

Temporary Layoffs and Unemployment Insurance ^{*}

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Abstract

This paper examines the labor market impact of unemployment insurance (UI), with a particular emphasis on firm layoff behavior. I begin by providing empirical evidence that UI induces temporary layoffs of otherwise employed workers. I then estimate a search and matching model with endogenous job search effort and temporary layoffs. UI induces temporary layoffs through an interaction between worker moral hazard and firm layoff incentives, and perfect experience rating does not fully eliminate UI-driven temporary layoffs. The estimated model suggests that increasing the benefit level and extending the benefit duration have quantitatively different implications for the flow into unemployment.

JEL Classification: J63, J64, J65

Keywords: Unemployment; Layoffs; Unemployment Insurance; Experience Rating

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1 Introduction

Unemployment insurance (UI) is a key social insurance program and an important stabilization policy in the labor market. How it affects labor market outcomes is a classic question, and it remains the subject of a growing body of research. A central focus of this literature is how much UI reduces job search among unemployed workers by distorting their incentives to return to work quickly (Krueger and Meyer 2002, Schmieder and Von Wachter 2016, Le Barbanchon, Schmieder and Weber 2024). Yet, for a comprehensive understanding of the labor market impact of UI, workers and firms cannot be viewed in isolation. Since workers and firms interact in the labor market, the way UI discourages job search may also shape firm behavior. This paper aims to shed light on how workers' job search responses affect firms and equilibrium outcomes through the UI system, thereby offering new insights into the labor market impact of UI.

More specifically, I study the labor market impact of UI with an emphasis on temporary layoffs followed by recalls. Recent empirical evidence shows that temporary layoffs account for about one-third of job losses, and they have important implications for labor market dynamics (Fujita and Moscarini 2017, Gertler, Huckfeldt and Trigari 2024). Temporary layoffs create a connection between workers and firms: if workers intensely search for new jobs upon unemployment, firms may hesitate to put workers on temporary layoffs for fear of losing the option to recall them. This link between workers and firms implies that workers' job search responses to UI changes can directly affect firms' layoff incentives and, in turn, the aggregate labor market.

I start by providing new empirical evidence that UI induces temporary layoffs of otherwise employed workers. Exploiting differential changes in UI benefit levels across states over time in the spirit of Chetty (2008) and Kroft and Notowidigdo (2016), I find that more generous UI benefits induce temporary layoffs of otherwise employed workers. Specifically, I find that 10% increase in UI benefits increases the transition from employment to temporary layoff by 5% while it has almost no impact on separations to permanent layoff.

To understand the exact mechanisms behind the impact of UI on temporary layoffs and explore its aggregate labor market and policy implications, I extend a standard random search and matching with recalls (Fujita and Moscarini, 2017) by adding UI eligibility and experience rating. Being hit by a temporary negative productivity shock, a firm decides

between employment and temporary layoff. Through temporary layoff, a firm can preserve future production opportunities that are lost once the laid-off worker leaves for another employer during temporary layoff. The option of temporary layoff in the model introduces a link between worker search behavior and firm layoff behavior; to the extent that workers search for a new job more intensely, firms worry more about losing the future recall opportunity, becoming more reluctant to put workers on temporary layoff. This link serves as a key channel through which UI induces separations to temporary layoffs. Changing the relative value of unemployment, UI discourages unemployed workers from searching for a job (i.e. worker moral hazard), which is a well-established empirical result in the literature ([Krueger and Meyer 2002](#), [Schmieder and Von Wachter 2016](#), [Le Barbanchon et al. 2024](#)). The worker moral hazard, in turn, makes firms less worried about the possibility of losing the laid-off worker during temporary layoff, which encourages firms to put workers on temporary layoff. In other words, UI serves as a worker retention tool that firms can use during temporary layoff.

With a set of simplifying assumptions, I theoretically explore how the UI system affects temporary layoffs. I analytically show that (i) increasing UI benefits makes firms more willing to place workers on temporary layoff, (ii) experience-rated taxes attenuate the impact of UI, and (iii) perfect experience rating does not fully eliminate UI-driven temporary layoffs. Although perfect experience rating makes UI benefits merely a transfer within a match and therefore keeps the joint surplus resilient to changes in UI benefits, it does not eliminate worker-side moral hazard, and the reduced job search effort caused by UI still increases the value of temporary layoff compared to the case without UI. This result highlights the role of worker job search, or the role of UI as a worker retention tool during temporary layoff, in shaping firms' layoff behavior.

I estimate the model by targeting key features of labor market flows in the U.S. economy. A particularly important parameter for my quantitative analysis is the curvature of the search cost function. The curvature dictates the elasticity of job search and therefore matters for how much policy changes affect firm layoff behavior given the link between worker job search and firm layoff behavior. This parameter is disciplined by the empirical estimates of the impact of UI on worker job search. The estimated model generates the response of temporary layoffs to UI that is quantitatively consistent with my reduced-form estimate even though it is not targeted in the estimation.

With the estimated model, I first ask how much of temporary layoffs are driven by UI benefits by removing UI from the model. This reduces the probability of temporary layoff by 45%, suggesting that a large fraction of temporary layoffs in the baseline economy is driven by public UI. I next study what happens if firms are fully liable for the fiscal cost of separations through perfect experience rating. As mentioned, the theory suggests that perfect experience rating does not fully eliminate UI-driven temporary layoffs since the reduced job search gives an incentive for a firm to put workers on temporary layoff. Quantitatively, I find that perfect experience rating eliminates about 75% of the UI-driven temporary layoffs but still a sizable number of temporary layoffs remain in the economy.

I next study the implications of temporary layoffs for the design of the UI system. In particular, I explore how the presence of temporary layoffs affects the labor market impact of two key UI policy levers: the benefit level and the potential benefit duration. Ex-post heterogeneity in layoff status results in different targeting properties of these two policy levers. Data suggest that workers on temporary layoff get reemployed about twice as quickly as those on permanent layoff, which is captured by the model. As a result, extending benefit duration is largely irrelevant for workers on temporary layoff; both the worker value of temporary layoff and the worker search behavior are irresponsive to benefit duration. In turn, this leads to a muted impact of extending benefit duration on firms' layoff incentives. In contrast, increasing the benefit level strongly affects workers on temporary layoff, and firms respond by changing their layoff behavior. Overall, extending benefit duration has a smaller impact on the unemployment rate because it does not increase the inflow into unemployment. This result provides a justification for the literature's focus on the flow out of unemployment when studying the extension of potential benefit duration (e.g., [Rothstein 2011](#), [Farber and Valletta 2015](#), [Johnston and Mas 2018](#), [Chodorow-Reich](#), [Coglianese and Karabarbounis 2019](#), [Acosta, Mueller, Nakamura and Steinsson 2023](#)), and it is consistent with recent empirical evidence by [Karahan, Mitman and Moore \(2025\)](#).

Related literature. The theory of temporary layoffs, especially in the context of unemployment insurance, dates back to the seminal work by [Feldstein \(1976\)](#) and [Baily \(1977\)](#), followed by, among others, [Burdett and Wright \(1989a\)](#) and [Burdett and Wright \(1989b\)](#). These papers emphasize the subsidy aspect of UI in an environment where workers are permanently attached to a firm, which is removed by perfect experience rating. In addition

to the subsidy aspect of UI, I emphasize the role of reduced search effort during temporary layoff caused by UI, which I refer to as a retention aspect of UI, and I theoretically show the retention aspect does not go away even under perfect experience rating.

The empirical literature on the UI impact on layoffs is relatively thin compared to the voluminous literature on the UI impact on job finding as discussed by [Le Barbanchon et al. \(2024\)](#). In early years, [Feldstein \(1978\)](#) and [Saffer \(1982\)](#) use a cross-sectional variation in UI benefits to find a positive correlation between temporary layoffs and UI generosity. More recent papers exploit plausibly exogenous variations and recent methodological advancement in program evaluations to provide causal evidence of UI generosity on separations to unemployment ([Tuit and van Ours 2010](#), [Lalive, van Ours and Zweimüller 2011](#), [Albanese, Picchio and Ghirelli 2020](#), [Jäger, Schoefer, Young and Zweimüller 2020](#), [Hartung, Jung and Kuhn 2022](#)), which do not make a distinction between temporary and permanent layoffs. I contribute to the literature by providing empirical evidence that more generous UI increases temporary layoffs in ways those temporary layoffs replace employment, not permanent layoffs.

The model in this paper is built on recent development in equilibrium search and matching framework ([Mortensen and Pissarides, 1994](#)). In particular, [Fujita and Moscarini \(2017\)](#) introduce recalls and aggregate shocks to [Mortensen and Pissarides \(1994\)](#) in a tractable way and study implications of recalls on unemployment fluctuations. In this vein, [Lam and Qiu \(2022\)](#) extend [Fujita and Moscarini \(2017\)](#) to study life-cycle patterns of recalls. [Albertini, Fairise and Terriau \(2023\)](#) study experience rating in a similar model but without job search intensity, and their focus is on recall decisions instead of separations to temporary layoff unemployment. In contrast, [Gertler et al. \(2024\)](#) build an alternative model where the loss of recall options during temporary layoffs due to the exit of firms affect unemployment fluctuations and use the estimated model to study a policy during the Covid recession. Although my model is built on these papers in terms of the modeling framework, my focus is on the interaction between worker job search and firm layoff behavior, and its implications for unemployment insurance policies.

In a broad sense, this paper also contributes to the literature on social insurance programs that emphasize firm-side responses and equilibrium effects ([Acemoglu and Shimer 1999](#), [Pries and Rogerson 2005](#), [Blanchard and Tirole 2008](#), [Jung and Kuester 2015](#), [Mitman and Rabinovich 2015](#), [Landais, Michaillat and Saez 2018b](#), [Landais, Michaillat and Saez 2018a](#), [Aizawa, Kim and Rhee 2022](#), [Aizawa, Mommaerts and Rennane 2023](#)). I add to the literature

by demonstrating that firms' layoff decisions play an important role in shaping how labor market equilibrium responds to UI policy changes through their layoff behavior.

