Quits and Optimal Unemployment Insurance

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Abstract

Quits account for the majority of transitions into non-employment. Should quitters receive insurance benefits, and if so, how generous should those benefits be? We address these questions using a set of directed search models extended to incorporate endogenous quits to non-employment. Workers quit too often in the equilibria of these economies, not internalizing that shorter expected match duration translates into lower offered wages. We derive an extended Baily-Chetty formula to illustrate how this quitting externality introduces an additional consideration in the calculus of optimal benefit provision. In a quantitative multi-sector model featuring both quits to other jobs and quits to non-employment we find that quitters should receive positive benefits, in contrast to the current U.S. system. However, those benefits should be roughly half as large as benefits for laid off workers.

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1 Introduction

A common view of the labor market is that layoffs drive most separations to non-employment. However, this view is wrong. The majority of movements into and out of employment in the United States reflect worker decisions to quit jobs, to spend some time non-employed, and to then start new jobs. Almost the entire literature on public insurance against employment risk has focused on insuring workers who were laid off. But the fact that quitters constitute a larger group of temporarily non-employed individuals is a powerful motivation for studying insurance for quitters. In the United States, this group is generally ineligible for much government support.[1] In many other countries, quitters are eligible for unemployment insurance (UI) benefits after a waiting period.[2] This paper is one of the few that asks how the presence of a quitting margin changes the optimal provision of UI. Should quitters be eligible for public insurance benefits? If so, how generous should those benefits be, and should quitters be treated differently from workers who were laid off?

We start by laying out a series of facts to document that quitting to non-employment is very common, and that the question of how policy should treat quitters is therefore important.

First, quits to non-employment are more common than layoffs. Graves et al. (2024) and Ellieroth and Michaud (2024) construct times series for quit and layoff rates from the Current Population Survey (CPS). Both papers estimate quit rates that exceed layoff rates. For the period 1978 to 2023, Ellieroth and Michaud (2024) find that 60% of separations to non-employment are quits, while 40% are layoffs. The finding that quits to non-employment are more common than layoffs extends to the Survey of Income and Program Participation (SIPP). Simmons (2023) explores monthly separations in the SIPP over the period 1996-2013. He reports a total separation rate of 4.2%, of which 1.2% are involuntary from the worker perspective (layoffs), 1.0% are traditional quits (job-to-job transitions), and the remaining 2.0% are quits where the worker does not have another job lined up.

Second, most workers who quit to non-employment do so only temporarily. Table 1 in Simmons (2023) indicates that 60.8% of workers who quit to non-employment remain in the labor force, and these workers find new jobs more quickly than workers who were laid off. But even

[1] Some states have "good cause" exemptions that allow quitters to collect UI. For example, in Minnesota you can quit and collect UI if you had to relocate because your spouse got a new job, if you left to care for a family member with a serious illness, or if you quit in order to escape domestic violence. UI eligibility requirements were temporarily relaxed nation wide during the COVID pandemic.

[2] See Table B2 in Venn (2012) for details of country-specific rules.

quitters who report being out of the labor force are re-employed at a high rate. In particular, Kudlyak and Lange (2017) use the panel structure of the CPS to document high job finding rates for non-workers who report being out of the labor force but who were recently employed. For example, 39% of non-workers with a previous three month history of EEN are employed in the next month, compared to 46% of non-workers with a history of EEU (see their Table 3.1). In fact, over 60% hires from non-employment each month come from people who report being out of the labor force, not people who report being unemployed (see Table 3.1 in Kudlyak and Lange 2017, or Tables 1 and 2 in Graves et al. 2024).

Third, economic considerations appear to be important for quitting decisions. Ellieroth and Michaud (2024) document that the quit to non-employment rate is strongly pro-cyclical, falling in recessions by almost as much as the layoff rate rises. If most quitters plan to return to work soon, it is natural that they should be more hesitant to quit in recessions when finding a new job is likely to be more difficult. Graves et al. (2024) show that the contractionary monetary shocks reduce the quit rate. Coglianese (2018) defines "in-and-outs" as people who report being out of the labor force for less than two years; "dropouts" are those who are out of the labor force for longer. Ranking prime-age men by wages in the SIPP, he finds that over 10% of prime age men in the bottom wage decile are in the in-and-out group, compared to around 1% for men in the top wage decile. Our interpretation will be that low wage workers are more likely to quit because their opportunity cost of non-employment is smaller. Ahn et al. (2023) partition the CPS population into three buckets based on their labor market histories: one that is almost always employed, one that is almost always non-participating, and one that bounces frequently between employment and non-employment. Workers in this last group are concentrated in low wage industries and low wage occupations. Relatedly, we will show that quit rates decline quite steeply with average industry earnings (see also Krueger and Summers 1988).

We develop a series of directed search and matching models extended to incorporate quits. Workers in our models are subject to idiosyncratic shocks to the disutility of work and may choose to quit to non-employment when these shocks are large. We will use evidence on cross-industry variation in quit rates to pin down the variance of these preference shocks.

Crucially, firms do not observe workers' preference shocks. This information friction implies that workers quit inefficiently often, breaking up matches that have positive joint surplus. In equilibrium, this translates into workers directing search toward high wage jobs: high "efficiency" wages partially mitigate the excessive quitting problem. Optimal policy addresses the excessive quitting inefficiency by reducing the UI replacement rate, relative to the rate that would be optimal without the quit margin.

We illustrate these results most starkly in a simple static version of the model in which workers are risk neutral and where there would be no role for any policy intervention absent the quitting margin (Acemoglu and Shimer, 1999). In this environment, we show that once that margin is introduced, the optimal transfer to non-workers becomes negative. Introducing risk aversion adds an insurance motivation for providing positive UI for quitters. But we show that if the government can differentiate between workers who have been laid off and those who have quit, then quitters should receive less generous benefits.

In a dynamic version of the model with risk averse workers, we show how introducing the quitting margin changes the Baily-Chetty formula defining the optimal UI replacement rate. A new term appears in this equation, which reflects the cost of UI via lower equilibrium wages: more generous UI increases the equilibrium quit rate, which reduces expected match duration, which necessitates a lower flow wage to cover job-filling costs. We show that while the equilibrium elasticity of the wage to the replacement rate is small, the channel is quantitatively important for the optimal level of UI. The reason is simply that workers, who bear the cost of lower wages, constitute the vast majority of model individuals.

Finally, we consider a more quantitative multi-sector model to study optimal levels of UI for quitters v.s. non-quitters in the United States. This model allows for on-the-job search, so a portion of quits involve immediate transitions to a new job. Risk neutral firms can commit to dynamic wage contracts. They offer contracts with two features designed to reduce quitting. First, wages rise with tenure: backloading wage payments reduces incentives to quit to non-employment or to another job. Second, firms stochastically match outside offers, which reduces the rate at which workers quit to take other jobs.

We also introduce stochastic match quality to reflect the reallocation aspect of quitting. In particular, if job search is easier when not employed, workers might quit to try to improve match quality (see Acemoglu and Shimer 2000 or Marimon and Zilibotti 1999). The quantitative version of our model replicates the observed rate of job-to-job transitions (Fujita et al. 2023). Most quitters to non-employment in our model are in low quality matches. Because reducing UI lowers the quit rate, it also therefore slows down the rate at which workers reallocate from bad to good matches. The design of optimal UI policy in our quantitative model therefore takes into account both the inefficiency and reallocation aspects of quitting behavior.

Following current U.S. practice, we set the model UI replacement rate to 43% for those laid off, but to zero for quitters, who are currently generally ineligible for benefits. Individuals receive additional unearned income, reflecting income from other household members or asset income, which we quantify using evidence from the CPS ASEC survey.

We calibrate the model vacancy posting cost, the match efficiency parameter, and the average utility cost of work to match observed unemployment, the job opening rate, and the quit rate. To calibrate the cross-sectional variance of the utility cost of work, we exploit cross-industry variation in wages and quit rates. To the extent that quits are heavily concentrated in low wage industries (such as food services), the model indicates a large average utility cost of work, but modest cross-worker dispersion in that cost.

We then use the calibrated model to study optimal UI policies. We conduct a series of optimal policy experiments. First, we retain the current exclusion of quitters and compute an optimal UI replacement rate for laid off workers of about 38%, which is not far from the current level. Next, we consider a uniform benefit model under which quitters receive the same benefits as laid off workers. Under this system, the optimal UI replacement rate is cut in half. Thus, incorporating quitting has a big impact on the optimal policy.

Finally, we consider a fully flexible case where the government can differentiate between non-workers who quit versus those who were laid off. In this case, the optimal replacement rate for laid-off workers is 39.9%, close to the benchmark, while quitters optimally receive about 15.6%. Quitters are given more generous benefits compared to the baseline policy, where they receive nothing. However, consistent with our theoretical predictions, they receive much lower benefits than laid off workers, as the government seeks to discourage excessive quitting. We compute the welfare gain of moving from the optimal uniform non-employed benefit system to the optimal fully flexible system and find that it is equivalent to a permanent consumption gain of 0.18%. To the extent that the cost of eliciting information about precisely how particular workers came to be non-employed exceeds this gain, a universal benefit system would therefore be preferable to the current system.

The paper is related to two literatures, one on optimal unemployment insurance design, and another on quits.

There is a large literature on optimal unemployment insurance. Baily (1978) and Chetty (2006) framed a trade-off between UI helping risk averse workers smooth consumption when unemployed, versus UI reducing incentives for job search and thus raising unemployment. Landais et al. (2018a,b) extend this analysis to consider a range of wage-setting mechanisms that might generate inefficient labor market tightness. We also develop a version of the Baily-Chetty formula, but in contrast to Landais et al. (2018a) our planner is not trying use UI as a lever to push market tightness in the efficient direction. In fact, in our directed search setup, tightness is efficient (conditional on the replacement rate). Rather, our planner wants to reduce the replacement rate – relative to what the standard Baily-Chetty equation would dictate – in order to reduce the quit rate and thereby boost equilibrium wages. In our richer quantitative model, the planner also internalizes how the UI replacement rate affects average match quality and thus productivity.

Acemoglu and Shimer (1999) was one of the first papers to study optimal unemployment insurance in a directed search setting with risk averse workers. Golosov et al. (2013) develop additional insights on the nature of optimal policy in a similar setting. Our key innovation relative to those papers is again to emphasize the impact of quitting on optimal policy design – both to non-employment and to other jobs – in a quantitative environment.[3]

Our model predicts that more generous transfers should translate into a higher job separation rate and shorter employment duration (as long as quitters can receive those transfers). Consistent with this prediction, several papers document a dramatic spike in the fraction of jobs that end exactly at the moment that workers become eligible for UI.[4] These papers focus mostly on Canada, exploiting exogenous historical variation in the length of time required to build UI eligibility (see Christofides and McKenna 1996, Green and Riddell 1997, and Baker and Rea 1998). Note that at that time, quitters in Canada could collect UI benefits, as long as they were UI eligible, after a 6 week waiting period. Jager et al. (2023) find that a temporary expansion of UI benefits in Austria increased the job separation rate for treated workers by 11 percentage points (27 percent) over a five year period relative to a control group that did not receive extra benefits. Using a displaced workers survey, Jurajda (2003) estimates that being entitled to UI reduces employment durations in the United States. Schmieder et al. (2016) use age discontinuities in UI eligibility to estimate that UI extensions reduced job tenure for middle-aged workers in Germany.[5]

The empirical evidence suggests that the impact of UI on wages is small. Schmieder et al.

[3]There is a related literature on how UI should optimally vary over the business cycle: see, for example, Mitman and Rabinovich (2015).

[4]There is a large literature on the impact of UI on *unemployment* duration. Johnston and Mas (2018) and Karahan et al. (2022) exploit an unexpected cut in maximum UI duration in Missouri in 2011; they find significant declines in non-employment duration and a large rise in market tightness. Ganong et al. (2022) find that the expansion of benefits during COVID had only a small negative impact on-the-job-finding rate, but argue that this outcome occurred because they were introduced at a time when the job finding rate was already depressed and thus could not fall much.

[5]In Germany, quitters are eligible for unemployment benefits after a three month waiting period (Venn 2012).

(2016) estimate that UI extensions reduced wages in Germany. In contrast, Nekoei and Weber (2017) and Jager et al. (2020) find a small positive impact of UI on wages in Austria.[6] But Jager et al. (2020) conclude that they can reject an impact of UI on wages exceeding three cents per dollar increase in benefits. In our model, increasing UI leads workers to direct search toward higher wage jobs. In addition, more generous UI may boost wages by speeding up transitions to high quality matches. Working against these two conventional effects is our new channel, whereby more generous UI reduces wages by reducing expected job tenure. We will show that our model with quitting is consistent with the Jager et al. (2020) estimates, while an analogous model without quitting delivers a wage impact that exceeds their bound. But a key message of our paper is that the impact of UI on equilibrium wages via the quitting channel is a key determinant of the optimal UI replacement rate, even though the aggregate equilibrium impact on wages is very small.

There are many papers modeling quits, but these focus mostly on workers leaving their current jobs for different ones, so-called "job-to-job transitions". Early examples include Shimer (2006) in random search models and Delacroix and Shi (2006) in a directed search setting (see also Shi 2009 and Menzio and Shi 2011). More recently, Mercan and Schoefer (2020) and Elsby et al. (2022) explore the notion of "vacancy chains," illustrating the interactions between workers' quitting behavior and firm's replacement hiring, and how such interactions can lead to the amplification of labor market fluctuations.

Regarding how firms can attempt to reduce quitting, Salop (1979) was one of the first formal efficiency wage models, in which higher wages reduce turnover. Stevens (2004) and Burdett and Coles (2003) were the first to recognize that backloading compensation can further reduce quitting. Shi (2009) shows that this insight also applies in a directed search setting. Balke and Lamadon (2022) find that firms also want to backload wages when there is a moral hazard friction such that low worker effort can lead to job destruction.

Besides backloading wages, we also give firms a second tool to reduce quitting, which is to match outside offers. A common assumption in the literature (e.g., in Shi 2009) is that firms do not respond to outside offers. One motivation for this assumption has been that outside offers are typically not verifiable.[7] However, Moore (1985) shows that stochastic contracts can incentivize

[6] In Austria, quitters are eligible for unemployment benefits after a one month waiting period (Venn 2012).

[7] Burdett and Coles (2003) write, "An important assumption ... is that a firm does not respond to outside offers received by any of its employees. Clearly this restriction is not satisfied in some labor markets such as the academic labor market in the U.S. Nevertheless, there are reasons to suspect our restriction holds in other labor markets, especially those markets where workers are homogeneous. First, outside offers may not be observable by firms. Indeed, why should a firm verify to another firm that it has made a particular offer to a worker? Of course given offers from other firms are not observed, they will be ignored."

truthful reporting of a privately observed worker reservation wage. We build on that insight in modeling stochastic offer matching, whereby firms either match a reported outside offer or lay off the worker, and show that this is more profitable than simply ignoring such offers.[8] One attractive feature of this model is that it offers an endogenous explanation for a common exogenous assumption: that it is easier to find a job while not working than while employed. The explanation is simply that it is costly to target recruiting effort toward employed workers, since a large share of matches will generate matching counteroffers rather than new hires.

An emerging literature studies models where workers can quit into non-employment. The simple static version of our model in Section 2 is similar to the static version of the economy considered by Guerrieri (2008). The key differences in our dynamic economies are (1) our workers are risk averse – which is critical for the optimal insurance question – and (2) we explore repeated preference shocks rather than permanent preference heterogeneity. Hopenhayn and Nicolini (2009) frame optimal UI policy as a principal agent problem, where the agent chooses search effort while unemployed and can also quit. When the principal wants to prevent quits but cannot differentiate between quits and layoffs, consumption optimally rises during employment spells and drops discretely following separations. Blanco et al. (2023) consider an environment where workers quit because of productivity shocks coupled with wage rigidities, and explore the impact of monetary policy shocks. Qiu (2022) and Bagga et al. (2023) study the business cycle implications of the quitting channel. Mazur (2016) explores the welfare implications of extending UI benefits to quitters, though in a model that is very different from ours. In particular, wages are drawn from an exogenous distribution in his model, so the mechanism we emphasize whereby quitting reduces returns to vacancy creation and thus offered wages is absent.

Our focus is on designing social insurance for individuals with a strong labor force attachment who experience temporary spells of non-employment when they are either quit or are laid off. We abstract from the subset of the U.S. population that is persistently out of the labor force, owing to advanced age, disability, or other factors. Of course, the size of the labor force is somewhat endogenous to policy, and exploring the joint design of social insurance targeted at different groups is an important research direction (see, e.g., Pavoni and Violante 2007).

[8]Outside offers can also be matched in the Postel–Vinay and Robin (2002) model. But note that theirs is a complete information setup, in which the details of outside offers are fully observable. In this tradition, Elsby and Gottfries (2022) consider a setting where firms can match offers with an exogenously-specified probability.

2 A Static Model with Linear Utility

We consider first a tractable static model with linear utility. Analytic tractability will make it easy to understand how the quitting margin impacts the directed search equilibrium and how it impacts optimal policy design. In subsequent sections we will extend the analysis to introduce concave utility and to consider a dynamic setting. But the basic lessons from the static linear utility model will also apply to those richer models. Those lessons are as follows. First, workers quit too frequently, because they do not internalize that a higher quit rate depresses equilibrium wages. Second, policy should address this excess quitting problem by reducing benefits to quitters.

The model features a continuum of workers, a continuum of competititive firms, and a government that runs an unemployment insurance system. Workers have linear utility and start the period unmatched. The labor market is modeled in the directed search tradition. Firms post vacancies in submarkets indexed by the wage promised to a worker, w, and by market tightness θ, which is the ratio of vacancies v to searching workers (in fact, $\theta = v$, given a unit mass of searching workers). Vacancies can be created at cost ϕ. Workers find jobs with probability $p(\theta)$, and vacancies find workers with probability $q(\theta)$.

Once matched, workers draw an idiosyncratic cost of work shock χ from a cumulative distribution function $F(.)$. In our baseline model specification, the shock χ is not observable by the firm, and thus the wage w must be independent of χ.[9] After χ is realized, matched workers decide whether to remain with the firm and produce, or quit the firm and not work. The government imposes a lump-sum tax τ on all workers, and uses the revenue collected to pay benefits b to non-workers. To start, we assume that all non-workers must receive the same benefit. Later we will allow the government to pay different benefits to non-workers who never found a job versus those who matched but chose to quit.

If a matched worker with offered wage w and realized preference shock χ chooses not to quit, she enjoys utility given by $U^e = w - \tau - \chi$, while a non-employed worker (who either quit or failed to match) receives $U^n = b$. It is immediate that the worker will quit if and only if her draw for χ exceeds a threshold $\bar{\chi}$ given by

$$\bar{\chi} = w - (\tau + b). \tag{1}$$

[9]There is one way in which firms could potentially separate workers with different private χ realizations, even in our static model. In particular, they could do so by offering stochastic contracts (Moore, 1985). For example, a firm could offer matched workers two alternative contracts: a low wage with guaranteed employment, or a higher wage with a low employment probability. Workers with a low χ realization might prefer the first, while workers with a higher χ realization might prefer the second. We will not pursue these sorts of stochastic contracts in this simple example.

Note that $\bar{\chi}$ is increasing in w.

Firms are happy to post vacancies at any wage w that delivers positive expected profits, and free entry drives profits to zero in equilibrium. This zero profit condition is

$$qF(\bar{\chi})(z - w) = \phi. \tag{2}$$

The right-hand side is the cost of posting a vacancy. The left-hand side is the expected profit from doing so: the job-filling probability times the probability the worker does not quit times the firm surplus from a producing worker.

Since $pF(\bar{\chi})$ is the expected share of employed workers at the time of production, the government budget constraint is $pF(\bar{\chi})\tau = (1 - pF(\bar{\chi}))\, b$. Workers' expected utility is given by

$$pF(\bar{\chi})U^e + (1 - pF(\bar{\chi}))U^n. \tag{3}$$

We think of an unmatched worker as choosing across different labor submarkets characterized by different combinations (p, w) to maximize expected utility (3) subject to the zero profit condition (2). This constraint ensures that firms are happy to post vacancies into the market where the worker wants to search.

We will also consider an alternative specification in which the firm observes the realization of χ and can offer contracts in which wages are contingent on χ, which we denote $w(\chi)$. In this "public χ" version of the model, the firm can reduce quitting without raising the average wage paid $\mathbb{E}[w] = \int_{-\infty}^{\bar{\chi}} w(\chi) dF(\chi)$ by promising higher wages when the realization of χ is high, and lower wages when it is low. Spreading out wages in this fashion is not costly to the worker, given linear utility. The firm will pay a wage of up to z in order to retain a worker with a high realization for χ, and thus the quitting threshold in the public χ economy will be $\bar{\chi} = z - (\tau + b)$, which is independent of $\mathbb{E}[w]$.[10] Note that this threshold is higher than the corresponding threshold in the private χ economy (equation 1).

We assume that the matching function is Cobb-Douglas: the number of matches given vacancies v and searching workers u is given by $Av^{\frac{1}{2}}u^{\frac{1}{2}}$. This implies that the probability q that a vacancy finds a worker is related to the probability p that a worker finds a vacancy by $q(p) = A\theta^{-\frac{1}{2}} = \frac{A^2}{p}$.

[10] There are lots of contingent wage contracts that deliver efficient quitting. One is a piecewise-linear wage rule:

$$w(\chi) = \begin{cases} \chi + (\tau + b) & \bar{w} - (\tau + b) \leq \chi \leq z - (\tau + b), \\ \bar{w} & \text{otherwise} \end{cases}$$

where $\bar{w}$ satisfies

$$\mathbb{E}[w] = \int_{-\infty}^{\bar{w} - (\tau + b)} \bar{w} dF(\chi) + \int_{\bar{w} - (\tau + b)}^{z - (\tau + b)} [\chi + (\tau + b)]\, dF(\chi).$$

This allocation delivers $\bar{w}$ for all workers with χ realizations below a threshold, and a wage that increases one-for-one with χ above that threshold before maxing out at $w = z$.

