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Household Income, Liquidity, and Optimal Unemployment Insurance *

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Abstract

We examine the optimal provision of unemployment insurance (UI) benefits in a directed search model with matching frictions. Workers have differing levels of liquidity to smooth consumption during an unemployment spell. The model allows workers to choose between paying a fixed cost to collect the government provided UI benefits, or to forgo this scheme. Non-collectors do not receive liquid UI benefits, but do experience a shorter expected unemployment duration. Using data from the SIPP and a Mixed Proportional Hazard (MPH) model, we estimate jointly the decision to collect UI benefits and the risk of going back to work, which yields several novel results with policy implications. Households with lower liquidity are less likely to opt into the government UI scheme, as the need to find a job quickly outweighs the short-lived liquidity provided by UI benefits. The MPH estimation also finds that collecting benefits significantly lengthens the duration of unemployment. The model is calibrated to the empirical results. The optimal policy in the calibrated economy features a relatively high replacement rate and short potential duration.

Keywords: unemployment insurance, liquidity, moral hazard, search, calibration
JEL classification: E61, J32, J64, J65

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1 Introduction

Unemployment insurance (UI) benefits provide insurance against the risk of job loss. More specifically, as discussed in Shimer and Werning (2008), UI benefits provide both liquidity and insurance. Liquidity to supplement unemployed consumption, and insurance against an uncertain length of the unemployment spell. For example, the current U.S. system provides roughly 50% of previous weekly earnings (liquidity) for a potential length of 26 weeks (insurance). The optimal provision of UI benefits has generally focused on managing these two components (see for example Wang and Williamson (2002), Shimer and Werning (2008), and Chetty (2008), among many others). These previous analyses assume, however, that all workers collect UI benefits; that is, no alternative exists to the insurance provided by the UI agency. In this paper, we argue that a sizeable fraction of workers choose a different strategy: aiming for very short unemployment spells, which reduces liquidity constraints and allows them to forego collecting benefits entirely. This paper analyzes the relationship between liquidity, insurance, and non-collection, producing novel insights for the provision of UI benefits.

Examining the optimal government provided UI scheme, in an environment where workers can decide between the government UI scheme and a "market-provided" scheme, represents one contribution of this paper. This framework is motivated by the observation that not all workers eligible for the government UI scheme actually collect the benefits. Acemoglu and Shimer (1999) note that in a search model with matching frictions, an economy without government provided UI benefits offers its own insurance in the form of faster job arrivals (and lower wages). Viewed in this way, non-collectors may exist for three reasons: (i) Collecting entails a fixed cost, and either (ii) they do not need the liquidity, or (iii) they need more insurance in shorter unemployment spells. Determining which force drives non-collection is another central question our analysis seeks to untangle.

Using SIPP data, labor market transitions and UI take-up decisions are simultaneously estimated. Liquidity during the unemployment spell represents an important determinant of both the UI take-up decision and the moral hazard effects of UI benefits. Both Chetty (2008) and Birinci and See (2021) use SIPP data and focus on the impact of liquid assets. Chetty (2008) finds that liquidity constrained households are more responsive to changes in the UI benefit level relative to unconstrained households, and Birinci and See (2021) find that UI take-up is higher among households with lower asset to income ratios. While liquid assets certainly play a role in how unemployed individuals respond to UI benefits, Browning and Crossley (2001) show that primary earner status represents the main determinant of consumption changes during an unemployment spell. They argue that this relationship is the result of differences in access to credit markets; primary earner (PE) households have little income during an unemployment spell, and thus lose access to credit markets. Given this, in addition to assets and total income, our empirical analysis also includes data on primary earner status in the household.

Our empirical analysis shows that primary earner status is *negatively* related to the probability of UI take-up and to the unemployment duration, while assets and total household income have little impact on the take-up decision. Thus, our results highlight the importance of accounting for primary earner status. The results also show the liquidity effects highlighted by Chetty (2008) are even stronger: liquidity constrained households may need to find a job so quickly that they optimally forgo UI benefits, since they do not expect to be collecting for a long period.

A directed search model with matching frictions is developed to explain the negative relationship between PE status and UI take-up probability. Analytical results are derived showing that allowing for variable search intensity delivers this negative correlation. Workers with PE status value the liquidity provided by UI benefits; however, their low liquidity also implies a strong need for a short unemployment spell. For high efficacy of search intensity, it may be optimal for PE status workers to forgo the government provided UI benefits in favor of the market-provided "insurance."

The model is calibrated to the empirical results, and then simulated under different policy parameters to determine the optimal level and potential duration of UI benefits. The optimal UI scheme features a relatively high UI benefit level, with a replacement rate close to 100%, and a short potential duration, around 9 weeks. Under the optimal scheme, the UI take-up rate decreases from 54% under the current U.S. scheme, to 17%. Moreover, the unemployment rate decreases from 6% baseline to 3.5% in the optimal scheme. The optimal scheme has these features because of the relatively strong moral hazard effect of UI benefits. Even with a higher generosity, the shorter potential duration makes starting to collect less appealing for individuals who would have anticipated collecting for the whole 26 weeks. Specifically, UI collectors have much longer unemployment durations via their choice of the lower search intensity. The higher benefit levels for short potential durations maximize the liquidity value of UI, while minimizing the impact on search effort. These results further underscore the importance of jointly accounting for UI take-up and job finding probabilities, and how these vary with PE status.

These results are novel in the optimal UI literature. This literature, which is too large to summarize completely here, has generally formed around two different approaches. Determining the fully-optimal scheme, utilizing dynamic-contracting methodology, represents the first approach. Hopenhayn and Nicolini (1997), Wang and Williamson (2002), Mitchell and Zhang (2010), and Fuller (2014), among many others are examples. These papers all consider the optimal timing of benefits, in environments where benefits last forever. The second approach in the optimal UI literature is similar to our approach, which is to consider a Ramsey-type problem: set the benefit level and potential duration, subject to equilibrium conditions of the labor market. Examples include Acemoglu and Shimer (1999, 2000), Lentz (2009), Mitman and Rabinovich (2015), and Birinci and See (2021), again among many others.

This paper makes two primary contributions to the optimal UI literature. First, we explicitly allow workers to decide between a government provided scheme and a market-based scheme; i.e. allowing for endogenous UI take-up. Birinci and See (2021) and Blasco and Fontaine (2021) are two recent exceptions that allow for endogenous UI take-up. Blasco and Fontaine (2021) examine UI take-up in France, focusing on the impact of claiming frictions. Their results focus on quantifying the precise local benefit elasticity, taking into account endogenous take-up. Birinci and See (2021) is the paper most closely related to this one. They focus on the role of heterogeneity of the unemployed, in particular heterogeneity in income, wealth, and UI take-up. Consistent with our work, Birinci and See (2021) find an important role for heterogeneity.

Our paper offers a contribution relative to Birinci and See (2021) on several dimensions. First, our empirical analysis jointly estimates the probabilities of UI take-up and exits to employment. This matters as shorter unemployment durations are associated with lower UI take-up. Moreover, our analysis also controls for the effects of assets, income, but we find these effects are dwarfed by the impact of PE status. These findings combined imply potentially different policy prescriptions.

The paper proceeds as follows. Section 2 presents an empirical analysis of the relationships between liquidity, UI collection, and job finding rates. A simple one-shot model is analyzed in Section 3 to understand the forces underlying the empirical relationships. This one-shot model is extended to a dynamic setting in Section 4. Section 5 calibrates the model and determines the optimal UI scheme, and Section 6 concludes. All proofs are provided in Appendix B.

2 Empirical Analysis

Examining the optimal provision of UI benefits, when workers may decide between a government provided scheme (collection) and a market provided one (non-collection) represents the primary objective of this paper. To determine the relationship between liquidity, insurance, UI take-up, and unemployment duration, this section presents an analysis of SIPP (Survey of Income Program Participants) data. SIPP is a longitudinal household survey that provides simultaneous information on unemployment spells and unemployment insurance take up. Every four months, referred to as a "wave," households are asked to recall the work history of the previous four months. They provide detailed information on their work status on a weekly basis, particularly in terms of layoff or absence from work, the ending of jobs, and the start of new ones. The detailed work history information is necessary to determine eligibility for UI benefits, which we now discuss.

2.1 Take-up Rate Estimation

The UI take-up rate is defined as the fraction of eligible unemployed who collect UI benefits. In the SIPP, individuals are asked if they collected UI benefits during each month and the precise amount received. Thus, determining the UI take-up rate requires determining whom among the unemployed are eligible for UI benefits. UI eligibility is determined by each U.S. State and depends on Monetary and Separation requirements. Detailed eligibility rules were gathered for each state via the U.S. Department of Labor's "Significant Provisions of State UI Laws," available at oui.doleta.gov. Monetary criteria set thresholds for wages and/or hours/weeks worked in the previous year. Separation criteria require individuals are unemployed through no fault of their own. Finally, an individual must also remain unemployed, available for work, and actively looking for work.

To begin, we first code each state's eligibility requirements over time. Then, we are able to determine eligibility using the detailed information on hours worked and wage income in the SIPP.[1] One downside, however, is the need for at least a full year of employment history to verify whether

[1]To ensure that work history is assessed precisely, we exclude spells that start on week one of a wave, since this signals considerable uncertainty in the actual start date.

the monetary eligibility criteria are met. Thus, the first year of each panel is excluded. Several states have a waiting period of one week before workers are allowed to receive benefits. This is taken into account when determining eligibility.

With respect to the separation criteria, the SIPP asks workers the main reason why they were absent, out of work, or why their previous job ended. In this regard, we consider only workers who report being on layoff when computing take-up rates, thus excluding workers who voluntarily quit. Further details on the determination of UI eligibility are presented in Appendix A.1. Similarly to the case of monetary criteria, our precision implies a loss of observations. As seen in Table A.1, only 11.6% of spells are associated with a UI eligible separation.

In addition to the aforementioned eligibility criteria, UI benefits also have a fixed potential duration. In normal times, for example, an individual can collect UI benefits in most states for up to 26 weeks.[2] The SIPP records the amount of state unemployment compensation and any supplemental compensation the individual may receive during a month. However, benefit receipt information is unavailable at the weekly frequency.

This matters with regards to UI eligibility and benefit exhaustion. Given the fixed potential duration of UI benefits, some individuals unemployed for longer than 26 weeks may fail to collect because they have exhausted their benefits. In this case, they are not eligible for UI. Since the benefit receipt information is calculated at a monthly frequency, we are unable to determine if benefits were received in every week during a month, and therefore are unable to determine if an individual exhausted UI benefits. Furthermore, this also implies that we cannot distinguish between the regular program (26 weeks) or extended benefits. Thus, our take-up rate is the fraction of workers who collect any type of benefits, regular or extended, during a month in which they were eligible for at least a week. As a robustness check, we also calculated take-up rates counting anyone unemployed for longer than 26 weeks as ineligible, removing any doubt regarding benefit exhaustion. This change had a negligible impact on the take-up rate.