2 Background and Empirical Evidence

2.1 Temporary Layoffs: Definition, Measurement, and Some Facts

An unemployed worker is classified as being on temporary layoff if the worker has been given a date to return to work or expects to return to work within six months.¹ This definition is given by the Bureau of Labor Statistics (BLS), which is used in the design and publication of the Current Population Survey (CPS). The literature follows this definition (e.g. [Fujita and Moscarini 2017](#), [Gallant, Kroft, Lange and Notowidigdo 2020](#), [Gertler et al. 2024](#), and [Hall and Kudlyak 2022](#)). Throughout this paper, I refer to all other unemployed workers as being on permanent layoff although some of them are quitting.²

Since the prevalence of temporary layoffs are widely documented in recent studies cited above, I just briefly outline their key features here. I relegate detailed sample construction and data patterns to Appendix [A.1](#). I focus on workers in private sectors over 2001-2018. In this sample, I find that 14% of unemployed workers are on temporary layoffs while 29% of the inflow to unemployment is accounted for by temporary layoffs. The difference between the stock and flow of temporary layoffs comes from the fact that workers on temporary layoff quickly get reemployed. Specifically, the monthly job finding rate of workers on permanent layoff is 22% while that of workers on temporary layoff is 50%. Although I cannot distinguish between a transition from temporary layoff to a new employer and a previous employer in the CPS, [Fujita and Moscarini \(2017\)](#) use the Survey of Income and Program Participation to show that more than 80% of workers on temporary layoff return to previous employers.

It would also be worth mentioning that although temporary layoffs tend to be linked to seasonality, it is not entirely the case. The displaced worker supplement of the CPS 2002-2018 suggests that, among workers who lost a job during the past three years, only 4.3% of them report that they lost a job because of the completion of a seasonal job, which is small relative to the share of temporary layoffs among job losses mentioned earlier.

¹See <https://www.bls.gov/cps/definitions.htm#reasons>

²Note that permanent layoff does not mean workers are permanently unemployed.

2.2 Impact of Unemployment Insurance on Temporary and Permanent Layoffs

In the U.S., workers on temporary layoff can receive UI benefits, and unlike permanently laid-off workers, workers on temporary layoffs are exempt from job search requirements of the UI programs.³ This feature of the UI system implies that firms, when hit by a temporary negative shock, can let the government pay their employees during unproductive periods by putting them on temporary layoff to save costs.

To examine this implicit subsidy aspect of UI, I estimate the impact of UI benefits on separations to unemployment, making a distinction between temporary and permanent layoffs. UI programs in the U.S. are a joint state-federal program run by state governments. Although basic rules are set by the federal government, each state sets UI benefit levels differently, generating variations across states over time that can be exploited in an empirical analysis.⁴

The generosity of UI benefits depends on two variables: the weekly benefit amount (WBA) and the potential benefit duration (PBD). The individual-level WBA is a mostly linear function of previous wages, but it is subject to a minimum and a maximum. The minimum WBA, the maximum WBA, and the slope in between all differ across states, but only the maximum WBA is frequently changed over time, partly to keep pace with inflation. The PBD does not depend on previous wages and is uniformly applied to all workers in a state. Unlike the maximum WBA, the PBD rarely changes over time, and it is 26 weeks in most states, with a few exceptions in recent years. In addition, during recessions, workers may qualify for Extended Benefits (EB), a permanent federal–state program that provides additional weeks of UI once state unemployment rates exceed certain thresholds. In severe downturns, Congress sometimes legislates temporary programs such as Emergency Unemployment Compensation (EUC), which further lengthen benefit durations on a temporary basis.

I follow a commonly used approach of estimating a two-way fixed effects model that exploits differential changes in the WBA across states over time (Chetty 2008, Kroft and Notowidigdo 2016, Hsu, Matsa and Melzer 2018). The basic idea is to compare layoff patterns

³See <https://oui.doleta.gov/unemploy/pdf/uilawcompar/2023/nonmonetary.pdf>

⁴I describe the UI system in detail in Appendix B.

across states that experience different trajectories in UI benefit levels. I measure the level of UI benefits by the average WBA in each state and period, as reported by the BLS.⁵

A main concern with this empirical strategy is that the WBA may be correlated with time-varying state characteristics. Hsu et al. (2018) and Gaillard and Kankanamge (2025) define *Max Benefit* as the product of the maximum WBA and the regular PBD, excluding EB and EUC extensions, and they confirm that changes in *Max Benefit* are not correlated with state-level economic conditions or transfers after controlling for state fixed effects and time fixed effects.⁶ Since variations in *Max Benefit* are mostly driven by the maximum WBA, the maximum WBA should be largely orthogonal to local economic conditions. Nevertheless, I control for observed local labor market conditions in the estimation.

Another concern is that although the maximum WBA may be orthogonal to time-varying state variables, the average WBA actually received by workers—which I use as the treatment variable—might be correlated with them, since it depends on the composition of workers and the average wage. I address this concern in two ways. First, I control for the state-level average wage. Second, I use the maximum WBA as an instrument for the average WBA, thereby isolating the variation in the average WBA that comes from changes in the maximum WBA.

Lastly, states might be differently exposed to EB and EUC extensions over time, which might confound the estimated effect of the regular benefits. I address this concern by estimating the impact using (i) the full sample period and (ii) a restricted sample that excludes 2002–2004 and 2008–2013, when EB and EUC extended benefit durations in some states.

Specifically, I estimate the linear probability model with two-way fixed effects given by

$$y_{istm} = \beta \log b_{st} + x'_{istm} \gamma + \eta_s + \mu_{tm} + \varepsilon_{istm}, \quad (1)$$

where the outcome y_{istm} is either (1) an indicator for the transition from employment to temporary layoff or (2) an indicator for the transition from employment to permanent layoff for individual i in state s in year t and month m . The treatment variable b_{st} is the average WBA in state s in year t , x_{istm} is a vector of covariates of individual i , η_s is state fixed effects, μ_{tm} is year-month fixed effects, and ε_{istm} is an error term. Individual-level demographic controls include age, education, sex, race, and the full interactions among them together with

⁵See https://oui.doleta.gov/unemploy/ui_replacement_rates.asp.

⁶See Table 3 of Hsu et al. (2018).

Table 1: UI Impact on Separations to Unemployment: Average Weekly Benefit

	OLS		IV	
	TL	PL	TL	PL
	(1)	(2)	(3)	(4)
log (average benefit)	0.194** (0.089)	-0.036 (0.124)	0.342*** (0.105)	-0.163 (0.164)
Average outcome	0.39	1.03	0.39	1.03
Elasticity	0.50	-0.04	0.88	-0.16
Observations	5,219,805	5,219,805	5,219,805	5,219,805
R-sq	0.05	0.05	0.05	0.05

Note: This table reports the estimation results of the linear probability model (1). Data are from the CPS 2001-2018. The outcome variable is an indicator function multiplied by 100. The treatment variable is the log of the average weekly benefit amount in each state and year. The implied elasticity is calculated by dividing the estimated coefficient by the average outcome. Survey weights are used in the regression. Standard errors are clustered at the state level. * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$.

years. I also control for year specific dummies for 3-digit occupations, 3-digit industries, and regions. Furthermore, I flexibly control for the local labor market conditions by including in covariates the third-order polynomials of the log of the number of unemployed workers and the number of job openings each month, which come from the Job Openings and Labor Turnover Survey (JOLTS).

Table 1 shows the estimation results using all the sample periods 2001-2018. In estimating the regression coefficients, I multiply the outcome variable by 100 so that the estimated coefficients represent percentage point impacts. In the first two columns, I obtain the estimated coefficients of 0.194 for separations to temporary layoff unemployment and -0.036 for separations to permanent layoff unemployment. These estimated coefficients suggest that a 10% increase in UI benefits leads to a 5% increase in the probability of separations to temporary layoff unemployment and a 0.4% decrease in the probability of separations to permanent layoff unemployment although the latter is not statistically significant. Importantly, since the impact on permanent layoff is not statistically significantly negative, this suggests that UI induces temporary layoffs in a way those temporary layoffs replace employment, not permanent layoffs. The last two columns show the case where I use the maximum WBA as an instrument for the average WBA. I find a even larger impact on temporary layoffs while the estimated coefficient for permanent layoffs remain statistically insignificant.

Table 2: UI Impact on Separations to Unemployment: Excluding Recessions

	OLS		IV	
	TL	PL	TL	PL
	(1)	(2)	(3)	(4)
log (average benefit)	0.304*** (0.098)	-0.037 (0.158)	0.318*** (0.103)	-0.221 (0.184)
Average outcome	0.34	0.93	0.34	0.93
Elasticity	0.89	-0.04	0.93	-0.24
Observations	2,414,018	2,414,018	2,414,018	2,414,018
R-sq	0.05	0.05	0.05	0.05

Note: This table reports the estimation results of the linear probability model (1). Data are from the CPS 2001-2018, excluding 2002-2004 and 2008-2013. The outcome variable is an indicator function multiplied by 100. The treatment variable is the log of the average weekly benefit amount in each state and year. The implied elasticity is calculated by dividing the estimated coefficient by the average outcome. Survey weights are used in the regression. Standard errors are clustered at the state level. * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$.

Table 2 reports the results based on the restricted sample that excludes 2002-2004 and 2008-2013. I confirm that the impact on temporary layoffs remains positive and statistically significant while the impact on permanent layoffs remain insignificant.

Experience rating. UI benefits are financed by taxes on firms, and one striking feature of the UI system in the U.S. is that UI taxes are experience-rated. A firm’s UI tax rate increases based on the total amount of benefits collected by workers the firm has laid off in the past, relative to its total payroll. Experience rating, in effect, serves as a firing tax where the size of the tax depends on the amount of benefits collected. One might wonder why UI still induces temporary layoffs, even though layoffs are taxed. It is worth mentioning that the experience rating in the UI system in the U.S. is far from perfect in the sense that only a fraction of the benefits collected by laid-off workers is passed through to the UI taxes paid by the firm. Pavosevich (2020) documents that, on average, 29% of UI benefits collected by laid-off workers are directly passed on to the taxes paid by the firm.