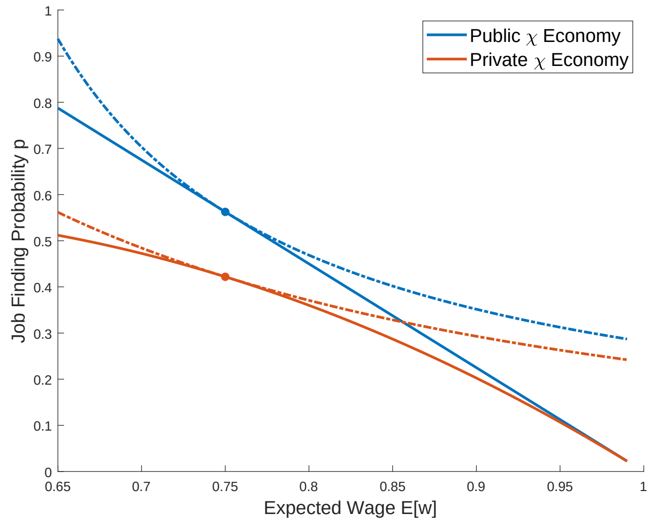

Figure 1: Equilibria in the Public and Private χ Economies. The solid lines show the set of submarkets available to searching workers. The dashed lines are indifference curves. The dots are the equilibrium choices.

We further assume that the preference shock is drawn from a uniform distribution with support $[0, a]$, where $a > z$.[11] With these assumptions, we can characterize the competitive equilibrium in closed form.

Figure 2 is a graphical illustration of the unmatched worker's choice regarding where to direct search.[12] The red solid line is the set of feasible (w, p) pairs derived from the firms' free entry condition in the baseline private χ economy, while the blue sold line is the set of feasible $(\mathbb{E}[w], p)$ pairs in the public χ economy. One can think of these lines as tracing out the budget sets faced by workers. The dashed lines are indifference curves from the workers' perspective, where all points on a given line offer identical expected utility. The points where the two curves are tangent are the competitive equilibria.

Note that the budget line for the private χ economy in Figure 2 lies below the one for the public χ economy. The reason is that for any $w < z$, workers in the private χ economy quit more frequently than in the corresponding (i.e., $\mathbb{E}[w] = w$) public χ economy. Anticipating a higher quit rate, firms need to be compensated with a higher job-filling probability q (corresponding to a lower p) in order to be willing to post vacancies at the same expected wage level. Note also that the budget line is flatter in the private χ economy. Firms are willing to post higher wages in

[11]Since firms will never pay a wage exceeding z, this last assumption guarantees that some workers will quit in equilibrium.

[12]The parameter values used to construct the plot are: $A = 1.5$, $a = 2$, $z = 1$, $\phi = 0.5$, and $b = 0$.

exchange for only a small increase in their job filling probability q (and thus a small decline in p) because part of the direct cost of paying a higher wage is offset by a smaller chance that the match dissolves.[13]

Proposition 2.1 *Given policy parameters b and τ, competitive equilibrium allocations in the economies in which χ is publicly observable and in which χ is not observable are given by*

	public χ		*private* χ
$\bar{\chi}$	$z-(\tau+b)$	$>$	$\frac{3}{4}z-\frac{3}{4}(\tau+b)$
$\mathbb{E}[w]$	$\frac{3}{4}z+\frac{1}{4}(\tau+b)$	$=$	$\frac{3}{4}z+\frac{1}{4}(\tau+b)$
p	$\frac{A^2}{\phi}\frac{1}{a}\frac{1}{4}(z-(\tau+b))^2$	$>$	$\frac{A^2}{\phi}\frac{3}{4a}\frac{1}{4}(z-(\tau+b))^2$

Proof: See Appendix A for all proofs.

Because workers face a smaller budget set in the private χ economy, they must choose some combination of a lower wage or a lower job finding probability. The proposition indicates that in this example they choose to pay the cost associated with the private information friction entirely in terms of a lower equilibrium job finding probability; there is no change in the average wage paid. They make this choice because, from the worker's standpoint, the fact that p is less sensitive to w makes searching in a relatively high wage market more attractive. Thus, in the private χ economy, workers and firms coordinate on a relatively high wage equilibrium. This outcome is consistent with the old idea of "efficiency wages." The interpretation is that even though workers cannot commit not to quit *ex ante*, they can partially address the lack-of-commitment friction by choosing to search in a high-wage market, which makes it more costly for them to quit *ex post*.

2.1 Efficiency and Optimal Policy

We now review the sense in which the competitive equilibrium in the private χ economy is inefficient, as a precursor to discussing optimal policy. Recall that in the competitive equilibrium, households make two choices: the job finding probability p (or, equivalently, market tightness θ) and the quitting threshold $\bar{\chi}$.

Proposition 2.2 *In the public χ economy, allocations are efficient when $b=\tau=0$. In the private χ economy, when $b=\tau=0$, $\bar{\chi}$ is inefficiently low (the quit rate is inefficiently high), and p is inefficiently*

[13] That can be readily seen when $p=A^2/q$, $F(\bar{\chi})=\bar{\chi}/a$ and $\bar{\chi}=w-(\tau+b)$ are substituted into eq. (13) to give $p=\frac{A^2}{\phi}\frac{w-(\tau+b)}{a}(z-w)$. A higher wage decreases flow profit $(z-w)$, necessitating a decline in p to maintain zero profit. But a higher wage also raises the matched worker retention rate $\frac{w-(\tau+b)}{a}$, which boosts profits.

low (workers are too picky). However, the equilibrium value for p is identical to the one preferred by a planner who can dictate market tightness, but must respect the private quitting constraint (eq. 1). In this sense, equilibrium market tightness is conditionally efficient.

Given linear utility, the efficient values for p and $\bar{\chi}$ are the ones that maximize per capita consumption net of the utility cost of work; that is, they solve

$$\max_{p,\bar{\chi}} p \int_0^{\bar{\chi}} (z - \chi)\, dF(\chi) - \theta\phi. \tag{4}$$

where, from the matching function, $\theta = p^2/A^2$.

It is immediate that the efficient value for the quitting threshold is $\bar{\chi} = z$, where the value of output created by the match is exactly equal to the cost of producing it. From Proposition 2.1, the quitting threshold is efficient in the public χ economy when $b = \tau = 0$. Thus, state-contingent wage contracts deliver efficient quitting. In the private χ version of the model, there is too much quitting at $b = \tau = 0$ because in the laissez faire equilibrium $\bar{\chi} = \frac{3}{4}z < z$. Quitting is inefficiently high because workers with $\chi \in (\bar{\chi}, z)$ quit when the value to the firm from continuing to produce, $z - w$, exceeds the value to the worker from quitting, $\chi - w$. In the decentralized equilibrium, this inefficiency shows up in the form of offered wages that are depressed relative to the public χ economy for any given p.

In the public χ economy, the equilibrium value for p at $b = \tau = 0$ described in Proposition 2.1 maximizes equation (4) when $\bar{\chi} = z$. Thus, directed search delivers efficient market tightness and vacancy posting. The intuition is straightforward: workers simply choose to search in the submarket that offers the highest expected welfare, subject to firms making zero profits. Acemoglu and Shimer (1999) consider a directed search environment similar to ours and also find that a zero unemployment benefit delivers the first best allocation.

In the baseline private χ economy, there is an equilibrium relationship between the quitting threshold and job finding probability $\bar{\chi}(p)$ via equations (1) and (2). We have already noted that at $b = \tau = 0$, workers are too picky (p is too low) relative to the public χ economy. But it is straightforward to verify that if the planner maximizing (4) must take as given the quitting rule (1) (rather than the efficient value $\bar{\chi} = z$), then that planner would choose the same value for p that emerges in equilibrium at $b = \tau = 0$. In this sense, wage setting in the private χ economy is conditionally efficient. Thus, the motivation for policy intervention in this paper is different from that in Landais et al. (2018b), who consider models with inefficient wage setting.

We now address optimal policy. In the private χ economy, policy can be used to reduce the quit rate. In particular, a negative value for b raises $\bar{\chi}$, pushing it closer to the efficient level. But if the government has only one independent policy instrument b it cannot, in general, deliver the efficient values for both $\bar{\chi}$ and p.[14] The optimal policy, which is $\tau^* + b^* = -\frac{z}{5}$, strikes a balance.[15] It delivers $\bar{\chi} = \frac{9}{10}z < z$, so there is still too much quitting, but also a job finding rate p that is too high, so there is also too much vacancy creation. The job finding rate is too high because when $b < 0$, workers perceive the cost of non-employment to be larger than the true social cost, and they become too desperate to find a job.

To achieve the first best, the government needs an additional policy instrument. Suppose the government can distinguish non-workers who failed to match from those who matched but quit before producing. Suppose further that the government can pay differential benefits to those two groups: b_s to job seekers who never find a job, and b_q to those who quit. In this case, the government can achieve the first best by adjusting both instruments. Intuitively, with differential benefits the government can tax quitting to deliver the first best quit rate without simultaneously distorting job search behavior. Compared to a uniform benefit system, this policy involves taxing quitters more aggressively. These results are summarized as follows.

Proposition 2.3 *(A) In the public χ economy, $b^* = \tau^* = 0$ (laissez-faire) delivers the first-best allocation.*
(B) In the private χ economy, the optimal policy when all non-workers must be paid the same benefit is $b^* + \tau^* = -\frac{z}{5}$. Associated welfare is strictly lower than the first-best.
(C) In the private χ economy, the optimal policy when the planner can pay differential benefits to workers who never find a job versus those who quit delivers lower benefits to quitters compared to the optimal uniform policy: $b_q^* + \tau^* = -\frac{z}{4}$. This policy delivers the first best allocation.

3 A Static Model with Concave Utility

We now turn to our next model, which adds two new elements to the private χ economy just described. First, we now assume concave utility from consumption. This introduces an insurance value for providing government benefits to non-workers. Utility for workers and non-workers is given by $U(w - \tau) - \chi$ and $U(b)$ respectively, where $U()$ is a concave function. Second, we now allow for exogenous as well as endogenous match separations. In particular, we assume that after

[14]The government can also decide on τ, but it needs to maintain a balanced budget, so it really only has only one independent policy lever.

[15]We summarize policy by the optimal value for $b + \tau$, since policy parameters enter all equilibrium variables in the form of this sum (see the previous proposition). It is straightforward to compute the optimal value for b, given $b + \tau$, using the equilibrium expressions for $\bar{\chi}$ and p and the government budget constraint.

matching, a fraction $1-\gamma$ of matches are immediately destroyed. Workers in matches that survive then draw idiosyncratic preference shocks χ, and decide whether to work or quit. For technical reasons, we assume that χ shocks are drawn from a continuous distribution with an unbounded support, which guarantees a positive quit rate in equilibrium.

Abstracting, to start, from both types of separation, this is the textbook model of unemployment insurance. The government chooses a level of benefits for searchers b_s funded by a tax on workers τ. If benefits are lower than equilibrium after-tax earnings, then increasing benefits has an insurance value that was absent in the model with linear utility. But the planner's desire to provide insurance will be tempered by a fiscal externality. In particular, with $b_s > 0$ workers will be too picky at the search stage, choosing a job finding probability p that is inefficiently low. The reason is that workers will not internalize that if they were to search for lower wage but easier to find jobs, the equilibrium tax required to fund the UI system would fall. The welfare maximizing value for b_s trades off insurance and efficiency as summarized in the standard Baily-Chetty formula (see Section 4).

Now, suppose we introduce exogenous separations but do not allow for endogenous quits. Suppose the government can pay differential benefits to workers who never find a job, b_s, versus those who separate exogenously, b_f. The optimal policy here features perfect insurance for workers who are laid off: $b_f^* = w - \tau^*$. Suppose, to the contrary, that laid off workers received less net income than workers. Then a marginal increase in benefits funded by higher taxes on workers would improve insurance and expected welfare for workers who match. And at the search stage, a higher expected value from matching would reduce pickiness and thus mitigate the fiscal externality.[16]

Finally, consider the most general version of the model in which both exogenous separations and endogenous quits are possible. Let b_q denote the benefit level for quitters. The first result here is that the optimal policy features $b_q^* < b_f^*$. The logic is that while benefits to quitters and laid off workers are equally valuable from an insurance perspective, benefits to quitters have an additional efficiency cost. The key idea is that workers quit too frequently, as in the linear model, because they do not internalize that a higher quit rate depresses equilibrium wages.[17]

[16]Note that in a dynamic model, workers who are laid off transit to searching, so the distinction between the two types of non-worker is elided.

[17]Consider a situation in which workers receive the same benefit regardless of whether they quit or separated exogenously, $b_q = b_f$. Now consider a perturbation that reduces b_q and raises b_f, without changing the tax rate. This will not impose a direct expected consumption cost from an *ex ante* perspective, but will reduce the quit rate. Expecting fewer quits, firms will be willing to post more vacancies at any given wage. This translates into an expanded budget set for workers in terms of the set of labor sub-markets that are available at the search stage.

A second result here is that in the presence of quitting, optimal insurance for laid off workers is incomplete, $b_f^* < w - \tau^*$, in contrast to the model without quitting. To see why, note that the planner has two tools to reduce excessive quitting. One is to reduce the benefit b_q. But that comes at the cost of reducing valuable insurance to quitters. The second tool is to reward work, which the planner can do by lowering the tax τ on workers. And reducing b_f below the perfect insurance level allows the planner to lower τ. These results are summarized in the following proposition.

Proposition 3.1 *Suppose that the χ shock is drawn from a continuous distribution with an unbounded support. The optimal policy features*

$$b_q^* < b_f^* < w - \tau^*. \tag{5}$$

4 A Dynamic Model and an Extended Baily-Chetty Formula

We now consider a dynamic version of the model just described. We develop a version of the Baily-Chetty optimal replacement rate formula which provides a clear understanding of how the quitting margin changes the optimal provision of social insurance.

Time is discrete, and there are no aggregate shocks. Workers are ex ante identical and infinitely-lived, and workers and firms discount at a common rate β. Each period unmatched workers choose which labor sub-market to search in. Next, matches are destroyed with probability $1-\gamma$, generating involuntary exogenous separations.[18] Workers who remain matched then draw an idiosyncratic cost of work shock χ. These shocks are drawn independently each period from a distribution F. Finally, all workers who remain matched produce identical output z, and all workers consume.

We assume that labor sub-markets are indexed by a job finding probability p and a constant wage w that firms promise to pay for as long as the match survives (in Section 5 we will allow firms to post contracts in which wages vary with tenure). The government runs an unemployment insurance scheme in which all non-workers receive a benefit $b = \kappa z$ where κ controls the replacement rate. These benefits are funded by a proportional tax τ on wage income w. Workers also have access to unearned income φ which corresponds to wage income from other household members and asset income. Thus,

$$c_{it} = \begin{cases} w(1-\tau) + \varphi & \text{if } i \text{ is working at } t \\ \kappa z + \varphi & \text{if } i \text{ is not working at } t. \end{cases}$$

[18] Exogenous match destruction shocks could be interpreted as reflecting large negative shocks to match productivity.

The initial state is one in which all workers are unmatched. The matching technology is the same as in the static model. Conditional on matching, expected firm profits are given by

$$\Pi(w) = \gamma F(\bar{\chi}) \left(z - w + \beta \Pi(w)\right),$$

where $\gamma F(\bar{\chi})$ is the probability that the match neither dissolves exogenously nor because the worker quit. Free entry implies that expected profits in any active labor submarket must exactly cover the cost of posting a vacancy:

$$\phi = q(p)\Pi(w),$$

which implies the following equilibrium relationship between p and w:

$$\phi = q(p)\frac{\gamma F(\bar{\chi})}{1 - \beta\gamma F(\bar{\chi})}(z - w). \tag{6}$$

We can therefore think of labor submarkets as being indexed by the job finding probability p, with the corresponding wage $w(p)$ being pinned down by equation (6).

Consider a stationary environment in which workers are choosing a job finding probability p. Let $W^u(p)$ and $V^u(p)$ denote the values of being unmatched at the start of the period and after the search and matching stage. Let $V^e(p)$ be the value of being matched at the start of the period. These values are related as follows:

$$\begin{aligned}
W^u(p) &= pV^e(p) + (1-p)V^u(p), \\
V^u(p) &= U(\kappa z + \varphi) + \beta W^u(p), \\
V^e(p) &= \gamma F(\bar{\chi})(U\left(w(p)\left(1-\tau\right) + \varphi\right) - \mathbb{E}[\chi_{|\chi \le \bar{\chi}}] + \beta V^e(p)) + (1 - \gamma F(\bar{\chi}))V^u(p).
\end{aligned}$$

A worker will quit when $\chi \geq \bar{\chi}$, where $\bar{\chi}$ is the solution to the following equating the value of work to the value of quit:

$$U\left(w(p)\left(1-\tau\right) + \varphi\right) - \bar{\chi} + \beta V^e(p) = V^u(p).$$

This equation, after substituting in the expressions for $V^e(p)$ and $V^u(p)$, pins down the quitting threshold $\bar{\chi}$ as an implicit function of (p, τ, κ):

$$-\beta\gamma F(\bar{\chi})(1-p)\left(\bar{\chi} - \mathbb{E}[\chi_{|\chi \le \bar{\chi}}]\right) = U\left(w(p)\left(1-\tau\right) + \varphi\right) - \bar{\chi} - U(\kappa z + \varphi). \tag{7}$$

Given a time invariant policy (τ, κ) and a constant p, the value of being unmatched can be written as a weighted average of the per-period utilities when employed and when non-employed:

$$(1-\beta)W^u(p) = (1-\tilde{u})\left[U\left(\left(1-\tau\right)w(p) + \varphi\right) - \mathbb{E}[\chi_{|\chi \le \bar{\chi}}]\right] + \tilde{u}U(\kappa z + \varphi), \tag{8}$$

where $w(p)$ is given by equation (6), where $\bar{\chi}(p, \tau, \kappa)$ is given by equation (7), and where $1 - \tilde{u} = \frac{\gamma p F(\bar{\chi})}{1 - \beta\gamma(1-p)F(\bar{\chi})}$ is the expected fraction of time (appropriately discounted) that an initially unmatched worker will spend employed. The first term on the right-hand side of equation (8) is $(1 - \tilde{u})$ times expected per period flow utility if the worker is employed, and the second term is $\tilde{u}$ times utility if non-employed.

The worker chooses to direct search to the labor submarket p offering the highest expected utility. When doing so, the worker internalizes the impact of the probability p on the wage w via equation (6): search in a tighter market with a lower p translates to a higher wage w. The searching worker also internalizes that his choice for p (and thus w) will affect his future quitting threshold $\bar{\chi}$ via equation (7). Of course, workers do not internalize the equilibrium impact of either of these choices on the policy variables. Thus, an unmatched worker solves

$$\max_p W^u \left(p, \bar{\chi}\left(p; \tau, \kappa\right); \tau, \kappa\right)$$

with optimality condition

$$\frac{\partial W}{\partial p} + \frac{\partial W}{\partial \bar{\chi}} \frac{\partial \bar{\chi}}{\partial p} = 0, \tag{9}$$

where $\frac{\partial \bar{\chi}}{\partial p}$ is taken with respect to the no-quitting condition (7).

We now move to the planner's problem. Our planner's policy problem is to choose κ to maximize $W^u(p)$. The planner internalizes three constraints. The first is that given a choice for κ, the planner must adjust τ to achieve present value budget balance:

$$\tau(1 - \tilde{u}\left(p, \bar{\chi}\right))w\left(p, \bar{\chi}\right) = \kappa \tilde{u}\left(p, \bar{\chi}\right) z. \tag{10}$$

The planner also internalizes how policy choices (τ, κ) affect the private equilibrium $(p, \bar{\chi})$ via the no-quitting condition (7) and the optimal job-search condition (9). These three equations pin down a mapping from κ to $\left(\tau, p, \bar{\chi}\right)$. We can compactly write the general form of this problem as

$$\max_\kappa W^u\left(p(\kappa), \bar{\chi}\left(p\left(\kappa\right); \tau\left(\kappa\right), \kappa\right), \tau(\kappa), \kappa\right). \tag{11}$$

This notation captures the idea that changes in κ affect social welfare directly, and indirectly via p, $\bar{\chi}$ and τ.

The optimal choice for κ is thus defined by a first order condition with respect to equation (11). This equation can alternatively be expressed in terms of marginal utilities and elasticities capturing how changes in the replacement rate affect labor market equilibrium, similarly to Baily (1978) and Chetty (2006).

Proposition 4.1 *At the optimum of the social planner's problem defined in equation (11), the following extended Baily-Chetty formula holds:*

$$\underbrace{\frac{U'(c^u) - U'(c^w)}{U'(c^w)}}_{\text{consumption insurance}} + \underbrace{- \left[\frac{1}{1-\tilde{u}} \varepsilon_{\tilde{u},\kappa} - \varepsilon_{w,\kappa} \right]}_{\text{fiscal externality}} + \underbrace{\frac{1-\tau}{\tau} \varepsilon_{w,\kappa|p}}_{\text{quitting externality}} = 0, \tag{12}$$

where

c^u (c^w) *is the consumption of the non-employed (employed),*

$\varepsilon_{\tilde{u},\kappa}$ *is the general equilibrium elasticity of present value non-employment* $\tilde{u}$ *with respect to* κ*,*

$\varepsilon_{w,\kappa}$ *is the general equilibrium elasticity of the wage* w *with respect to* κ*, and*

$\varepsilon_{w,\kappa|p} = \frac{\kappa}{w} \frac{\partial w}{\partial \bar{\chi}} \left(\frac{\partial \bar{\chi}}{\partial \tau} \frac{d\tau}{d\kappa} + \frac{\partial \bar{\chi}}{\partial \kappa} \right)$ *is the partial elasticity of* w *with respect to* κ *via* $\bar{\chi}$*, holding fixed* p*.*

The first term in equation (12), labeled "consumption insurance," captures the mechanical impact of an increase in κ on consumption inequality, in the absence of any behavioral responses via p or $\bar{\chi}$. A higher κ means non-workers enjoy higher consumption, while workers enjoy lower consumption. This term appears identically in the standard Baily-Chetty formula – it is exactly the left-hand side of equation (8) in Chetty (2006).

The second term, labeled "fiscal externality," captures the behavioral impact of raising κ on tax revenue. In the model, a higher replacement rate will lower the quitting threshold $\bar{\chi}$ and lower the job finding probability p. These effects will increase the equilibrium share of non-workers, necessitating an additional increase in the tax rate τ to balance the government budget. In the standard Baily-Chetty formula, the analogous term is the elasticity of unemployment to benefit duration. Here, with a quitting margin, the replacement rate affects the frequency of non-employment, as well as the duration of non-employment spells: the elasticity of $\tilde{u}$ with respect to κ captures both margins. A second difference relative to the standard Baily-Chetty condition is the $\varepsilon_{w,\kappa}$ term. This term is present because we assume general equilibrium, and thus the budget-balancing tax rate must adjust to changes in the equilibrium wage in addition to changes in equilibrium unemployment.[19]

The third term, labeled "quitting externality," is novel. It captures the fact that in our economy, a change in κ changes the equilibrium wage via the impact on the quitting threshold $\bar{\chi}$. A higher κ makes matched workers more willing to quit, lowering $\bar{\chi}$. Anticipating shorter match durations, firms will offer lower wages for any given p, which is welfare reducing. This negative wage effect pushes the optimal replacement rate downward.