Figure 1 plots the SIPP estimates of the take-up rate over-time (solid line). Tracking the take-up rate over time creates additional challenges due to the division of the data set into four panels. As discussed above, the first year of each panel is lost because of the need to observe sufficient

[2] In periods of high unemployment, many states have automatic benefit extension triggers. These extend the potential duration of UI benefits either 13 or 20 weeks depending on the state's unemployment rate. From 2008-2013, the Federal government passed legislation creating additional benefit extensions providing UI benefits for up to 99 weeks in some states.

employment history to determine monetary eligibility. When reaching the end of panels, observed spells also become shorter due to censoring. This shortening affects average take-up rates since they may change with the length of the unemployment spell. To avoid this source of bias, we compute take-up rates for each duration and take the average of these rates, weighted by the prevalence of each duration in the entire sample. This solution requires a relatively large sample size for each possible monthly length in each time period, which is often unavailable for longer spells. Hence, to create Figure 1, we restrict the sample to spell durations shorter than 9 months and require at least 5 observations for each monthly spell length. Our measure for the take up rate for the quarter t is thus:

$$\mathrm{TUR}_t = \sum_{m=1}^{8} (\pi_m \mathrm{TUR}_{t,m})$$

where $\mathrm{TUR}_{t,m}$ is the fraction of eligible unemployed collecting UI benefits who have been unemployed for m months. In addition, π_m is the fraction of eligible unemployed who have been unemployed for m months, among those who have been unemployed for a maximum of 8 months, in all time periods. The graph only displays those TUR_t for which each $\mathrm{TUR}_{t,m}$ is computed with at least 5 observations. The grey area in Figure 1 represents the 95% confidence interval.

Figure 1: Take-up Rates Over Time

Over the entire period where sample data permits estimation of the UI take-up rate, the average

UI take-up rate is 54%. This is similar to other estimates of the UI take-up rate in the existing literature. Anderson and Meyer (1997) find a take-up rate around 40% for the period from the late 1970s to early 1980s. Blank and Card (1991) find a take-up rate of 71% for the period from 1977-1987, using CPS data. Auray, Fuller, and Lkhagvasuren (2019) also uses CPS data for the period from 1989-2017, finding a take-up rate of around 77%.[3] Birinci and See (2021) also use SIPP data over a similar time period to our data and find a take-up rate of 55%. Figure 1 also plots the unemployment rate over the same period of time. While the gaps in the SIPP data make the cyclicality somewhat difficult to see visually, the unemployment rate and take-up rates have a positive correlation over this time period. Higher take-up rates obtain in periods of higher unemployment.

2.2 Empirical Model

The dynamic and endogenous nature of the decision of if and when to collect UI benefits suggests a simple linear regression or a binary model may not be appropriate modelling strategies. A natural way to model such a process is a mixed proportional hazard (MPH) model. Specifically, the MPH model describes the hazard rates into UI collection and spell length between different labor market states (i.e. active and inactive search, and employment). The decision to start collecting benefits is obviously endogenous, but the arrival of the information leading to the decision may be considered random. Further, once the unemployed worker starts to collect benefits, the change in the rate of transition to employment is a good indication of the impact of unemployment benefits on the return to work. Further, we jointly estimate the transition from unemployment to employment and the transition into receiving benefits, allowing for unobserved heterogeneity in the underlying risks, as pioneered by Abbring and Van den Berg (2003). Doing so indicates whether workers who have higher chance of finding work quickly also tend to collect less, and whether once they do start collecting, their job finding probability changes, perhaps reflecting a change in search efforts.

To model the decision to collect UI benefits, taking into account its joint relationship with the

[3] Higher take-up rates tend to obtain in the CPS data, as individual level data on UI receipt is unavailable. The CPS is used to determine what fraction of the unemployed are eligible, which is combined with the fraction of unemployed collecting.

spell length, we specify the following hazard model:

$$\theta_{AW}\left(t \mid c_t, x_t, V_{AW}\right) = \lambda_{AW}\left(t\right) \exp\left(x_t \beta_{AW} + \gamma c_t + V_{AW}\right) \tag{1}$$

where θ_{AW} is the hazard rate for going back to work, conditional on time spent unemployed and being actively searching for work. It is modeled as mixed proportional hazards where, $\lambda_{AW}(t)$ is a multiplicative component capturing the baseline dependence between the length of the spell and the hazard rate. It is specified as a linear spline with nodes at durations of 1, 2, 4, 6, 10, 15 and 26 weeks.

The variable x_t is a vector of possibly time-varying characteristics, c_t is a dummy equal to 1 if the worker has started collecting UI benefits, and V_{AW} captures remaining stable unobserved characteristics of individuals that may influence the hazard rates out of unemployment. The 'impact' of collecting on the spell length is captured by the parameter γ, which represents a parameter of particular interest. A negative value for γ implies that collecting UI benefits is associated with longer unemployment durations.

To disentangle whether workers who anticipate longer spells from the beginning start collecting early or whether they may change their search effort once they do start collecting, we jointly estimate the risk of going back to work and the risk of taking up UI benefits. The risk of observing a worker starting to collect is

$$\theta_C\left(t \mid x_{\tau_C}, V_C\right) = \lambda_C\left(t\right) \exp\left(x_t \beta_C + V_C\right).$$

where again θ_C is the hazard rate for starting to collect, $\lambda_C(t)$ is the baseline dependence between the length of the spell and the collecting hazard rate, x_t is a vector of potentially time-varying characteristics, and V_C is the remaining unobserved heterogeneity that may influence the UI collection hazard rate.

The fact that only individuals actively looking for work are entitled to UI benefits presents an obvious concern in estimating θ_C. Estimating $\lambda_C(t)$ without accounting for workers who exit the labor force would confound the decision to stop looking for work with the decision not to collect. One option is to restrict the analysis to workers who are actively looking for work. Since many workers immediately transition from inactivity to work, without spending time in the unemployment pool, this entails the loss of roughly half of all matches. The preferred solution is to explicitly model transitions in and out of the labor market.

This implies three new risks, which are denoted as follows. Let A denote the state of actively searching, I the inactive state, and W the working state. The corresponding risks are denoted by $\theta_{AI}(t \mid x_t, V_{AI})$, $\theta_{IA}(t \mid x_t, V_{IA})$ and $\theta_{IW}(t \mid x_t, V_{IW})$. These represent the risk of transitioning from activity (A) to inactivity (I), from inactivity (I) to activity (A), and from inactivity to work directly (IW), respectively. Of course, a spell of non-employment may include several periods during which a worker actively looks for work and multiple periods of inactivity, implying several transitions from activity to inactivity, and vice versa.

For a spell of non-employment involving J transitions from activity to inactivity, and K transitions from inactivity to activity, the contribution to the likelihood is

$$
\begin{aligned}
&L(V_{AW}, V_C, V_{AI}, V_{IA}, V_{IW}) = \\
&(\theta_{AW}(\tau_{AW} \mid c_{\tau_{AW}}, x_{\tau_{AW}}, V_{AW}))^{I(\tau_{AW})} \exp\left[\int_0^{\min(T,52)} I(\alpha_{AW}(t)) * \theta_{AW}(t \mid c_t, x_t, V_{AW})\, dt\right] \\
&\times (\theta_C(\tau_C \mid x_{\tau_C}, V_C))^{I(\tau_C)} \exp\left[\int_0^{\min(T,52)} I(\alpha_C(t)) * \theta_C(t \mid x_t, V_C)\, dt\right] \\
&\times \prod_{j=1}^{I}\left[(\theta_{AI}(\tau_{AI,j} \mid x_{\tau_{AI,j}}, V_{AI}))^{I(\tau_{AI,j})}\right] \exp\left[\int_{T_{min}}^{\min(T,52)} I(\alpha_{AI}(t)) * \theta_{AI}(t \mid x_t, V_{AI})\, dt\right] \\
&\times \prod_{k=1}^{K}\left[(\theta_{IA}(\tau_{IA,k} \mid x_{\tau_{IA,k}}, V_{IA}))^{I(\tau_{IA,k})}\right] \exp\left[\int_0^{\min(T,52)} I(\alpha_{IA}(t)) * \theta_{IA}(t \mid x_t, V_{IA})\, dt\right] \\
&\times (\theta_{IW}(\tau_{IW} \mid x_{\tau_{IW}}, V_{IW}))^{I(\tau_{IW})} \exp\left[\int_0^{\min(T,52)} I(\alpha_{IW}(t)) * \theta_{IW}(t \mid x_t, V_{IW})\, dt\right]
\end{aligned}
$$

where T_{min} is either 0 or 1 week if there is a waiting period and T is the total length of the jobless spell in weeks. $I(\tau_{AW})$ is an indicator that equals one when the individual transitions from activity to employment, if that transition occurs before the spell is censored at 52 weeks. $I(\alpha_{AW}(t))$ is an indicator that equals one if the individual is actively looking for work at time t. $I(\tau_C)$ indicates when an individual is observed starting to collect and $I(\alpha_C(t))$ indicates that the individual has not started collecting during the present spell and is actively looking for work at time t. $I(\tau_{AI}, j)$ indicates the timing of the j^{th} transition from activity to inactivity and $I(\alpha_{AI}(t))$ indicates that the individual is currently actively looking for work. $I(\tau_{IA}, k)$ indicates the timing of the k_{th} transition from inactivity to activity and $I(\alpha_{IA}(t))$ indicates that the worker is inactive at time t. Finally, $I(\tau_{IW})$ indicates the timing of the transition from inactivity to a job directly if the spells end in this way and $I(\alpha_{IW}(t))$ indicates that the worker is inactive at time t. Note that by construction, $\alpha_{AW}(t) = \alpha_{AI}(t)$ and $\alpha_{IA}(t) = \alpha_{IW}(t)$.

The unobserved heterogeneities $(V_{AW}, V_C, V_{AI}, V_{IA}, V_{IW})$ are allowed to be correlated between processes. This captures correlations between each risk that may still be present in the data, even after controlling for the observable x_t. The V_i's are assumed to be stable for each individual over time. This is necessary as workers are typically observed for short periods, which provides an average of 1.3 spells per individual.

The unconditional likelihood contribution of an individual with n unemployment spells is obtained by integrating $L(V_{AW}, V_C, V_{AI}, V_{IA}, V_{IW})$ over V_{AW}, V_C, V_{AI}, V_{IA}, and V_{IW}:

$$L = \int\int\int\int\int \left(\prod_{i=1}^{n} L_i (V_{AW}, V_C, V_{AI}, V_{IA}, V_{IW}) \right) dG (V_{AW}, V_C, V_{AI}, V_{IA}, V_{IW}).$$

The unobserved heterogeneity $G(V_{AW}, V_C, V_{AI}, V_{IA}, V_{IW})$ is specified as a two-factor loading distribution (see Heckman and Singer (1984), Aitkin and Rubin (1985) and Lindsay (1983) for discrete mixtures).[4] For each hazard $h \in \{AW, C, AI, IA, IW\}$, $V_h = \exp(a_h U_a + b_h U_b)$. We impose as normalization that U_a, U_b are independently distributed on $\{-1, 1\}$, with $\Pr(U_a = 1) = p_a$, $\Pr(U_b = 1) = p_b$. The parameters p_a, p_b and (a_h, b_h), $h \in \{AW, C, AI, IA, IW\}$ are estimated, and one b_h for some h is normalized to zero. This specification does not impose any restriction on the correlations between any two risks. To ensure that $p \in [0, 1]$, it is specified as logit: $p = \frac{\exp(\pi)}{1+\exp(\pi)}$.

2.3 Control Variables

Understanding the relationship between liquidity, unemployment durations (i.e. insurance need), and UI take-up represents a central hypothesis of this paper. Standard search theory implies that those with less liquidity search harder, transitioning to employment faster, on average (see Wang and Williamson (2002) for example). The effects of income and liquidity on the take-up hazard are less certain. Generally, one expects that lower income households and those with less liquidity are more likely to collect UI benefits. They have the higher marginal utility gain from the additional consumption smoothing provided by UI benefits. There is a competing effect, however.

Specifically, workers with shorter expected unemployment durations may be less likely to collect. For example, if the costs of applying for benefits are primarily paid upfront, a worker with a short expected duration is more likely to find the expected benefits of collecting to be less than the

[4] A two-factor loading distribution failed to converge.

upfront cost. Thus, if the low income/liquidity workers also transition to employment much faster, this effect may dominate the marginal utility effect. Therefore, our results below provide valuable insights into how these key aspects interact with each other.