3 Model

The model is built on a standard random search and matching model with endogenous separations (Mortensen and Pissarides, 1994) and its extension by Fujita and Moscarini (2017). I introduce UI eligibility and imperfect experience rating to the model. Motivated by the empirical results in the previous section, I assume that temporary layoffs are endogenously determined and can response to changes in UI benefits while I treat permanent layoffs as exogenous.

3.1 Setup

Time is discrete and runs forever. There is a unit measure of homogeneous risk-neutral workers and a large measure of risk-neutral homogeneous firms. Both workers and firms live infinitely and have a common discount factor $\beta \in (0, 1)$.

Workers. Workers are either employed or unemployed and either eligible for UI or not. Only unemployed workers, be it temporary or permanent, are engaged in job search. In each period, workers receive utility from consumption c and disutility $\psi(s)$ from job search. The job search effort is a continuous variable $s \geq 0$ that affects the probability with which a worker finds a vacant job. I assume that $\psi(s)$ satisfies $\psi(0) = \psi'(0) = 0$ and strictly increasing and convex for $s > 0$. Employed workers consume wages while unemployed workers consume home production b_H and, if eligible, public UI benefits b . Eligibility status ϕ takes either 1 (eligible) or 0 (not eligible).

Firms. Firms open a vacancy by paying a flow recruiting cost κ that needs to be paid in each period until the position is filled. A match of a firm and a worker with match productivity z produces output $y(z) = \bar{y} \cdot z$ where $\bar{y}$ is a scale parameter. The initial match productivity is given by z_0 , which is assumed to be large enough so that the match is formed and immediately starts producing output. In each period, one of the two types of idiosyncratic shocks can hit match productivity. First, with probability δ , a permanent shock hits and productivity gets 0 permanently, and the match is destroyed. Second, with the remaining probability $1 - \delta$, a temporary shock hits and new productivity z' is updated according to $\log z' = \rho \log z + \sigma \epsilon$ where $\epsilon \sim N(0, 1)$. I assume that match productivity is

persistent $\rho > 0$. I denote the whole process by $F(z'|z)$, which is decreasing in z .

I follow [Fujita and Moscarini \(2017\)](#) and assume that firms and workers can stop production without destroying a match. Match productivity keeps evolving according to the same process $F(z'|z)$ while the match is inactive. I refer to separations induced by a permanent shock δ as permanent layoff and endogenous separations induced by ϵ as temporary layoff as only the latter can lead to subsequent recalls.

Labor market. The mass of matches formed each period is given by a constant returns to scale matching function $m(\bar{s}, v)$ where $\bar{s}$ is the aggregate search effort and v is a measure of aggregate vacancies. I define market tightness by $\theta = \frac{v}{\bar{s}}$. An unemployed worker who exerts job search effort s meets a vacancy at rate $s\mu(\theta)$ where $\mu(\theta) = \frac{m(\bar{s}, v)}{\bar{s}} = m(1, \theta)$, and a vacancy meets a worker at rate $\mu(\theta)/\theta$.

Wage determination. Wages are determined according to Nash bargaining and renegotiated each period with worker bargaining power γ , taking future wages as given. I denote by $w(z, \phi)$ the Nash bargained wages.

UI benefits, eligibility, and financing. Workers are initially not eligible for UI benefits upon employment, and switch to being eligible with probability p_{gain} each period, which is intended to capture the actual UI system where workers need to earn sufficient wages to be eligible for UI benefits. During unemployment, eligible workers receive UI benefits b but eligibility expires with probability p_{lose} each period. These stochastic changes in eligibility allow me to keep stationarity of the model without adding unemployment duration as another state variable.⁷

UI benefits are financed by two types of taxes. One is a uniform tax $\tau \geq 0$ and the other is an experience-rated tax $\tau_e \in [0, 1]$. Firms pay τ each period while they produce output. Upon laying off a worker, a firm pays the fraction τ_e of the total amount of UI benefits that the laid-off worker will collect in the future. Let u be the mass of unemployed workers, and u_ϕ be the mass of unemployed workers of eligibility status $\phi \in \{0, 1\}$. The government

⁷[Mitman and Rabinovich \(2015\)](#) and [Chodorow-Reich et al. \(2019\)](#) take the same approach for tractability.

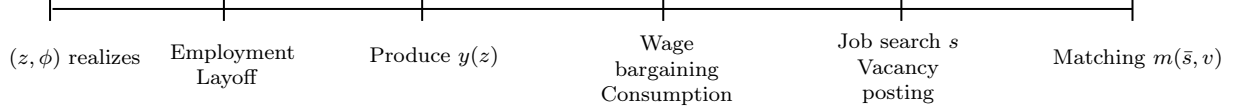


Figure 1: Timing within a Period

budget constraint is given by

$$(1 - u) \cdot \tau + u_1 \cdot \tau_e \cdot b = u_1 \cdot b. \quad (2)$$

The left-hand side is the revenue from the uniform taxes (first term) and the experience-rated taxes (second term). The right-hand side is the spending on UI benefits paid to unemployed workers. $\tau_e = 0$ is the case without experience rating where UI is financed by uniform taxes on firms. In contrast, $\tau_e = 1$ is the perfect experience rating where a firm that lays off a worker is fully liable for the fiscal cost of UI benefits collected by the laid-off worker.

Timeline. Figure 1 displays the timing of events within a period. (i) At the beginning of a period, new match productivity z is drawn from $F(z|z_{-1})$ where z_{-1} is previous match productivity, and UI eligibility status ϕ stochastically changes. For a newly created match, initial productivity z_0 and initial UI eligibility $\phi = 0$ are assigned. (ii) Given z , a firm makes an employment / layoff decision. (iii) If the firm is active, it produces output $y(z)$ with its worker. (iv) The firm pays a bargained wage $w(z, \phi)$ to its worker. A worker consumes $w(z, \phi)$ if employed and an unemployed worker consumes home production b_H and, if eligible, public UI benefits b . (v) Unemployed workers choose job search intensity s , and potential entrants post vacancies in the frictional labor market. (vi) Given aggregate search intensity $\bar{s}$ and aggregate vacancies v , the matching function $m(\bar{s}, v)$ generates new matches of workers and firms.

3.2 Value Functions

In what follows, I focus on a steady state economy.

Workers. Let W denote the value of employed workers, U denote the value of unemployed workers. They satisfy the following Bellman equations.

$$W(z, \phi) = w(z, \phi) + \beta \mathbb{E}_1 [\bar{W}(z', \phi') \mid z], \quad (3)$$

$$U(z, \phi) = b_H + b\phi + \max_s \left[-\psi(s) + \beta \left(s\mu(\theta)W(z_0, 0) + (1 - s\mu(\theta))\mathbb{E}_0 [\bar{W}(z', \phi') \mid z] \right) \right], \quad (4)$$

Equation (3) is the Bellman equation for employed workers where the first term is a wage and the second term is the expected continuation value where $\bar{W}(z', \phi')$ encodes the employment status of the next period. The expectation $\mathbb{E}_1[\cdot \mid z]$ is taken over the distribution of future productivity z' conditional on current productivity z and also over the possibility of gaining eligibility that happens with p_{gain} . The subscript 1 is intended to emphasize that the expectation operator is different from when a worker is unemployed. Equation (4) is the Bellman equation for unemployed workers with the possibility of recalls. Unemployed workers choose job search intensity s trading off the disutility of job search against the expected gain from job search. Importantly, if the worker does not meet a new firm, the future value is given by $\mathbb{E}_0[\bar{W}(z', \phi') \mid z]$ because of recall options. The expectation $\mathbb{E}_0$ is taken over the distribution of future productivity z' conditional on current productivity z and also over the possibility of losing eligibility that happens with p_{lose} . If productivity recovers, the worker gets recalled by the previous employer, which is captured by $\bar{W}(z', \phi')$. Note that the value of permanent layoff is given by $U(0, \phi)$. Since $z = 0$ is an absorbing state, there is no possibility of recalls. In what follows, I denote by $s(z, \phi)$ the solutions to job search problem.

Firms. Let J denote the value of an active job, V the value of an inactive job. The value functions satisfy the following Bellman equations.

$$J(z, \phi) = y(z) - w(z, \phi) - \tau + \beta \mathbb{E}_1 [\bar{J}(z', \phi') \mid z], \quad (5)$$

$$V(z, \phi) = -\tau_e b\phi + \beta(1 - s(z, \phi)\mu(\theta))\mathbb{E}_0 [\bar{J}(z', \phi') \mid z]. \quad (6)$$

Equation (5) is the Bellman equation for active jobs where the first three terms of equation (5) is the flow profit, and the last term is the expected continuation value. Equation (6) is

the Bellman equation for inactive jobs where the first term of equation (6) is experience-rated taxes, and the second term captures future production opportunities preserved by temporary layoff. If future productivity is high, the firm recalls the worker and produces again, which is encoded in $\bar{J}(z', \phi')$. Importantly, the value of a temporary layoff depends on the worker decision $s(z, \phi)$. To the extent that the worker searches more intensely, the firm is more likely to lose connection to the previous worker, which results in the loss of future production opportunities.

Note that the value of permanent layoff $V(0, \phi)$ is not zero but instead τ_e fraction of the expected UI benefits collected by the previous worker because of the experience rating.

One can assume that a firm with an inactive job searches for a new worker by paying a flow recruiting cost κ . However, I later impose the free entry condition, which ensures that firms have no such an incentive in equilibrium.