The quitting effect term is proportional to the partial elasticity of the wage to a change in κ,

[19] The reason the $\varepsilon_{\tilde{u},\kappa}$ elasticity is pre-multiplied by $1/(1-\tilde{u})$ and the $\varepsilon_{w,\kappa}$ term is not is that a rise in $\tilde{u}$ means both more benefit recipients and fewer taxpayers, while a decline in w reduces tax revenue without increasing costs.

holding p constant, which we denote $\varepsilon_{w,\kappa|p}$. To see why this partial elasticity is negative, note that $\varepsilon_{w,\kappa|p} = \frac{\kappa}{w}\frac{\partial w}{\partial \bar{\chi}}\left[\frac{\partial \bar{\chi}}{\partial \tau}\frac{d\tau}{d\kappa} + \frac{\partial \bar{\chi}}{\partial \kappa}\right]$. Wages are increasing in $\bar{\chi}$ ($\frac{\partial w}{\partial \bar{\chi}} > 0$) because less quitting raises the expected match surplus. Increases in κ or τ make workers more likely to quit, by raising the value of non-employment or reducing the value of employment; hence, $\frac{\partial \bar{\chi}}{\partial \kappa} < 0$ and $\frac{\partial \bar{\chi}}{\partial \tau} < 0$.

Recall from equation (6) that changes in κ change w both via an impact on p and via an impact on $\bar{\chi}$. Why does the planner worry only about the impact via the $\bar{\chi}$ channel? The reason is that unmatched workers are choosing p optimally, internalizing the impact of p on wages via $\bar{\chi}$ as part of that optimization. So the planner perceives no marginal welfare gain from using κ to manipulate w via changes in p. That is why there is no analogue of the quitting term in the (textbook) version of the model in which workers cannot quit.

4.1 Quantification

We set the model period length to one month. We assume workers have logarithmic utility from consumption, and set $\beta = 0.96$ on an annual basis. The preference shock χ is assumed to be drawn from a lognormal distribution, with mean μ_χ and variance $\sigma_\chi^2 : \chi \sim LN(\mu_\chi, \sigma_\chi^2)$.

We normalize productivity z to one and assume the same Cobb-Douglas matching technology as in the static models described above. We set the replacement rate parameter κ to 0.43, which is the average replacement rate for workers receiving unemployment benefits in 2023.[20] We set $\varphi = 0.721$, which corresponds to an estimate from the CPS ASEC survey of other household income (see Section 6 for more details).

There are five remaining parameters: the exogenous match destruction rate $1-\gamma$, the vacancy posting cost ϕ, the match efficiency parameter A, and the mean and variance of the distribution for $\log \chi$, μ_χ and σ_χ^2. We set the first four of these parameters so that the model steady state replicates average monthly labor market flow and stock values for the United States over the three year period from March 2022 to February 2025. We think of the U.S. economy as being in steady state during this period.

We set $1-\gamma$ to 1.22 percent, which is the average CPS layoff rate between March 2022 and February 2025 according to Ellieroth and Michaud (2024). We set ϕ, A and μ_χ jointly to match average values for the job openings rate, the quit to non-employment rate, and the unemployment rate. The average job openings rate over this period was 5.81 percent according to the JOLTS

[20] See https://www.minneapolisfed.org/article/2025/how-unemployment-insurance-access-and-benefits-vary-by-state

survey. The average quit to non-employment rate was 1.91 percent according to Ellieroth and Michaud (2024). The average CPS unemployment rate was 3.78 percent. Loosely speaking, the job opening rate and the unemployment rate identify the vacancy posting cost ϕ and match efficiency A, while the quit rate identifies the average cost of work, μ_χ. In the model, we count all non-workers as unemployed except for those who quit in the current period, who we label out of the labor force OLF. The model steady state shares of workers employed and out of the labor force are $e = \frac{\gamma p F(\bar{\chi})}{\gamma p F(\bar{\chi})+1-\gamma F(\bar{\chi}}$ and $OLF = e\gamma(1-F(\bar{\chi}))$ respectively, and the steady state unemployment rate is $u = \frac{1-e-OLF}{1-OLF}$. Given our calibration targets for γ, u and $F(\bar{\chi})$, the implied monthly job finding probability p is 55.1 percent.

One parameter remains, which is the variance of idiosyncratic preference shocks, σ_χ. This parameter is important because it determines how sensitive the model quit rate is to policy parameters. We set this parameter to 0.508 to match an estimate of the elasticity of the quit rate to worker earnings. See Section 6 for a more detailed account of how we exploit cross-sectoral variation in average earnings and in quit rates to estimate a value for σ_χ. In Section 4.2 we will consider a counterfactual experiment with much higher value for σ_χ, which makes the quit rate largely insensitive to the replacement rate.

Panel B of Table 1 reports the values of the different terms in our extended Baily-Chetty formula, along with some other equilibrium variables. The first row evaluates these terms at $\kappa = 0.43$. The second row evaluates the same terms at the optimal replacement rate, which is $\kappa = 0.111$. The key findings are as follows.

First, the quitting term is quantitatively important. At $\kappa = 0.43$, the welfare cost of a marginal increase in κ via a lower equilibrium wage because of quits is more than double the gain from better consumption insurance. Second, the quitting effect is not large because the equilibrium wage is very sensitive to κ. In fact, the general equilibrium elasticity is tiny, and the partial equilibrium elasticity (holding constant p) is also quite small. Rather, the reason the quitting term is quantitatively important is that this partial equilibrium elasticity is pre-multiplied by $(1-\tau)/\tau$, which is large because τ is small.[21] Intuitively, small declines in equilibrium wages are costly because they apply to employed workers, who constitute the vast majority of the population, while the other terms in the Baily-Chetty formula are effectively proportional to the much smaller share of unemployed workers.

[21]The model τ should be interpreted as the tax used to finance unemployment insurance payments. As unemployment is a small fraction of overall working population, the rax rate is small as well.

Second, at the much lower optimal replacement rate of $\kappa = 0.111$, the marginal gain from increasing κ via better consumption insurance is larger. This gain is offset by marginal costs in terms of lower wages and higher taxes, where the wage effect (reflecting the quitting externality) is much larger than the tax effect (reflecting the fiscal externality). The existing literature has focused entirely on lower equilibrium employment as the cost of more generous unemployment insurance. Our finding here suggests that the cost of lower equilibrium wages may be quantitatively more important when the quitting friction is taken into account.

The Baily-Chetty formula has proven very popular because it offers an intuitive formulation of the trade-offs in setting UI and because the elasticities that appear in the formula can in principle be estimated and used to calibrate actual policy. Unfortunately, however, one elasticity in equation (12) is the elasticity of wages to κ, holding constant p. How one would go about estimating that elasticity is unclear. And because this elasticity is scaled by a large constant, a very precise estimate would be required. Jager et al. (2020) estimate the aggregate elasticity of wages to the UI replacement rate and conclude that it is less than 3 cents per dollar of additional benefits: at $\kappa = 0.43$, the corresponding value in our model is 0.3 cents.[22]

4.2 Sensitivity: Quitting Less Sensitive to UI

We now show how the Baily-Chetty decomposition changes in an alternative model calibration in which the standard deviation of χ is much higher. This makes the quit rate much less sensitive to the UI replacement rate κ, since only a small mass of workers are close to indifferent about quitting. We recalibrate A, ϕ and μ_χ so that at $\kappa = 0.43$, this high preference variance specification delivers the same unemployment rate, job openings rate, and quit rate as the baseline calibration. Panel A of Table 1 shows this implies no change in the calibrated value for A, a much lower value for μ_χ, and a sixfold increase in the the vacancy cost ϕ.

Rows 3 and 4 of Panel B report results for this high preference variance calibration. At $\kappa = 0.43$, the quitting term is much smaller than in the corresponding baseline model, reflecting a much smaller partial elasticity of wages with respect to κ, $\varepsilon_{w,\kappa|p}$. This partial elasticity is smaller because the quit rate is much less sensitive to κ. Because this negative partial elasticity is smaller than in the baseline model, the full general equilibrium elasticity of wages to κ is larger. Now, a one dollar increase in benefits leads to a 2 cent increase in the wage.

[22] There are many estimates of the elasticity of non-employment $\tilde{u}$ with respect to κ; see Schmieder and von Wachter (2016) for a recent survey.

The optimal replacement rate in the high variance calibration is much higher than in the baseline calibration, at $\kappa = 0.392$. Again, that is because the costs of more generous benefits, in terms of shorter expected match duration and thus lower wages, are much smaller.

Note that an important message from this experiment is that it is not the presence of quitting *per se* that dictates a less generous optimal UI replacement rate. Rather, quitting is a problem only if a significant share of quitters are close to marginal workers and would be induced not to quit – thereby preserving matches with positive joint surplus – if UI was slightly less generous.

Why is the calibrated value for vacancy posting costs six times smaller in the baseline calibration than in the high preference variance specification? Recall that these two economies replicate identical values for unemployment, job openings and quits. Given identical values for p and $F(\bar{\chi})$, it is immediate from the firm's free entry condition that lower vacancy costs in the baseline (low σ_χ) model must translate into a higher wage level w, which is evident in Panel C, column 3. Thus, workers in the baseline model choose to benefit from low vacancy costs in the form of high wages rather than a high job finding probability. The reason they do so is again the efficiency wage logic: higher wages signal lower future quitting, which firms are happy to reward. Thus, one lesson from this experiment is that models with endogenous quitting can generate significant unemployment with very low job creation costs. In this sense, the quitting margin amplifies frictional unemployment.

5 A Dynamic Quantitative Model

We now describe the model we will use for a more quantitative exploration of optimal policy. Relative to the model explored in the previous section, the key new ingredients are: (i) the introduction of multiple sectors with cross-sector variation in wages, (ii) variation in match quality, which introduces a motive to quit less productive matches, (iii) on the job search, which generates quits that do not involve a period of non-employment, (iv) richer dynamic wage contracts that give firms additional tools to reduce the quit rate, and (v) a social insurance system that pays differential benefits to workers who are laid off versus workers who quit.

The economy is composed of different sectors indexed by n. Infinitely-lived workers are *ex ante* heterogeneous with respect to the sector to which they belong and cannot move across sectors. Workers start each period either matched to a firm or unmatched. Matched workers are further differentiated by the quality of their match z, where match quality is drawn at the time a new

Table 1: Welfare Decomposition with Baily-Chetty Formula

Panel A: Parameter values

	A	ϕ	μ_χ	σ_χ	γ	φ	z
Baseline	0.563	0.117	-1.700	0.51	0.988	0.721	1
$\sigma_\chi = 100$	0.563	0.605	-207.709	100	0.988	0.721	1

Panel B: Terms in Baily-Chetty formula and elasticities

	κ	c ineq.	fiscal extn.	quit extn.	$\varepsilon_{\tilde{u},\kappa}$	$\varepsilon_{w,\kappa}$	$\varepsilon_{w,\kappa\|p}$
Baseline	0.430	0.466	-3.424	-1.126	3.224	-0.003	-0.031
Optimum	0.111	1.058	-0.246	-0.813	0.241	-0.001	-0.001
$\sigma_x = 100$	0.430	0.440	-0.549	-0.021	0.536	0.020	-0.0006
Optimum	0.392	0.491	-0.469	-0.022	0.461	0.018	-0.0005

Panel C: Model moments

	κ	$\tilde{u}$ (%)	w	τ (%)	p	Quit rate (%)	$\Delta w/\Delta\kappa$
Baseline	0.430	5.76	0.9928	2.64	0.550	1.91	-0.006
Optimum	0.111	1.56	0.9929	0.18	1.000	0.34	-0.013
$\sigma_x = 100$	0.430	5.76	0.9628	2.73	0.550	1.91	0.045
Optimum	0.392	5.50	0.9611	2.37	0.575	1.91	0.044

match is formed, and remains fixed for the duration of the match. We assume two possible values for match quality, $z \in \{z_H, z_L = 2 - z_H\}$, which are drawn with equal probability. A worker in sector n with match quality z produces zY_n units of output each period for as long as the match survives.

Individuals have three potential sources of income. First, workers receive wage income, which is taxed at rate τ. We describe wage determination below. Second, all individuals receive sector specific non-wage income φ_n. This captures the value of wage income from other household members, and the value of household unearned income. If an individual is not working after being laid off, they receive a sector-specific unemployment insurance benefit b_n. An individual who is not working after a quit does not receive unemployment insurance. Thus, consumption for different types is given as follows:

$$c = \begin{cases} w(1-\tau) + \varphi_n & \text{if employed,} \\ b_n + \varphi_n & \text{if non-employed, laid off,} \\ \varphi_n & \text{if non-employed, quit.} \end{cases}$$

The idiosyncratic utility cost of work is again drawn independently each period from a distribution F, where F is common across sectors.

Firms post vacancies at a sector-specific cost ϕ_n. A match can end because of an exogenous separation or because the worker chooses to quit, either to move to another job, or to transit to non-employment.

Firms commit to flexible dynamic contracts that specify how wages will vary with the realization of match quality and with tenure. In contrast, workers cannot commit to future job search or quitting choices. Firms do not observe preference shocks χ, the worker's on-the-job search behavior, or their receipt of outside offers. We will formalize the firm problem recursively, and summarize the state of a particular firm-worker match by the pair (V, z), where V is the expected present value of utility promised to the worker and z is the match quality.

Before describing how promised values and wages evolve, we first summarize the sequence of events during a period.

1. All workers (matched and unmatched) choose the submarket to which they direct job search.
   (a) Unmatched workers search in submarkets indexed by sector n and promised value V^s.
   (b) Matched workers search in submarkets indexed by the characteristics of the incumbent match (V, z) in addition to sector n and promised value V^s.
2. Workers who started the period matched report to their current employer whether or not they have received an outside offer. If the worker reports an offer, the incumbent firm either matches the expected value of the offer V^s, in which case the worker stays with the incumbent firm, or else the incumbent firm tells the worker to leave the firm.
3. New matches draw match quality z, which is immediately observed by both firm and worker.
4. With probability $(1-\gamma)$ each match is destroyed, generating an involuntary separation.
5. Workers who remain matched draw an idiosyncratic cost-of-work shock χ. Given their realization of this shock, a worker chooses whether or not to quit.
6. Workers who remain matched produce, and all workers consume.

We now describe the search stage and the firm's dynamic contracting problem. To simplify notation, we temporarily suppress the sector notation.

Consider the vacancy posting problem for firms posting in markets for unmatched workers. For any possible submarket indexed by V^s, let $J^u(V^s)$ denote the expected profit from posting an additional vacancy. That is equal to the probability that the vacancy translates into a match, $q(V^s)$, times expected profits conditional on a match, minus the vacancy posting cost; that is,

$$J^u(V^s) = q(V^s)\,\mathbb{E}\left[\Pi(V^s)\right] - \phi,$$

where $\mathbb{E}\left[\Pi(V^s)\right]$ denotes the maximum expected present value of profits for a firm exiting the search and matching stage newly matched to a worker promised V^s, before match quality is revealed. Let V^f and V^q denote the value of being unmatched after the search and matching stage for workers who became non-employed following a layoff and a quit respectively. At the matching stage, unmatched workers of type $i \in \{f, q\}$ solve

$$\max_{V^s}\left\{p(V^s)\,V^s + (1 - p(V^s))\,V^i\right\},$$

subject to $J^u(V^s) = 0$.

For any possible submarket for matched workers indexed by (V^s, V, z), let $J^m(V^s, V, z)$ denote the profit from posting an extra vacancy. For firms posting vacancies in markets for matched workers, only meetings in which the incumbent firm does not match the outside offer translate into new hires. Let $\bar{\zeta}(V^s, V, z)$ denote the probability that an incumbent firm that has promised V with match quality z matches an outside offer of V^s. The payoff from posting an additional vacancy is now

$$J^m(V^s, V, z) = q(V^s, V, z)\,(1 - \bar{\zeta}(V^s, V, z))\mathbb{E}\left[\Pi(V^s)\right] - \phi. \tag{13}$$

Matched workers in state (V, z) solve

$$\max_{V^s}\left\{p(V^s, V, z)\,V^s + (1 - p(V^s, V, z))\,V\right\} \tag{14}$$

subject to $J^m(V^s, V, z) = 0$. Note that the higher is the equilibrium offer matching probability $\bar{\zeta}(V^s, V, z)$, the larger must be the equilibrium contact rate $q(V^s, V, z)$, which in turn will dictate a lower ratio of vacancies to searching workers.

Once a worker transitions to a firm offering an expected value V^s, match quality is revealed. Let $\Pi(V, z)$ denote the maximum expected present value of profits for a firm that has promised V to a worker when match quality is z. Firms choose contingent values V_H and V_L, conditional on the realization of match quality, subject to a promise-keeping constraint. Thus,

$$\mathbb{E}\left[\Pi(V^s)\right] = \max_{V_H, V_L}\left\{0.5 \times \Pi(V_H, z_H) + 0.5 \times \Pi(V_L, z_L)\right\}, \tag{15}$$

subject to

$$0.5 \times V_H + 0.5 \times V_L \geq V^s.$$

We next describe the firm dynamic profit maximization problem, for a firm exiting the search and matching stage (i.e., at step 4 in the timeline outlined above) matched to a worker with a promise V and known match quality z . We will think of the firm as directing the choices of the worker about when to quit and about where to direct on-the-job search, recognizing that those choices must be consistent with utility maximization by the worker. The firm chooses (i) the current period wage, w; (ii) the current period quitting threshold, $\bar{\chi}$; (iii) a promised continuation value V' if the match survives into the next period and the worker does not report an outside offer after the search phase at the start of the next period; (iv) the promised value $V^{s'}$ of the market to which the worker will direct job search in the next period; and (v) the probability ζ' that the firm will match outside offers in the next period.

The firm makes these five choices to maximize the expected present value of profits. Flow current period profits are given by $zY - w$, but these are realized only if the match is not destroyed and the worker does not quit, which occurs with probability $\gamma F(\bar{\chi})$. Expected continuation profits depend on whether the worker receives an outside offer at the start of the next period (the probability of which is $p(V^{s\prime}, V', z)$, and, if they do, on whether the firm matches the offer. Thus, the firm solves

$$\Pi(V,z) \quad = \quad \max_{w,V',\bar{\chi},V^{s\prime},\zeta'} \gamma F(\bar{\chi}) \left[zY - w + \beta\left(1 - p(V^{s\prime}, V', z)\right)\Pi(V', z) + \beta p(V^{s\prime}, V', z)\zeta'\Pi(V^{s\prime}, z)\right], \tag{16}$$

subject to the following constraints.

First, the quitting threshold must be consistent with optimal quitting behavior on the part of the worker:

$$U(w(1-\tau)+\varphi) - \bar{\chi} + \beta p(V^{s\prime}, V', z)V^{s\prime} + \beta\left(1 - p(V^{s\prime}, V', z)\right)V' = V^q. \tag{17}$$

The left-hand side of this expression defines the worker's expected present value when they do not quit: they receive wage and non-wage income, pay the utility cost of work, and enter the next period matched. In the next period, the worker receives an outside offer with probability $p(V^{s\prime}, V', z)$, in which case their continuation value is $V^{s\prime}$, while with reciprocal probability their continuation value is V'. If they quit, the worker gets the value V^q.

Second, the contract offered by the firm must deliver V to the worker. This promise-keeping constraint can be written as

$$\begin{aligned}
&\gamma F(\bar{\chi})\left[U(w(1-\tau)+\varphi) - \mathbb{E}\left[\chi|\chi \leq \bar{\chi}\right] + \beta p(V^{s\prime}, V', z)V^{s\prime} + \beta\left(1 - p(V^{s\prime}, V', z)\right)V'\right] \\
&+(1-\gamma)V^f + \gamma(1 - F(\bar{\chi}))V^q \geq V.
\end{aligned} \tag{18}$$

Third, the choice for $V^{s\prime}$ must be consistent with optimal job search behavior on the part of the worker; that is, it must solve equation (14), subject to $J^m(V^{s\prime}, V', z) = 0$, where the offer matching functions in equation (13) are taken as given.

Finally, the firm's choice for the probability of matching outside offers ζ' must be such that a worker without an outside offer weakly prefers not to falsely report an offer:

$$\zeta' V^{s\prime} + (1-\zeta') V^f \leq V', \tag{19}$$

where the left hand side is the payoff to a worker without an outside offer who falsely reports having an offer, while the right hand side is the payoff if the worker truthfully reports no outside offer. Note that if the worker reports having an outside offer, the incumbent firm will infer that the value of that offer is the value $V^{s\prime}$ that solves the worker's on-the-job search problem.

We define a stationary equilibrium for this economy in Appendix B.

5.1 Backloading of Wages

We now characterize some properties of the solution to the dynamic contracting problem described above. To start, we abstract from UI taxes and benefits and from on-the-job search and focus on the impact of preference shocks driving quits to non-employment.[23] In this problem, the firm seeks to deliver the promised value V in the most profitable way. Given that worker utility is concave, it is conceivable that the firm would like to smooth wages over time. On the other hand, the quitting friction creates an incentive to backload wages, because by doing so, the firm can reduce the worker's future incentives to quit. The following inverse Euler equation characterizes the solution to the firm's problem.

Proposition 5.1 *Wage growth under the optimal contract satisfies:*

$$\frac{1}{U'(w_{t+1}+\varphi)} - \frac{1}{U'(w_t+\varphi)} = \frac{f(\bar{\chi}_{t+1})}{F(\bar{\chi}_{t+1})}\left[zY - w_{t+1} + \beta\Pi_{t+2}\right]. \tag{21}$$

The wage rises for as long as the worker and firm remain matched, and converges to zY.