The analysis provides two primary measures of liquidity. First, dummies are included for workers earning at least 75% of their household income. This may be interpreted as comparing primary earner households to dual-earner households. We also include measures of asset income. This is included as dummies for monthly interest income (before job loss), with three categories compared: real income below \$10/month (reference), between \$10-\$50, and above \$50. These two measures of liquidity should capture an individual's ability to smooth consumption during a spell of unemployment. Primary earner households, all else equal, have less ability to smooth consumption, and similarly for higher asset income households.

We also include controls for total household income. While total household income provides some measure of liquidity, it generally provides a better measure of wages/productivity, when taking primary earner status and asset income as given. That is, primary earner status determines the ability to smooth consumption during unemployment (i.e. liquidity), while total household income determines overall consumption levels. Similarly to interest income, we measure three categories of total household income, with the lowest levels the reference group.

Since individuals do not collect when the expected benefit is too low given the costs, it is natural to also consider whether direct administrative costs associated with collecting UI benefits influence take-up decisions. Similarly to Ebenstein and Stange (2010), we infer these costs from the method used to file the unemployment benefit claim. Here we use the average fraction under each method listed in Table 1 for the individual's state of residence.

In addition to the income/liquidity variables, we also include standard demographic variables including dummies for the number of kids, race (white, black and other), union membership, sex crossed with marital status, firm size, and educational achievement. To explore the extent to which political preferences influence the take-up decision, we include dummies for region and for individuals in a state which votes mostly Republican, mostly Democratic, or a swing state in the four general presidential elections of 2000 to 2012. Why include political preferences? These may offer some insight into any role that negative "stigma" plays in the UI collection decision. For example, more conservative voters may view UI collection unfavorably, and thus be less likely to collect in order to avoid this negative stigma. Many time-varying controls are introduced as linear splines to guarantee that hazard rates vary smoothly during spells. This includes time splines, age splines, month splines, and state-level unemployment rate splines. Finally, we also include 16 sector dummies and a dummy for blue-collar workers.

2.4 Results

Table 1 displays the results as hazard ratios and corresponding standard errors computed by the delta method. One, two or three stars indicate whether the underlying coefficient is significantly different from zero at the .1, .05 and .01 levels, respectively. On the issue of liquidity, we find that unemployed individuals from less liquid households appear *less* likely to collect UI benefits. Consider the results on the variable "Earns at least 75% of hh income." From Table 1, these primary earners are around 60% *less* likely to take up UI benefits. They are also over 5 times more likely to transition from actively searching for a job to being back to work. Thus, it appears the aforementioned second effect, short-expected duration making it less likely to collect, is dominating for the low liquidity workers. Another interesting result is the fact that principal earners are 39% more likely to become inactive, suggesting that the liquidity they would gain from collecting UI benefits while being active is not enough to motivate them to search.

Contrary to expectations, having interest income does not seem to influence the willingness to collect, as none of the effects are statistically significant. It is interesting that once inactive, those eligible for benefits with substantial assets have a significantly lower probability of starting to look for work again (column 5 of Table 1).

Total monthly household income has relatively small effects, with only those in the middle range (monthly income between $\$2,000$ and $\$10,000$) significantly more likely to take up UI benefits relative to those with the lowest total monthly income (less than $\$2,000$). The highest income category (more than $\$10,000$) is not significantly different from the lowest group. Again, this result is somewhat surprising, as the lowest-income households would appear to benefit the most from collecting UI. That the middle income group is more likely to collect could stem from two possibilities. First, it could be related to our discussion above for the 75% of household income variable. That is, the lowest income households may need to find a job quickly, and thus do not find the expected benefits of UI worth the upfront cost. The results send mixed signals with regards to

Table 1: Results, Empirical model

Hazards:	Active to job 1	Active to Inactive 2	Take-up 3	Inactive to job 4	Inactive to Active 5
Earns at least 75% of hh income	5.383***	1.392***	0.392***	5.795***	1.712***
	(0.323)	(0.148)	(0.0421)	(0.454)	(0.188)
Monthly interest inc. before j.l.					
Income < 10 (ref.)					
Income bet. 10 and 50	0.943	1.093	1.093	0.997	0.653***
	(0.0888)	(0.129)	(0.122)	(0.0933)	(0.0834)
Income > = 50	0.798	1.021	0.776	0.885	0.603***
	(0.112)	(0.171)	(0.148)	(0.111)	(0.108)
Monthly hh income before j.l.					
Income < 2000 (ref.)					
Income bet. 2000 and 10000	1.293***	1.078	1.145*	1.249***	1.054
	(0.0705)	(0.0790)	(0.0896)	(0.0922)	(0.0863)
Income > = 10000	1.364***	1.276**	1.057	1.347***	0.975
	(0.128)	(0.155)	(0.133)	(0.147)	(0.127)
Union cov./mem.	1.011	0.991	1.365***	0.778**	0.755**
	(0.0787)	(0.106)	(0.142)	(0.0767)	(0.0860)
Blue collar worker	1.100	0.949	1.058	0.936	1.299***
	(0.0659)	(0.0768)	(0.0890)	(0.0770)	(0.116)
Firm size					
Under 25 employees (ref.)					
25 to 99 employees	1.040	1.080	1.002	1.052	1.016
	(0.0579)	(0.0824)	(0.0807)	(0.0775)	(0.0848)
100 employees or more	0.905	1.092	1.174	1.048	1.091
	(0.0495)	(0.0787)	(0.0854)	(0.0726)	(0.0861)
Voting pattern					
Swing (ref.)					
Republican	0.950	1.031	1.100	1.089	0.866
	(0.0571)	(0.0832)	(0.0984)	(0.0781)	(0.0759)
Democrat	1.026	1.020	1.117	1.087	1.038
	(0.0624)	(0.0820)	(0.0975)	(0.0851)	(0.0924)
Race					
White alone (ref.)					
Black alone	0.692***	0.999	0.838*	0.910	1.301***
	(0.0529)	(0.0933)	(0.0846)	(0.0912)	(0.132)
Other	0.863	1.014	0.877	0.930	1.140
	(0.0786)	(0.118)	(0.106)	(0.113)	(0.148)
Regions					
Northeast (ref.)					
Midwest	1.232***	1.053	0.907	1.162	0.846
	(0.0950)	(0.112)	(0.0950)	(0.117)	(0.0969)
South	1.194**	1.180*	0.759**	0.927	0.811*
	(0.0904)	(0.118)	(0.0816)	(0.0912)	(0.0892)
West	1.228***	1.272***	0.811**	1.061	0.841*
	(0.0828)	(0.114)	(0.0801)	(0.0927)	(0.0817)
Marital status*Sex					
Married*Woman (ref.)					
Married*Man	1.043	0.849*	0.999	1.513***	1.243**
	(0.0725)	(0.0753)	(0.0889)	(0.132)	(0.123)
Wid. / Div. / Sep.*Woman	0.774***	0.990	1.342***	1.127	1.274**
	(0.0737)	(0.111)	(0.150)	(0.125)	(0.157)
Wid. / Div. / Sep.*Man	1.016	0.922	1.043	1.194	1.289*
	(0.0997)	(0.122)	(0.129)	(0.160)	(0.192)
Never Married*Woman	0.919	0.916	1.116	1.033	1.179
	(0.0787)	(0.103)	(0.140)	(0.112)	(0.145)
Never Married*Man	0.904	0.774**	0.881	1.064	1.305**
	(0.0723)	(0.0824)	(0.100)	(0.114)	(0.154)

...

Empirical model: (continued)

Hazards:	Active to job 1	Active to Inactive 2	Take-up 3	Inactive to job 4	Inactive to Active 5
Degree					
No degree (ref.)					
High School degree	1.047	0.848**	1.280**	1.077	0.819**
	(0.0705)	(0.0703)	(0.129)	(0.100)	(0.0786)
College degree	1.183**	0.812**	1.418***	1.270**	1.035
	(0.0902)	(0.0775)	(0.153)	(0.132)	(0.110)
Higher degree	1.208	0.718**	1.244	1.413***	1.021
	(0.146)	(0.118)	(0.205)	(0.199)	(0.181)
Cost of collecting					
Increase phone claim			1.018		
			(0.108)		
Increase internet claims			1.033		
			(0.0969)		
Office closed			0.936		
			(0.0977)		
Has started collecting	0.602***				
	(0.0313)				
Constant	0.0202***	0.0112***	0.149***	0.0172***	0.0879***
	(0.00423)	(0.00780)	(0.0454)	(0.00640)	(0.0249)
a	0.575***	0.530***	1.522***	0.875	0.377***
	(0.0427)	(0.0361)	(0.183)	(0.111)	(0.0226)
b	1.284***	0.211**	1.339***	0.472***	1
	(0.0744)	(0.138)	(0.0705)	(0.110)	(0)
p_a			1.000***		
			(0.000)		
p_b			0.617***		
			(0.024)		
Observations			137,154		

*** p<0.01, ** p<0.05, * p<0.1
Note : Odds ratios presented. S. e. in parentheses.

this explanation.[5]

Like Ebenstein and Stange (2010), we do not find a significant link with a change in the way benefits are applied for and the likelihood of taking up UI. While these results appear to show no role for the administrative costs of filing for UI benefits, the procedural costs captured by the filing method may not be the most important dimensions of costs considered by workers. Likely the actual filing method has only a small impact on the cost of filing for benefits. For example, gathering the required wage information to demonstrate eligibility is similar to filing a tax return. In that sense, submitting the tax return online relative to taking it to the post office is only a minor reduction in the overall cost of filing the tax return. These same considerations apply to the costs of filing UI benefits.

[5] Birinci and See (2021) examine heterogeneity in the asset/income ratio and UI take-up. They show that the lowest asset/income ratios have higher UI take-up rates. Our results are not inconsistent with this. Rather, our results highlight that when jointly estimating take-up and unemployment exit hazards, and when further controlling for PE status, these relationships are more nuanced.

Finally, residual unobserved heterogeneity does not seem to play an important role[6], suggesting that most of individual heterogeneity was captured by the controls.

A positive correlation between other household income (measured by the 75% of HH income variable) and UI take-up probability represents the main result from our empirical analysis. Of similar importance is the significantly faster job finding probabilities of this same group. This is consistent with the findings presented in Browning and Crossley (2001). While they do not explore the issue of UI take-up, Browning and Crossley (2001) do find that UI benefits have the largest effect on consumption for single-earner households; that is, single earner households are the most liquidity constrained. The results in Table 1 show that liquidity constrained households are less likely to collect UI benefits, but more likely to find employment.

Below we develop and analyze a search model to capture these empirical features, and then use it to determine the optimal level and potential duration of UI benefits. The analysis begins with a one-shot version of the model, which is extended to a fully dynamic version that is used in the calibration and policy experiments.

3 One-Shot Model

The salient features of the problem are illuminated nicely in the following one-shot model. There exists a large number of risk-averse workers and risk neutral firms. Workers have utility over consumption, with the per-period flow utility denoted by $h(c)$, where $h'(c) > 0, h''(c) \leq 0$. Before searching, the worker also decides whether or not to collect UI benefits. If deciding to collect, the worker pays a fixed up-front cost, denoted by μ. The worker's idiosyncratic cost of collecting is drawn at this time from the distribution $F(\mu)$. When collecting UI benefits, the worker receives flow consumption b.

We also assume that workers have additional household income available to smooth consumption if unemployed. This income is denoted by I. Workers are heterogeneous with respect to I, with the population distribution given by $G(I)$, and support $I \in \left[\underline{I}, \bar{I}\right]$. Furthermore, we assume that this income only contributes to consumption while unemployed, and thus does not affect employed consumption.[7] This assumption is made simply to make the key mechanisms more transparent. It

[6] The estimates for a and b combined with $p_a = 1$ result mechanically in all correlations also being the unobserved heterogeneity being equal to one.