3.3 Wage Bargaining and Temporary Layoffs

When a match is active and produces output, a wage is determined according to the Nash bargaining with worker bargaining power γ . Since wages are perfectly transferrable, the Nash bargained wage $w(z, \phi)$ is determined such that

$$(1 - \gamma) \cdot (W(z, \phi) - U(z, \phi)) = \gamma \cdot (J(z, \phi) - V(z, \phi)). \quad (7)$$

I define the joint surplus by $S(z, \phi) = (W(z, \phi) - U(z, \phi)) + (J(z, \phi) - V(z, \phi))$. The Bellman equations imply that the joint surplus satisfies the following recursion.

$$\begin{aligned} S(z, \phi) = & y(z) - b_H - \tau - (1 - \tau_e)b\phi + \psi(s(z, \phi)) \\ & + \beta \left(\mathbb{E}_1 \left[K(z', \phi') \mid z \right] - \mathbb{E}_0 \left[K(z', \phi') \mid z \right] \right) \\ & - \beta s(z, \phi) \mu(\theta) \left(W(z_0, 0) - \mathbb{E}_0 \left[K(z', \phi') \mid z \right] \right), \end{aligned} \quad (8)$$

where $K(z, \phi)$ is the joint value of the match, be it active or idle, and given by

$$K(z, \phi) = U(z, \phi) + V(z, \phi) + \max\{S(z, \phi), 0\}. \quad (9)$$

The first line on the right-hand side of equation (8) is the net flow value of the match, the second line is the difference in the future joint value because of the potential difference in the expected eligibility changes, and the last line is the net loss from the worker turnover during temporary layoff.

Equation (7) implies that the values of employment for workers and firms satisfy

$$W(z, \phi) = U(z, \phi) + \gamma S(z, \phi), \quad (10)$$

$$J(z, \phi) = V(z, \phi) + (1 - \gamma)S(z, \phi), \quad (11)$$

where employed workers get γ fraction of the joint surplus on top of the unemployment value while firms get the remaining part of the surplus on top of the value of the idle job. The Nash bargaining (7) implies that the endogenous separation of a worker and a firm is jointly efficient. This implies that the continuation values are

$$\bar{W}(z, \phi) = \max\{W(z, \phi), U(z, \phi)\}, \quad (12)$$

$$\bar{J}(z, \phi) = \max\{J(z, \phi), V(z, \phi)\}. \quad (13)$$

3.4 Steady State Equilibrium

Free entry. I impose a free entry condition that pins down market tightness. Firms can freely enter the labor market, driving down the expected value of setting up a new vacancy to zero. Specifically, I have

$$0 = -\kappa + \beta \frac{\mu(\theta)}{\theta} J(z_0, 0), \quad (14)$$

where the first term is the vacancy posting cost and the second term is the vacancy-filling rate times the expected value of a new job.

Steady state worker stocks and flows. I denote by $G(z, \phi)$ the joint distribution of workers over match productivity z and eligibility status $\phi \in \{0, 1\}$ such that it is added and integrated to 1: $\sum_{\phi \in \{0, 1\}} \int_0^\infty dG(z, \phi) = 1$. I relegate the derivation of the distribution $G(z, \phi)$ to Appendix C. Let $\mathbb{I}_u(z, \phi) = \mathbb{1}\{S(z, \phi) < 0\}$ an indicator for unemployment. The

mass of unemployed workers of eligibility status ϕ is given by

$$u_\phi = \int_0^\infty \mathbb{I}_u(z, \phi) dG(z, \phi), \quad (15)$$

and the unemployment rate is

$$u = \sum_{\phi \in \{0,1\}} u_\phi. \quad (16)$$

The mass of UI eligible unemployed workers u_1 is used to determine the revenue neutral uniform tax τ . The aggregate search effort is given by $\bar{s} = \sum_{\phi=0,1} \int_0^\infty \mathbb{I}_u(z, \phi) s(z, \phi) dG(z, \phi)$.

Steady state equilibrium. Given a UI policy $(b, \tau_e, p_{\text{gain}}, p_{\text{lose}})$, a steady state equilibrium consists of value functions $\{W, U, J, V\}$, a bargained wage function w , worker job search effort functions s , the market tightness θ , the distribution of workers $G(z, \phi)$, and the mass of unemployed workers u_ϕ , and the uniform tax τ that solve the Bellman equation, the Nash bargaining, the job search problem, the free entry condition, the steady state conditions, and the government budget constraint.

3.5 Temporary Layoffs and Unemployment Insurance

I discuss the layoff incentives of a firm (or a match) and how they interact with UI. For notational brevity, I focus on UI-eligible workers ($\phi = 1$) and set $y(z) = z$, $\delta = 0$, and $b_H = 0$. I consider an existing match in period t with productivity z and eligibility $\phi = 1$, assuming that the model ends in period $t + 1$.

I make the following simplifying assumptions for analytical tractability: (i) I fix $\tau = 0$ and $\mu(\theta) = 1$, (ii) An outside job offers an exogenous wage $\bar{w} > b$, (iii) I let $\gamma = 0$ and $\rho = 0$, and denote the distribution of z by $F(z)$, (iv) UI benefits are small enough that $b < \mu_z$, where μ_z is the mean of F .

The first assumption effectively means this is a partial-equilibrium analysis, ignoring the government's budget constraint and the free-entry condition. The second assumption requires that a new job offers a sufficiently high wage so that unemployed workers on temporary layoff exert positive search effort. The third assumption imposes vanishing bargaining power and idiosyncratic match productivity over time, which greatly simplifies the analysis by making both the second-period recall wage and the optimal job search effort depend only

on b . The last assumption requires the UI benefit b not to be too large.

Since bargaining power is set to 0, the second period wage upon recall is simply b . Then, the joint surplus of the match is

$$S(z; b, \tau_e) = z - (1 - \tau_e)b + \psi(s(b)) - \beta s(b) \left(\bar{w} - \mathbb{E}[\max\{z', (1 - \tau_e)b\}] \right), \quad (17)$$

$$s(b) = \arg \max_s \left\{ -\psi(s) + \beta \left(s \bar{w} + (1 - s)b \right) \right\}. \quad (18)$$

Since the joint surplus is strictly increasing in z , there exists a cutoff $\bar{z}(b, \tau_e) > 0$ at which the joint surplus hits zero unless the job search is too costly. If z is below the cutoff, workers are placed on temporary layoff.

Now I consider how unemployment insurance (UI) benefits affect the joint surplus and the cutoff $\bar{z}(b, \tau_e)$. First, the optimal search effort $s(b)$ is decreasing in b —the standard moral hazard effect of UI. Although this is intuitive, it partly relies on the maintained assumption that the outside wage $\bar{w}$ does not scale with b . This assumption is justified in the general model developed in the previous subsections: upon finding a new job, workers are initially ineligible for UI, and UI benefits do not serve as an outside option at the time of reemployment.

A higher UI benefit b reduces the joint surplus and therefore raises the cutoff $\bar{z}(b, \tau_e)$ through two channels. First, under imperfect experience rating ($\tau_e < 1$), a larger outside option directly lowers the current-period flow surplus and also lowers the continuation value. Second, a higher b reduces optimal search effort $s(b)$, reinforcing the increase in the cutoff.

With perfect experience rating $\tau_e = 1$, the joint surplus simplifies to

$$S(z; b, 1) = z + \psi(s(b)) - \beta s(b) \left(\bar{w} - \mathbb{E}[\max\{z', 0\}] \right). \quad (19)$$

In this case, the joint surplus no longer depends directly on b —perfect experience rating effectively makes UI benefits an internal transfer within the match—and b enters only through the optimal search effort $s(b)$. However, even under perfect experience rating, higher b still reduces search effort. The resulting reduction in $s(b)$ lowers the joint surplus and raises the cutoff, and therefore perfect experience rating does not fully eliminate the effect of UI benefits on the cutoff $\bar{z}$.

The impact of UI on temporary layoffs under perfect experience rating in this model

contrasts with the classical argument that UI mainly serves as a layoff subsidy [Feldstein \(1976\)](#), and that perfect experience rating eliminates that aspect.⁸ The subsidy aspect applies to my environment as well; UI serves as a layoff subsidy in the sense that it directly reduces the joint surplus in the same way as providing subsidies to firms for stopping operation. Importantly, however, UI also serves as a *retention tool* during temporary layoffs since it reduces turnover during temporary layoff. This retention aspect of UI remains even under perfect experience rating, which highlights the role of job search in shaping temporary layoffs in my model.

I summarize the discussion above as a proposition and provide a formal proof in Appendix [D.1](#).

Proposition 1. *Suppose the assumptions (i)-(iv) are satisfied. Then there exists a unique productivity cutoff $\bar{z}(b, \tau_e) \in [0, \infty)$ such that workers with productivity below the cutoff are placed on temporary layoff. Moreover, if the cutoff $\bar{z}(b, \tau_e)$ is strictly positive, it satisfies the following properties:*

1. *The cutoff is increasing in UI benefits b for any $\tau_e \in [0, 1]$: $\frac{\partial \bar{z}(b, \tau_e)}{\partial b} > 0$.*
2. *If $s(b)$ is sufficiently small, experience rating attenuates the impact of UI benefits: $\frac{\partial^2 \bar{z}(b, \tau_e)}{\partial \tau_e \partial b} < 0$.*

The comparative statics are given explicitly by

$$\frac{\partial \bar{z}(b, \tau_e)}{\partial b} = (1 - \tau_e) \left[1 - \beta s(b) F(\hat{b}) \right] + \frac{\beta^2}{\psi''(s(b))} \left(\mathbb{E}[\max\{z', \hat{b}\}] - b \right), \quad (20)$$

$$\frac{\partial^2 \bar{z}(b, \tau_e)}{\partial \tau_e \partial b} = -1 + \beta s(b) \left(F(\hat{b}) + \hat{b} f(\hat{b}) \right) - \frac{\beta^2}{\psi''(s(b))} F(\hat{b}) b, \quad (21)$$

where $\hat{b} = (1 - \tau_e)b$.

Proof. See Appendix [D.1](#). □

Note that the proposition provides closed-form expressions for these effects. The equations highlight that the *curvature* of the job search disutility function plays a central role.

⁸In [Feldstein \(1976\)](#), what matters for a firm's employment choice is what he refers to as the net UI subsidy, $\frac{[(1-t_b)-(1-t_y)e]b}{1-t_y}$, where t_b is the tax on UI benefit income, t_y is the tax on wage income, and e is the degree of experience rating (τ_e in my model). If $t_y = t_b$, then UI benefit b has no impact under perfect experience rating.