Condition (21) can be understood in the following way. Imagine that the firm needs to deliver some promised value V_t to a worker, and is contemplating some wage sequence that delivers that

[23] Specifically, this simplified contracting problem is:

$$\Pi(V,z) = \max_{w,V',\bar{\chi}} \left\{\gamma F(\bar{\chi})(zY - w + \beta\Pi(V',z))\right\} \tag{20}$$

$$U(w+\varphi) - \bar{\chi} + \beta V' = V^q$$

$$\gamma F(\bar{\chi})\left(U(w+\varphi) - \mathbb{E}\left[\chi | \chi \leq \bar{\chi}\right] + \beta V'\right) + (1-\gamma)V^f + \gamma(1-F(\bar{\chi})))V^q \geq V,$$

where the first constraint states that the quitting threshold $\bar{\chi}$ satisfies the worker's indifference condition (17), while the second constraint is the promise-keeping condition (18).

value. Now consider a perturbation that pushes the deliver of value from period t to period $t+1$. The left-hand side of the equation measures the net pecuniary cost to the firm, where the firm's profit is increased by $\frac{1}{U'(w_t+\varphi)}$ in period t and reduced by $\frac{1}{U'(w_{t+1}+\varphi)}$ in period $t+1$. The right-hand side measures the benefit of increasing future promised value: a higher future value V_{t+1} raises the $t+1$ quitting threshold $\bar{\chi}_{t+1}$, leading to reduced quitting in proportion to the normalized density function $\frac{f(\bar{\chi}_{t+1})}{F(\bar{\chi}_{t+1})}$. The value of the match is then increased by the change in the probability of quitting times the future expected profit if the worker remains with the firm, $zY - w_{t+1} + \beta\Pi_{t+2}$. Under the optimal wage sequence, the cost of an additional delay to worker compensation must equal the benefit, resulting in (21).

As long as the match remains profitable, the right hand side of condition (21) will be positive, and thus the left hand side must be too. Given concave utility, this implies that w_{t+1} must be greater than w_t; this is, wages are backloaded. A very simple way to understand this backloading result is that a higher wage at t reduces quitting at t but not at $t+1$, while a higher promised wage at $t+1$ reduces quitting at both t *and* $t+1$. As wage growth continues, wages converge to productivity, zY.

5.2 Outside Offer Matching

We now turn to the on-the-job search feature of the model. In equilibrium, workers search for offers that yield higher value than their current match: $V^{s\prime} \geq V'$. Whether the incumbent firm will consider matching an offer $V^{s\prime}$ depends on whether the match would remain profitable at the higher promised value. But even if the match would remain profitable, the incumbent firm cannot promise to match with probability one, because that would incentivize workers to falsely report such offers. If $\Pi(V^{s\prime}, z) \geq 0$, then profit maximization implies that firms choose the highest matching probability ζ' consistent with the incentive constraint (19), which ensures that workers do not want to fake offers:

$$\zeta' = \frac{V' - V^f}{V^{s\prime} - V^f}.$$

The matching probability is decreasing in $V^{s\prime}$ because a higher $V^{s\prime}$ makes mimicking more attractive to workers who do not have an outside offer. Thus, the firm needs to impose a harsher punishment (a higher probability of firing instead of matching) to deter such mimicking. When $V^{s\prime}$ is sufficiently high, the value of the match to the incumbent firm drops below zero: $\Pi(V^{s\prime}, z) < 0$. In this case the offer matching rate is zero.

Proposition 5.2 *The equilibrium offer matching rule* $\zeta'(V^{s\prime}, V', z)$ *is given by:*

$$\zeta'\left(V^{s\prime}, V', z\right) = \begin{cases} \frac{V'-V^f}{V^{s\prime}-V^f} & \text{if } \Pi(V^{s\prime}, z) \geq 0 \\ 0 & \text{otherwise.} \end{cases}$$

6 Calibration

Preferences are identical to those in the simpler dynamic model described previously. The matching technology is also the same. As for the simpler model, our calibration targets are based on data for the three year period March 2022 through February 2025.

We identify different model sectors with the sectors for which data on job openings, layoffs and quits are available in the JOLTS database, and for which data on employment and average weekly earnings are also available in the CES survey.[24] For each of our sectors, we define the share of the population in sector n, λ_n, as employment in that sector relative to total employment across all sectors. And we define the productivity of sector n, Y_n, as average weekly earnings in that sector relative to average earnings across all sectors. Thus, $\sum_{n=1}^{N} \lambda_n Y_n = 1$.[25] The cost of posting vacancies in sector n is assumed proportional to average sectoral productivity: $\phi_n = \hat{\phi} Y_n$.

As in the simpler model, we set the exogenous match destruction probability $1-\gamma$, the average utility cost of work μ_χ, match efficiency A, and the vacancy posting cost parameter $\hat{\phi}$, to jointly replicate CPS-based estimates for the layoff rate, the quit to non-employment rate, the unemployment rate, and the JOLTS job openings rate.

We set the ratio of productivity in high versus low quality matches, z_H/z_L, to 1.33, which replicates the estimate of the job-to-job transition rate from Fujita et al. (2023), which averages 2.32 percent over our March 2022 through February 2025 calibration time period.[26] Intuitively, more dispersion in match quality boosts the job-to-job transition rate, as workers seek to escape low quality matches.

[24] These sectors are: mining and logging, construction, durable manufacturing, non-durable manufacturing, wholesale trade, retail trade, transportation, warehousing and utilities, information, financial activities, professional and business services, education and health, arts, entertainment and recreation, accommodation and food services, and other services.

[25] In the equilibrium of our model, individual earnings are endogenous, and vary within sectors with idiosyncratic match quality, tenure, and the history of outside offers. But average equilibrium earnings within a sector n turn out to be very close to the exogenous sectoral productivity parameter Y_n.

[26] Fujita et al. (2023) show that a change in the CPS survey methodology can partly explain a puzzling decline in the measured CPS J2J rate. However, they highlight two important open data puzzles. One is that even with their correction, the CPS-measured total quit rate looks pretty flat over the post-Global Financial Crisis period, while there is a dramatic upward trend in the JOLTS quit rate. A second puzzle is that the level of quits in the CPS is much higher than in JOLTS. Both of these puzzles are clearly illustrated in Figure 11 of their Online Appendix.

Unemployment benefits for laid off workers are assumed to be proportional to sectoral productivity $b_n = \kappa Y_n$.[27] We again set $\kappa = 0.43$.[28] Note that, in contrast to the simpler dynamic model considered before, we now assume that non-employed workers who quit receive no benefits.[29]

For any exploration of optimal public insurance against non-employment risk, it is critical to assess the extent to which individuals can use other sources of private income to cushion the decline in consumption associated with lost wage income. Here we take the following approach. In the 2019 CPS ASEC survey, we identify all individuals aged between 25 and 60 who worked full time in the previous year and had at least $20,000 of individual wage and salary income.[30] For those individuals we also record other family income, defined as total family income minus individual wage income. This "other income" captures wage income of spouses and other houseshold members, in addition to family unearned income. In this sample, average individual wage income is $68,303 while average other income is $49,227. We regress other income on individual wage income, and estimate a constant of $37,728 and a slope coefficient of 0.169. Average individual earnings are normalized to one in our economy. We therefore impose the following model for private insurance:

$$\varphi_n = 0.552 + 0.169 \times Y_n$$

Note that this model implies substantial private insurance. For a worker with average individual earnings ($Y_n = 1$), pre-tax income values when working, when non-employed and receiving UI benefits, and when non-employed and not receiving UI are, respectively, 1.721, 1.151, and 0.721.[31] Note also that this model implies that for relatively high wage workers, individual wage earnings are a larger share of total household income. That implies that high wage workers will be relatively more reluctant to quit.[32]

[27] Our assumption that benefits are linked to average sectoral earnings rather than to individual earnings simplifies the analysis, because it implies that all laid off workers in a sector have the same expected value V_n^f.

[28] This value is similar to standard calibrations in the literature (e.g., Braxton et al. 2023, Birinci and See 2023, Guimaraes and Lourenco 2023). Note, however, that Birinci and See (2023) report that only 57 percent of the unemployed are eligible for UI, and only 61 percent of the eligible group actually collects benefits (see also Chodorow-Reich and Karabarbounis, 2016).

[29] Quitters are sometimes successful in collecting UI benefits, and may also qualify for other transfers (see Chodorow-Reich and Karabarbounis, 2016 and Jurajda, 2003). However, Rothstein and Valletta (2017) and Ganong and Noel (2019) find that other transfers offset only a small portion of lost UI for the unemployed who exhaust eligibility.

[30] We picked 2019 to estimate private insurance in order to capture a relatively stable pre-Covid labor market.

[31] We do not model cross-sectional variation in individuals' ability to use spousal income or savings to replace lost labor earnings, which translates into cross-sectional variation in workers' willingness to quit jobs (see Birinci and See 2023.). Our model attributes all variation in the willingness to quit, holding fixed wages, to variation in the utility cost of work.

[32] Absent the constant term in the φ_n formula, the model would be entirely homothetic: all sectors would exhibit identical labor market flows and stocks.

Table 2: Calibration

Parameters		Value	Source/Targets
Externally Calibrated			
Discount factor	β	$0.99^{1/3}$	Monthly model
UI replacement rate	κ	0.43	Footnote 20
Non-wage income	φ_n	$0.552 + 0.169 Y_n$	ASEC estimation (see text)
Exogenous separation rate	$1-\gamma$	1.22%	Ellieroth and Michaud (2024) CPS E to U rate
Sector weights/earnings	$\{\lambda_n, Y_n\}$		CES employment shares & avg. earnings
Internally Estimated			
Labor disutility shocks, mean	μ_χ	-1.62	Ellieroth and Michaud (2024) CPS E to N rate 1.88%
Labor disutility shocks, variance	σ_χ	1.05	Elasticity of quits to sectoral earnings
Vacancy posting cost	$\hat{\phi}$	0.76	JOLTS job openings rate 5.80%
Match quality dispersion	z_H/z_L	1.33	Fujita et al. (2023) E to E rate 2.32%
Matching efficiency	A	0.89	CPS unemployment rate 3.78%

Ganong and Noel (2019) use bank account data to measure the declines in income and consumption associated with unemployment. They find relatively small declines in income and consumption upon becoming unemployed for workers who receive UI benefits, but larger declines when those benefits are exhausted. Their Figure 2 indicates that upon benefit exhaustion, household income is around 35 percent of its pre-unemployment level. In our model, an average-earning quitter experiences a slightly smaller decline in household income to 42 percent of its initial level (0.721/1.721).

One parameter remains, which is the standard deviation of idiosyncratic preference shocks, σ_χ. This parameter is important because it determines how sensitive the model quit rate is to policy parameters. We set σ_χ to replicate the observed elasticity of the sectoral quit rate to sectoral average earnings. Intuitively, if the quit rate is much higher in high wage sectors (like finance) than low wage sectors (like accommodation and food services), that would point to a relatively low value for σ_χ (and high sensitivity), while if quits are largely uncorrelated with wages, that would point to a high value (and low sensitivity). Figure 6 in Appendix C plots sectoral quit rates against sectoral average wages and indicates that quits are indeed heavily concentrated in low wage sectors.[33]

All parameter values are reported in Table 2.

[33] Krueger and Summers (1988) find a positive (negative) relationship between industry wage premia and tenure (quits).

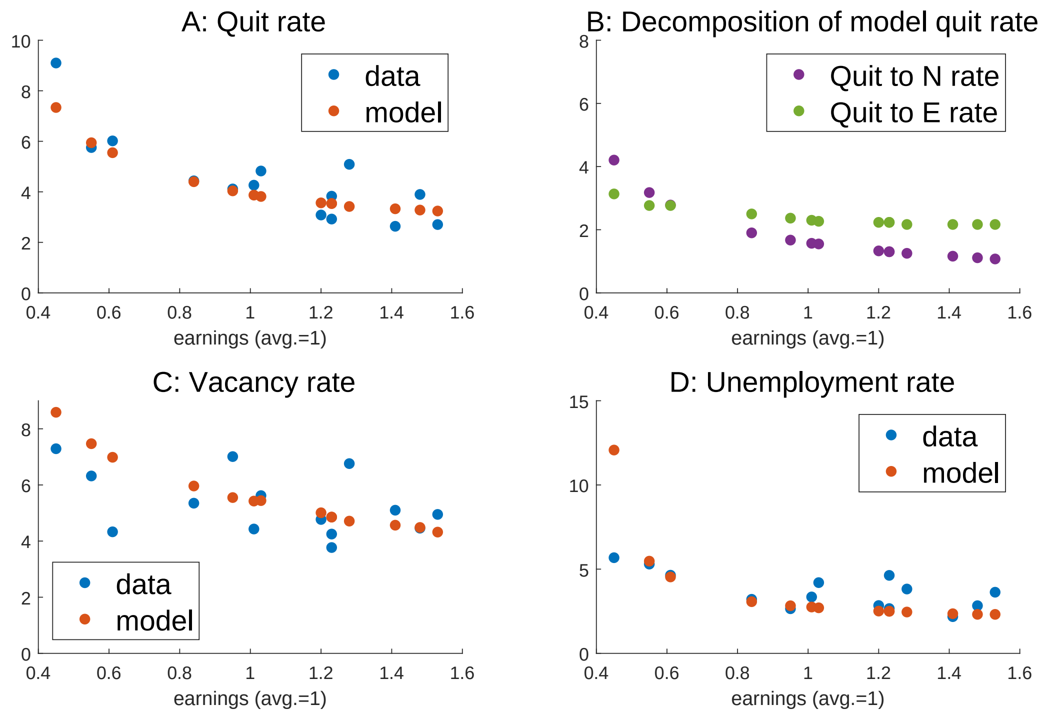

Figure 2: Quit Rate, Vacancy Rate, and Unemployment Rate by Sector

7 Quantitative Results

Figure 2 plots various industry-level labor market statistics generated by the model (red dots), against those in the data (blue dots). Given our calibration strategy, the model matches quite well the variation in quit rates across different industries (Panel A). In terms of untargeted moments, the model also performs reasonably well with respect to cross-industry variation in job opening rates and unemployment rates (Panels C and D, respectively), both of which tend to be higher in low wage industries.

Quits in the model can be decomposed into quits to non-employment and quits to another job. Panel B of Figure 2 plots such a decomposition across different industries. The purple dots show the share of workers who quit into non-employment, while the green dots show job-to-job transitions. The negative relationship in the model between industry earnings and the industry quit rate is driven mostly by variation in the quit-to-non-employment rate; the job-to-job transition rate varies little with sectoral earnings.[34]

[34] Bosler and Petrosky-Nadeau (2016) document that the job-to-job transition rate is similar across different occupations among recent cohorts of workers.

The fact that the quit-to-non-employment rate is quite sensitive to sector-level earnings suggests a preference shock distribution with significant density in the region where low wage workers will optimally quit but high wage workers will not.[35] A compressed labor disutility shock distribution means that reducing unemployment insurance can have a large impact on workers' quit rates and hence lead to large welfare improvements, as illustrated in Section 4.

Figure 3 plots various value and policy functions conditional on whether the worker is in a high-quality (left column) or low-quality (right column) match. The first row plots continuation values $V'(V)$ (red line) as a function of current promised value. For high quality matches, workers start with a low initial promised value but experience growth in promised value and wages (second row, left panel) with tenure. Workers with short tenure and low current promised values engage in on-the-job search (third row, left panel). If they succeed in finding an outside offer, their incumbent firm matches the offer with a high probability (fourth row), so only a few such workers switch employers. Lastly, the worker's quit-to-non-employment rate decreases as promised value increases.

Turning to low quality matches, we see that wages never exceed those for workers in high quality matches. Badly matched workers choose to search in submarkets where their job finding probability is around 90 percent (third row, right panel). The incumbent firm does not match those offers, because doing so would imply negative profits. Finally, the quit-to-non-employment rate is much higher for workers in low quality matches than for those in high quality matches (last row).

Figure 4 shows how wages rise with tenure and how the quit rate declines with tenure. High quality matches feature more scope for wage growth, while in low quality matches, wages quickly converge to productivity. This is due to an insurance mechanism. In particular, recall that firms need to allocate promised values conditional on the realization of match quality (eq. 15). Given concave utility, the firm optimally cross subsidizes workers who draw low match quality, so their initial wage is close to their marginal product. But the firm does not perfectly insure match quality risk, because paying higher wages to workers in high quality matches reduces the quit rate for those profitable matches.

Figure 5 plots a sample path for a worker who starts out unemployed. They find a job in month two, and the match turns out to be low quality (low quality matches are marked by blue

[35]There is an analogy here to the unemployment volatility puzzle (Shimer, 2005). The resolution proposed by Hagedorn and Manovskii (2008) is that the value of unemployment is high, so that workers are close to indifferent between working or not. This indifference generates high unemployment sensitivity with respect to aggregate labor productivity shocks. In our context, we observe a high sensitivity of the quit rate to sectoral earnings in cross-section, suggesting that the mean of the labor disutility shock must be high and its variance must be low.

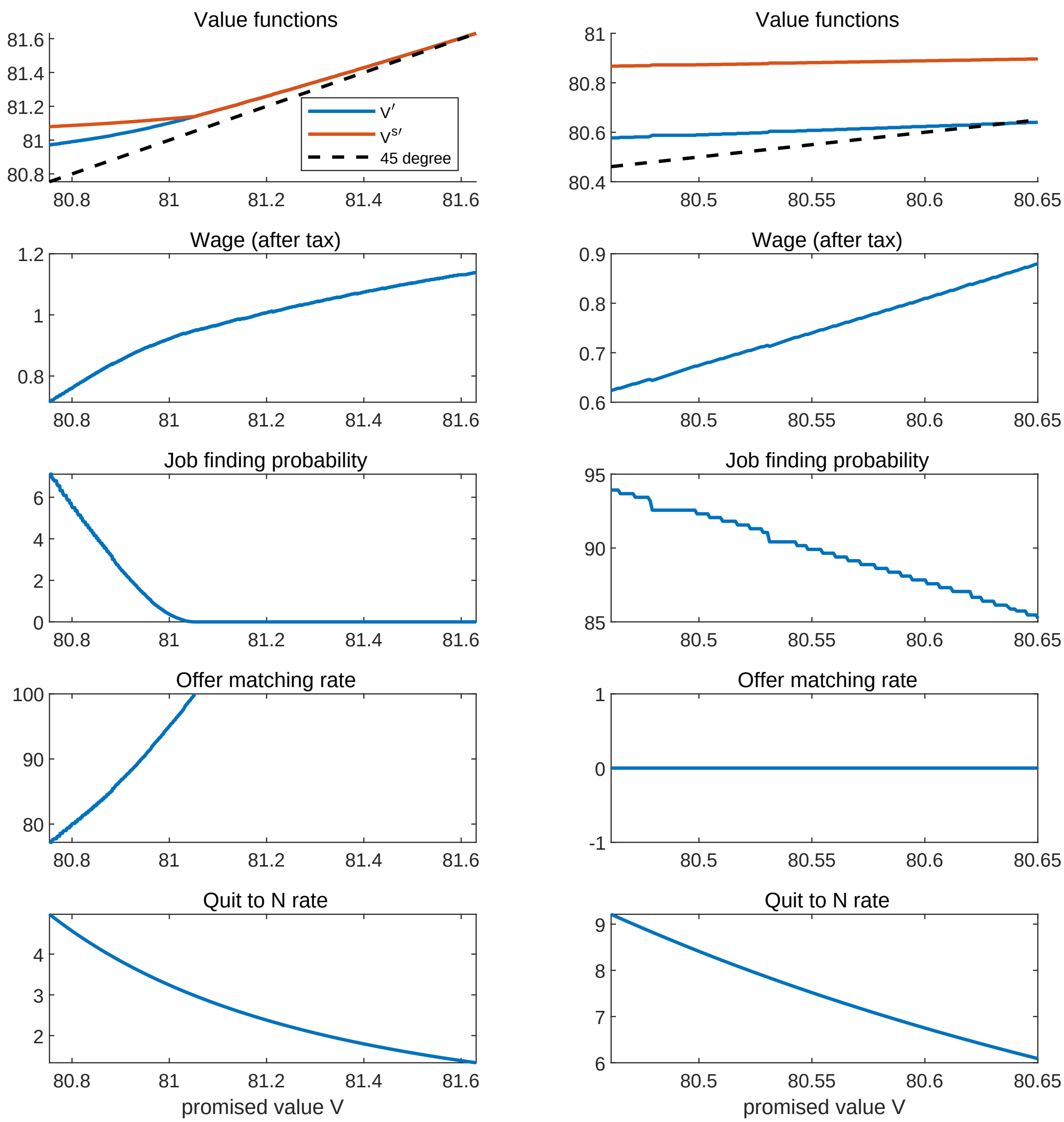

Figure 3: Value and Policy Functions ($Y_n = 1$). The left-side panels are for workers in a high quality match. The right-side panels are for workers in a low quality match. The x axis ranges show the set of values for promised value V observed in equilibrium, conditional on match quality.

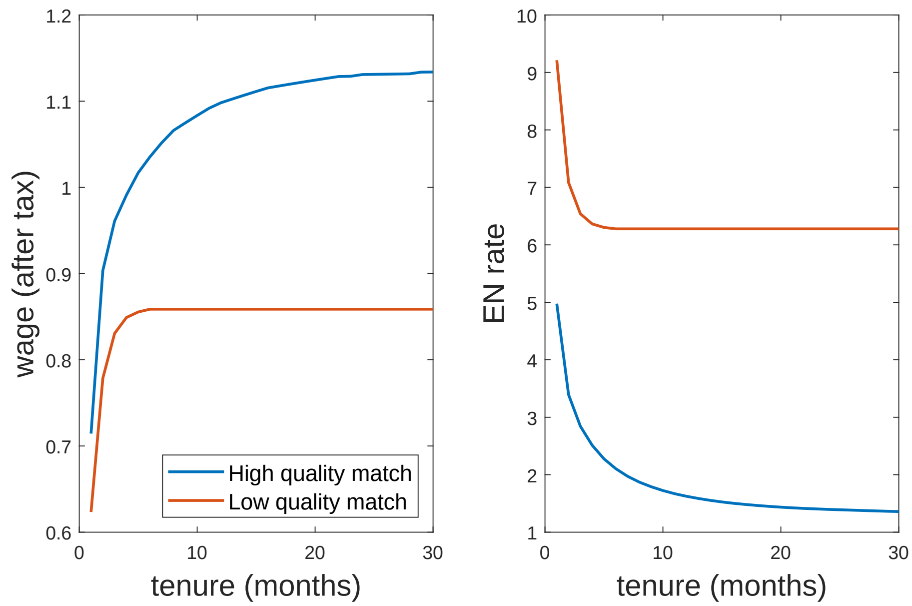

Figure 4: Wages and Quit Rate by Tenure (worker in sector with $Y_n = 1$)

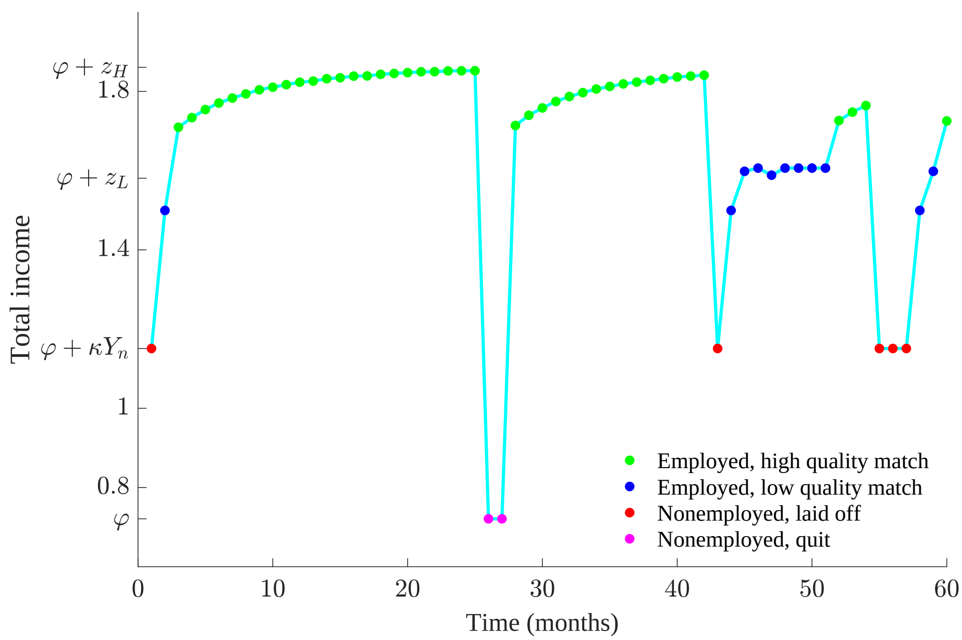

Figure 5: Sample Path for Total Income (worker in sector with $Y_n = 1$)

dots). At month three, successful on-the-job search leads to a high quality match (green dots). Within this match, the worker's wage gradually rises with tenure until the worker quits in month 25, because of a high draw for the cost of work shock χ. The worker finds another job in month 27, which again turns out to be high quality, and works until month 43 when they are laid off. They find another job one month later, which turns out to be low quality. Between months 44 and 51 the worker conducts on-the-job search. At month 47 they land a new job, but it turns out to be another low quality match, which translates into a small observed decline in earnings.