[7] This assumption simply states that the other household income has a larger impact on consumption if unem-

does not ultimately impact the analysis, although quantitatively the assumption of I only available while unemployed matches the data better (quantitative exercises for the alternative model are also available in the online appendix).

Workers have a choice over search intensity. Searching more intensely is costly in utility, but it accelerates the job finding process. Specifically we allow workers a discrete choice of search: search intensely, $s = 1$, or maintain "normal" search intensity, $s = 0$. The utility cost is linear in search intensity, given by νs, for some $\nu > 0$. Thus, flow utility for an unemployed worker with consumption c and search intensity s is given by $h(c) - \nu s$.

It is important to note that $s = 0$ does not represent no search effort, or "inactive" search as it is often referred to. A worker setting $s = 0$ in our context, is simply choosing the lower of two search effort options. All workers have the alternative of "inactive" search via their queue length choices. Thus, an unemployed worker setting $s = 0$ is not to be confused with a non-participant, as the worker is actively searching for work, simply at a lower intensity that an unemployed worker setting $s = 1$.

3.1 Wages and Matching

We assume directed search. Firms post wages and workers direct their search to the wage maximizing their expected lifetime utility (see Moen (1997) or Acemoglu and Shimer (1999) for a similar formulation of the environment).

There exists a matching function, denoted $A(s)m(u, \mathrm{v})$, describing the number of matches formed between the v vacancies opened by a firm offering a job with wage w, and the u unemployed workers searching for the firm's job. Here, $A(s)$ represents the efficacy of job search intensity by workers.[8] By assumption, $A(1) > A(0)$; intensive search is more productive at finding a match. We assume standard properties of the matching function, *i.e.* m is continuous, strictly increasing, strictly concave (with respect to each of its arguments), and exhibits constant returns to scale. Furthermore, $m(0, \cdot) = m(\cdot, 0) = 0$ and $m(\infty, \cdot) = m(\cdot, \infty) = \infty$. Let $q = \dfrac{u}{\mathrm{v}}$ denote the "queue" length.

ployed than if employed. Thus, this assumption really stipulates that the extent to which I closes the gap between unemployed and employed consumption is constant with respect to I.

[8] The search effort here, s, is technically the average search intensity of workers searching for that job. Note, in equilibrium, all workers searching for a job optimally select the same level of search intensity. For brevity, we have excluded the more formal set-up with potentially different individual search intensities.

Given this matching technology, a vacancy is filled with Poisson arrival rate $A(s)m(\frac{u}{\mathrm{v}},1)$. Similarly, an unemployed worker finds a job according to a Poisson process with arrival rate $A(s)m(1,\frac{\mathrm{v}}{u})$. Let $p(q) \equiv m(\frac{u}{\mathrm{v}},1)$ and $f(q) \equiv m(1,\frac{\mathrm{v}}{u})$. Then, the vacancy filling and job finding rates, conditional on job search intensity, are $A(s)p(q)$ and $A(s)f(q)$, respectively.

Based on the empirical results in Table 1, the model must replicate the fact that workers with higher values of I are *more likely* to take-up UI benefits. To analyze this feature, first consider the worker's utility under the option of collecting, denoted by $C(\cdot)$, and not-collecting, denoted $NC(\cdot)$. Workers direct their search taking the expected queue length for that particular wage, $q(w)$, as given. For a worker with other income I, the utility of searching for a particular wage w with expected queue length $q(w)$ and search intensity s, for a collector and non-collector, respectively is:

$$C(I,w,q,s) = A(s)f[q(w)]h(w) + \big(1 - A(s)f[q(w)]\big)h(b+I) - \nu s \tag{2}$$

$$NC(I,w,q,s) = A(s)f[q(w)]h(w) + \big(1 - A(s)f[q(w)]\big)h(I) - \nu s \tag{3}$$

Wages are determined by firms to maximize their profits. Letting V denote the value of posting a job at wage w, given the expected queue length $q(w)$ and expected worker search intensity s, we have:

$$V = -\gamma + A(s)p\big[q(w)\big]\big(y - w\big) \tag{4}$$

Assuming free-entry implies that the value of this vacancy must be zero in equilibrium.

To define an equilibrium in this economy, let $\mathbb{W}$ define the set of all wages offered by some firm, and $Q(w)$ the corresponding queue lengths for every $w \in \mathbb{W}$. An allocation is defined as a set $\Big\{\mathbb{W}, \mathcal{S}, Q, \mathbf{C}(I), \mathbf{NC}(I), \mathcal{M}(I)\Big\}$. This consists of a set of wages, $\mathbb{W}$, a set of search efforts $\mathcal{S}$, a queue length associated with each wage $Q(w)$, sets of indirect utilities, $\mathbf{C}, \mathbf{NC}$, for workers in each possible unemployment state, and the set of workers collecting UI benefits, $\mathcal{M}(I)$. An equilibrium is then defined as follows:

Definition 1 *An equilibrium is an allocation* $\Big\{\mathbb{W}^*, \mathcal{S}^*, Q^*, \mathbf{C}, \mathbf{NC}, \mathcal{M}(I)\Big\}$ *such that:*

1. ***Profit maximization****: for all w and all I,*

$$y - w - \frac{\gamma}{A(s)p[q(w)]} \geq 0 \tag{5}$$

with equality if $w \in \mathbb{W}^*$,

2. ***Optimal job application***: *for all w, all s, and all I,*

$$\mathbf{C}^*(I) \geq C(I, w, Q^*(w), s) \tag{6}$$
$$\mathbf{NC}^*(I) \geq N(I, w, Q^*(w), s) \tag{7}$$

for $Q(w) > 0$, where

$$\mathbf{C}^*(I, s) = \sup_{w' \in \mathbb{W}^*} C(w', Q(w'), s, I) \tag{8}$$
$$\mathbf{NC}^*(I, s) = \sup_{w' \in \mathbb{W}^*} N(w', Q(w'), s, I) \tag{9}$$

3. ***Optimal Search Intensity***: *for $s \in \mathcal{S}^*(I)$ (and $w \in \mathbb{W}^*$),*

$$C^*(I) \geq C(I, w^*(I), Q^*(w^*(I)), \tilde{s}) \tag{10}$$

where $\tilde{s}$ is the complement of s.

4. ***Optimal Take-up***: *A worker $i \in \mathcal{M}(I)$ if and only if $\mathbf{NC}^*(I) \leq \mathbf{C}^*(I) - \mu$, for all I.*

This is a standard definition of equilibrium under directed search. Profit maximization and optimal job application imply that firms earn zero-profits in equilibrium, and select wages taking worker's optimal application responses (choosing wage/queue length combo to maximize utility) as given. Optimal search requires that at the equilibrium wage, w^*, workers select the search intensity maximizing utility. The optimal take-up component of equilibrium simply states that workers select into or out of insured unemployment based on $\mathbf{C}(I) - \mu - \mathbf{NC}(I) \geq 0$. Next we turn to analyzing the properties of this equilibrium.

3.2 Properties of Equilibrium

The first property of an equilibrium is endogenous segmentation of markets. This occurs along two dimensions. First, markets segment according to other income, I, and second, they segment along the UI take-up dimension. Similarly to the effect of I, collecting or not-collecting affects the worker's preferences over wages and queue lengths. This result is summarized as:

Proposition 1 *If an allocation $\left\{\mathbb{W}^*, \mathcal{S}^*, Q^*, \mathbf{C}, \mathbf{NC}, \mathcal{M}(I)\right\}$ is an equilibrium, then any $w_j^*(I) \in$*

$\mathbb{W}^*, s_j^*(I) \in \mathcal{S}^*, q_j^*(I) = Q(w_j^*(I))$, *$j \in \{C, NC\}$ solves*

$$\mathbf{C}(I) = \max_{w,q,s\in\{0,1\}} f^s(q)h(w) + \Big(1 - f^s(q)\Big)h(b+I) - \nu s \tag{11}$$

$$s.t. \quad w = y - \frac{\gamma}{p^s(q)} \tag{12}$$

$$\mathbf{NC}(I) = \max_{w,q,s\in\{0,1\}} f^s(q)h(w) + \Big(1 - f^s(q)\Big)h(I) - \nu s \tag{13}$$

$$s.t. \quad w = y - \frac{\gamma}{p^s(q)} \tag{14}$$

and is such that $\mathcal{M}(I) = \Big\{\mu \,|\, \mu \leq \mu^*(I)\Big\}$, *where*

$$\begin{aligned}\mu^*(I) =& A\big(s_C^*(I)\big)f\big(q_C^*(I)\big)h\Big(w\big(q_C^*(I)\big)\Big) + \Big[1 - A\big(s_C^*\big)f\big(q_C^*(I)\big)\Big]h(b+I) - \nu s_C^*(I) - \\ & A\big(s_{NC}^*(I)\big)f\big(q_{NC}^*(I)\big)h\Big(w\big(q_{NC}^*(I)\big)\Big) - \Big[1 - A\big(s_{NC}^*(I)\big)f\big(q_{NC}^*(I)\big)\Big]h(I) + \nu s_{NC}^*(I)\end{aligned} \tag{15}$$

where $s_j^*(I)$ and $q_j^*(I)$, $j \in \{C, NC\}$, denote the optimal search effort and queue lengths for a collector ($j = C$) and non-collector ($j = NC$).

Consider the UI take-up decision described by Equation (15), which depends on the value of μ drawn by the worker. Specifically, the worker collects if $\mathbf{C}(I) - \mu - \mathbf{NC}(I) \geq 0$, or simply for all $\mu \leq \mu^*(I)$. The UI take-up rate in this one-shot model then is simply $F\big[\mu^*(I)\big]$, and it moves in the same direction as changes in $\mu^*(I)$.

A take-up rate increasing in other income, I, represents the key empirical fact for the model to qualitatively capture. This is accomplished with $\mu^*(I)$ increasing in I, or $\dfrac{\partial \mu^*(I)}{\partial I} > 0$. Denoting $f\big(q_C^*(I)\big)$ and $f\big(q_{NC}^*(I)\big)$ as $f_C(I)$ and $f_{NC}(I)$, respectively, using Equation (15) we can write this expression as:

$$\frac{\partial \mu^*(I)}{\partial I} = \big(1 - A(s_C^*)f_C(I)\big)h'(b+I) - \big(1 - A(s_{NC}^*)f_{NC}(I)\big)h'(I) \tag{16}$$

If $A(s_C^*)f_C(I) = A(s_{NC}^*)f_{NC}(I)$, that is jobs arrive at the same rate for collectors and non-collectors, risk aversion implies that $\dfrac{\partial \mu^*(I)}{\partial I} < 0$, opposite of the empirical facts. Thus, determining the sign of Equation (16) requires analyzing differences in collector and non-collector job arrival rates. The following Lemma describes this.

Lemma 1 *Equilibrium is such that* $A\big(s_{NC}^*(I)\big)f\big(q_{NC}^*(I)\big) > A\big(s_C^*(I)\big)f\big(q_C^*(I)\big)$. *That is, non-*

collectors find jobs faster than the collectors in equilibrium.

Lemma 1 states a simple relationship: the UI collector has higher unemployed consumption, and therefore is willing to wait longer (higher queue length) for a job, all else equal. This result is essential to understanding how the take-up decision changes with other income I. This represents what Acemoglu and Shimer (1999) refer to as "market-generated moral hazard." That is, collecting UI benefits increases the average duration of unemployment, by causing workers to search for higher wage jobs that arrive less frequently, and/or lowering their search intensity (as a note, the Lemma applies to *any* equilibrium allocation of search intensity).