Intuitively, curvature governs how strongly search effort responds to changes in UI benefits. From the job search first-order condition, $\psi'(s(b)) = \beta(\bar{w} - b)$, it follows that

$$s'(b) = -\frac{\beta}{\psi''(s(b))}. \quad (22)$$

Thus, the closer ψ is to linear, the larger the response of search effort to changes in b . Since the value of temporary layoff depends on the probability that a worker exits for another employer, a stronger behavioral response amplifies the sensitivity of the cutoff to UI.

In this sense, the curvature of the search disutility function is a crucial parameter for quantifying the impact of UI on temporary layoffs. In the estimation, I discipline this parameter by ensuring that the model's implied search response to UI is consistent with existing quasi-experimental evidence.

Note that the cross-partial effect relies on the assumption that the job-finding probability $s(b)$ is sufficiently small. In Appendix D.2, I derive a sufficient condition that depends only on β σ and then evaluate it at a plausible value. Specifically, for $\beta = 1$ and $\sigma = 0.1$ —which is close to my estimate in Section 4—the sufficient condition is $s(b) < 0.20$. In both the data and the model, workers on temporary layoff find a job with monthly probability below 0.15 (see Section 4.4), suggesting that this condition is reasonable.

Although the assumptions $\rho \rightarrow 0, \gamma \rightarrow 0$ allow me to get a sharp prediction, it is restrictive and I relax them later in the quantitative analysis. Nevertheless, these mechanisms highlighted here translates into the aggregate equilibrium impact of UI policy changes in Section 5.

Once match productivity is assumed to be persistent over time, not just the cutoff but also the entire distribution of workers matter for the aggregate rate of temporary layoffs. For brevity, I keep assuming that all workers are eligible for UI $\phi = 1$ and suppress the dependence on ϕ , and there is no exogenous permanent layoff $\delta = 0$. Then, the probability of transitioning from employment to temporary layoff for a match with productivity z is given by $F(\bar{z}|z)$ where I omit the dependence on (b, τ_e) for notational brevity. The average probability of employed workers transitioning to temporary layoff is given by

$$p_{TL} = \int_{\bar{z}}^{\infty} F(\bar{z}|z) dG_e(z; \bar{z}), \quad \text{where} \quad G_e(z; \bar{z}) = \frac{G(z; \bar{z})}{1 - G(\bar{z}; \bar{z})} \quad (23)$$

where G_e is the distribution of *employed* workers over productivity, and I make it explicit that the stationary distribution of workers depends on the endogenous cutoff $\bar{z}$. The impact of UI benefits on temporary layoff probability can be written as

$$\frac{dp_{TL}}{db} = \frac{\partial \bar{z}}{\partial b} \cdot \left[\underbrace{\int_{\bar{z}}^{\infty} f(\bar{z}|z) dG_e(z; \bar{z})}_{\text{Direct cutoff effect}} \underbrace{- g_e(\bar{z}; \bar{z}) F(\bar{z}|\bar{z})}_{\text{Selection at margin}} + \underbrace{\int_{\bar{z}}^{\infty} F(\bar{z}|\bar{z}) d(\partial_{\bar{z}} G_e(z; \bar{z}))}_{\text{Reshuffling of } G_e(z; \bar{z})} \right], \quad (24)$$

where $\partial_{\bar{z}}$ is a short-hand notation for $\frac{\partial}{\partial \bar{z}}$. The first term in the bracket captures the direct effect of the change in the cutoff: raising the cutoff mechanically raises the chance of falling below it next period, averaged over the current distribution.

The second term in the bracket captures the selection effect. When $\bar{z}$ rises, matches right at the margin drop out of the conditioning set $z > \bar{z}$. To the extent that matches dropping out of the conditioning set are riskier (i.e., higher $F(\bar{z} | \bar{z})$), this term negatively contributes to the overall effect.

A change in the cutoff can also shifts the distribution of employed workers G_e since workers dropping out of the conditioning set $z > \bar{z}$ can find a new job, reshuffling the entire distribution. If the induced reweighting places relatively more mass near the cutoff, the last term is positive; if it moves mass away from the cutoff, the term has a negative contribution.

Note that if match productivity is idiosyncratic over time so that $F(\bar{z} | z) = F(\bar{z})$, then the second term and the third term cancel out and the overall impact is simply the product of the change in the cutoff and the density at the cutoff $\frac{dp_{TL}}{db} = \frac{d\bar{z}}{db} \cdot f(\bar{z})$.

Overall, although the change in the cutoff matters, the entire effects depend on various primitives such as the shape of F , and worker search behavior and firms' job creation that affects $\partial_{\bar{z}} G_e(z; \bar{z})$.

4 Estimation

In this section, I first add a few realistic features of the UI system to the model, and then estimate model parameters. I estimate the model at a monthly frequency.

Table 3: List of Parameters Externally Set or Normalized

Parameter	Description	Source	Value
β	Discount factor	Annual interest rate of 5 percent	0.996
α	Matching function elasticity	Petrolongo and Pissarides (2001)	0.50
γ	Worker bargaining power	Hosios condition	0.50
$\bar{m}$	Matching efficiency	Normalization	1.00
δ	Exogenous destruction	Permanent Layoff Probability	0.01
b	Public UI benefit	Average benefit amount from BLS	1.40
b_H	Home production	Unemployment consumption	1.42
τ_e	Experience rating	Pavosevich (2020)	0.29
p_{gain}	Probability of getting eligible	9 months	0.11
p_{lose}	Probability of UI expiration	6 months	0.17
κ	Vacancy posting cost	Normalization $\theta = 1$	103.3

Note: This table lists the values of model parameters that are not estimated but directly taken from other papers or from data. Monetary values are presented in \$1,000, adjusted to 2015 dollars.

4.1 Quantitative Specification

Functional forms. The search disutility function is represented by a convex function, taking an iso-elastic form of $\psi(s) = \bar{\psi} \frac{s^{1+\eta}}{1+\eta}$ where $\bar{\psi}$ is the scale parameter while $\eta > 0$ captures the convexity. This functional form does not necessarily guarantee that the job finding probability does not exceed 1 but as long as $\bar{\psi}$ is estimated to be consistent with data, the job finding probability never exceeds 1 unless I consider an extreme counterfactual economy. The matching function follows a Cobb-Douglas functional form $m(\bar{s}, v) = \bar{m} \bar{s}^{1-\alpha} v^\alpha$ where $\bar{m}$ is the match efficiency and α represents the elasticity of a vacancy-filling rate with respect to tightness.

Externally set parameters. I first externally set or normalize some parameters, which are summarized in Table 3. A discount factor β is set to reflect the annual interest rate of 5%. The elasticity of matches with respect to vacancies α is set to 0.5 following Petrongolo and Pissarides (2001). I set the worker bargaining power $\gamma = 0.5$ by imposing the standard Hosios condition $\gamma = \alpha$, following the convention in the literature, although this does not guarantee the constrained efficiency in tightness θ due to the presence of temporary layoffs. Exogenous job destruction probability δ is set to $\delta = 0.01$ to match the transition probability from employment to permanent layoff. Home production b_H is set so that consumption during unemployment $b + b_H$ is 75% of average consumption during employment in line with

Chodorow-Reich and Karabarbounis (2016). I use the average weekly benefits reported by the BLS and set $b = 1.4$, or \$1,400 per month. I set $p_{\text{gain}} = 1/9$ so that newly hired workers become eligible for UI on average in 9 months, reflecting the actual UI rule that workers in most states are required to earn enough wages in two quarters during the first four of the last five quarters preceding a layoff. I set $p_{\text{lose}} = 1/6$ so that unemployed workers who are eligible for UI lose eligibility in 6 months. I set the uniform tax τ to zero during estimation, which is adjusted in the counterfactual so that each policy change is associated with the same net spending as in the baseline. The degree of experience rating τ_e captures the marginal UI tax cost of a layoff. Pavosevich (2020) uses the tax schedule in 2018 and reports that an employer who lays off a worker faces a UI tax increase equal to 29% of the UI benefits collected by the worker. I therefore set $\tau_e = 0.29$.

Normalization. Since the match efficiency $\bar{m}$ and the scale of search cost $\bar{\psi}$ cannot be separately identified from the job finding rate, I normalize the match efficiency by $\bar{m} = 1$. In addition, although tightness θ is an equilibrium object, it can be normalized during the estimation by appropriately choosing the recruiting cost κ ex-post so that the free entry condition is satisfied. I normalize tightness at $\theta = 1$ during the estimation.

4.2 Identification and Estimation

The remaining parameters are estimated by targeting the average wage and worker flows in the data. Table 4 summarizes the parameters and targeted moments. Although all the remaining parameters are jointly estimated by a set of moments, each moment is intended to be particularly informative about some parameters. I briefly discuss each of them below.

When a match is not hit by a permanent shock, match productivity evolves according to $\log z' = \rho \log z + \sigma \epsilon$ where $\epsilon \sim N(0, 1)$, and I identify the AR(1) coefficient ρ of the match productivity process by targeting the UE rate of workers on temporary layoff because more persistent shocks lead to a longer time before a recall. The standard deviation of shocks σ affects the transition probability from employment to temporary layoff as a larger shock makes it more likely to cross the cutoff, and I target the corresponding transition probability in the data. I identify the scale of output $\bar{y}$ by matching the average wage in the data. The scale $\bar{\psi}$ of the match disutility is informed by the job-finding rate of permanently laid-off workers.

Table 4: Estimation Result

(a) Estimated Parameters			(b) Model Fit		
Parameter	Description	Value	Targeted Moment	Model	Data
ρ	AR(1) coef. of productivity	0.98	TL rate (x 100)	0.38	0.38
σ	Std. dev. of productivity shock	0.15	Job finding rate: PL worker	0.22	0.22
$\bar{y}$	Scale of output	4.45	Job finding rate: TL worker	0.51	0.50
$\bar{\psi}$	Search disutility: scale	14.10	Average wage	3.78	3.76
η	Search disutility: curvature	0.47	UI elasticity of job finding	-0.34	-0.34

Note: Monetary values are presented in \$1,000, adjusted to 2015 dollars. The left panel reports the estimated parameters, and the right panel reports the moments in the model and the corresponding data moments.