7.1 Optimal Policy

We turn now to optimal policy. In Table 3 we report optimal replacement rates under three alternative models for social insurance. In the first model, we impose zero benefits for quitters. In the second model, we impose identical benefits for quitters and workers who are laid off. In the third model, the planner optimizes with respect to a replacement rate for quitters and a potentially different rate for laid off workers. In each case, the planner maximizes average (across sectors) expected welfare in steady state for an individual who is non-employed and not currently receiving UI, i.e., $\sum_{n=1}^{N} \lambda_n V_n^f$.[36]

Under model 1 (imposing no benefits for quitters), the welfare-maximizing policy involves reducing the replacement rate for laid off workers modestly from 43 percent to 38 percent. The table indicates that this reduces the equilibrium unemployment rate by a full percentage point by increasing the job finding rate for workers collecting benefits.[37]

Under model 2, with a uniform benefit, the optimal replacement rate is cut in half. Because quitters receive benefits in this model, workers quit to non-employment at a higher rate (relative to the baseline under which they receive no benefits), and quitters subsequently find jobs at a lower rate. At the same time, because laid off workers receive lower benefits than under the baseline policy, they are less picky and find jobs at a higher rate. The net effect of these changes is that the equilibrium unemployment rate is similar to the one under the baseline policy.

[36] We have also considered an objective of average lifetime utility in cross section; results were very similar. In this section we do not consider transitional dynamics: for any policy we evaluate welfare given the corresponding steady state distribution over employment and match quality. In Section 4, we compared policies assuming all workers are initially unmatched, incorporating transition. In our directed search setting, the only difference between the two approaches is the value for the tax rate τ required to balance the government budget.

[37] In our model, because there is a utility cost of working, it is not possible to implement very generous replacement rates. As an illustrative calculation, for a worker with earnings $Y_n = 1$, unearned income $0.552 + 0.169$, and utility cost of work $\chi = \exp(\mu_\chi)$, flow utility is $\log(1.721) - \exp(-1.62)$. Flow utility for the same individual when collecting benefits given a replacement rate κ_f is $\log(0.721 + \kappa_f)$. These two values are equal at $\kappa_f = 0.691$.

Finally, consider model 3, under which the planner is free to choose both κ_f^* and κ_q^*. In this case, the planner optimally replaces 39.9 percent of lost earnings for laid off workers, and 15.6 percent of lost earnings for those who quit. Thus, quitters are treated more generously than under the baseline policy, where they receive nothing. It is optimal to give them positive benefits because doing so improves consumption insurance. But they optimally receive much lower benefits than laid off workers because quitters quit too readily – internalizing neither the fiscal externality (a higher quit rate necessitates higher taxes) nor the quitting externality (a higher quit rate reduces expected tenure and depresses offered wages). The welfare gain from implementing this policy (starting from the current policy) is equivalent to a permanent 0.16 percent increase in consumption.

Suppose that it is costly for the planner to verify whether a non-employed individual quit or was laid off. How large a cost is worth paying? To answer this question, we compute the welfare gain of moving from the optimal policy under model 2 (a uniform benefit) to the optimum under model 3 (differential benefits for laid off workers versus quitters). The associated welfare gain is equivalent to a 0.18 percent permanent increase in consumption. For comparison, Guimaraes and Lourenco (2023) estimate that administration costs amount to 10 percent of the value of UI benefits paid in the United States, which is less than 0.18 percent of US consumption.[38] But workers applying for benefits likely bear a larger portion of the cost of administering the current system. In their model, Birinci and See (2023) attribute the fact that many unemployed workers choose not to apply for UI to such costs. Thus, to the extent that a system of uniform benefits for all non-workers would allow for a much simpler application process, it might be preferable to the current system.

Finally, we consider two counterfactuals, one in which we rule out on-the-job search, so there are no job-to-job quits, and one in which we eliminate variation in match quality (see the last two columns of Table 3). In both these extensions we focus on optimal policy when the planner can offer different benefits to laid off workers versus quitters.

Absent on-the-job search, optimal benefits to quitters are slightly higher than in the baseline, while the replacement rate for laid off workers is slightly lower. In this economy the only way workers can escape from low quality matches is to quit to non-employment, and to then search again. The lower are benefits for quitters, the less inclined workers will be to pursue this route. Thus, to preserve incentives to transition out of good matches, the planner optimally increases

[38]Total UI spending is typically only around 0.15 percent of US GDP, though it surged to 2.3 percent in fiscal year 2020.

Table 3: Optimal Policies

	Actual Policy (Benchmark)	Optimal Policies (1) $\kappa_q^* = 0$	(2) $\kappa_f^* = \kappa_q^*$	(3) Flexible	Counterfactuals (4) No OJS	(5) $z_H = z_L$
κ_f^* rate (%)	43.0	38.0	19.7	39.9	37.5	32.6
κ_q^* rate (%)	00.0	00.0	19.7	15.6	17.2	12.7
EN rate (%)	1.91	1.91	2.95	2.69	3.46	4.63
EE rate (%)	2.42	2.53	2.89	2.74	0.00	0.24
u rate (%)	3.89	2.92	3.75	4.04	4.46	5.16
v rate (%)	5.73	5.91	7.10	6.55	5.23	5.80
p_f rate (%)	42.9	51.1	69.2	48.0	50.7	48.1
p_q rate (%)	88.1	88.2	69.2	73.3	73.5	69.1

κ_f^* and κ_q^* are optimal replacement rates for laid off workers and quitters,
EN and EE are the quit to non-employment rate and the job-to-job transition rate,
u and v are the unemployment and vacancy rates, and
p_f and p_q are job finding rates for workers who entered non-employment after being laid and after quitting.

quitter benefits relative to the baseline economy (compare column 4 to column 3).

When we eliminate variation in match quality there is no longer an efficiency rationale for job-to-job transitions: all jobs are equally productive. We now find lower optimal replacement rates for both laid off workers and quitters (compare column 5 to column 3). The optimal replacement rate for quitters is lower in part because the planner no longer has an incentive to help workers escape bad matches via quitting to non-employment.

8 Conclusion

In a directed search model in which quits to non-employment are driven by private, idiosyncratic preference shocks, workers quit too readily, destroying matches with positive joint surplus. This translates into depressed wages and wasteful vacancy creation, and motivates designing public insurance so as to discourage quits. If the government cannot differentiate between separations in which the worker was laid off versus those in which the worker quit, the negative effect of a higher quit rate on wages reduces the optimal common UI replacement rate. An extended Baily-Chetty formula illustrates that the quantitative impact of this novel quitting externality on the optimal replacement rate depends on the elasticity of wages to the replacement rate via the quitting channel.

In our calibrated model, firms and workers understand that quits can be costly, and adapt to reduce quits in three ways. First, firms offer contracts in which wages are backloaded as a way to increase worker retention. Second, firms stochastically match outside offers, which reduces the rate at which workers quit to other jobs. Third, workers choose to direct search to high "efficiency" wage jobs, understanding that this is a way to partially commit to not quit. However, while high efficiency wages are privately welfare maximizing, holding out for high wage jobs translates to a higher equilibrium unemployment rate and higher taxes. Thus, the quitting margin exacerbates the standard fiscal externality associated with unemployment insurance.

The quantitative relevance of the quitting margin for the optimal UI replacement rate depends not on the quit rate *per se* but rather on the elasticity of quits to the replacement rate, which in turn is linked to the variance of idiosyncratic preference shocks. We identified this variance using cross-industry variation in the quit rate. In our baseline quantitative calibration, we find that quitters should receive positive benefits – contrary to the default policy currently in place in the United States. However, the optimal replacement rate for quitters is only 15.6%, compared to 39.9% for laid off workers.

Our model could be extended to introduce persistent preference shocks in order to generate more persistent non-employment. Another possible extension would introduce repeated shocks to match productivity throughout employment spells, to generate additional wage dispersion. One could also explicitly model savings and other sources of self-insurance against unemployment risk. In all such extensions, the impact of UI policy parameters on quits and thus on other labor market variables would remain an important consideration in optimal social insurance design.

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Appendix: Not for Publication

A Proofs

A.1 Proof of Proposition 2.1

We start by solving for the equilibrium in the public χ economy. Given policy parameters, the problem of private agents is given by the following:

$$\max_{\theta,w,\bar{\chi}} p(\theta) \int^{\bar{\chi}} (w-\tau-\chi)\, dF(\chi) + [1-p(\theta) F(\bar{\chi})]\, b$$

$$s.t.$$

$$q(\theta) \int^{\bar{\chi}} (z-w)\, dF(\chi) = \phi$$

$$\bar{\chi} = z-\tau-b.$$

Plug the second constraint $\bar{\chi} = z-\tau-b$ into the objective function and into the first constraint

$$\max_{\theta,w,\bar{\chi}} p(\theta) \int^{z-\tau-b} (w-\tau-\chi)\, dF(\chi) + [1-p(\theta) F(z-\tau-b)]\, b$$

$$s.t.$$

$$q(\theta) \int^{z-\tau-b} (z-w)\, dF(\chi) = \phi.$$

With the assumption that χ is uniformly distributed, we have

$$\max_{\theta,w} p(\theta) \frac{\left[(w-\tau)(z-\tau-b) - \frac{1}{2}(z-\tau-b)^2\right]}{a} + b - p(\theta) \frac{z-\tau-b}{a} b$$

$$s.t.$$

$$q(\theta) \frac{z-\tau-b}{a} (z-w) = \phi.$$

Collecting terms, we get that the objective function becomes

$$p(\theta) \left[\frac{(z-\tau-b)(w-\tau-b)}{a} - \frac{(z-\tau-b)^2}{2a}\right] + b.$$

With the assumptions on the matching function

$$p(\theta) = A\theta^{0.5}$$

$$q(\theta) = A\theta^{-0.5}$$

we can substitute out θ and obtain q as a function of p:

$$q(p) = \frac{A^2}{p}.$$

With this expression we can transform this problem into

$$\max_{w,p} p\left[\frac{(z-\tau-b)(w-\tau-b)}{a}-\frac{(z-\tau-b)^2}{2a}\right]+b$$

$$s.t.$$

$$\frac{A^2}{p}\frac{z-\tau-b}{a}(z-w)=\phi.$$

The constraint can be rearranged to express p as a function of all other variables

$$p=\frac{A^2}{\phi}\frac{z-\tau-b}{a}(z-w).$$

Plug this into the objective

$$\max_{w}\frac{A^2}{\phi}\frac{z-\tau-b}{a}(z-w)\left[\frac{(z-\tau-b)(w-\tau-b)}{a}-\frac{(z-\tau-b)^2}{2a}\right]+b.$$

Take a first order condition with respect to w

$$-\left[\frac{(z-\tau-b)(w-\tau-b)}{a}-\frac{(z-\tau-b)^2}{2a}\right]+(z-w)\frac{(z-\tau-b)}{a}=0$$

$$-(w-\tau-b)+\frac{(z-\tau-b)}{2}+z-w=0$$

$$w=\frac{3}{4}z+\frac{1}{4}(\tau+b).$$

With the wage given by the above expression, the job finding probability p is given by

$$\begin{aligned} p &= \frac{A^2}{\phi}\frac{z-\tau-b}{a}(z-w) \\ &= \frac{A^2}{\phi}\frac{z-\tau-b}{a}\left(z-\left(\frac{3}{4}z+\frac{1}{4}(\tau+b)\right)\right) \\ &= \frac{A^2}{\phi}\frac{(z-\tau-b)^2}{4a}. \end{aligned}$$

The case of public χ is now fully characterized.

Next, we move to the case with private χ. The problem is given by

$$\max_{\theta,w,\bar{\chi}} p(\theta)\int^{\bar{\chi}}(w-\tau-\chi)\,dF(\chi)+[1-p(\theta)F(\bar{\chi})]\,b$$

s.t.

$$q(\theta)\int^{\bar{\chi}}(z-w)\,dF(\chi)=\phi$$

$$w-\tau-\bar{\chi}=b.$$

Substitute in $\bar{\chi}=w-\tau-b$

$$\max_{\theta,w,\bar{\chi}} p(\theta)\int^{w-\tau-b}(w-\tau-\chi)\,dF(\chi)+[1-p(\theta)F(w-\tau-b)]\,b$$

s.t.

$$q\left(\theta\right)\int^{w-\tau-b}\left(z-w\right)dF\left(\chi\right)=\phi.$$

Plug in the uniform distribution of χ

$$\max p\left(\theta\right)\left[\left(w-\tau-b\right)\frac{\left(w-\tau-b\right)}{a}-\frac{1}{2a}\left(w-\tau-b\right)^{2}\right]+b$$

s.t.

$$q\left(\theta\right)\frac{w-\tau-b}{a}\left(z-w\right)=\phi.$$

Plug in

$$q\left(p\right)=\frac{A^{2}}{p},$$

we have

$$\max p\left[\left(w-\tau-b\right)\frac{\left(w-\tau-b\right)}{a}-\frac{1}{2a}\left(w-\tau-b\right)^{2}\right]+b$$

subject to

$$\frac{A^{2}}{p}\frac{w-\tau-b}{a}\left(z-w\right)=\phi$$

or

$$p=\frac{A^{2}}{\phi}\frac{w-\tau-b}{a}\left(z-w\right).$$

Plug this into the objective:

$$\max\frac{A^{2}}{\phi}\frac{w-\tau-b}{a}\left(z-w\right)\left[\left(w-\tau-b\right)\frac{\left(w-\tau-b\right)}{a}-\frac{1}{2a}\left(w-\tau-b\right)^{2}\right]+b$$

Simplifying, we obtain

$$\max\frac{A^{2}}{\phi}\frac{\left(w-\tau-b\right)^{3}}{a}\left(z-w\right)\frac{1}{2a}+b.$$

Take the FOC with respect to w

$$3\left(w-\tau-b\right)^{2}\left(z-w\right)+-\left(w-\tau-b\right)^{3}=0$$

$$3z-3w-w+\tau+b=0$$

$$w=\frac{3}{4}z+\frac{1}{4}(\tau+b).$$

Hence, the quitting threshold is given by

$$\begin{aligned}\bar{\chi} &= w-\tau-b\\ &= \frac{3}{4}z+\frac{1}{4}(\tau+b)-\tau-b\\ &= \frac{3}{4}\left(z-\tau-b\right),\end{aligned}$$

and the job finding probability is given by

$$\begin{aligned} p &= \frac{A^2}{\phi} \frac{w - \tau - b}{a} (z - w) \\ &= \frac{A^2}{\phi} \frac{3}{4a} \frac{1}{4} (z - \tau - b)^2 . \end{aligned}$$

A.2 Proof of Proposition 2.2

We will first show that the public χ economy can achieve a first-best allocation. For the public χ economy, denote this value function $V(\tau, b)$:

$$\begin{aligned} V(\tau, b) &= p \int^{z-\tau-b} [w - \tau - \chi] \, dF(\chi) + (1 - pF(z - \tau - b)) \, b \\ &= pF(z - \tau - b)(w - \tau) - p \int^{z-\tau-b} \chi dF(\chi) + (1 - pF(z - \tau - b)) \, b \\ &= pF(z - \tau - b)(w - \tau - b) + b - \frac{p}{2a} (z - \tau - b)^2 . \end{aligned}$$

Using the government budget constraint:

$$pF(z - \tau - b) \, \tau = (1 - pF(z - \tau - b)) \, b,$$

we have

$$pF(z - \tau - b)(b + \tau) = b.$$

Using this relation to substitute out the middle term b, we have:

$$\begin{aligned} V(\tau, b) &= pF(z - \tau - b)(w - \tau - b) + pF(z - \tau - b)(b + \tau) - \frac{p}{2a} (z - \tau - b)^2 \\ &= pF(z - \tau - b) \, w - \frac{p}{2a} (z - \tau - b)^2 \\ &= p \frac{z - \tau - b}{a} w - \frac{p}{2a} (z - \tau - b)^2 . \end{aligned}$$

Plug in the expressions for w and p :

$$w = \frac{3}{4} z + \frac{1}{4} (\tau + b)$$

$$p = \frac{A^2}{\phi} \frac{(z - \tau - b)^2}{4a}$$

We have

$$\begin{aligned} V(\tau,b) &= p\frac{z-\tau-b}{a}w-\frac{p}{2a}(z-\tau-b)^2 \\ &= \frac{A^2}{\phi}\frac{(z-\tau-b)^3}{4a^2}\left[\frac{3}{4}z+\frac{1}{4}(\tau+b)-\frac{2}{4}(z-\tau-b)\right] \\ &= \frac{A^2}{\phi}\frac{(z-\tau-b)^3}{16a^2}[z-\tau-b] \\ &= \frac{A^2}{\phi}\frac{(z-\tau-b)^4}{16a^2}. \end{aligned} \tag{22}$$

It is easy to see that V is minimized when $\tau+b=0$. By the budget constraint, if $\tau+b=0$, it follows that b must also be zero. Hence, the Acemoglu-Shimer result holds in this environment. We now show that this optimal allocation coincides with the first-best allocation.

Under the first best allocation, the planner solves:

$$\max_{\theta,\bar{\chi}} p(\theta)\int^{\bar{\chi}}(z-\chi)\,dF(\chi)-\theta\phi.$$

Plug in the uniform distribution and $p(\theta)=A\theta^{\frac{1}{2}}$, and substitute in $\bar{\chi}=z$:

$$\max_{\theta} A\theta^{\frac{1}{2}}\frac{\frac{1}{2}z^2}{a}-\theta\phi.$$

Take the FOC:

$$\begin{aligned} \frac{1}{2}A\theta^{-\frac{1}{2}}\frac{\frac{1}{2}z^2}{a} &= \phi \\ \frac{1}{4}A\frac{z^2}{a\phi} &= \theta^{\frac{1}{2}} \\ \theta &= \left(\frac{1}{4}A\frac{z^2}{a\phi}\right)^2. \end{aligned}$$

Plug this back into the objective. The value becomes:

$$\begin{aligned} & A\frac{1}{4}A\frac{z^2}{a\phi}\frac{\frac{1}{2}z^2}{a}-\left(\frac{1}{4}A\frac{z^2}{a\phi}\right)^2\phi \\ & \frac{1}{8}A^2\frac{z^4}{a^2\phi}-\frac{1}{16}A^2\frac{z^4}{a^2\phi} \\ =\ & \frac{1}{16}A^2\frac{z^4}{a^2\phi}. \end{aligned}$$

which is exactly equal to the value in the public χ economy. Hence, we confirm that the first best allocation can be achieved in the public χ economy. It then follows that in the private χ economy, agents quit too often, and they are also too picky relative to the first-best case.

We will now show that a government that respects the same no-quitting condition would pick the same submarket as private agents.

The government's problem is given by:

$$\max_{p,w} p\left(\theta\right) \int\limits_{0}^{\bar{\chi}} \left(z-\chi\right) dF\left(\chi\right) - \theta\phi$$

$$s.t.$$

$$\bar{\chi} = w$$

$$q\left(\theta\right) F\left(\bar{\chi}\right)\left(z-w\right) = \phi$$

$$p = A\theta^{\frac{1}{2}}.$$

The first constraint is the no-quitting condition (with no taxes and subsidies). The second is the zero profit condition that pins down θ. The third condition determines p as a function of market tightness θ.

It is easy to see that quitting is inefficient: $\bar{\chi} < z$. Suppose instead that $\bar{\chi} = z$. That would imply $w = \bar{\chi} = z$, which means that firm makes zero profit *ex post*; hence, $\theta = p = 0$, which is inconsistent with welfare maximization.

We need to compare the solution to this problem with the private agent's problem, which is given by:

$$\max_{p,w} p \int^{\bar{\chi}} \left[w-\chi\right] dF\left(\chi\right)$$

$$s.t.$$

$$\bar{\chi} = w$$

$$q\left(\theta\right) F\left(\bar{\chi}\right)\left(z-w\right) = \phi$$

$$p = A\theta^{\frac{1}{2}}.$$

Those constraints are exactly the same; hence, it is sufficient to show that the objective functions are equivalent for given values of p and w. From the zero profit condition,

$$A\theta^{-\frac{1}{2}} F\left(\bar{\chi}\right)\left(z-w\right) = \phi,$$

where we have plugged in that

$$q\left(\theta\right) = A\theta^{-\frac{1}{2}}.$$

Multiply both sides by θ :

$$A\theta^{\frac{1}{2}} F\left(\bar{\chi}\right)\left(z-w\right) = \theta\phi$$

or

$$p(\theta) F(\bar{\chi})(z-w) = \theta\phi.$$

Noting that

$$p(\theta) = A\theta^{\frac{1}{2}},$$

use this equation to substitute out the $\theta\phi$ term in the social planner's problem:

$$\begin{aligned}
& p(\theta) \int_0^{\bar{\chi}} (z-\chi)\, dF(\chi) - \theta\phi \\
= \; & p(\theta) \int_0^{\bar{\chi}} (z-\chi)\, dF(\chi) - p(\theta) F(\bar{\chi})(z-w) \\
= \; & p(\theta) \int_0^{\bar{\chi}} (w-\chi)\, dF(\chi).
\end{aligned}$$

Hence, the objective functions are exactly the same, implying that the planner and the private agents would choose exactly the same submarket, or allocation pair (p, w).