If $A(s_C)f_C(I) = A(s_{NC})f_{NC}(I)$, that is jobs arrive at the same rate for collectors and non-collectors, risk aversion implies that $\frac{\partial \mu^*(I)}{\partial I} < 0$, opposite of the empirical facts. Lemma 1 establishes that $A(s_C)f_C(I) < A(s_{NC})f_{NC}(I)$. Depending on the gap between the collector and non-collector arrival rates, it remains possible that $\frac{\partial \mu^*(I)}{\partial I} > 0$.

To see this, re-arrange Equation (16):

$$\frac{\partial \mu^*(I)}{\partial I} = \underbrace{h'(b+I) - h'(I)}_{X} + \underbrace{A(s^*_{NC})f_{NC}(I)h'(I) - A(s^*_C)f_C(I)h'(b+I)}_{Y}$$

The properties of $h(\cdot)$ imply that $X < 0$. These properties, combined with Lemma 1 imply $Y > 0$. Thus, whether $\frac{\partial \mu^*(I)}{\partial I} < 0$ or $\frac{\partial \mu^*(I)}{\partial I} > 0$ depends on the relative size of each effect. If the gap in Y is large enough, then $\frac{\partial \mu^*(I)}{\partial I} > 0$.

Intuitively, this represents an appealing story that is consistent with other empirical facts established above. Workers with more additional household income (higher I) are more likely to collect UI benefits *if* non-collectors find jobs sufficiently faster than collectors. Thus, workers with relatively low I may not collect simply because they need to find a job quickly. The additional liquidity provided by the UI benefit does not compensate for the need for insurance against the length of the unemployment spell. Under which circumstances this result obtains is the central question. Below we explore the possibilities.

3.2.1 Effects of Risk Aversion

As the curvature of the utility function increases (i.e. risk aversion increases), there are two competing effects. First, all workers, regardless of UI collection status, prefer shorter unemployment durations, making UI take-up less valuable. Second, the increased curvature in the utility function increases the gap between insured and non-insured unemployed consumption, making UI take-up more valuable. The next result shows that in the case of CRRA utility, there exists a parametrization such that UI take-up increases with I.

Proposition 2 *Suppose that $h(c) = \dfrac{c^{1-\zeta}}{1-\zeta}$, then there exists a ζ^* such that $\dfrac{\partial \mu^*(I)}{\partial I} > 0$.*

To see how this result obtains, consider linear utility, $h(c) = c$ (i.e. $\zeta = 0$). Examining Equation (16), we see that $\dfrac{\partial \mu^*(I)}{\partial I} > 0$. Under linear utility, the liquidity value of UI take-up remains constant as I increases; therefore, only the need for insurance against the length of the unemployment spell matters. Since workers with higher I have less need for insurance in the form of shorter durations, they are more likely to collect UI benefits. That is, linear utility holds one half of the liquidity-insurance relationship constant.

Although this particular case uses CRRA (and DARA), the result should be generally true for other utility functions. Since it holds for linear utility, a small increase in risk aversion can be tolerated to maintain $\dfrac{\partial \mu^*(I)}{\partial I} > 0$. How much additional risk aversion may be tolerated then depends on whether $h(c)$ has DARA, IARA, or CARA.

Therefore, one possibility to explain the empirical fact of low take-up in households with one primary earner is via risk-aversion. Our quantitative analysis of this model shows that indeed risk-aversion must remain relatively low for the result to obtain. While this delivers $\dfrac{\partial \mu^*(I)}{\partial I} > 0$, it also implies a relatively low gap in $A(s_C)f_C(I)$ and $A(s_{NC})f_{NC}(I)$; too low to match empirically how much faster non-collector, primary-earner households transition from unemployment to employment. Next we explore an alternative that delivers both key facts.

3.2.2 Effects of Search Intensity

There are two points worth noting. First, the option for non-collectors to search intensively allows them to essentially "buy" additional insurance. By paying the utility cost ν, these workers are able to achieve even shorter unemployment spells. In the absence of the liquidity provided by additional household income, I, this insurance may be very valuable. Indeed, it may be valuable enough to convince such workers to forgo the liquidity and insurance provided by UI benefits. Second, examining Equation (16), the fundamental trade-offs that determine the slope of $\dfrac{\partial \mu^*(I)}{\partial I}$

remain the same. A positive slope requires that $A(s_{NC})f_{NC}(I)$ is sufficiently large relative to $A(s_C)f_C(I)$. The following result establishes that there exists a parametrization that delivers $\dfrac{\partial \mu^*(I)}{\partial I} > 0$.

Proposition 3 *Assume that $b + \underline{I} > \bar{I}$. Then, there exists a search efficacy parameter, $A(1)$, and associated search cost parameter, ν, such that $s^*_C(I) = 0$ and $s^*_{NC}(I) = 1$ are optimal decisions for all I, and $\dfrac{\partial \mu^*(I)}{\partial I} > 0$.*

Proposition 3 obtains because the optimal non-collector job arrival rate, $A(s)f_{NC}$, is increasing in the parameter $A(s)$. Given a fixed $A(0)$, increasing $A(1)$ has the effect of increasing the ratio $\dfrac{A(1)f_{NC}}{A(0)f_C}$, which in turn is the key to achieving $\dfrac{\partial \mu^*(I)}{\partial I} > 0$. For a given $A(1)$, the cost of search, ν, must be selected to ensure $s^*_C(I) = 0$ and $s^*_{NC}(I) = 1$.

The analysis presented in this section establishes the potential reasons why a primary earner would be less likely to collect UI benefits than an unemployed worker in a household with multiple incomes. There exist two possibilities: (i) risk aversion and (ii) sufficiently efficacious search effort. Below we extend this one-shot model to a dynamic version, allowing for relevant features of the current U.S. unemployment insurance system, such as a finite potential duration of benefits.

4 Dynamic Model

Time is continuous and lasts forever. Workers and firms discount the future at rate $r > 0$. There exist two additions to the one-shot model. First, filled jobs receive negative idiosyncratic productivity shocks rendering the match unprofitable with a Poisson arrival rate λ. Second, if collecting UI benefits while unemployed, benefits expire at the exogenous Poisson rate δ. A balanced budget constraint for the UI provider is also imposed. Benefits are financed by a lump-sum tax levied on firms with a filled vacancy. Let τ denote this lump-sum tax.

With these additions, the firm's value functions, for an open and filled vacancy, respectively are,

$$rV = -\gamma + A(s)p\big[q(w)\big]\Big[J(w) - V\Big] \tag{17}$$

Here, J denotes the value of a filled vacancy paying the wage w. This is given by,

$$rJ(w) = y - w - \tau + \lambda\Big[V - J(w)\Big] \tag{18}$$

Under the free-entry assumption, the value of a vacancy is $V = 0$. Combining this with Equations (17) and (18) gives

$$w = y - \frac{\gamma(r+\lambda)}{A(s)p\big(q(w)\big)} - \tau \tag{19}$$

Finally, worker employment-states now include employment, denoted by E. The employed value function is given by,

$$rE(w,I) = h(w) + \lambda\left[\max\Big\{C(I) - \int \mu dF(\mu), NC(I)\Big\} - E(w,I)\right] \tag{20}$$

According to Equation (20), the worker receives flow consumption from the wage, w, and at rate λ the match is destroyed. At this instant, the worker decides whether or not to collect UI benefits. If collecting, the worker draws a cost of collecting, μ, from the distribution $F(\mu)$ and then enters state C. As in the one-shot model, there exists a function $\mu^*(I)$, such that the worker collects UI if $\mu \leq \mu^*(I)$ and does not collect if $\mu > \mu^*(I)$. Given this, the employed value function becomes,

$$rE(w,I) = h(w) + \lambda\left\{F\big(\mu^*(I)\big)\Big[C(I) - \int_0^{\mu^*(I)} \mu dF(\mu)\Big] + \Big(1 - F\big(\mu^*(I)\big)\Big)NC(I) - E(w,I)\right\} \tag{21}$$

Taking w, s, and q as given, the value of collecting and not-collecting, respectively, are given by,

$$rC(I) = h(b+I) - \nu s + A(s)f(q)\Big[E(w,I) - C(I)\Big] + \delta\Big[NC(I) - C(I)\Big] \tag{22}$$

$$rNC(I) = h(I) - \nu s + A(s)f(q)\Big[E(w,I) - NC(I)\Big] \tag{23}$$

4.1 Equilibrium

Equilibrium is defined in the same manner as Definition 1. In the dynamic version, an allocation is extended to include the employed value function. An allocation is thus given by $\Big\{\mathbb{W}, \mathcal{S}, Q, \mathbf{E}(w,I), \mathbf{C}(I), \mathbf{NC}(I), \mathcal{M}(I)\Big\}$. Similarly to Proposition 1, the equilibrium allocation is determined as:

Proposition 4 *If an allocation,* $\Big\{\mathbb{W}^*, \mathcal{S}^*, Q^*, \mathbf{E}, \mathbf{C}, \mathbf{NC}, \mathcal{M}(I)\Big\}$ *is an equilibrium, then any* $w_j^*(I) \in \mathbb{W}^*, s_j^*(I) \in \mathcal{S}^*, q_j^*(I) = Q(w_j^*(I))$*,* $j \in \{C, NC\}$ *solves (where* $\mathbf{E}(w, I)$ *is given by Equation (21))*

$$\mathbf{C}(I) = \max_{w,q,s\in\{0,1\}} \left(\frac{1}{r + A(s)f(q) + \delta}\right)\Bigg(h(b + I) - \nu s + A(s)f(q)\mathbf{E}(w, I) + \delta\mathbf{NC}(I)\Bigg) \tag{24}$$

$$s.t. \quad w = y - \frac{\gamma(r + \lambda)}{A(s)p(q)} - \tau \tag{25}$$

$$\mathbf{NC}(I) = \max_{w,q,s\in\{0,1\}} \left(\frac{1}{r + A(s)f(q)}\right)\Bigg(h(I) - \nu s + A(s)f(q)\mathbf{E}(w, I)\Bigg) \tag{26}$$

$$s.t. \quad w = y - \frac{\gamma(r + \lambda)}{A(s)p(q)} - \tau \tag{27}$$

and is such that $\mathcal{M} = \Big\{\mu \,|\, \mu \leq \mu^*(I)\Big\}$*, where* $\mu^*(I)$ *solves*

$$\int_0^{\mu^*(I)} \mu dF(\mu) = \mathbf{C}(I; \mu^*(I)) - \mathbf{NC}(I; \mu^*(I)) \tag{28}$$

According to Proposition 4, equilibrium wages and queue lengths are determined by maximizing worker utility. As in the case of the one-shot equilibrium, the market naturally segments along the dimensions of other household income, I, and UI collection status, C or NC. The only difference here is that a worker may be in state NC by choice at the time of job loss, or by chance, via expired UI benefits (occurring at rate δ).

In the dynamic model, we must also specify the equilibrium flow equations that determine the steady state stocks of workers in each employment state. Let $n_E(I)$ denote the number of employed workers with other income I, and $n_U^j(I)$ denotes the number of unemployed workers with collection status $j = C, NC$, with other household income I. This implies 3 stock values (for each I) to determine. These follow from the following flow equations:

$$\lambda n_E(I) = f_C(I)n_U^C(I) + f_{NC}(I)n_U^{NC}(I) \tag{29}$$

$$\lambda F\big(\mu^*(I)\big)n_E(I) = n_U^C(I)\Big[f_C(I) + \delta\Big] \tag{30}$$

$$g(I) = n_E(I) + n_U^C(I) + n_U^{NC}(I) \tag{31}$$

Equation (29) equates the flows into and out of employment, Equation (30) equates the flows into and out of insured unemployment, and Equation (31) specifies the population size at each I.