Table 5: UI Impact on TL

	Model	Data (OLS)	Data (IV)
UI Elasticity of TL	0.78	0.50	0.88

Note: This table reports the elasticity of the probability of temporary layoff with respect to UI benefit levels b . In the model, I increase b by 10% and solve the model fixing market tightness θ and the uniform tax τ . The data counterparts are the implied elasticity in Table 1.

The curvature of the job search disutility function η is a key parameter that affects how a worker’s job search effort responds to the gain from a match. In particular, the curvature affects how much UI benefits discourage workers from searching for a new job. I identify this parameter by targeting the empirical evidence of the impact of UI benefit level b on job finding reported by [Cohen and Ganong \(2024\)](#).

4.3 Estimated Parameters

The left panel of Table 4 reports the estimated parameters. The curvature of search disutility function $\psi(s) = \bar{\psi} \frac{s^{1+\eta}}{1+\eta}$ is estimated to $\eta = 0.47$, implying elastic search behavior. The estimate here is close to the existing estimates given by, for example, [Lise \(2013\)](#) and [Bagger and Lentz \(2019\)](#) and much more elastic than implied by the quadratic cost function as commonly assumed (e.g. [Fujita and Moscarini 2017](#)). The right panel of Table 4 shows that the model fits the data well.

4.4 Nontargeted Moments

Impact of UI on TL. Table 5 compares the elasticity of temporary layoffs with respect to UI benefit levels in the model and in the data implied by the Table 1 in Section 2. In computing the elasticity in the model, I fix the labor market tightness to be consistent with the reduced-form estimation, where I control for local labor market conditions. Although I do not target the UI elasticity of temporary layoffs in the estimation, the estimated model generates a similar elasticity as in the data. Specifically, the model generates an elasticity of 0.78, which is larger than the OLS estimate but almost the same as the IV estimate.

Job search during TL. The model in the previous section shows that the job search behavior of workers on temporary layoff qualitatively affects firm layoff behavior. The validity of it hinges on whether job search behavior during temporary layoff in the estimated model is consistent with the data. However, the estimation does not directly target the probability that workers on temporary layoff find a *new* job and instead targets the overall UE transition rate of workers on temporary layoff, which includes recalls. This is because it is not possible to distinguish between a worker on temporary layoff (i) going to a new employer and (ii) going back to the previous employer in the CPS. Nonetheless, I can compare the probability that workers on temporary layoff find a new job in my model with the one reported in other data sources that can make the distinction. I find that the probability that workers on temporary layoff find a new job is 13% in the estimated model, which aligns with the numbers reported in Gertler et al. (2024). Gertler et al. (2024) use data from the Survey of Income and Program Participation and reports that the monthly probability of finding a new job for workers on temporary layoff is about 10-15% within the first three months of unemployment.⁹

5 Quantitative Implications for UI Design

In this section, I investigate the role of temporary layoffs in shaping the impact of UI policy changes on labor market outcomes.

⁹See Figure A.5 of Gertler et al. (2024).

5.1 Experience Rating

The UI system in the U.S. has a unique feature in terms of how taxes are collected. Experience-rated taxes increase the marginal cost of a layoff, discouraging firms from putting workers on temporary layoff. Theoretically, experience-rated taxes serve as a way to let firms internalize the fiscal externality associated with separations where workers collect UI benefits. In fact, simple models suggest that the perfect experience rating eliminates the negative fiscal externality associated with endogenous separations (Blanchard and Tirole, 2008) while the actual UI system features an imperfect experience rating where firms do not fully bear the fiscal cost of layoffs.

In the current model, the perfect experience rating does not fully eliminate the fiscal externality associated with temporary layoffs. This is because of the novel interaction between worker job search and firm layoff incentives. To see that, see equation (8) and let $\tau_e = 1$, which leads to

$$\begin{aligned} S(z, \phi) = & y(z) - b_H - \tau + \psi(s(z, \phi)) + \beta \left(\mathbb{E}_1 \left[K(z', \phi') \mid z \right] - \mathbb{E}_0 \left[K(z', \phi') \mid z \right] \right) \\ & - \beta s(z, \phi) \mu(\theta) \left(W(z_0, 0) - \mathbb{E}_0 \left[K(z', \phi') \mid z \right] \right). \end{aligned} \quad (25)$$

As discussed in detail in Section 3.5, this joint surplus no longer directly depends on UI benefits b since the perfect experience rating makes UI benefits just a transfer within a match. However, the joint surplus still indirectly depends on b through worker job search effort $s(z, \phi)$. In response to UI benefits b , workers still reduce job search intensity—the standard moral hazard effect—which in turn increases the incentive of firms to stop operation and put workers on temporary layoff. In addition, to the extent that the experience rating reduces the value of job creation, fewer vacancy creation further reduces the turnover rate during temporary layoff through $\mu(\theta)$, which in turn provides a further incentive for temporary layoff.

As a benchmark, I first ask how many temporary layoffs remain even in the absence of UI. The second column of Table 6 shows that the monthly probability of temporary layoff goes down by 45% from 0.38 to 0.21. In other words, 45% of temporary layoffs in the baseline economy are caused by UI, which I refer to as UI-driven temporary layoffs.

The last column of the table shows that although the perfect experience rating reduces

Table 6: Impact of Perfect Experience Rating

Outcome	Baseline	No UI	Perfect ER
Unemployment rate (%)	5.11	3.95	4.90
TL rate (%)	0.38	0.21	0.25
Job finding rate (%)	25.8	29.7	24.4
Vacancy (% change)	-	1.83	-6.14

Note: This table reports the labor market outcomes in the baseline and the counterfactual economies. No UI is the case where UI benefits b is set to 0. Perfect ER is the case where experience-rated tax τ_e is set to 1.

the probability of temporary layoff, it does not fully eliminate UI-driven temporary layoffs. Quantitatively, the perfect experience rating reduces the probability of temporary layoffs by 34%. In relative terms, this suggests that the experience rating reduces about 76% of the UI-driven temporary layoffs; however, many temporary layoffs still remain because of the reduced job finding rate of workers.

5.2 Increasing Benefit Levels vs. Extending Benefit Duration

I turn to the question of how the presence of temporary layoffs changes the view of how changes in the UI design affect the labor market. Specifically, I explore the two main key features of the UI design: the benefit amount and the potential benefit duration.

The presence of temporary layoffs introduces different targeting properties of each policy lever. The data suggests that workers on temporary layoff get out of unemployment more than twice as quickly as workers on permanent layoff, which is captured by the model. As a result, increasing the benefit level matters for all unemployed workers, whereas extending potential benefit duration mostly matters for workers on permanent layoff. This, in turn, affects the incentive for firms (or matches) to put workers on temporary layoff.

I compute the new steady state with 30% larger UI benefit level (High UI) and 30% longer potential benefit duration (Long UI). Table 7 compares the baseline economy with the two counterfactual economies. I find that increasing the benefit level increases the unemployment rate more than extending potential benefit duration. This comes from the different responses of temporary layoffs. Increasing the benefit level raises the probability of temporary layoff by 0.12 p.p. (32%) by increasing the value of temporary layoff unemployment while extending

Table 7: Generous UI Policy

Outcome	Baseline	High UI	Long UI
Unemployment rate (%)	5.11	5.68	5.42
TL rate (%)	0.38	0.50	0.40
Job finding rate (%)	25.8	25.1	24.6
Vacancy (% change)	-	-0.08	-0.66

Note: This table reports the labor market outcomes in the baseline and the counterfactual economies. High UI is the case where the UI benefit level b is increased by 30%. Long UI is the case where the potential benefit duration $1/p_{\text{lose}}$ is increased by 30%.

Table 8: Contribution of Job Losing to Unemployment-to-Employment Ratio

	High UI	Long UI
Contribution of Job Losing (%)	74.7	20.7

Note: This table reports the contribution of the response of job losing rates in the change in the unemployment-to-employment ratio according to equation (26).

the potential benefit duration has little impact.

To provide a quantitative sense of the contribution of temporary layoffs, I use the following decomposition. In the steady state, the unemployment rate u is related to the job losing rate and the job finding rate in the following way.

$$\log\left(\frac{u}{1-u}\right) = \log(\text{job loss}) - \log(\text{job finding}). \quad (26)$$

This allows me to decompose a percentage change in the unemployment-to-employment ratio into a percentage change in the job losing rate and a percentage change in the job finding rate.

Table 8 shows that the response of temporary layoffs accounts for about 75% of the change in the unemployment-to-employment ratio in the economy with the higher benefit level while it accounts for just 21% in the economy with the longer potential benefit duration.

Relation to the literature of the macro effect of UI. The growing number of papers in the macro literature studies the impact of the extension of potential benefit duration on the aggregate unemployment rate (e.g., Rothstein 2011, Farber and Valletta 2015, Johnston and Mas 2018, Chodorow-Reich et al. 2019, Acosta et al. 2023). These papers typically

focus on the impact of UI on unemployment through job finding, either by the standard moral hazard on the worker side or by the response of vacancy creation on the firm side, while mostly ignoring the job losing side. My result here provides a justification: Since extending duration does not matter for workers on temporary layoff, it is less likely to induce a meaningful impact on the flow into unemployment. The result is consistent with recent empirical evidence about the cut in potential benefit duration by [Karahana et al. \(2025\)](#) although I still find a small positive impact in the model.

6 Conclusion

This paper examines the labor market impact of unemployment insurance (UI) in the presence of endogenous temporary layoffs. I provide empirical evidence that UI induces temporary layoffs of otherwise employed workers. I then develop and estimate an equilibrium labor search and matching model with endogenous temporary layoffs and subsequent recalls. Reduced job search effort caused by UI incentivizes temporarily unproductive firms to place workers on temporary layoff, as it makes firms less concerned about losing their connection to these workers during temporary layoff. The worker retention aspect of UI has two key implications for UI policy. First, the perfect experience rating does not fully eliminate UI-driven temporary layoffs because although experience rating eliminates the role UI as a layoff subsidy, it still reduces workers' job search effort, which in turn makes firms willing to place workers on temporary layoff. Second, extending potential benefit duration has a smaller impact on the unemployment rate than increasing the benefit level since it has little effect on unemployment inflow through temporary layoff. This is because workers on temporary layoff much more quickly get reemployed than workers on permanent layoff, and as a result, extending potential benefit duration is mostly irrelevant for the value of temporary layoff and hence irrelevant for endogenous separations as well.

