let $M_{\tilde{y}}(t) = \int_0^t \mu_{\tilde{y}}(s)ds$. Then, the average separation rate between time $t$ and $t'$ is,

$$sep(t,t') = \frac{\lambda_l^*(M_l(t') - M_l(t)) + \lambda_h^*(M_h(t') - M_h(t))}{(M_l(t') - M_l(t)) + (M_h(t') - M_h(t))} \tag{C.2}$$

Of course, as we do have job-to-job movements in the model, this formula is an approximation whose accuracy depends on the length of time $t' - t$. For this reason, we target rates of separation to unemployment over intervals of a single month. We use the first, second, and sixth month separation rates to unemployment in the data as targets. The separation rate model hits these targets exactly. We then obtain the implied discrete time values of the parameters from their continuous time counterparts. For example, $\lambda_h = 1 - \exp(-\lambda_h^*)$.

# D Solution Algorithm and Simulation

Our solution algorithm is largely standard; we do however impose a restriction on the vacancy creation cost to ensure numerical stability. Our dual separation rate structure along with on-the-job search causes the slope of the job-finding rate to become very shallow across nearly all of the wage distribution. This means that without placing a grid point precisely on the wage that corresponds to $m(\theta(w)) = 0$, our solution would potentially embed a large deviation from the free entry condition, in which firms with negative profits post vacancies. With risk-neutral agents, these off-equilibrium wage-tightness offerings often provide the highest expected value (because in expectation the firm is subsidizing the worker). With on-the-job search, this changes the entire equilibrium wage distribution, as other employers must incorporate the prospect of workers searching in off-equilibrium submarkets. This approximation error exists in many BRE models with on-the-job search, but can be mitigated somewhat by including other sources of heterogeneity and shape-preserving interpolation. Here, because $\frac{\partial m(\theta(w))}{\partial w} \approx 0$, we instead require that the wage, $\hat{w}$, that solves $m(\theta(\hat{w})) = 0$, be explicitly included in our wage grid. Because $q(\theta(w))_{w \to \hat{w}} = 1$, we can derive the following expression for the present value of this vacancy:

$$c = \frac{(1-(1+\tau)w)[1+\frac{\beta(q_\lambda(1-\lambda_l))}{(1-\beta(1-\lambda_l))}]}{1-\beta(1-q_\lambda)(1-\lambda_h)} \tag{D.1}$$

which is the present value of a vacancy that recoups only its vacancy creation cost. Each parameter except $c$ is calibrated externally: as a result, we rescale the cost, $c$ to the nearest wage node to ensure that $m(\theta(\hat{w})) = 0$ exists among the set of equilibrium wages. This requires a proportional change in matching efficiency, $m$ to ensure that equilibrium job-finding rates are unaffected. Because the tax rate, $\tau$ enters into this expression, and each segment of any sensible interpolation routine partially depends on the location of each node, we could not credibly differentiate the results coming from changes in our interpolated functions from changes in the equilibrium. As a result, we change the replacement rate to clear the government budget in each of our general equilibrium exercises after estimating $\tau$ for the baseline set of equilibrium wages.

The remainder of our solution algorithm is largely standard: First, we define the grids for the spaces of UI eligibility and wage. UI eligibility is set in [0, 6] in the general equilibrium analysis with 7 grids. Wage is set to be in [0, 1], although as described above, part of this domain is explicitly off-equilibrium.

The steps of the algorithm are as follows:

(1) Solve for $\hat{w}$ given our initial guess of the tax rate, $\tau$, and the preset parameters not included in our calibration. Rescale $m$ proportional to change in initial guess of $c$.

(1) Guess initial value functions of workers and firms given the initial values of the parameters to be calibrated and tax rate ($\tau$).

(2) Given the value function of firms, solve for the market tightness that is consistent with competitive entry of firms.

(3) Solve worker's optimization problem using the shape-preserving Cubic Hermite interpolation to calculate the policy functions. The total number of evaluation points for interpolated wages is 1,000.

(4) Iterate on the value functions of the workers and firms until convergence.

(5) Use the worker and firm policy functions to simulate the economy and recover the ergodic distribution across wage and UI eligibility. To this, we simulate the model 1,000 time periods and take the average of the final 500 periods of simulations.

(6) Repeat (5) 20 times. Calculate average of target moments and check if government budget clears.

(7) Iterate on parameters until the model converges.