A.3 Proof of Proposition 2.3

In the proof of Proposition 2.2, we already shown that optimal allocation is achieved with $\tau + b = 0$, and the optimal allocation corresponds to the first best allocation. See equation 22 and subsequent discussions. Let's move to characterizing the private χ economy. Denote this value function $V(\tau, b)$:

$$\begin{aligned}
V(\tau, b) &= p \int^{w-\tau-b} [w-\tau-\chi]\, dF(\chi) + (1 - pF(w-\tau-b))\, b \\
&= pF(w-\tau-b)(w-\tau) - p \int^{w-\tau-b} \chi dF(\chi) + (1 - pF(w-\tau-b))\, b \\
&= pF(w-\tau-b)(w-\tau-b) + b - \frac{p}{2a}(w-\tau-b)^2.
\end{aligned}$$

Using the government budget constraint

$$pF(w-\tau-b)\,\tau = (1 - pF(w-\tau-b))\, b,$$

we have

$$\begin{aligned}
V(\tau, b) &= pF(w-\tau-b)(w-\tau-b) + pF(w-\tau-b)(b+\tau) - \frac{p}{2a}(w-\tau-b)^2 \\
&= pF(w-\tau-b)\, w - \frac{p}{2a}(w-\tau-b)^2 \\
&= p\frac{w-\tau-b}{a} w - \frac{p}{2a}(w-\tau-b)^2.
\end{aligned}$$

Plug in

$$w = \frac{3}{4}z + \frac{1}{4}(\tau + b)$$
$$p = \frac{A^2}{\phi}\frac{3}{4a}\frac{1}{4}(z - \tau - b)^2.$$

We have

$$\begin{aligned}
V(\tau, b) &= p\frac{(w - \tau - b)}{a}\left[w - \frac{w - \tau - b}{2}\right] \\
&= p\frac{(w - \tau - b)}{a}\left[\frac{w + \tau + b}{2}\right] \\
&= \frac{A^2}{\phi}\frac{3}{4a}\frac{1}{4}(z - \tau - b)^2\frac{\left(\frac{3}{4}z + \frac{1}{4}(\tau + b) - \tau - b\right)}{a}\left[\frac{\frac{3}{4}z + \frac{1}{4}(\tau + b) + \tau + b}{2}\right] \\
&= \frac{A^2}{\phi}\frac{3}{4a}\frac{1}{4}(z - \tau - b)^2\frac{\left(\frac{3}{4}z - \frac{3}{4}(\tau + b)\right)}{a}\left[\frac{\frac{3}{4}z + \frac{5}{4}(\tau + b)}{2}\right] \\
&= \frac{A^2}{\phi}\frac{3}{4a}\frac{1}{4}\frac{3}{4}\frac{(z - (\tau + b))^3}{a}\left[\frac{\frac{3}{4}z + \frac{5}{4}(\tau + b)}{2}\right].
\end{aligned}$$

Taking the derivative with respect to

$$x = \tau + b,$$

we have:

$$-3(z - x)^2(3z + 5x) + 5(z - x)^3 = 0$$
$$-3(3z + 5x) + 5(z - x) = 0$$
$$5z - 5x = 9z + 15x$$
$$20x = -4z$$
$$x = -\frac{z}{5}.$$

Hence, the optimal policy in this case calls for taxing the unemployed:

$$\tau + b = -\frac{z}{5}.$$

With the optimal policy, the value function is given by

$$\begin{aligned}
V(\tau,b) &= \frac{A^2}{\phi}\frac{3}{4a}\frac{1}{4}\frac{3}{4}\frac{\left(z+\frac{z}{5}\right)^3}{a}\left[\frac{\frac{3}{4}z-\frac{5}{4}\frac{z}{5}}{2}\right] \\
&= \frac{A^2}{\phi}\frac{3}{4a}\frac{1}{4}\frac{3}{4}\left(\frac{6}{5}\right)^3\frac{1}{4}\frac{z^3}{a}z \\
&= \frac{A^2}{\phi}\frac{3}{4}\frac{1}{4}\frac{3}{4}\left(\frac{6}{5}\right)^3\frac{1}{4}\frac{z^4}{a^2} \\
&= \frac{3}{4}\frac{1}{4}\frac{3}{4}\left(\frac{6}{5}\right)^3\frac{1}{4}\frac{A^2}{\phi}\frac{z^4}{a^2} \\
&= 0.0607\frac{A^2}{\phi}\frac{z^4}{a^2} < \frac{1}{16}\frac{A^2}{\phi}\frac{z^4}{a^2} = \text{ value at the first best allocation.}
\end{aligned}$$

Hence, we have shown that the private χ economy cannot achieve the welfare of the first best allocation.

We now solve for the equilibrium where workers receive differential benefits with b_s and b_q.

The worker's problem is laid out as follows:

$$p^{\bar{\chi}}(w-\tau-\chi)\,dF(\chi)+p\,(1-F(\bar{\chi}))\,b_q+(1-p)\,b_s$$

s.t.

$$qF(\bar{\chi})(z-w)=\phi$$

$$\bar{\chi}=w-\tau-b_q$$

The objective can be written as follows, using the uniform assumption on the χ shock:

$$\begin{aligned}
&p^{\bar{\chi}}(w-\tau-\chi)\,dF(\chi)+p\,(1-F(\bar{\chi}))\,b_q+(1-p)\,b_s \\
&= p\frac{1}{a}\left((w-\tau)\chi-\frac{1}{2}\chi^2\right)\Big|_0^{\bar{\chi}}+p\left(1-\frac{\bar{\chi}}{a}\right)b_q+(1-p)\,b_s \\
&= p\frac{1}{a}\left((w-\tau)\bar{\chi}-\frac{1}{2}\bar{\chi}^2\right)+p\left(1-\frac{\bar{\chi}}{a}\right)b_q+(1-p)\,b_s \\
&= p\frac{1}{a}\left((w-\tau)\bar{\chi}-\frac{1}{2}\bar{\chi}^2-\bar{\chi}b_q\right)+pb_q+(1-p)\,b_s \\
&= p\frac{1}{a}\left((w-\tau-b_q)\,\bar{\chi}-\frac{1}{2}\bar{\chi}^2\right)+pb_q+(1-p)\,b_s
\end{aligned}$$

with $\bar{\chi}=w-\tau-b_q$, the objective becomes:

$$p\frac{1}{a}\left((w-\tau-b_q)(w-\tau-b_q)-\frac{1}{2}(w-\tau-b_q)^2\right)+pb_q+(1-p)\,b_s$$

$$=p\frac{1}{2a}(w-\tau-b_q)^2+pb_q+(1-p)\,b_s$$

From the zero profit condition and the equation that $q = \frac{A^2}{p}$, we have:

$$\frac{A^2}{p}\frac{\bar{\chi}}{a}(z-w) = \phi$$

$$p(w) = \frac{A^2}{\phi}\frac{\bar{\chi}}{a}(z-w)$$

Thus we can take the following first order condition to solve for optimal wage w:

$$\max_w p(w)\frac{1}{2a}\left(w-\tau-b_q\right)^2 + p(w)\,b_q + (1-p(w))\,b_s$$

$$\max_w \frac{A^2}{\phi}\frac{\left(w-\tau-b_q\right)}{a}(z-w)\frac{1}{2a}\left(w-\tau-b_q\right)^2 + \frac{A^2}{\phi}\frac{\left(w-\tau-b_q\right)}{a}(z-w)\left(b_q-b_s\right) + b_s$$

$$\max_w \frac{A^2}{\phi}\frac{1}{a}(z-w)\frac{1}{2a}\left(w-\tau-b_q\right)^3 + \frac{A^2}{\phi}\frac{\left(w-\tau-b_q\right)}{a}(z-w)\left(b_q-b_s\right) + b_s$$

$$\max_w \frac{A^2}{\phi}\frac{1}{a}(z-w)\left[\frac{1}{2a}\left(w-\tau-b_q\right)^3 + \left(w-\tau-b_q\right)\left(b_q-b_s\right)\right] + b_s$$

Take the FOC:

$$-\left[\frac{1}{2a}\left(w-\tau-b_q\right)^3 + \left(w-\tau-b_q\right)\left(b_q-b_s\right)\right] + (z-w)\left[\frac{3}{2a}\left(w-\tau-b_q\right)^2 + \left(b_q-b_s\right)\right] = 0$$

In the benchmark case where $b_q = b_s$, this equation yields a closed form solution for w :

$$-\left(w-\tau-b_q\right) + 3(z-w) = 0$$

$$w = \frac{3}{4}z + \frac{1}{4}\left(\tau+b_q\right)$$

. Without this assumption, there is no closed form for wage.

Now, given any b_q and b_s, we can solve for $\bar{\chi}, w, \tau$ with the following three equations:

$$\text{quitting condition: } \bar{\chi} = w-\tau-b_q$$

$$\text{search optimality: } -\left[\frac{1}{2a}\left(w-\tau-b_q\right)^3 + \left(w-\tau-b_q\right)\left(b_q-b_s\right)\right] + (z-w)\left[\frac{3}{2a}\left(w-\tau-b_q\right)^2 + \left(b_q-b_s\right)\right] = 0$$

$$\text{government budget: } (1-p(w))\,b_s + p(w)\,(1-F(\bar{\chi}))\,b_q = p(w)\,F(\bar{\chi})\,\tau$$

The question is, can we use these instruments to replicate the socially efficient quitting threshold and wage level (also the associated job finding probability).

The socially efficient quit threshold is

$$\bar{\chi} = z$$

and wage level is (same as the laize fair public χ economy):

$$w = \frac{3}{4}z$$

The first equation becomes:

$$beginequation]\tau + b_q = -\frac{1}{4}z$$

The second equation becomes:

$$-\left[\frac{1}{2a}z^3 + z\left(b_q - b_s\right)\right] + (z - \frac{3}{4}z)\left[\frac{3}{2a}z^2 + \left(b_q - b_s\right)\right] = 0$$

$$-\frac{1}{2a}z^3 - z\left(b_q - b_s\right) + \frac{3}{8a}z^3 + \frac{1}{4}z\left(b_q - b_s\right) = 0$$

$$-\frac{1}{2a}z^2 - 3\left(b_q - b_s\right) = 0$$

$$b_q - b_s = -\frac{1}{6a}z^2$$

Thus the government must provide more benefit to the unemployed than to the quitters.

The last equation becomes:

$$(1 - p(w))\, b_s + p(w)\,(1 - F(\bar{\chi}))\, b_q = p(w)\, F(\bar{\chi})\, \tau$$

where the socially efficient job findg probability is given by:

$$p^* = \frac{A^2}{\phi}\frac{z}{a}\frac{1}{4}z$$

From the government budget:

$$\begin{aligned} b_s &= p^*\left(b_s - b_q\right) + p^* F(\bar{\chi})\left(\tau + b_q\right) \\ &= p^*\frac{1}{6a}z^2 + p^*\frac{z}{a}\left(-\frac{1}{4}z\right) \\ &= p^*\frac{1}{a}z^2\left(\frac{1}{6} - \frac{1}{4}\right) \\ &= -\frac{1}{12}\frac{p^*}{a}z^2 < 0 \end{aligned}$$

Thus

$$b_q = -\frac{1}{12}\frac{p^*}{a}z^2 - \frac{1}{6a}z^2.$$

Thus we have solved for the policy that can deliver first best allocation. Note that this policy has the following property to guarantee efficient quitting:

$$\tau + b_q = -\frac{1}{4}z$$

.

A.4 Proof of Proposition 3.1

All workers start off unmatched. They then look for jobs in directed-search labor markets. With probability p they find jobs. Then they draw a χ shock which leads to a quit rate of $F(\bar{\chi})$. Next comes the exogenous separation shock after which only γ fraction of the matches are preserved. The remaining workers work and receive an after-tax wage $w - \tau$. Quitters get b_q, laid off workers (laid-offs) get b_f, and those who searched but did not find job get b_s. The relative proportions of these three types of unmatched workers are given, respectively, by u_q, u_f, and u_s :

$$u_q = p\gamma\left(1 - F\left(\bar{\chi}\right)\right)$$

$$u_f = p\left(1 - \gamma\right)$$

$$u_s = 1 - p$$

The share of workers is given by:

$$1 - u_q - u_f - u_s = p\gamma F\left(\bar{\chi}\right)$$

The government budget is given by

$$\tau\left(1 - u_q - u_f - u_s\right) = \sum_{i=q,f,s} b_i u_i$$

We now set up the optimal policy problem. The objective of the government is to maximize *ex ante* expected utility:

$$W\left(b_q, b_f, b_s, \tau, p, w, \bar{\chi}\right) = \max_{b_q, b_f, b_s} \sum_{i=q,f,s} u_i U(b_i) + \left(1 - u_q - u_f - u_s\right)\left[U\left(w - \tau\right) - \mathbb{E}\left(\chi | \chi < \bar{\chi}\right)\right]$$

The government is subject to several constraints. The first is the zero profit condition for the firms, where $q\left(p\right)$ is the vacancy filling rate given that the job finding rate is p :

$$q\left(p\right)\gamma F\left(\bar{\chi}\right)\left(z - w\right) = \phi \tag{23}$$

The second is the quitting condition where $\bar{\chi}$ is the threshold of the taste shock, above which workers choose to quit:

$$U\left(w - \tau\right) - U\left(b_q\right) = \bar{\chi} \tag{24}$$

The third is a job search optimality condition, indicating that workers choose optimally the sub-market in which to search:

$$\frac{\partial W}{\partial p} + \frac{\partial W}{\partial w}\frac{\partial w}{\partial p} + \frac{\partial W}{\partial \bar{\chi}}\frac{\partial \bar{\chi}}{\partial p} = 0 \tag{25}$$

And the last constraint is the government budget constraint:

$$\tau = \frac{\sum_{i=q,f,s} b_i u_i}{\left(1 - u_q - u_f - u_s\right)}.$$

The government maximizes $W(.)$ subject to those constraints.

We now prove the proposition:

$$b_q < b_f < w - \tau$$

Proof by contradiction.

Suppose that $w - \tau \leq b_f$.

Note that conditions 23 and 24 express w and $\bar{\chi}$ as functions of (p, b, τ), where b is a vector of policy variables $b = [b_q, b_f, b_s]$. Hence we can write the objective function more compactly as:

$$W\left(b, \tau, p, w\left(p, b, \tau\right), \bar{\chi}\left(p, b, \tau\right)\right).$$

Due to worker job search optimality, we have: (note that workers internalize how changes in p affect the wage and the quitting threshold)

$$\frac{\partial W}{\partial p} + \frac{\partial W}{\partial w}\frac{\partial w}{\partial p} + \frac{\partial W}{\partial \bar{\chi}}\frac{\partial \bar{\chi}}{\partial p} = 0,$$

and government budget constraint:

$$\tau = \frac{\sum\limits_{i=q,f,s} b_i u_i}{\left(1 - u_q - u_f - u_s\right)}.$$

Under the assumption that $w - \tau \leq b_f$, we will show that the following perturbation will strictly increase welfare. This will contradict the optimality of policy and hence it must be the case that $w - \tau > b_f$.

The perturbation is as follows: for some very small number $\delta > 0$,

reduce the benefit of the laid off from b_f to $b_f - \delta$

and reduce the tax to $\tau - \dfrac{u_f \delta}{\left(1 - u_q - u_f - u_s\right)}$

We proceed with the following strategy: first, without any behavioral responses, this perturbation is budget neutral and generates non-negative consumption gain. Second, we check behaivoral responses. Namely how it affects quitting $\bar{\chi}$, job searching w and p. Lastly we check how those behavioral responses affect the tax rate.

We first focus on the direct consumption gain, holding fixed all other variables such as $\bar{\chi}, w, p$, and τ. Reducing b_f generates a consumption loss of

$$u_f U'\left(b_f\right)\delta$$

while reducing the tax increases the consumption gain by

$$\left(1 - u_q - u_f - u_s\right) U'\left(w - \tau\right) \frac{u_f \delta}{\left(1 - u_q - u_f - u_s\right)} = u_f U'\left(w - \tau\right)\delta$$

Given that $w - \tau \leq \kappa_1 z$, $U'\left(b_f\right) \geq U'\left(w - \tau\right)$. Thus, the gain is no less than the loss. Hence, the net gain from consumption smoothing is greater than or equal to zero.

Consider the impact on $\bar{\chi}$:

$$U\left(w-\tau\right)-U\left(b_q\right)=\bar{\chi}$$

A reduction in taxes τ leads to an increase in the quitting threshold, indicating that fewer workers quit. With less quitting, social welfare increases. To see this, collect all terms containing $\bar{\chi}$ in the social welfare expression:

$$\begin{aligned}
&W\tilde{\ }p\gamma F\left(\bar{\chi}\right)\left(U\left(w-\tau\right)-\mathbb{E}\left(\chi|\chi<\bar{\chi}\right)-U\left(b_q\right)\right)\\
&\tilde{\ }p\gamma F\left(\bar{\chi}\right)\left(\bar{\chi}-\mathbb{E}\left(\chi|\chi<\bar{\chi}\right)\right)\\
&\tilde{\ }p\gamma\int^{\bar{\chi}}\left(\bar{\chi}-\chi\right)dF\left(\chi\right)
\end{aligned}$$

which increases with $\bar{\chi}$.

Now consider the impact on the wage:

$$q\left(p\right)\gamma F\left(\bar{\chi}\right)\left(z-w\right)=\phi$$

With a lower quit rate, $F\left(\bar{\chi}\right)$ increases, which implies that the wage goes up. This also increases social welfare W.

We now consider the impact on the job finding rate p. Write out explicitly the first order condition for p :

$$\gamma\left(1-F\left(\bar{\chi}\right)\right)U\left(b_q\right)+\gamma F\left(\bar{\chi}\right)U\left(w-\tau\right)+\left(1-\gamma\right)U\left(b_f\right)-U\left(b_s\right)+p\gamma F\left(\bar{\chi}\right)U'\left(w-\tau\right)\frac{\partial w}{\partial p}+p\gamma F\left(\bar{\chi}\right)\frac{\partial\bar{\chi}}{\partial p}=0$$

Note that $\gamma F\left(\bar{\chi}\right)=\frac{1-u_q-u_f-u_s}{p}$, and $1-\gamma=\frac{u_f}{p}$, hence the perturbation generates a non-negative consumption smoothing gain from those two terms:

$$\gamma F\left(\bar{\chi}\right)U\left(w-\tau\right)+\left(1-\gamma\right)U\left(b_f\right)=\frac{\left(1-u_q-u_f-u_s\right)U\left(w-\tau\right)+u_fU\left(b_f\right)}{p}.$$

It also reduces the wage cost term $p\gamma F\left(\bar{\chi}\right)U'\left(w-\tau\right)\frac{\partial w}{\partial p}$ because a tax cut reduces marginal utility $U'\left(w-\tau\right)$. All these effects combined imply that the job finding probability increases.

By the envelope theorem and job search optimality (condition 25), we will ignore the direct impact on welfare of p as well as its indirect impact through w and $\bar{\chi}$. What cannot be ignored is its fiscal impact on τ :

$$\begin{aligned}
\tau &= \frac{b_qp\gamma\left(1-F\left(\bar{\chi}\right)\right)+b_fp\left(1-\gamma\right)+b_s\left(1-p\right)}{p\gamma F\left(\bar{\chi}\right)}\\
&= \frac{b_q\gamma\left(1-F\left(\bar{\chi}\right)\right)+b_f\left(1-\gamma\right)+b_s\left(\frac{1}{p}-1\right)}{\gamma F\left(\bar{\chi}\right)}
\end{aligned}$$

Hence an increase in p reduces the tax rate. It can also be shown that an increase in $\bar{\chi}$ increases the value of $F\left(\bar{\chi}\right)$ and hence reduces the tax rate. Hence we find a profitable perturbation, contradicting the optimality of government policy. Hence $w - \tau > b_f$.

Now we will follow a similar procedure to show that $b_f > b_q$. Suppose not, and that $b_f \leq b_q$. Consider the following budget-neutral perturbation:

$$\text{increase } b_f \text{ by } \delta$$
$$\text{reduce } b_q \text{ by} \frac{u_q}{u_f}\delta$$

The net utility gain from this perturbation is

$$u_f U'\left(b_f\right)\delta - u_q U'\left(b_q\right)\delta \geq 0$$

Impact on $\bar{\chi}$: $\bar{\chi}$ increases because b_q decreases:

$$U\left(w-\tau\right) - U\left(b_q\right) = \bar{\chi}$$

This increases the value of social welfare.

Impact on w : given that $\bar{\chi}$ increases, the wage w also increases (from the zero profit condition), which increases social welfare.

Impact on p. Given that this perturbation yields a non-negative consumption gain and a hence non-negative increase in the value of the job, we have that the job finding probability p must increase. This together with the increase in the quitting threshold $\bar{\chi}$ means that the tax rate must decrease:

$$\begin{aligned} \tau &= \frac{b_q p\gamma\left(1-F\left(\bar{\chi}\right)\right) + b_f p\left(1-\gamma\right) + b_s\left(1-p\right)}{p\gamma F\left(\bar{\chi}\right)} \\ &= \frac{b_q\gamma\left(1-F\left(\bar{\chi}\right)\right) + b_f\left(1-\gamma\right) + b_s\left(\frac{1}{p}-1\right)}{\gamma F\left(\bar{\chi}\right)} \end{aligned}$$

Hence we find a profitable perturbation that will strictly increase welfare. This contradicts the optimality of $b_f \leq b_q$. Hence It must be the case that

$$w - \tau > b_f > b_q.$$

A.5 Proof of Proposition 4.1

The proof is organized into the following steps. We first derive the social welfare function (equation 8), the optimal quitting condition (equation 7), and the government budget constraint (equation 10).

To derive the Baily-Chetty formula in the elasticity form (equation 12), we first derive its non-elasticity form by taking a first order condition with respect to the replacement rate in the government's problem. At this step, we don't need to assume any specific functional forms for the various functions, such as the social welfare function or the tax function. We then plug in the specific functional forms for these functions and derive the Baily-Chetty formula in its elasticity form.