Next denote the total number of workers in employment state $i \in \{E, U\}$, and UI collection state $j \in \{C, NC\}$ by N_i^j. Then, the total number of unemployed workers collecting UI benefits, and the total number not collecting, is given by, respectively,

$$N_U^C = \int_{\underline{I}}^{\bar{I}} n_U^C(I)dI \tag{32}$$

$$N_U^{NC} = \int_{\underline{I}}^{\bar{I}} n_U^{NC}(I)dI \tag{33}$$

The take-up rate is defined as the fraction of eligible unemployed collecting. At each I, the take-up rate is simply $F\big(\mu^*(I)\big)$. The economy-wide take-up rate is thus given by,

$$TUR = \int_{\underline{I}}^{\bar{I}} F\big(\mu^*(I)\big)dG(I) \tag{34}$$

Finally, there also exists the UI budget constraint:

$$bN_U^C = \tau N_E \tag{35}$$

where $N_E = \displaystyle\int_{\underline{I}}^{\bar{I}} n_E(I)dI$.

5 Quantitative Analysis

Calibrating the model of Section 4 and using this calibrated economy to determine the optimal level and potential duration of UI benefits represents the goal of this section.

As discussed in Section 3, the key empirical fact, $\dfrac{\partial \mu^*(I)}{\partial I} > 0$, is generated by either manipulating risk-aversion, or via the efficacy of search intensity. The empirical analysis produces several key moments the calibration targets. These include the overall UI take-up rate, and the "duration-ratio" and "take-up rate-ratio." These ratios compare the respective moment for those primary earners (PE) and non-primary earners (NPE). Thus, the "duration-ratio" is calculated as the average unemployment duration for NPE divided by the average unemployment duration for PE. Similarly for the "take-up rate-ratio." The empirical results in Table 1 show a duration ratio of 5.38, and a take-up rate-ratio of 0.39. Primary earner non-collectors find jobs around 5 times faster than non-primary earner collectors, but are around 60% less likely to collect UI benefits.

To understand the importance of allowing for variable search intensity, consider the model with one baseline level of search intensity. Lemma 1 describes the "market-generated moral hazard" feature of directed search models. Non-collectors prefer to search for jobs offering lower wages, but that arrive faster. This naturally creates a duration-ratio above one. Simulations of the model without search effort show, however, this market-generated moral hazard is insufficient to match the observed duration-ratio. Thus, generating an empirically plausible duration-ratio requires a more traditional moral hazard, in the form of variable search intensity. Our calibration strategy uses both mechanisms to match the empirical facts.

5.1 Calibration

There are several parameters we take directly from the data or other micro evidence. The time-period is taken to be one week, and we set $r = 0.04/52$. UI benefits are set to match an observed replacement rate of 0.5, and the arrival rate of UI benefit expiry is set to match the standard 26 week potential duration of benefits ($\delta = 1/26$). The matching function is specified as Cobb-Douglas, $m(u, \mathrm{v}) = u^{\eta}\mathrm{v}^{1-\eta}$, and we set $\eta = 0.5$. Utility takes on the CRRA form, $u(c) = \dfrac{c^{1-\zeta} - 1}{1-\zeta}$.

The distribution of other household income, $G(I)$, is also taken directly from the data. Specifically, the fraction of total household income is partitioned into deciles, and we calibrate to the fraction of the unemployed population in each decile. The empirical distribution is presented in the Appendix, Figure A.1.

This leaves the following parameters to be determined: $\{\eta, \lambda, \gamma, A(0), A(1), F(\mu)\}$. The job destruction rate, λ, is set to match the average unemployment rate over our period of study (1996-2012), 6%. Next, the parameters ζ, γ, $A(0)$, and $A(1)$ are set to match the total average duration of unemployment over our period of study (20.5 weeks), the ratio of durations among primary earners and non-primary earners (5.382 in our empirical results), the average queue length (2.53 from 2000-2019 from JOLTS data), and to capture $\dfrac{\partial \mu^*(I)}{\partial I} > 0$. The calibration strategy is to use γ (vacancy creation cost) to target the unemployment/vacancy ratio and $A(0)$ (efficacy of lower search effort) targets the average unemployment duration. In each iteration, $A(1)$ (efficacy of intensive search) is set at the lowest level still achieving $\dfrac{\partial \mu^*(I)}{\partial I} > 0$ (with ν, the cost of search parameter, adjusted via Proposition 3), and ζ (coefficient of relative risk aversion) is adjusted to hit the 5.382 duration ratio between primary and non-primary earners.

Finally, we parametrize $F(\mu)$ as a log-normal distribution and select the mean, μ_μ to match the total take-up rate of 54%, and the standard deviation, σ_μ, to match the take-up rate "ratio" between workers with low I (earn at least 75% of total HH income) and workers with high I (less than 75%). According to our empirical analysis, this ratio is 0.39. This calibration strategy yields the following parameters:

Table 2: Parameters

Parameter	Value	Description
r	0.04/52	Discount rate (Weekly time period)
ζ	0.82	Coefficient of Rel. Risk Aversion
b	0.45	UI benefit
λ	0.0057	Job separation rate
δ	0.0385	Arrival rate of UI expiry
γ	1.4	Cost of opening vacancy
$A(0)$	0.065	Efficacy of baseline search effort
$A(1)$	0.13	Efficacy of intense search
η	0.5	Elasticity of job filling rate
ν	1.855	Utility cost of intense search
μ_μ	1.945	Mean of collection cost distribution
σ_μ	0.162	Standard deviation of collection cost distribution

This parametrizations produces the results in Table 3 below. Table 3 also presents one un-

Table 3: Calibration Results

Moment	Data	Model
Unemployment rate	6.0%	6.07%
Avg. Duration	20.5 weeks	20.5 weeks
Duration Ratio	5.38	5.29
TUR	54%	54%
TUR Ratio	0.39	0.39
Dur. Elast. collectors	0.2-1.0	0.23

targeted moment, the elasticity of the unemployment duration with respect to the UI benefit. Here we increase the UI benefit by 10% and measure the response of the average unemployment duration, among UI collectors. The elasticity of 0.23 is in the range found in the literature (see Krueger and Meyer (2002)). The overall elasticity, accounting for changes in the take-up rate, is 1.59.

5.2 Optimal UI Benefits

In this section, we examine the optimal level, b, and potential duration, δ, of UI benefits. To determine the optimal UI parameters, we use the following welfare function:

$$W(b,\delta) = \int_{\underline{I}}^{\bar{I}} n_E(I)\Big\{t_C(I)E(w_C(I),I)+(1-t_C(I))\,E(w_{NC}(I),I)\Big\}+n_U^C(I)C(I)+n_U^{NC}(I)NC(I)dI \tag{36}$$

where $t_C(I) = \dfrac{n_U^C(I)}{n_U^C(I)+n_U^{NC}(I)}$ is the fraction of employment arriving from insured unemployment. This welfare function simply represents a weighted average of worker expected lifetime utilities. With this welfare function, the optimal UI system must satisfy,

$$\max_{b,\delta} W(b,\delta)$$

$$\text{s.t. } (21), (24) - (31)$$

That is, maximize worker welfare, subject to an equilibrium, given b and δ.

Moment	Baseline	Optimal UI
TUR	54%	16.7%
Unemp. Rate	6.06%	3.48%
Avg. Dur	20.1 weeks	9.25 weeks
Avg. Dur Coll.	27.77 weeks	26.7 weeks
Avg. Dur Non-Coll.	4.77 weeks	5.45 weeks
Welfare Gain	–	1.51%

The welfare gain is calculated in consumption-equivalent terms. Let W_{eq} denote the value of Equation (36) under the calibrated equilibrium, and W_{opt} the value at the optimal b^* and δ^*, determined by the program described above. Using the utility parametrization $h(c) = \dfrac{c^{1-\zeta}}{1-\zeta}$, the consumption-equivalent welfare gain is given by:

$$\%\text{ gain } = \left(\frac{W_{opt}}{W_{eq}}\right)^{\frac{1}{1-\zeta}} - 1$$

Section 5.2 presents the results, comparing the optimal benefit scheme to the baseline calibrated scheme. Overall, a change to the optimal scheme produces a steady state consumption-equivalent welfare gain of 1.51%. The optimal benefit level is $b^* = 0.71$, and the potential duration is $\delta^* = 0.11$. The optimal potential duration of benefits is thus $1/\delta^* = 9.1$ weeks. Thus, the optimal scheme prescribes relatively high benefits (liquidity) accompanied by relatively short potential duration (low insurance). This is generally in contrast to the existing literature on UI benefits, that find optimal schemes featuring low benefit levels that last for long periods of time. What explains this difference?

In the existing literature, the moral hazard cost of UI benefits is relatively low. This obtains because UI take-up is either 100% or is exogenous. The addition of the endogenous take-up decision in our framework matters insofar as it allows us to measure the full moral hazard cost of UI benefits. Specifically, in our framework, workers effectively choose between two different UI schemes. The government provided scheme offers higher liquidity, b, and insurance in that b lasts for an average of $1/\delta$ weeks. There is another UI scheme provided: non-collection. While this scheme provides no liquidity, it does provide insurance against a long unemployment duration–firms offer jobs arriving very quickly. The key difference in our analysis is not the inclusion of UI take-up, per-se, but rather the ability to determine how quickly these jobs arrive for non-collectors. Our empirical analysis and calibrated model suggest that including this implies a much higher moral hazard cost of UI benefits: non-collectors find jobs around 5 times faster than collectors.

Given the availability of these very short unemployment durations, the optimal scheme prefers to have more workers in non-collection. The optimal take-up rate is 17% compared to 54% under the current scheme. Indeed, under the optimal scheme, the unemployment rate and average unemployment durations are much lower than under the current U.S. UI scheme–3.48% and 9.25 weeks optimally, compared to 6.07% and 20.5 weeks under U.S. scheme. This is directly the result of the efficacy of searching intensely, which has strong gains in terms of job finding rates. Moreover, note that our baseline model features a benefit-duration elasticity similar to the other studies. Thus, small changes to the UI benefit scheme produce relatively small changes in equilibrium unemployment durations. This occurs because they have a small effect on the UI take-up rate, and thus a small effect on search intensity decisions. Much larger changes in the UI benefit scheme, however, induce much larger changes in behavior.

6 Conclusion

This paper explores the relationship between liquidity, UI take-up, and the optimal UI scheme. SIPP data indicate that primary earner households, those with the highest apparent liquidity need, are the least likely to collect UI benefits. This group also transitions to employment more than five times faster than dual earner households. A directed search model with matching frictions is developed to explain these facts. Analytical results show that delivering these empirical results requires different search intensities between collectors and non-collectors. The calibrated model suggests potentially much stronger moral hazard effects of UI benefits than previously characterized in the literature.

While the model is calibrated to match existing local duration elasticities, larger changes in UI benefit levels and potential duration have much larger effects on the unemployment rate and average duration of unemployment. The optimal UI scheme prescribes much higher benefit levels and a much shorter potential duration, producing a sizable welfare gain. This obtains because of the relatively large gains to higher search intensity. The optimal scheme results in a lower take-up rate, unemployment rate, and average duration of unemployment relative to the current U.S. scheme.

There exist a number of simplifications made in the analysis that relaxing would provide interesting directions for future research. For example, households rely on exogenous sources of liquidity (other household income). Indeed, changes in the UI benefit structure may have non-trivial effects on precautionary savings motives. Including an endogenous mechanism for precautionary savings is an interesting question for future research.

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A SIPP Sample Construction and Details

While the SIPP contains many interesting variables, information regarding unemployment spells are the most important for our analysis. Spells are identified using the SIPP's weekly employment status variable. The employment status variable codes a person in five categories : 1. With job - working; 2. With job - not on layoff, Absent without pay; 3. With job - on layoff, absent without pay; 4. No job - looking for work or on layoff; 5. No job - not looking for work and not on layoff. Categories 1 to 3 are workers with jobs and categories 4 and 5 are workers without jobs[9]. A spell starts when a worker who had a job in the previous week has no job in the current week. The spell ends when the worker goes back to work. The number of hours or the number of weeks in work is not considered for defining spells.