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Online Appendix (Not for Publication)

A Data

In this section, I describe details about data and sample selection for each analysis, and basic data patterns.

A.1 Current Population Survey

The Current Population Survey (CPS) is the monthly household survey conducted by the Bureau of Labor Statistics. It is a source of labor market statistics in the U.S. The CPS has a short panel structure. Each household in the CPS is interviewed each month for 4 months, then being out of sample for 8 months, and then interviewed again for 4 more months. Although each household is interviewed (up to) 8 times, earnings information in the monthly CPS is asked only in the 4th and 8th interviews. Respondents in the 4th or 8th interviews are called the Outgoing Rotation Group (ORG).

I obtained the monthly samples of the CPS over 2001-2018 from IPUMS ([Flood, King, Rodgers, Ruggles, Warren, Backman, Chen, Cooper, Richards, Schouweiler and Westberry, 2023](#)). The monthly CPS samples contain information on labor market status and other demographic variables.

Employment status. I use EMPSTAT to identify the employment status of each individual. I categorize workers who are either “at work” or “has a job, not at work last week” to be employed. I drop workers who are not in universe (those who are not civilians or not age 15+), those who are armed force, or not in labor force. The remaining workers are categorized as being unemployed, and they are further categorized into either on temporary layoff or on permanent layoff.

Temporary layoff and permanent layoff. I follow [Fujita and Moscarini \(2017\)](#) and use WHYUNEMP to categorize unemployed workers into temporary layoffs and permanent layoffs. WHYUNEMP can take the following six categorical values (excluding 0 for not-in-universe): 1.

Job loser - on layoff, 2. Other job loser, 3. Temporary job ended, 4. Job leaver, 5. Re-entrant, 6. New entrant. WHYUNEMP=1 is categorized to temporary layoff while WHYUNEMP=2,3,4,5 are categorized to permanent layoff. I drop workers in WHYUNEMP=6 from the sample.

Worker flows. Although the CPS has a panel structure, there is no individual identifier in the original survey that allows linking across samples. IPUMS provides CPSIDV for linking individuals across different months, which allows me to look at labor market transitions for each worker.

Additional sample selection. CLASSWKR identifies whether a worker is self-employed, working in the private sector, working in the public sector, working in the armed forces, or working without pay in a family business or farm. For unemployed workers, the classification is according to the most recent job. I restrict the sample to workers who are working in the private sector or unemployed workers who were previously working in the private sector. I similarly remove employed workers in or unemployed workers from the agricultural or mining sectors.

A.2 Supplemental Data

In my regression analysis, I use variables from several sources. The average WBA is downloaded from the UI Replacement Rates Report by the Department of Labor, available at https://oui.doleta.gov/unemploy/ui_replacement_rates.asp. The maximum WBA is hand-gathered from the publication of *Significant Provisions of State Unemployment Insurance Laws*, available at <https://oui.doleta.gov/unemploy/statelaws.asp>. The unemployment rate is downloaded from the website of the BLS (<https://download.bls.gov/pub/time.series/la/>). The number of job openings is downloaded from the website of the BLS (<https://www.bls.gov/jlt/data.htm>). The CPI is downloaded from FRED (CPI-AUCSL).

A.3 Temporary Jobs

The model assumes that temporary layoffs occur solely due to stochastic changes in productivity. This translates into endogenous responses in temporary layoffs to policy changes as a result of shifts in the cutoff productivity for temporary layoffs. In doing so, the model

Table 9: Monthly Job Losing Probabilities given Employment Types

	TL prob. (%)	PL prob. (%)	TL share (%)
Temporary job	2.05	4.92	29.46
Non temporary job	0.30	0.76	28.38

Source: The Contingent Worker Supplement of the CPS in 2001, 2005, and 2017.

abstracts from temporary layoffs arising from the deterministic nature of commonly observed production processes (e.g., fixed-term construction projects during specific seasons), which might also be a quantitatively large contributing factor to the prevalence of temporary layoffs.

To explore this, I utilize the sample from the Contingent Worker Supplement of the CPS that is available in the years 2001, 2005, and 2017, which offers details on types of employment, such as if a worker is in a temporary job. Specifically, a temporary job encompasses employment arrangements including (i) independent contracting, (ii) contract work for a company, (iii) work through a temporary help agency, and (iv) on-call work. I apply the same sample restrictions as previously and calculate the probability of transitioning from employment to either temporary or permanent layoff based on whether a worker holds a temporary job.

Table 9 presents the findings. Naturally, the probability of job loss is considerably higher for those in temporary positions. However, when considering the proportion of temporary layoffs within total job losses, the number is only slightly higher for workers with temporary jobs. Also, the share of workers in temporary jobs is small in the first place, only making up 3% of all employed workers. These results suggest that workers in temporary jobs are not the main contributors to prevalent temporary layoffs in the economy.

B Unemployment Insurance in the U.S.

I briefly summarize important features of the UI system in the U.S. based on [Bureau of Labor Statistics \(2021\)](#). UI in the U.S. is a joint state-federal program run by state governments. Each state government runs its own UI program, but all states follow the same guidelines established by federal law.

B.1 Benefits

A UI benefit amount depends on weekly earnings prior to a job loss. An individual's weekly benefit amount is increasing in weekly earnings of the individual prior to a job loss, but there are minimum and maximum weekly benefit amounts specified by each state.¹⁰ The generosity of UI benefits is usually measured by a replacement rate, which is calculated by dividing WBA by weekly earnings prior to a job loss. A replacement rate is typically around 45%. UI benefits expire in 26 weeks in most states.

Variations in weekly benefit amounts come from several sources. First, the maximum weekly benefit amount is usually linked to x percent of the average weekly wage within the state during a 1-year period, where x is different across states and sometimes x changes over time within a state. The variation in the average weekly wage and x both affect the average weekly benefit amount by affecting the maximum weekly benefit amount. Second, in a small number of states, the minimum weekly benefit amount is also linked to the average weekly wage, although the weekly benefit amount in many other states is specified in law and not linked to the average weekly wage. Finally, a weekly benefit amount between the minimum and the maximum is given by $f(w)$ where w is the base-period wage of a worker and f is a rule determining a weekly benefit amount based on the wage. The rule f is different across states and is sometimes changed over time, making variations in weekly benefit amounts.

B.2 Eligibility

In general, each state requires a worker to be unemployed through no fault of his/her own and meet minimum work and wage requirements prior to a job loss. There is a period of time called a base period during which a worker is required to have earned a certain amount of wages or worked for a certain period of time to be eligible for UI. In most states, a base period is the first four of the last five completed calendar quarters preceding the filing of the UI claim. How much wages unemployed workers are required to earn or how many weeks they are required to work differs across states, but most states require a worker to work at least two quarters in the base period to be eligible for UI. Many states impose additional requirements about how much wages need to be earned during the period.

¹⁰Table 3-5 of [Bureau of Labor Statistics \(2021\)](#) shows minimum and maximum weekly benefit amounts for each state.

In addition, unemployed workers are required to be actively seeking work. But most states exempt an unemployed worker from job search requirements if a separation is classified as a temporary layoff and there is a reasonable expectation that the worker will be back to work soon. In Wisconsin, for example, a worker is asked if the worker is expected to be recalled for work within 8 weeks in the initial claim application. The waiver in this case is valid for 8 weeks, but the worker can extend the waiver for another 4 weeks if the previous employer contacts the state UI office to verify a return-to-work date within 12 weeks of the first week claimed. A similar approach is taken in other states where a worker can get a short-term waiver in the initial application without verification by the previous employer, but the worker needs the verification if he/she wants to get a long-term waiver. These workers become no longer eligible if they do not respond to a recall.

B.3 Financing

UI programs are financed by both federal taxes and state taxes that are paid by employers as a form of payroll taxes. One striking feature of UI financing in the U.S. is the partial experience rating of state UI tax rates; A tax rate imposed on an employer is an increasing function of UI benefits collected by workers the employer laid off in the past, but it is partial in the sense that there are a minimum tax rate and a maximum tax rate. A minimum tax rate implies that an employer faces a positive tax rate even if it has not laid off any workers in the past while a maximum tax rate implies that once an employer lays off sufficiently many workers, then its tax rate no longer increases even if it lays off more workers. In this sense, it is partial or imperfect experience rating.

Historically, the UI system was established in the 1930s when the unemployment rate was much higher than today. One of the main intentions of implementing experience rating was to stabilize employment by making layoffs more costly in such a period (Miller and Pavosevich, 2019).

C Steady State Worker Distributions

Let $\mathbb{I}_u(z, \phi) = \mathbb{1}\{S(z, \phi) < 0\}$ be an indicator for unemployment, and let $\mathbb{I}_e(z, \phi) = 1 - \mathbb{I}_u(z, \phi)$ be an indicator for employment. In the steady state, a fraction of workers with

match productivity not greater than z is

$$\begin{aligned}
G(z, 0) = & \underbrace{\int_0^\infty \mathbb{I}_e(\tilde{z}, 0) \cdot (1 - p_{\text{gain}}) \cdot F(z|\tilde{z}) dG(\tilde{z}, 0)}_{\text{Currently employed, not gaining eligibility}} \\
& + \underbrace{\sum_{\tilde{\phi} \in \{0,1\}} \int_0^\infty \mathbb{I}_u(\tilde{z}, \tilde{\phi}) \cdot [(1 - \tilde{\phi}) + \tilde{\phi} \cdot p_{\text{lose}}] \cdot (1 - s(\tilde{z}, \tilde{\phi})\mu(\theta)) \cdot F(z|\tilde{z}) dG(\tilde{z}, \tilde{\phi})}_{\text{Currently unemployed, not eligible or losing eligibility, without job finding}} \\
& + \underbrace{\mathbb{1}\{z \geq z_0\} \cdot \sum_{\tilde{\phi} \in \{0,1\}} \int_0^\infty \mathbb{I}_u(\tilde{z}, \tilde{\phi}) \cdot [(1 - \tilde{\phi}) + \tilde{\phi} \cdot p_{\text{lose}}] \cdot s(\tilde{z}, \tilde{\phi}) \cdot \mu(\theta) dG(\tilde{z}, \tilde{\phi})}_{\text{Currently unemployed, finding a job}}. \tag{27}
\end{aligned}$$

The first term captures those who are employed and not eligible $\phi = 0$ and not gaining eligibility $1 - p_{\text{gain}}$, experiencing productivity changes resulting in new productivity less than z . The second term captures productivity changes for those who are unemployed, either not eligible or eligible but newly losing eligible, and not succeeding in finding a new job. The last term captures an inflow through new job finding in case $z \geq z_0$.