The Social Welfare Function

We first derive the social welfare function (equation 8). Let W^u and W^e denote the values of being unmatched and matched at the start of the period, before search and matching. Let V^u and V^e be the values of being unmatched and matched after the search and matching stage, but before separations happen. These values are given by

$$\begin{aligned} W^u &= pV^e + (1-p)V^u \\ W^e &= V^e \\ V^u &= U(\kappa z) + \beta W^u \\ V^e &= \gamma F(\bar{\chi})(U(w(1-\tau)) - \mathbb{E}[\chi_{|\chi \le \bar{\chi}}] + \beta W^e) + (1-\gamma F(\bar{\chi}))V^u. \end{aligned}$$

Let us denote $F = F(\bar{\chi})$; $E = \mathbb{E}[\chi|\chi \le \bar{\chi}]$; and $u = U(w(1-\tau))$:

$$W^u = pV^e + (1-p)V^u$$

$$V^u = U(\kappa z) + \beta W^u$$

$$W^e = V^e$$

$$V^e = \gamma F(u - E + \beta W^e) + (1-\gamma F)V^u.$$

First, let's substitute out W^u and W^e:

$$\begin{aligned} V^u &= U(\kappa z) + \beta\left(pV^e + (1-p)V^u\right) \\ V^u(1-\beta(1-p)) &= U(\kappa z) + \beta p V^e. \end{aligned}$$

We obtain:

$$V^e = \gamma F(u - E + \beta V^e) + (1-\gamma F)V^u.$$

Hence, the expression for V^e is given by:

$$V^e = \frac{\gamma F(u-E)}{(1-\beta\gamma F)} + \frac{(1-\gamma F)V^u}{(1-\beta\gamma F)}. \tag{26}$$

Now substitute the V^e expression into V^u :

$$
\begin{aligned}
V^u(1-\beta(1-p)) &= U(\kappa z)+\beta p\left(\frac{\gamma F(u-E)}{(1-\beta\gamma F)}+\frac{(1-\gamma F)V^u}{(1-\beta\gamma F)}\right) \\
V^u\left(1-\beta(1-p)-\beta p\frac{(1-\gamma F)}{(1-\beta\gamma F)}\right) &= U(\kappa z)+\beta p\frac{\gamma F(u-E)}{(1-\beta\gamma F)} \\
V^u\left(\frac{1-\beta}{1-\beta\gamma F}(1-\beta\gamma F(1-p))\right) &= U(\kappa z)+\beta p\frac{\gamma F(u-E)}{(1-\beta\gamma F)} \\
V^u(1-\beta) &= \frac{(1-\beta\gamma F)}{(1-\beta\gamma F(1-p))}\log(\kappa z)+\frac{\beta p\gamma F}{(1-\beta\gamma F(1-p))}(u-E).
\end{aligned}
$$

Now,

$$
V^e(1-\beta\gamma F)=\gamma F(u-E)+(1-\gamma F)V^u.
$$

We can obtain the following expression for W^u:

$$
\begin{aligned}
W^u &= pV^e+(1-p)V^u \\
&= p\frac{\gamma F(u-E)+(1-\gamma F)V^u}{(1-\beta\gamma F)}+(1-p)V^u \\
&= \frac{p\gamma F}{(1-\beta\gamma F)}(u-E)+\frac{p(1-\gamma F)+(1-p)(1-\beta\gamma F)}{(1-\beta\gamma F)}V^u \\
&= \frac{p\gamma F}{(1-\beta\gamma F)}(u-E)+\frac{1-p\gamma F-(1-p)\beta\gamma F}{(1-\beta\gamma F)}V^u \\
&= \left[\frac{p\gamma F}{(1-\beta)(1-\beta\gamma F(1-p))}\right](u-E)+\frac{1}{(1-\beta)}\left(\frac{1-p\gamma F-(1-p)\beta\gamma F}{(1-\beta\gamma F(1-p))}U(\kappa z)\right).
\end{aligned}
$$

Normalizing this expression by multiplying $1-\beta$, we obtained the social welfare function W in the main paper (equation 8).

The optimal quitting condition

We now derive the optimal quitting condition (equation 7).

We start with the original expression for the optimal quitting condition:

$$
u-\bar{\chi}+\beta V^e=V^u,
$$

where V^e is the value of employment (same with V'). Plug in the expression for V^e (equation 26):

$$
\begin{aligned}
u-\bar{\chi}+\beta\left(\frac{\gamma F(u-E)}{(1-\beta\gamma F)}+\frac{(1-\gamma F)}{(1-\beta\gamma F)}V^u\right) &= V^u \\
u-\bar{\chi}+\beta\frac{\gamma F}{(1-\beta\gamma F)}(u-E) &= \left(1-\frac{\beta(1-\gamma F)}{(1-\beta\gamma F)}\right)V^u \\
u-\bar{\chi}+\beta\frac{\gamma F}{(1-\beta\gamma F)}(u-E) &= \left(\frac{1-\beta}{1-\beta\gamma F}\right)V^u.
\end{aligned}
$$

This gives an expression for V^u:

$$
V^u(1-\beta)=\frac{(1-\beta\gamma F)}{(1-\beta\gamma F(1-p))}U(\kappa z)+\frac{\beta p\gamma F}{(1-\beta\gamma F(1-p))}(u-E).
$$

Plug this expression back into the last expression:

$$\begin{aligned}
u-\bar{\chi}+\beta\frac{\gamma F}{(1-\beta\gamma F)}(u-E) &= \frac{1-\beta}{1-\beta\gamma F}\left(\frac{(1-\beta\gamma F)}{(1-\beta)\left(1-\beta\gamma F(1-p)\right)}U(\kappa z)+\frac{1}{1-\beta}\left(1-\frac{(1-\beta\gamma F)}{(1-\beta\gamma F(1-p))}\right)(u-E)\right)\\
u-\bar{\chi} &= \frac{1}{(1-\beta\gamma F(1-p))}U(\kappa z)+\left(1-\frac{1}{(1-\beta\gamma F(1-p))}\right)(u-E)\\
-\bar{\chi} &= \frac{1}{(1-\beta\gamma F(1-p))}U(\kappa z)-\frac{1}{(1-\beta\gamma F(1-p))}u-\left(1-\frac{1}{(1-\beta\gamma F(1-p))}\right)E\\
\bar{\chi} &= \frac{-1}{(1-\beta\gamma F(1-p))}U(\kappa z)+\frac{1}{(1-\beta\gamma F(1-p))}u+\left(1-\frac{1}{(1-\beta\gamma F(1-p))}\right)E.
\end{aligned}$$

Rearrange those terms:

$$\begin{aligned}
\left(1-\beta\gamma F(1-p)\right)(\bar{\chi}-E) &= u-E-U(\kappa z)\\
\left(1-\beta\gamma F(1-p)\right)(\bar{\chi}-E)+(E-\bar{\chi}) &= u-E-U(\kappa z)+(E-\bar{\chi})\\
\left(1-\beta\gamma F(1-p)\right)(\bar{\chi}-E)-(\bar{\chi}-E) &= u-\bar{\chi}-U(\kappa z)\\
-\beta\gamma F(1-p)(\bar{\chi}-E) &= u-\bar{\chi}-U(\kappa z).
\end{aligned}$$

Hence, we obtained the no-quitting condition as in equation 7.

Government budget constraint

We now derive the (present-value) government budget constraint (equation 10). We denote the number of unmatched worker in period t to be u_t.

The number of workers in the first period is

$$1-u_0=p\gamma F(\bar{\chi}).$$

In the next period it is

$$\begin{aligned}
1-u_1 &= (1-u_0)\gamma F(\bar{\chi})+u_0 p\gamma F(\bar{\chi})\\
&= p\gamma F(\bar{\chi})+(1-u_0)\left(\gamma F(\bar{\chi})-p\gamma F(\bar{\chi})\right)\\
&= p\gamma F(\bar{\chi})+\left(\gamma F(\bar{\chi})\right)^2 p\,(1-p)\,.
\end{aligned}$$

Generally, the number of workers evolves according to

$$1-u_{t+2}=a+b(1-u_{t+1}),$$

where

$$\begin{aligned}
a &= p\gamma F(\bar{\chi})\\
b &= \gamma F(\bar{\chi})\,(1-p)\,.
\end{aligned}$$

So the present value of workers is

$$
\begin{aligned}
& a \\
& +\beta\left(a+ab\right) \\
& +\beta^2\left(a+ab+ab^2\right) \\
& +\beta^3\left(a+ab+ab^2+ab^3\right) \\
& +...
\end{aligned}
$$

Rearrange terms:

$$
\begin{aligned}
& a\left(1+\beta(1+b)+\beta^2(1+b+b^2)+...\right) \\
= & a\left(1+\beta+\beta^2+...\right) \\
& +ab\beta(1+\beta+\beta^2+...)+... \\
= & \frac{a}{1-\beta}\left(1+\beta b+\beta^2 b^2\right) \\
= & \frac{a}{1-\beta}\frac{1}{1-\beta b} \\
= & \frac{p\gamma F(\bar{\chi})}{(1-\beta)(1-\beta\gamma F(\bar{\chi})\,(1-p))}.
\end{aligned}
$$

The present value of tax revenue is thus

$$
w\tau\frac{p\gamma F(\bar{\chi})}{(1-\beta)(1-\beta\gamma F(\bar{\chi})\,(1-p))}.
$$

The present value of the number of unemployed is

$$
\begin{aligned}
& 1-a \\
& +\beta\left(1-(a+ab)\right) \\
& +\beta^2\left(1-\left(a+ab+ab^2\right)\right) \\
& +\beta^3\left(1-\left(a+ab+ab^2+ab^3\right)\right) \\
& +...,
\end{aligned}
$$

which is

$$
\begin{aligned}
& \frac{1}{1-\beta}-\frac{p\gamma F(\bar{\chi})}{(1-\beta)(1-\beta\gamma F(\bar{\chi})\,(1-p))} \\
= & \frac{1}{1-\beta}\left(1-\frac{p\gamma F(\bar{\chi})}{(1-\beta\gamma F(\bar{\chi})\,(1-p))}\right) \\
= & \frac{1}{1-\beta}\left(\frac{(1-\beta\gamma F(\bar{\chi})\,(1-p))-p\gamma F(\bar{\chi})}{(1-\beta\gamma F(\bar{\chi})\,(1-p))}\right).
\end{aligned}
$$

We can define $\tilde{u}$ as the total fraction of time an initially unemployed worker spend in non-employment, which is exactly the $\tilde{u}$ shown up in the social welfare function:

$$\begin{aligned}\tilde{u} &= 1-\frac{p\gamma F(\bar{\chi})}{(1-\beta\gamma F(\bar{\chi})(1-p))}=\frac{1-\beta\gamma F(\bar{\chi})(1-p)-p\gamma F(\bar{\chi})}{(1-\beta\gamma F(\bar{\chi})(1-p))}=\frac{1-\beta\gamma F(\bar{\chi})+(\beta-1)p\gamma F(\bar{\chi})}{(1-\beta\gamma F(\bar{\chi})(1-p))}\\ 1-\tilde{u} &= \frac{p\gamma F(\bar{\chi})}{(1-\beta\gamma F(\bar{\chi})(1-p))}.\end{aligned}$$

Hence, the government budget constraint is given by equation 10.

Baily-Chetty formula

We now derive equation 12. We start with the following social welfare function (equation 8) which is abbreviated as:

$$W(p,\bar{\chi},\tau,\kappa).$$

There is a no-quitting condition (equation 7):

$$U[w(p,\bar{\chi})(1-\tau)]-E[\chi_{|\chi\leq\bar{\chi}}]-U(\kappa z)=(1-(1-p)\beta\gamma F(\bar{\chi}))\left(\bar{\chi}-E[\chi_{|\chi\leq\bar{\chi}}]\right).$$

One could denote this condition as

$$H(p,\bar{\chi},\tau,\kappa)=0.$$

Note that we have not substituted any specific functional form into this condition.

The equation H can be solved implicitly as

$$\bar{\chi}=\bar{\chi}(p,\tau,\kappa).$$

The private agent solves the following problem, taking as given τ and κ, and the function $H(.)$, or

$$\max_p W(p,\bar{\chi}(p,\tau,\kappa),\tau,\kappa).$$

This gives the private optimality condition

$$G(p,\bar{\chi},\tau,\kappa)=\frac{\partial W}{\partial p}+\frac{\partial W}{\partial\bar{\chi}}\frac{\partial\bar{\chi}}{\partial p}=0. \tag{27}$$

Lastly, we have a government budget condition (equation 10), which boils down to expressing τ as a function of all other parameters:

$$\tau=\tau(p,\bar{\chi},\kappa),$$

because both $\tilde{u}$ and wages are functions of p and $\bar{\chi}$. Now the social planner's problem is to maximize social welfare $W(.)$ subject to the following three constraints:

$$H(p,\bar{\chi},\tau,\kappa)=0$$

$$G(p,\bar{\chi},\tau,\kappa)=0$$

and

$$\tau=\tau(p,\bar{\chi},\kappa).$$

These three constraints give a mapping from κ to $(p, \bar{\chi}, \tau)$:

$$p(\kappa), \bar{\chi}(\kappa), \tau(\kappa).$$

Note that

$$\bar{\chi}(\kappa) = \bar{\chi}(p(\kappa), \tau(\kappa), \kappa)$$

$$\tau(\kappa) = \tau(p(\kappa), \bar{\chi}(\kappa), \kappa).$$

Plug these back into the social welfare function:

$$\max_{\kappa} W(p(\kappa), \bar{\chi}(p(\kappa), \tau(\kappa), \kappa), \tau(\kappa), \kappa).$$

Take the FOC with respect to κ :

$$\frac{\partial W}{\partial p}\frac{\partial p}{\partial \kappa} + \frac{\partial W}{\partial \bar{\chi}}\frac{\partial \bar{\chi}}{\partial p}\frac{\partial p}{\partial \kappa} + \frac{\partial W}{\partial \bar{\chi}}\left(\frac{\partial \bar{\chi}}{\partial \tau}\frac{d\tau}{d\kappa} + \frac{\partial \bar{\chi}}{\partial \kappa}\right) + \frac{\partial W}{\partial \tau}\frac{d\tau}{d\kappa} + \frac{\partial W}{\partial \kappa} = 0.$$

Because of the envelope theorem (see equation 27), the first two terms cancel out. Rearrange the remaining terms and plug in the total derivative derived from:

$$\tau(\kappa) = \tau(p(\kappa), \bar{\chi}(\kappa), \kappa),$$

which is

$$\frac{d\tau}{d\kappa} = \frac{\partial \tau}{\partial p}\frac{dp}{d\kappa} + \frac{\partial \tau}{\partial \bar{\chi}}\frac{d\bar{\chi}}{d\kappa} + \frac{\partial \tau}{\partial \kappa}.$$

We have:

$$\underbrace{\frac{\partial W}{\partial \kappa} + \frac{\partial W}{\partial \tau}\frac{\partial \tau}{\partial \kappa}}_{\text{Consumption insurance}} + \underbrace{\frac{\partial W}{\partial \tau}\left(\frac{\partial \tau}{\partial \bar{\chi}}\frac{d\bar{\chi}}{d\kappa} + \frac{\partial \tau}{\partial p}\frac{dp}{d\kappa}\right)}_{\text{Fiscal externality}} + \underbrace{\frac{\partial W}{\partial \bar{\chi}}\left(\frac{\partial \bar{\chi}}{\partial \tau}\frac{d\tau}{d\kappa} + \frac{\partial \bar{\chi}}{\partial \kappa}\right)}_{\text{Quitting externality}} = 0.$$

Now we want to plug in specific forms for social welfare and the government budget constraint.

Start with the social welfare function:

$$W(p, \bar{\chi}, \tau, \kappa) = \underbrace{\left(\frac{p\gamma F(\bar{\chi})}{(1 - \beta\gamma(1-p)F(\bar{\chi}))}\right)}_{1-\tilde{u}}\left(U((1-\tau)w(p, \bar{\chi})) - E[\chi_{|\chi \leq \bar{\chi}}]\right) + \underbrace{\frac{1 - \beta\gamma F(\bar{\chi}) - (1-\beta)\gamma p F(\bar{\chi})}{(1 - \beta\gamma(1-p)F(\bar{\chi}))}}_{\tilde{u}}U(\kappa z).$$

And the government budget constraint is given by

$$\underbrace{\left(\frac{p\gamma F(\bar{\chi})}{(1 - \beta\gamma(1-p)F(\bar{\chi}))}\right)}_{1-\tilde{u}}\tau w(p, \bar{\chi}) = \underbrace{\frac{1 - \beta\gamma F(\bar{\chi}) - (1-\beta)\gamma p F(\bar{\chi})}{(1 - \beta\gamma(1-p)F(\bar{\chi}))}}_{\tilde{u}}\kappa z$$

$$\tau(p, \bar{\chi}, \kappa) = \frac{\tilde{u}}{1-\tilde{u}}\frac{\kappa z}{w(p, \bar{\chi})}.$$

We need to fill in those terms, and we do it one at a time:

$$\underbrace{\frac{\partial W}{\partial \kappa} + \frac{\partial W}{\partial \tau}\frac{\partial \tau}{\partial \kappa}}_{\text{Consumption insurance}} + \underbrace{\frac{\partial W}{\partial \tau}\left(\frac{\partial \tau}{\partial \bar{\chi}}\frac{d\bar{\chi}}{d\kappa} + \frac{\partial \tau}{\partial p}\frac{dp}{d\kappa}\right)}_{\text{Fiscal externality}} + \underbrace{\frac{\partial W}{\partial \bar{\chi}}\left(\frac{\partial \bar{\chi}}{\partial \tau}\frac{d\tau}{d\kappa} + \frac{\partial \bar{\chi}}{\partial \kappa}\right)}_{\text{Quitting externality}} = 0.$$

The consumption insurance term

Taking the derivative with respect to the social welfare function and the tax function:

$$\frac{\partial W}{\partial \kappa} = \tilde{u}U'(\kappa z)\, z$$

$$\frac{\partial W}{\partial \tau} = -(1-\tilde{u})\, U'((1-\tau)\, w)\, w$$

$$\frac{\partial \tau}{\partial \kappa} = \frac{\tilde{u}}{1-\tilde{u}}\frac{z}{w}.$$

Combine:

$$\begin{aligned}
\frac{\partial W}{\partial \kappa} + \frac{\partial W}{\partial \tau}\frac{\partial \tau}{\partial \kappa} &= \tilde{u}U'(\kappa z)\, z - (1-\tilde{u})\, U'((1-\tau)\, w)\, w\frac{\tilde{u}}{1-\tilde{u}}\frac{z}{w} \\
&= \tilde{u}U'(\kappa z)\, z - U'((1-\tau)\, w)\, \tilde{u}z \\
&= \tilde{u}z\left(U'(c^u) - U'(c^w)\right).
\end{aligned}$$

The fiscal externality Term

The fiscal term is given by

$$\frac{\partial \tau}{\partial \bar{\chi}}\frac{d\bar{\chi}}{d\kappa} + \frac{\partial \tau}{\partial p}\frac{dp}{d\kappa}.$$

Now, given that

$$\tau(p, \bar{\chi}, \kappa) = \frac{\tilde{u}}{1-\tilde{u}}\frac{\kappa z}{w(p, \bar{\chi})},$$

We take the partial derivatives with respect to p and $\bar{\chi}$:

$$\begin{aligned}
\frac{\partial \tau}{\partial \bar{\chi}} &= \frac{\frac{\partial \tilde{u}}{\partial \bar{\chi}}(1-\tilde{u}) - \tilde{u}\left(-\frac{\partial \tilde{u}}{\partial \bar{\chi}}\right)}{(1-\tilde{u})^2}\frac{\kappa z}{w(p,\bar{\chi})} - \frac{\tilde{u}}{1-\tilde{u}}\frac{\kappa z}{w^2}\frac{\partial w}{\partial \bar{\chi}} \\
&= \frac{1}{(1-\tilde{u})^2}\frac{\kappa z}{w(p,\bar{\chi})}\frac{\partial \tilde{u}}{\partial \bar{\chi}} - \frac{\tilde{u}}{1-\tilde{u}}\frac{\kappa z}{w^2}\frac{\partial w}{\partial \bar{\chi}} \\
\frac{\partial \tau}{\partial p} &= \frac{\frac{\partial \tilde{u}}{\partial p}(1-\tilde{u}) - \tilde{u}\left(-\frac{\partial \tilde{u}}{\partial p}\right)}{(1-\tilde{u})^2}\frac{\kappa z}{w(p,\bar{\chi})} - \frac{\tilde{u}}{1-\tilde{u}}\frac{\kappa z}{w^2}\frac{\partial w}{\partial p} \\
&= \frac{1}{(1-\tilde{u})^2}\frac{\kappa z}{w(p,\bar{\chi})}\frac{\partial \tilde{u}}{\partial p} - \frac{\tilde{u}}{1-\tilde{u}}\frac{\kappa z}{w^2}\frac{\partial w}{\partial p}.
\end{aligned}$$

Hence

$$\begin{aligned}
&\frac{\partial \tau}{\partial \bar{\chi}}\frac{d\bar{\chi}}{d\kappa} + \frac{\partial \tau}{\partial p}\frac{dp}{d\kappa} \\
=\ & \left[\frac{1}{(1-\tilde{u})^2}\frac{\kappa z}{w(p,\bar{\chi})}\frac{\partial \tilde{u}}{\partial \bar{\chi}} - \frac{\tilde{u}}{1-\tilde{u}}\frac{\kappa z}{w^2}\frac{\partial w}{\partial \bar{\chi}}\right]\frac{d\bar{\chi}}{d\kappa} \\
&+ \left[\frac{1}{(1-\tilde{u})^2}\frac{\kappa z}{w(p,\bar{\chi})}\frac{\partial \tilde{u}}{\partial p} - \frac{\tilde{u}}{1-\tilde{u}}\frac{\kappa z}{w^2}\frac{\partial w}{\partial p}\right]\frac{dp}{d\kappa}.
\end{aligned}$$

Regroup items, recognizing that

$$\frac{d\tilde{u}}{d\kappa} = \frac{\partial \tilde{u}}{\partial \bar{\chi}}\frac{d\bar{\chi}}{d\kappa} + \frac{\partial \tilde{u}}{\partial p}\frac{dp}{d\kappa}$$
$$\frac{dw}{d\kappa} = \frac{\partial w}{\partial \bar{\chi}}\frac{d\bar{\chi}}{d\kappa} + \frac{\partial w}{\partial p}\frac{dp}{d\kappa},$$

we have

$$\begin{aligned} & \frac{\partial \tau}{\partial \bar{\chi}}\frac{d\bar{\chi}}{d\kappa} + \frac{\partial \tau}{\partial p}\frac{dp}{d\kappa} \\ = \quad & \frac{1}{(1-\tilde{u})^2}\frac{\kappa z}{w}\frac{d\tilde{u}}{d\kappa} - \frac{\tilde{u}}{1-\tilde{u}}\frac{\kappa z}{w^2}\frac{dw}{d\kappa}. \end{aligned}$$