A spell can be censored for three reasons: if the end of the panel is reached, if data is missing from a wave, or if the spell lasts longer than 52 weeks (see Section 2.2). We also consider "Type Z" interview outcomes as missing. These occur when a person's information was not available and is mostly imputed.

An important caveat with the employment status variable is its lack of consistency between each interview. The average probability of a change in status from one week to the next within a four-month wave is 1.5%. However, this probability jumps to 8% between the last week of a wave and the first week of the next. A change in working status should be independent of the change of wave, but this effect persists even when controlling for month or week changes. (see Bound, Brown, and Mathiowetz (2001) for details). This 'seam' effect has obvious consequences on the timing of job changes. One quarter of our initial recorded spells start on the first week of a wave, while 17% of them end on the first week of a wave. Spells starting at the beginning of a wave can be safely removed since they are a random sample of all spells. Spells that end at the beginning of a wave, however, represent a more serious issue as this selection is based on an outcome variable. Removing these observations would bias the exit rate downward. Hence, in the analyses, we choose to keep them in the sample. Doing so may cause imprecision around the seam, but should not affect the average probability of exit.

[9]Note that in category 3, workers were with a job during the specific week, but on layoff or without pay at some point during the four-month wave.

Table A.1: Descriptive statistics (spell level)

Variable	Mean	s.d.	Variable	Mean	s.d.
Will be recalled	0.255	0.436	Married	0.399	0.49
Will collect benefits	0.116	0.32	Wid. / Div. / Sep.	0.148	0.355
Lost job (e.g. layoff)	0.203	0.402	Never married	0.453	0.498
Qualifies for benefits	0.672	0.469	Under 25 employees (ref.)	0.468	0.499
Spell length (week)	28.33	38.87	25 to 99 employees	0.242	0.428
1996	0.1	0.3	100 employees or more	0.29	0.454
1997	0.076	0.265	No degree (ref.)	0.23	0.421
1998	0.055	0.229	High School degree	0.482	0.5
1999	0.047	0.211	College degree	0.24	0.427
2000	0.01	0.097	Higher degree	0.048	0.214
2001	0.084	0.278	Blue collar worker	0.269	0.443
2002	0.058	0.233	Agri., For., Fish., Hunt.	0.026	0.158
2003	0.046	0.21	Mining	0.003	0.056
2004	0.12	0.325	Utilities	0.003	0.058
2005	0.077	0.267	Construction	0.075	0.263
2006	0.044	0.205	Manufacturing	0.097	0.296
2007	0.019	0.138	Wholesale Trade	0.024	0.154
2008	0.057	0.231	Retail Trade	0.144	0.352
2009	0.077	0.267	Transp. and Warehousing	0.03	0.17
2010	0.047	0.213	Information	0.02	0.14
2011	0.036	0.186	Finance and Insurance	0.027	0.163
2012	0.029	0.168	Real Est., Rental, Leasing	0.016	0.124
2013	0.016	0.124	Prof., Scientific, Tech. Serv.	0.043	0.202
Age	35.07	16.29	Manag. of Comp. and Enterprises	0	0.013
Northeast	0.157	0.364	Admin. Sup., Waste Manag., Remed.	0.074	0.262
Midwest	0.257	0.437	Education Services	0.072	0.258
South	0.356	0.479	Health Care and Social Assistance	0.098	0.298
West	0.23	0.421	Arts, Entertainment and Recreation	0.032	0.176
Not in union	0.943	0.231	Accommodation and Food Services	0.127	0.332
Covered by union	0.005	0.073	Other Serv. (except Public Admin.)	0.06	0.237
Member of union	0.051	0.221	Public Administration, replace	0.03	0.17
Man	0.474	0.499			

*Sample not restricted to eligible workers

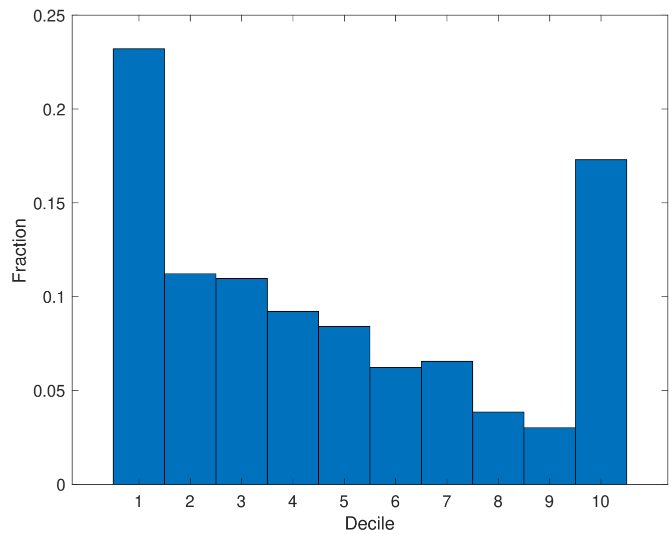

Figure A.1: Empirical Distribution of Other Household Income, I

A.1 UI Eligibility Determination

Monetary eligibility criteria require sufficient earnings in the previous year to qualify for UI benefits. These criteria vary considerably by U.S. state. For example, in 2013, California required at least \$1,300 earned in the Highest Quarter of earnings (HQ), or, \$900 in the HQ with at least 1.25× HQ earned in the past year. For comparison, Connecticut requires at least 40 × WBA in the previous year earnings; here WBA represents the weekly benefit amount, which is itself determined by previous earnings. Most states have various combinations of these two examples for monetary criteria. These criteria also change over time within states.

As discussed above in Section 2, workers must be unemployed through no fault of their own to qualify for UI benefits. This typically makes those who quit their job ineligible, as well as those fired for cause. To determine if separation criteria are satisfied, we keep spells for which workers answered one of the following:

- "What is the main reason ... did not work at a job or business during the reference period?"; Answer: "On layoff (temporary or indefinite)".
- "There are weeks when ... was absent from work without pay. What was the main reason ... was not paid during those weeks?"; Answer: "On layoff (temporary or indefinite)".

- "What is the main reason ... stopped working for ...?"; Answer: "On Layoff", "Job was temporary and ended", "Employer bankrupt" or "Employer sold business".

A.2 Distribution of Other Household Income

In Section 5.1, the model is calibrated to match the distribution of other household income.

B Proofs for One-Shot Model

Proofs of Proposition 1 and Proposition 4: These proofs are omitted here, as the are fairly standard in the directed search literature (e.g. Moen (1997), Acemoglu and Shimer (1999), or Auray, Fuller, and Lkhagvasuren (2019)). The main idea is to (i) show that any equilibrium must satisfy both zero profits (achieved via free entry) and maximize worker utility. If another w and $q(w)$ achieves higher utility, then it must violate zero-profits; then (ii), show that by maximizing worker utility and zero profits, an allocation must be an equilibrium.

The effects of search intensity on job arrival rates play a role in several results/proofs below. The following result characterizes these effects:

Lemma 2 *Let $q_j(I;s), j = \{C, NC\}$ be the optimal queue length, given search effort s, from Equation (11) and Equation (13), respectively. Then, $A(0)f\big(q_j(I;0)\big) < A(1)f\big(q_j(I;1)\big)$.*

Proof: The key insight is to note that $q_j(I;s), j = \{C, NC\}$ denotes the optimal solution to Equation (11) and Equation (13), taking s as given. That is, $\mathbf{C}(I,s) \geq C(I,\tilde{w},q(\tilde{w}),s)$, for any $\tilde{w}$ and $q(\tilde{w})$. Let $w_j(I,s)$ denote the wage associated with $q_j(I,s)$; that is, the wage on the firm's zero-profit curve. Now, suppose instead that $A(0)f\big(q_j(I;0)\big) \geq A(1)f\big(q_j(I;1)\big)$. Since $A(1) > A(0)$ by assumption, the properties of $f(\cdot)$ imply that $q_j(I,0) \leq q_j(I,1)$. This, together with $A(1) > A(0)$ and the properties of $p(\cdot)$ imply $A(0)p(q_j(I,1) > A(0)p(q_j(I,0)$. From Equation (12) and Equation (14), this implies that $w_j(I,0) > w_j(I,1)$. Note, however, that since $A(1) > A(0)$, $A(1)f(q_j(I,0)) > A(0)f(q_j(I,0))$, which implies that $\tilde{w}_1 \equiv y - \dfrac{\gamma}{A(1)f(q_j(I,0))} > w_0$. If this were true, however, then $C(I,\tilde{w}_1,q(\tilde{w}_1),1) > \mathbf{C}(I,1)$, a contradiction to the definition of $\mathbf{C}(I,1)$. ■

Next, we need a result on how unemployed consumption affects the search decision. Towards this end, consider a general unemployed worker, with flow consumption while unemployed of c.

Denoting their indirect utility by $\mathbf{U}(c,q,s)$, and following the analysis in Section 3, we can write:

$$\mathbf{U}(c,q,s) = \max_{w,q,s\in\{0,1\}} A(s)f\big[q\big]h\big[w(q)\big] + \Big(1 - A(s)f\big[q\big]\Big)h(c) - \nu s \tag{37}$$

$$\text{s.t.} \quad w(q) = y - \frac{\gamma}{A(s)p\big[q\big]} \tag{38}$$

Then, the search decision amounts to a comparison of $\mathbf{U}(c,q_1,1)-\mathbf{U}(c,q_0,0)$, where q_1 and q_0 denote the optimal queue lengths, given $s=1$ and $s=0$, respectively. Let $\nu^*(c) = \mathbf{U}(c,q_1,1) - \mathbf{U}(c,q_0,0)$. The next Lemma describes the slope of this function.

Lemma 3 *Assuming c such that non-zero equilibrium queue lengths exist, $\big(\nu^*\big)'\big(c\big) < 0$. That is, higher unemployed consumption makes searching intensively less appealing.*

Proof: By definition of $\nu^*(c)$, $\big(\nu^*\big)'\big(c\big) = \dfrac{\partial \mathbf{U}(c,q_1,1)}{\partial c} - \dfrac{\partial \mathbf{U}(c,q_0,0)}{\partial c}$. Using the definition of $\mathbf{U}$ and the Envelope theorem, we have $\dfrac{\partial \mathbf{U}(c,q,s)}{\partial c} = h'(c)\big[1 - A(s)f(q_s)\big]$. Thus,

$$\big(\nu^*\big)'\big(c\big) = \frac{\partial \mathbf{U}(c,q_1,1)}{\partial c} - \frac{\partial \mathbf{U}(c,q_0,0)}{\partial c} = h'(c)\big[A(0)f(q_0) - A(1)f(q_1)\big] < 0$$

where the < 0 derives from Lemma 2 which implies that $A(0)f(q_0) - A(1)f(q_1) < 0$. ■

The key implication of this result pertains to optimal search effort choices. Non-collectors always search more intensely (or at least as intensely) than collectors. Since collectors have higher unemployed consumption, $\nu^*(b+I) < \nu^*(I)$. Note, a worker sets $s=1$ when the cost of search is such that $\nu < \nu^*$. Thus, we have: (i) if $\nu \le \nu^*(b+I) < \nu^*(I)$, then $s^*_{NC} = 1 = s^*_C$; (ii) if $\nu^*(b+I) < \nu \le \nu^*(I)$, then $s^*_C = 0 < s^*_{NC} = 1$; and (iii) if $\nu^*(b+I) < \nu^*(I) < \nu$, $s^*_{NC} = 0 = s^*_C$. Thus, $s^*_C \le s^*_{NC}$.