Similarly, I have

$$\begin{aligned}
G(z, 1) = & \sum_{\tilde{\phi} \in \{0,1\}} \int_0^\infty \mathbb{I}_e(\tilde{z}, \tilde{\phi}) \cdot [(1 - \tilde{\phi}) \cdot p_{\text{gain}} + \tilde{\phi}] \cdot F(z|\tilde{z}) dG(\tilde{z}, \tilde{\phi}) \\
& + \int_0^\infty \mathbb{I}_u(\tilde{z}, 1) \cdot (1 - p_{\text{lose}}) \cdot (1 - s(\tilde{z}, 1)\mu(\theta)) \cdot F(z|\tilde{z}) dG(\tilde{z}, 1). \tag{28}
\end{aligned}$$

Since workers are initially not eligible upon finding a new job, the inflow comes only from productivity changes. The first term captures employed workers who are eligible or not eligible but newly gaining eligibility, experiencing productivity changes into $\leq z$. The second term captures productivity changes for eligible unemployed workers.

D Proofs

D.1 Proof of Proposition 1

Proof. Let $\rho \rightarrow 0$, and the distribution of z' in the next period no longer depends on current match productivity z . The value functions are

$$W(z; b, \tau_e) = w_1(z; b, \tau_e) + \beta \mathbb{E} \left[\max\{w_2(z'; b, \tau_e), b\} \right], \quad (29)$$

$$J(z; b, \tau_e) = z - w_1(z; b, \tau_e) + \beta \mathbb{E} \left[\max\{z' - w_2(z'; b, \tau_e), -\tau_e b\} \right], \quad (30)$$

$$U(z; b, \tau_e) = -\psi(s(b, \tau_e)) + \beta \left(s(b, \tau_e) \bar{w} + (1 - s(b, \tau_e)) \mathbb{E} \left[\max\{w_2(z'; b, \tau_e), b\} \right] \right), \quad (31)$$

$$V(z; b, \tau_e) = -\tau_e b + \beta (1 - s(b, \tau_e)) \mathbb{E} \left[\max\{z' - w_2(z'; b, \tau_e), -\tau_e b\} \right], \quad (32)$$

where

$$s(b, \tau_e) = \arg \max_s -\psi(s) + \beta \left[s \bar{w} + (1 - s) \mathbb{E} \left[\max\{w_2(z'; b, \tau_e), b\} \right] \right], \quad (33)$$

$$w_2(z; b, \tau_e) = \gamma z + (1 - \gamma(1 - \tau_e))b. \quad (34)$$

For notational brevity, I define

$$m(b, \tau_e) = \mathbb{E} \left[\max\{z', (1 - \tau_e)b\} \right], \quad (35)$$

$$m_w(b, \tau_e) = \mathbb{E} \left[\max\{w_2(z'; b, \tau_e), b\} \right]. \quad (36)$$

Let $\gamma \rightarrow 0$. Then, $w_2(z; b, \tau_e) = b$ and $m_w(b, \tau_e) = b$.

The joint surplus is given by

$$S(z; b, \tau_e) = z - (1 - \tau_e)b + \psi(s(b)) - \beta s(b)(\bar{w} - m(b, \tau_e)). \quad (37)$$

Existence and uniqueness of $\bar{z}$: Differentiating the joint surplus with respect to z , I have

$$\frac{\partial S(z; b, \tau_e)}{\partial z} = 1 > 0 \quad (38)$$

and hence the joint surplus is strictly increasing in z . It is easy to see $S(z; b, \tau_e) \rightarrow \infty$ as $z \rightarrow \infty$.

If there exists $\bar{z}(b, \tau_e) > 0$ such that $S(\bar{z}(b, \tau_e); b, \tau_e) = 0$, then the worker is placed on temporary layoff below $\bar{z}(b, \tau_e)$. Otherwise, $S(z; b, \tau_e) > 0$ for all z and I set $\bar{z}(b, \tau_e) = 0$.

Proof that $\bar{z}$ is increasing in b for any $\tau_e \in [0, 1]$ if $\bar{z} > 0$: Note that the FOC for job search is $\psi'(s(b)) = \beta(\bar{w} - b)$, which implies $s'(b) = -\frac{\beta}{\psi''(s(b))}$. Using this, differentiating the joint surplus with respect to b , I have

$$\begin{aligned} \frac{\partial S(z; b, \tau_e)}{\partial b} &= -(1 - \tau_e) + s'(b) \left(\psi'(s(b)) - \beta(\bar{w} - m(b, \tau_e)) \right) + \beta s(b) \frac{\partial m(b, \tau_e)}{\partial b} \\ &= -(1 - \tau_e) + s'(b) \beta (m(b, \tau_e) - b) + \beta s(b) (1 - \tau_e) F((1 - \tau_e)b) \\ &= -(1 - \tau_e) \left[1 - \beta s(b) F((1 - \tau_e)b) \right] - \frac{\beta^2}{\psi''(s(b))} (m(b, \tau_e) - b). \end{aligned} \quad (39)$$

If the cutoff is strictly positive, then $S(\bar{z}(b, \tau_e); b, \tau_e) = 0$. Then, the implicit function theorem implies that

$$\begin{aligned} \frac{\partial \bar{z}(b, \tau_e)}{\partial b} &= -\frac{\frac{\partial S(\bar{z}(b, \tau_e); b, \tau_e)}{\partial b}}{\frac{\partial S(\bar{z}(b, \tau_e); b, \tau_e)}{\partial z}} \\ &= (1 - \tau_e) \left[1 - \beta s(b) F((1 - \tau_e)b) \right] + \frac{\beta^2}{\psi''(s(b))} (m(b, \tau_e) - b). \end{aligned} \quad (40)$$

The first term is strictly positive for $\tau_e \in [0, 1)$ and zero for $\tau_e = 1$. Note that the second term is strictly positive since

$$\begin{aligned} m(b, \tau_e) - b &= \mathbb{E} \left[\max\{z', (1 - \tau_e)b\} \right] - b \\ &\geq \mathbb{E}[z'] - b \\ &= \mu_z - b > 0, \end{aligned} \quad (41)$$

where μ_z is the mean of the distribution F , which is assumed to be larger than b . Therefore, the cutoff is strictly increasing in b for any $\tau_e \in [0, 1]$.

Proof that $\frac{\partial \bar{z}}{\partial b}$ is decreasing in τ_e : Let $\hat{b} = (1 - \tau_e)b$. Differentiating equation (40) with respect to τ_e yields

$$\begin{aligned} \frac{\partial^2 \bar{z}(b, \tau_e)}{\partial \tau_e \partial b} &= -\left[1 - \beta s(b)F(\hat{b})\right] + (1 - \tau_e)\beta s(b)bf(\hat{b}) + \frac{\beta^2}{\psi''(s(b))} \frac{\partial m(b, \tau_e)}{\partial \tau_e} \\ &= -\left[1 - \beta s(b)F(\hat{b})\right] + (1 - \tau_e)\beta s(b)bf(\hat{b}) - \frac{\beta^2}{\psi''(s(b))} F(\hat{b})b \\ &= -1 + \beta s(b)\left(F(\hat{b}) + \hat{b}f(\hat{b})\right) - \frac{\beta^2}{\psi''(s(b))} F(\hat{b})b. \end{aligned} \quad (42)$$

If $s(b)$ is sufficiently small, the second term is small enough, and the whole expression is negative, which implies that the impact of b on the cutoff is decreasing in τ_e . $\square$

D.2 Bound for $s(b)$

Let $Z' \sim \text{Lognormal}(\mu, \sigma^2)$ and set $\hat{b} = (1 - \tau_e)b$ and

$$t = \frac{\log \hat{b} - \mu}{\sigma}. \quad (43)$$

Then letting Φ and ϕ be the standard normal cdf and pdf, I have

$$F(\hat{b}) = \Pr(Z' \leq \hat{b}) = \Phi(t), \quad f(\hat{b}) = \frac{1}{\hat{b}\sigma} \phi(t), \quad (44)$$

so that

$$F(\hat{b}) + \hat{b}f(\hat{b}) = \Phi(t) + \frac{1}{\sigma} \phi(t). \quad (45)$$

The cross-partial can be written as

$$\frac{\partial^2 \bar{z}(b, \tau_e)}{\partial \tau_e \partial b} = -1 + \beta s(b) \left[\Phi(t) + \frac{1}{\sigma} \phi(t) \right] - \frac{\beta^2}{\psi''(s(b))} b \Phi(t). \quad (46)$$

Using $\Phi(t) \leq 1$ and $\phi(t) \leq \phi(0) = 1/\sqrt{2\pi}$,

$$\Phi(t) + \frac{1}{\sigma} \phi(t) \leq 1 + \frac{1}{\sigma\sqrt{2\pi}}, \quad (47)$$

and therefore a sufficient condition for negativity is

$$\beta s(b) \left(1 + \frac{1}{\sigma\sqrt{2\pi}}\right) < 1, \quad (48)$$

or

$$s(b) < \frac{1}{\beta \left(1 + \frac{1}{\sigma\sqrt{2\pi}}\right)}. \quad (49)$$

Substituting $\beta = 1$ and $\sigma = 0.1$ yields

$$s(b) < \frac{1}{1 + \frac{1}{0.1\sqrt{2\pi}}} \approx 0.2004. \quad (50)$$

This provides a sufficient condition for the second property of Proposition 1.