We can now prove Lemma 1.

Proof of Lemma 1:

There are several cases to consider, depending on $s^*_j, j = \{C, NC\}$. Lemma 3 implies that $s^*_{NC} \ge s^*_C$; therefore, we only have two cases to consider: (i) $s^*_{NC} = s^*_C$ and (ii) $s^*_{NC} = 1 > s^*_C = 0$. We begin with Case (i): assume that $s^*_{NC} = s^*_C$. Since $q^*_C(I)$ denotes the solution to Equation (11), and q^*_{NC} the solution to Equation (13), by definition, the collector is strictly worse off when searching for the q^*_{NC} job, and vice versa. In other words,

$$A(s^*_C)f(q^*_C(I))\big[h(w^*_C(I)) - h(b+I)\big] + h(b+I) > A(s^*_C)f(q^*_{NC}(I))\big[h(w^*_{NC}(I)) - h(b+I)\big] + h(b+I)$$
$$A(s^*_{NC})f(q^*_{NC}(I))\big[h(w^*_{NC}(I)) - h(I)\big] + h(I) > A(s^*_{NC})f(q^*_C(I))\big[h(w^*_C(I)) - h(I)\big] + h(I)$$

Multiplying these inequalities together and simplifying, we are left with (where notice that by assumption, $A(s^*_C) = A(s^*_{NC})$):

$$h(w^*_{NC}(I))\big[h(I) - h(b+I)\big] > h(w^*_C(I))\big[h(I) - h(b+I)\big] \tag{39}$$

Since $h(I) < h(b+I)$, this implies that $w^*_C(I) > w^*_{NC}(I)$. Then, using Equation (12) and Equation (14) implies that $q^*_C(I) > q^*_{NC}(I)$. Given the properties of $f(\cdot)$, and that $A(s^*_C) = A(s^*_{NC})$, we have $A(s^*_C)f(q^*_C(I)) < A(s^*_{NC})f(q^*_{NC}(I))$, which is the desired result.

Next consider Case (ii): assume $s^*_{NC} = 1 > s^*_C = 0$. Here, we can combine the arguments for Case (i) with the results of Lemma 2. Notice that in Case (i), $s^*_C(I) = s^*_{NC}(I)$, but could be either 1 or 0. Taking the case where $s^*_C = 0$, the Case 1 argument shows that $A(0)f(q^*_C(I; s = 0)) < A(0)f(q^*_{NC}(I; s = 0))$. Then, Lemma 2 shows that $A(0)f(q^*_{NC}(I, s = 0)) < A(1)f(q^*_{NC}(I; s = 1))$, which gives the desired result. ■

Proof of Proposition 2:

Under the assumed utility function, $h'(c) = c^{-\zeta}$. Define the function

$$M(\zeta) = \frac{\partial \mu^*(I)}{\partial I} = \Big(1 - A\big(s^*_C(I)\big)\big(f\big(q^*_C(I)\big)\Big)(b+I)^{-\zeta} - \Big(1 - A\big(s^*_C(I)\big)\big(f\big(q^*_C(I)\big)\Big)(I)^{-\zeta} \tag{40}$$

First notice that $M(\zeta; I)$ is continuous in ζ. Then, consider $\zeta = 0$; that is linear utility. From Lemma 1, $A\big(s^*_C(I)\big)\big(f\big(q^*_C(I)\big) < A\big(s^*_{NC}(I)\big)\big(f\big(q^*_{NC}(I)\big)$, which combined with $b > 0$ implies that $M(0) > 0$. The continuity of $M(\zeta)$ then implies the existence of an $\varepsilon > 0$ such that $M(\varepsilon) > 0$. This establishes the existence of a $\zeta^* > 0$ such that $\dfrac{\partial \mu^*(I)}{\partial I} > 0$. ■.

Next, we turn to the proof of Proposition 3. Some additional results are required. The main idea of the proof of Proposition 3 is that for high enough $A(1)$, the effect of the faster job arrivals for non-collectors outweighs the marginal utility effect, regardless of risk aversion. This hinges on the job arrival rate being unbounded in $A(1)$. While Lemma 2 establishes a job arrival rate increasing in A, it remains to be shown that this is unbounded. Formally,

Lemma 4 *Let the worker's search effort choice be fixed at $s \in \{0,1\}$. Then,* $\lim_{A(s)\to\infty} A(s) f\big(q^*_{NC}(I;s)\big) = \infty$.

Proof: The main idea is to show that $q^*_{NC}(I;s)$ is bounded above as $A(s)$ approaches infinity. This bounds $f(q^*_{NC}(I;s))$ below, implying that the job arrival rate approaches infinity as $A(s)$ does. Towards this end, the equilibrium queue length is thus determined according to Equation (13). Holding s fixed, an equilibrium queue length, denoted $q^*_{NC}(I;s)$ (could be for either a collector or non-collector), must satisfy the FOC for Equation (13) with respect to q:

$$f'(q^*_{NC}(I;s))\Big[h\big(w^*_{NC}(I;s)\big) - h\big(I\big)\Big] + f(q^*_{NC}(I;s))h'\big(w^*_{NC}(I;s)\big)\left[\frac{\gamma p'(q^*_{NC}(I;s))}{A(s)\big(p(q^*_{NC}(I;s))\big)^2}\right] = 0 \quad (41)$$

which simply represents the first order condition with respect to q, where the term $\left[\frac{\gamma p'(q^*_{NC}(I;s))}{A\big(p(q^*_{NC}(I;s))\big)^2}\right]$ represents $\frac{dw(q)}{dq}$ from Equation (14). Taking Equation (41) along with the zero-profit condition,

$$w^*_{NC}(I;s) = y - \frac{\gamma}{A(s)p(q^*_{NC}(I;s))} \quad (42)$$

Thus, Equations (41) and (42) are the two equations determining equilibrium (q^*, w^*). Totally differentiating these produces the following system of equations:

$$A\Big\{f''(q)\big[h(w) - h(I)\big] + f'(q)h'(w)\frac{\gamma p'(q)}{A[p(q)]^2} + f(q)h'(w)Z\Big\}dq +$$
$$A\Big\{f'(q)h'(w) + f(q)h''(w)\frac{\gamma p'(q)}{A[p(q)]^2}\Big\}dw = -A\Big\{f'(q)\big[h(w) - h(I)\big] + f(q)h'(w)\frac{\gamma p'(q)}{A[p(q)]^2}\Big\}dA \quad (43)$$
$$\frac{\gamma p'(q)}{A[p(q)]^2}dq + dw = \frac{\gamma}{A^2 p(q)}dA \quad (44)$$

where $Z = \dfrac{\gamma\Big[p''(q)\big[p(q)\big]^2 - 2\big[p'(q)\big]^2 p(q)\Big]}{A\big[p(q)\big]^4}$. Solving this as a system of two equations in the two unknowns, dq and dw, produces the solution:

$$dq = dA \left(\frac{f'(q)\big[h(w) - h(I)\big] + f(q)h'(w)\frac{dw}{dq}}{A} \right) \tag{45}$$

$$dw = dA \left(\frac{\gamma}{A^3 p(q)} \right) \tag{46}$$

First, notice from Equation (46) that the equilibrium wage is always increasing in A. Second, dq may be positive or negative (given $dA > 0$); this represents the standard substitution vs. income effects. From Equation (45), $\frac{dq}{dA} < 0$ whenever $\Big|f'(q)\big[h(w) - h(I)\big]\Big| > f(q)h'(w)\frac{\gamma p'(q)}{A[p(q)]^2}$.

Since the matching function is homogeneous of degree one, by definition $p'(q) = \frac{\eta p(q)}{q}$ $f'(q) = \frac{(1-\eta)f(q)}{q}$, where η is the elasticity of $p(q)$ with respect to q. Thus, we can rewrite $\frac{dq}{dA}$ as,

$$\frac{dq}{dA} = \frac{f(q)\Big\{(\eta - 1)\big[h(w) - h(I)\big] + h'(w)\left[\frac{\gamma\eta}{Ap(q)}\right]\Big\}}{Aq} \tag{47}$$

If $\frac{dq}{dA}$ remains negative for all $A \geq \underline{A}$, then we are done. Set $\bar{q}$ equal to the $q^*_{NC}(I; s; \underline{A})$ obtaining at $A = \underline{A}$. If instead $\frac{dq}{dA} > 0$ at $A = \underline{A}$, then notice that eventually, there exists an A^* such that $\frac{dq}{dA} < 0$ for all $A \geq A^*$. To see this, notice that as A approaches infinity, the positive term in Equation (47) vanishes, while the negative term remains unchanged. Since eventually $\frac{dq}{dA}$ is negative, q is eventually decreasing. Thus, we can set $\bar{q} = q^*_{NC}(I; s; A^*)$, and we have now shown that $q^*_{NC}(I; s; A)$ is bounded above as $A(s)$ approaches infinity. This in turn implies that $f(q^*_{NC}(I, s); A)$ is bounded below as A approaches infinity. Denote this upper bound as $\bar{f}$. Taking these facts implies:

$$\lim_{A(s)\to\infty} A(s)f\big(q^*_{NC}(I; s)\big) > \lim_{A(s)\to\infty} A(s)\bar{f} = \infty$$

establishing our result. ■.

Proof of Proposition 3:

There are two results to show. First, we show that assuming $s_C(I) = 0$ and $s_{NC}(I) = 1$ for all

I, there exists an $A^*(1)$ such that $\dfrac{\partial \mu^*(I)}{\partial I} > 0$. From Equation (16), we can write:

$$\frac{\partial \mu^*(I)}{\partial I} = \left[1 - A(0) f\left(q_C^*(I,0)\right)\right] h'(b+I) - \left[1 - A(1) f\left(q_{NC}^*(I,1)\right)\right] h'(I) \tag{48}$$

Lemma 4 shows that, holding $A(0)$ fixed, there exists an $A^*(1)$ such that $A(1) f\left(q_{NC}^*(I,1)\right) = 1$. Then, from Equation (48), $\dfrac{\partial \mu^*(I)}{I} = (1 - A(0) f\left(q_C^*(I,0)\right)) h'(b+I) > 0$.

This assumes, however, that collectors still prefer to continue with $s_C = 0$; that is, not to search intensively. As $A(1)$ increases, this also increases the incentives to search. Therefore, we now prove the next part of the result, which claims that there exists a cost of search, ν^*, such that collectors prefer $s = 0$ while non-collectors prefer $s = 1$. Setting ν to discourage intensive search among UI collectors is straight-forward. The issue is to find a ν^* such that non-collectors still wish to search intensively.

To do so, let $\nu_C^*(I) \equiv \mathbf{C}(I; A(1)) - \mathbf{C}(I; A(0))$; that is, $\nu_C^*(I)$ is the cost of search such that a UI collector with other income I is indifferent between searching and not. If we set $\nu^* = \nu_C^*(\underline{I})$, then $s_C^*(I) = 0$, for all I, and $s_{NC}^*(I) = 1$, for all I, which establishes our claim.

Now, to show this, we can use Lemma 3 to establish that (i) $\nu_{NC}^*(\underline{I}) > \nu_{NC}^*(\bar{I})$, (ii) $\nu_C^*(\bar{I}) < \nu_C^*(\underline{I})$, and (iii) under the assumption that $b + \underline{I} > \bar{I}$, $\nu_{NC}^*(\bar{I}) > \nu_C^*(\underline{I})$. Combining these results, we have that $\nu_{NC}^*(\underline{I}) > \nu_{NC}^*(\bar{I}) > \nu_C^*(\underline{I}) = \nu^* > \nu_C^*(\bar{I})$. This implies that $s_{NC}(I) = 1$ and $s_C(I) = 0$, for all $I \in \left[\underline{I}, \bar{I}\right]$. ■

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