Hence, the whole tax benefit term is

$$\begin{aligned} & \frac{\partial W}{\partial \tau}\left(\frac{\partial \tau}{\partial \bar{\chi}}\frac{d\bar{\chi}}{d\kappa} + \frac{\partial \tau}{\partial p}\frac{dp}{d\kappa}\right) \\ = \quad & -\left(1-\tilde{u}\right)U'\left(\left(1-\tau\right)w\right)w\left[\frac{1}{(1-\tilde{u})^2}\frac{\kappa z}{w}\frac{d\tilde{u}}{d\kappa} - \frac{\tilde{u}}{1-\tilde{u}}\frac{\kappa z}{w^2}\frac{dw}{d\kappa}\right] \\ = \quad & -U'\left(\left(1-\tau\right)w\right)z\tilde{u}\left[\frac{1}{1-\tilde{u}}\frac{1}{\tilde{u}}\kappa\frac{d\tilde{u}}{d\kappa} - \frac{\kappa}{w}\frac{dw}{d\kappa}\right] \\ = \quad & -U'\left(c^w\right)z\tilde{u}\left[\frac{1}{1-\tilde{u}}\varepsilon_{\tilde{u},\kappa} - \varepsilon_{w,\kappa}\right]. \end{aligned}$$

The quitting externality term:

The quitting effect is given by:

$$\frac{\partial W}{\partial \bar{\chi}}\left(\frac{\partial \bar{\chi}}{\partial \tau}\frac{d\tau}{d\kappa} + \frac{\partial \bar{\chi}}{\partial \kappa}\right) = \left(-\frac{\partial \tilde{u}}{\partial \bar{\chi}}\left(U\left(c^w\right) - E[\chi_{|\chi\leq\bar{\chi}}] - U(\kappa z)\right) + (1-\tilde{u})\left(U'\left(c^w\right)(1-\tau)\frac{\partial w}{\partial \bar{\chi}} - \frac{\partial E[\chi_{|\chi\leq\bar{\chi}}]}{\partial \bar{\chi}}\right)\right)\left(\frac{\partial \bar{\chi}}{\partial \tau}\frac{d\tau}{d\kappa} + \frac{\partial \bar{\chi}}{\partial \kappa}\right).$$

We will argue that a component of this equation is zero:

$$-\frac{\partial \tilde{u}}{\partial \bar{\chi}}\left(U\left(c^w\right) - E[\chi_{|\chi\leq\bar{\chi}}] - U(\kappa z)\right) - (1-\tilde{u})\frac{\partial E[\chi_{|\chi\leq\bar{\chi}}]}{\partial \bar{\chi}} = 0, \tag{28}$$

which is implied from the optimal quitting condition:

$$U\left(c^w\right) - E[\chi_{|\chi\leq\bar{\chi}}] - U(\kappa z) = (1-(1-p)\beta\gamma F(\bar{\chi}))\left(\bar{\chi} - E[\chi_{|\chi\leq\bar{\chi}}]\right).$$

Plugging this into the last equation 28, we have:

$$-\frac{\partial \tilde{u}}{\partial \bar{\chi}}\left[(1-(1-p)\beta\gamma F(\bar{\chi}))\left(\bar{\chi} - E[\chi_{|\chi\leq\bar{\chi}}]\right)\right] - (1-\tilde{u})\frac{\partial E[\chi_{|\chi\leq\bar{\chi}}]}{\partial \bar{\chi}}.$$

Now, plug in:

$$\begin{aligned} \frac{\partial E[\chi_{|\chi\leq\bar{\chi}}]}{\partial \bar{\chi}} &= \frac{F(\bar{\chi})\bar{\chi}f(\bar{\chi}) - \int_{-\infty}^{\bar{\chi}}\chi dF(\chi)f(\bar{\chi})}{F(\bar{\chi})^2} \\ &= \frac{f\left(\bar{\chi}\right)}{F\left(\bar{\chi}\right)}\left[\frac{F(\bar{\chi})\bar{\chi}}{F(\bar{\chi})} - \frac{\int_{-\infty}^{\bar{\chi}}\chi dF(\chi)}{F\left(\bar{\chi}\right)}\right] \\ &= \frac{f\left(\bar{\chi}\right)}{F\left(\bar{\chi}\right)}\left(\bar{\chi} - E[\chi_{|\chi\leq\bar{\chi}}]\right). \end{aligned}$$

Now,

$$
\begin{aligned}
-\frac{\partial \tilde{u}}{\partial \bar{\chi}} &= \frac{\partial\left(1-\tilde{u}\right)}{\partial \bar{\chi}} = \frac{\partial \frac{p\gamma F(\bar{\chi})}{(1-\beta\gamma(1-p)F(\bar{\chi}))}}{\partial \bar{\chi}} \\
&= \frac{p\gamma f(\bar{\chi})\left(1-\beta\gamma\left(1-p\right)F\left(\bar{\chi}\right)\right) - p\gamma F(\bar{\chi})\left(-\beta\gamma\left(1-p\right)f\left(\bar{\chi}\right)\right)}{\left(1-\beta\gamma\left(1-p\right)F\left(\bar{\chi}\right)\right)^2} \\
&= \frac{p\gamma f(\bar{\chi})}{\left(1-\beta\gamma\left(1-p\right)F\left(\bar{\chi}\right)\right)^2}.
\end{aligned}
$$

Hence,

$$
\begin{aligned}
& -\frac{\partial \tilde{u}}{\partial \bar{\chi}}\left[\left(1-(1-p)\beta\gamma F(\bar{\chi})\right)\left(\bar{\chi}-E[\chi_{|\chi\leq\bar{\chi}}]\right)\right] - (1-\tilde{u})\frac{\partial E[\chi_{|\chi\leq\bar{\chi}}]}{\partial \bar{\chi}} \\
= & \frac{p\gamma f(\bar{\chi})}{\left(1-\beta\gamma\left(1-p\right)F\left(\bar{\chi}\right)\right)^2}\left[\left(1-(1-p)\beta\gamma F(\bar{\chi})\right)\left(\bar{\chi}-E[\chi_{|\chi\leq\bar{\chi}}]\right)\right] - \frac{p\gamma F(\bar{\chi})}{\left(1-\beta\gamma\left(1-p\right)F\left(\bar{\chi}\right)\right)}\frac{f\left(\bar{\chi}\right)}{F\left(\bar{\chi}\right)}\left(\bar{\chi}-E[\chi_{|\chi\leq\bar{\chi}}]\right) \\
= & \frac{p\gamma f(\bar{\chi})}{\left(1-\beta\gamma\left(1-p\right)F\left(\bar{\chi}\right)\right)}\left(\bar{\chi}-E[\chi_{|\chi\leq\bar{\chi}}]\right) - \frac{p\gamma F\left(\bar{\chi}\right)}{\left(1-\beta\gamma\left(1-p\right)F\left(\bar{\chi}\right)\right)}\frac{f\left(\bar{\chi}\right)}{F\left(\bar{\chi}\right)}\left(\bar{\chi}-E[\chi_{|\chi\leq\bar{\chi}}]\right) = 0.
\end{aligned}
$$

Hence we can use this equation to simply the quitting effect term. We have the following equation:

$$
\frac{\partial W}{\partial \bar{\chi}}\left(\frac{\partial \bar{\chi}}{\partial \tau}\frac{d\tau}{d\kappa} + \frac{\partial \bar{\chi}}{\partial \kappa}\right) = (1-\tilde{u})U'\left(c^w\right)\left(1-\tau\right)\frac{\partial w}{\partial \bar{\chi}}\left[\frac{\partial \bar{\chi}}{\partial \tau}\frac{d\tau}{d\kappa} + \frac{\partial \bar{\chi}}{\partial \kappa}\right].
$$

Hence we have:

$$
\underbrace{\tilde{u}z\left(U'\left(c^u\right) - U'\left(c^w\right)\right)}_{\text{C insurance (conventional)}} + \underbrace{-U'\left(c^w\right)z\tilde{u}\left[\frac{1}{1-\tilde{u}}\varepsilon_{\tilde{u},\kappa} - \varepsilon_{w,\kappa}\right]}_{\text{Fiscal externality (conventional)}} + \underbrace{(1-\tilde{u})U'\left(c^w\right)\left(1-\tau\right)\frac{\partial w}{\partial \bar{\chi}}\left[\frac{\partial \bar{\chi}}{\partial \tau}\frac{d\tau}{d\kappa} + \frac{\partial \bar{\chi}}{\partial \kappa}\right]}_{\text{Quitting externality (new)}} = 0.
$$

Dividing everything with $z\tilde{u}U'\left(c^w\right)$, we have

$$
\underbrace{\frac{U'\left(c^u\right) - U'\left(c^w\right)}{U'\left(c^w\right)}}_{\text{C insurance}} + \underbrace{-\left[\frac{1}{1-\tilde{u}}\varepsilon_{\tilde{u},\kappa} - \varepsilon_{w,\kappa}\right]}_{\text{Fiscal externality}} + \underbrace{\frac{(1-\tilde{u})U'\left(c^w\right)\left(1-\tau\right)}{z\tilde{u}U'\left(c^w\right)}\frac{\partial w}{\partial \bar{\chi}}\left[\frac{\partial \bar{\chi}}{\partial \tau}\frac{d\tau}{d\kappa} + \frac{\partial \bar{\chi}}{\partial \kappa}\right]}_{\text{Quitting externality}} = 0.
$$

Note that, given the GBC:

$$
\tau = \frac{\tilde{u}}{1-\tilde{u}}\frac{\kappa z}{w}
$$

$$
\frac{(1-\tilde{u})U'\left(c^w\right)\left(1-\tau\right)}{z\tilde{u}U'\left(c^w\right)} = \frac{\left(1-\tilde{u}\right)\left(1-\tau\right)}{z\tilde{u}} = \frac{1-\tau}{\tau}\frac{\kappa}{w}.
$$

Hence we have:

$$
\underbrace{\frac{U'\left(c^u\right) - U'\left(c^w\right)}{U'\left(c^w\right)}}_{\text{Cons insurance}} + \underbrace{-\left[\frac{1}{1-\tilde{u}}\varepsilon_{\tilde{u},\kappa} - \varepsilon_{w,\kappa}\right]}_{\text{Fiscal externality}} + \underbrace{\frac{1-\tau}{\tau}\frac{\kappa}{w}\frac{\partial w}{\partial \bar{\chi}}\left[\frac{\partial \bar{\chi}}{\partial \tau}\frac{d\tau}{d\kappa} + \frac{\partial \bar{\chi}}{\partial \kappa}\right]}_{\text{Quitting externality}} = 0
$$

$$
\underbrace{\frac{U'\left(c^u\right) - U'\left(c^w\right)}{U'\left(c^w\right)}}_{\text{Cons insurance}} + \underbrace{-\left[\frac{1}{1-\tilde{u}}\varepsilon_{\tilde{u},\kappa} - \varepsilon_{w,\kappa}\right]}_{\text{Fiscal externality}} + \underbrace{\frac{1-\tau}{\tau}\varepsilon_{w,\kappa|p}}_{\text{Quitting externality}} = 0,
$$

where $\varepsilon_{w,\kappa|p} = \frac{\kappa}{w}\frac{\partial w}{\partial \bar{\chi}}\left[\frac{\partial \bar{\chi}}{\partial \tau}\frac{d\tau}{d\kappa} + \frac{\partial \bar{\chi}}{\partial \kappa}\right]$.

A.6 Proof of Proposition 5.1

$$\Pi(V) = \max_{w,V'} \left\{ \gamma F(\bar{\chi}(w,V'))(z - w + \beta \Pi(V')) \right\}$$

s.t.

$$\log(w) - \bar{\chi}(w,V') + \beta V' = V^u : quitting\_rule$$

$$\gamma F(\bar{\chi}(w,V')) \left(U(w) - E\left[\chi | \chi \leq \bar{\chi}(w,V')\right] + \beta V' \right) + (1 - \gamma F(\bar{\chi}(w,V')))V^u \geq V : promise\_keeping$$

The quitting rule gives a closed form for $\bar{\chi}(w,V')$:

$$\bar{\chi}(w,V') = U(w) + \beta V' - V^u.$$

We can plug that into the second constraint and into the objective

So we have an objective with choice variables w and V':

$$\Pi(V) = \max_{w,V'} \left\{ \gamma F(U(w) + \beta V' - V^u)(z - w + \beta \Pi(V')) \right\}$$

s.t.

$$\gamma F(U(w)+\beta V' - V^u) \left(U(w) - E\left[\chi | \chi \leq U(w) + \beta V' - V^u\right] + \beta V' \right) + (1 - \gamma F(U(w)+\beta V' - V^u))V^u = V : \mu$$

where we denote the multiplier μ.

The promise keeping constraint can be rewritten as:

$$\gamma F(U(w) + \beta V' - V^u) \left(U(w) + \beta V' \right) - \gamma \int_{-\infty}^{U(w)+\beta V' - V^u} \chi f(\chi)\, d\chi + (1 - \gamma F(U(w) + \beta V' - V^u))V^u = V : \mu.$$

The Lagrangian is given by

$$\begin{aligned} L &= \gamma F(U(w) + \beta V' - V^u)(z - w + \beta \Pi(V')) \\ &\quad + \mu \left(V - \gamma F(U(w) + \beta V' - V^u) \left(U(w) + \beta V' \right) + \gamma \int_{-\infty}^{U(w)+\beta V' - V^u} \chi f(\chi)\, d\chi - (1 - \gamma F(U(w) + \beta V' - V^u))V^u \right). \end{aligned}$$

Take FOCs

$$\begin{aligned} w &: -\gamma F(U(w) + \beta V' - V^u) + \gamma f(U(w) + \beta V' - V^u)(z - w + \beta \Pi(V'))U'(w) \\ &\quad -\mu \begin{pmatrix} \gamma F(U(w) + \beta V' - V^u)U'(w) + \gamma f(U(w) + \beta V' - V^u) \left(U(w) + \beta V' \right) U'(w) \\ -\gamma \left(U(w) + \beta V' - V^u \right) f\left(U(w) + \beta V' - V^u \right) U'(w) \\ -\gamma f\left(U(w) + \beta V' - V^u \right) V^u U'(w) \end{pmatrix} \\ &= 0 \end{aligned}$$

and divide through by $f(.), U'(w)$, and γ :

$$\begin{aligned}
w \quad : \quad & -\frac{F(U(w)+\beta V'-V^u)}{f(U(w)+\beta V'-V^u)}\frac{1}{U'(w)}+(z-w+\beta\Pi(V')) \\
& -\mu\left(\begin{array}{c} \frac{F(U(w))+\beta V'-V^u)}{f(U(w)+\beta V'-V^u)}+\gamma\left(U(w)+\beta V'\right) \\ -\left(U(w)+\beta V'-V^u\right) \\ -V^u \end{array}\right) \\
= \quad & 0
\end{aligned}$$

$$w:-\frac{F(U(w)+\beta V'-V^u)}{f(U(w)+\beta V'-V^u)}\frac{1}{U'(w)}+z-w+\beta\Pi(V')-\mu\frac{F(U(w)+\beta V'-V^u)}{f(U(w)+\beta V'-V^u)}=0,$$

Rearranging w, we have the following relation:

$$w:\frac{f(\bar{\chi})}{F(\bar{\chi})}\left[z-w+\beta\Pi(V')\right]=\mu+\frac{1}{U'(w)}.$$

The other first order condition with respect to V' is:

$$\begin{aligned}
V' \quad : \quad & \beta\gamma f(U(w)+\beta V'-V^u)(z-w+\beta\Pi(V'))+\beta\gamma F(U(w)+\beta V'-V^u)\Pi'(V') \\
& -\mu\left(\begin{array}{c} \beta\gamma f(U(w)+\beta V'-V^u)\left(U(w)+\beta V'\right)+\beta\gamma F(U(w)+\beta V'-V^u) \\ -\beta\gamma\left(U(w)+\beta V'-V^u\right)f\left(U(w)+\beta V'-V^u\right) \\ -\beta\gamma f(U(w)+\beta V'-V^u))V^u \end{array}\right) \\
= \quad & 0.
\end{aligned}$$

Divide through with $\beta\gamma f(.)$:

$$\begin{aligned}
V' \quad : \quad & (z-w+\beta\Pi(V'))+\frac{F}{f}\Pi'(V') \\
& -\mu\frac{F}{f} \\
= \quad & 0.
\end{aligned}$$

Thus we have

$$\frac{f(\bar{\chi})}{F(\bar{\chi})}\left[z-w+\beta\Pi(V')\right]=\mu-\Pi'(V').$$

Combining the two we have

$$\frac{1}{U'(w_t)}=-\Pi'(V_{t+1}).$$

Now, we need to obtain an expression for $\Pi'(V_{t+1})$. We take the envelope theorem:

$$\Pi'(V_{t+1})=\mu_{t+1}=\frac{f(\bar{\chi}_{t+1})}{F(\bar{\chi}_{t+1})}\left[zY-w_{t+1}+\beta\Pi(V_{t+1})\right]-\frac{1}{U'(w_{t+1})}.$$

Hence we have

$$\frac{1}{U'(w_{t+1})}-\frac{1}{U'(w_t)}=\frac{f(\bar{\chi}_{t+1})}{F(\bar{\chi}_{t+1})}\left[zY-w_{t+1}+\beta\Pi(V_{t+1})\right].$$

B Definition of Equilibrium

A stationary equilibrium is a set of values for non-employed laid off workers $\left\{V_n^f\right\}$ (one for each sector n) and for non-employed workers who quit $\{V_n^q\}$, search target values for non-employed laid off workers and workers who quit, $\left\{V_{0,n}^f\right\}$ and $\left\{V_{0,n}^q\right\}$, decision rules $\{V_{H,n}(V), V_{L,n}(V), w_n(V,z), \bar{\chi}_n(V,z), V_n'(V,z), V_n^{s\prime}(V,z), \zeta_n'(V,z)\}$ for all (V,z) and for all n, profit value functions $\Pi_n(V,z)$ for all (V,z,n) and $E\left[\Pi_n\left(V^s\right)\right]$ for all (V^s,n), offer matching probability functions $\bar{\zeta}_n\left(V^s,V,z\right)$ for all (V^s,V,Z,n), and job-finding and worker-finding probability functions for non-employed and employed workers $q_n(V)$ and $p_n(V)$ and $q_n^s(V^s,V,z)$ and $p_n^s(V^s,V,z)$ s.t.

1. given V_n^q, $V_n'(V,z)$ and $V_n^{s\prime}(V,z)$, the threshold decision rule for quitting $\bar{\chi}_n(V,z)$ satisfies the worker optimal quitting condition (17) for all (V,z,n);

2. the decision rule for next period offer matching $\zeta_n'(V,z)$ satisfies eq. (19) with equality when $\Pi_n(V_n^{s\prime}(V,z),z) \geq 0$ and is zero otherwise (firms retain profitable matches as often as possible while preserving truth telling);

3. the job matching probabilities that posting firms take as given are consistent with optimal offer matching: $\bar{\zeta}_n\left(V^{s\prime},V',z\right) = \zeta_n'(V,z)$ when $V^{s\prime} = V_n^{s\prime}(V,z)$ and $V' = V_n'(V,z)$;

4. job search choices for employed workers $V_n^{s\prime}(V,z)$ are optimal at the searching stage in the following period for all (V,z), i.e., $V_n^{s\prime}(V,z) \in \arg\max\limits_{V^s}\{p_n^s(V^s,V',z)V^s + (1-p_n^s(V^s,V',z))V'\}$ subject to $q_n^s\left(V^s,V',z\right)\left(1-\bar{\zeta}_n\left(V^s,V',z\right)\right)E\left[\Pi_n\left(V^s\right)\right] - \phi_n = 0$ when $V' = V_n'(V,z)$.

5. given V_n^q and the functions $\bar{\chi}_n(V,z)$, $\zeta_n'(V,z)$ and $V_n^{s\prime}(V,z)$, the decision rules $w_n(V,z)$ and $V_n'(V,z)$ satisfy the firm's profit maximization problem for all (V,z) and corresponding profits are given by $\Pi_n(V,z)$;

6. given $\Pi_n(V,z_H)$ and $\Pi_n(V,z_L)$ the decision rules $V_{H,n}(V)$ and $V_{L,n}(V)$ solve problem (15) and $E\left[\Pi_n\left(V\right)\right]$ is the associated expected profit value for all V;

7. firms post vacancies up to the point that expected profits from entry are zero, i.e., in markets for non-employed workers $q_n(V)$ satisfies $q_n(V)E[\Pi_n(V)] = \phi_n$ and $p_n(V) = \frac{A^2}{q_n(V)}$, while in markets for employed workers with state (V,z) they satisfy $q_n^s(V^s,V,z)(1-\bar{\zeta}_n(V^s,V,z)E[\Pi_n(V)] = \phi_n$ and $p_n^s(V^s,V,z) = \frac{A^2}{q_n^s(V^s,V,z)}$;

8. $V_{0,n}^{q}$ maximizes welfare for non-employed workers who quit, i.e., $V_{0,n}^{q} \in \arg\max_{V}\{p_n(V)V + (1-p_n(V))V_n^{q}\}$ subject to $q_n(V)\, E\left[\Pi_n(V)\right] - \phi_n = 0$;

9. $V_{0,n}^{f}$ maximizes welfare for non-employed workers who were laid off, i.e., $V_{0,n}^{f} \in \arg\max_{V}\{p_n(V)V + (1-p_n(V))V_n^{f}\}$ subject to $q_n(V)\, E\left[\Pi_n(V)\right] - \phi_n = 0$;

10. values for non-employed workers who were laid off and who quit satisfy, respectively,
$V_n^{f} = U(\varphi_n + \kappa Y_n) + \beta\left(p_n(V_{0,n}^{f})V_{0,n}^{f} + (1-p_n(V_{0,n}^{f}))V_n^{f}\right)$
$V_n^{q} = U(\varphi_n) + \beta\left(p_n(V_{0,n}^{q})V_{0,n}^{q} + (1-p_n(V_{0,n}^{q}))V_n^{q}\right)$;

11. revenue from taxes at rate τ finances benefits to unmatched workers;

12. in each sector, the measure of unmatched workers and the joint distribution of workers over states (V, z) is constant over time.

C Additional Figures

Figure 6 plots JOLTS quit rates by industry against average weekly earnings by industry.

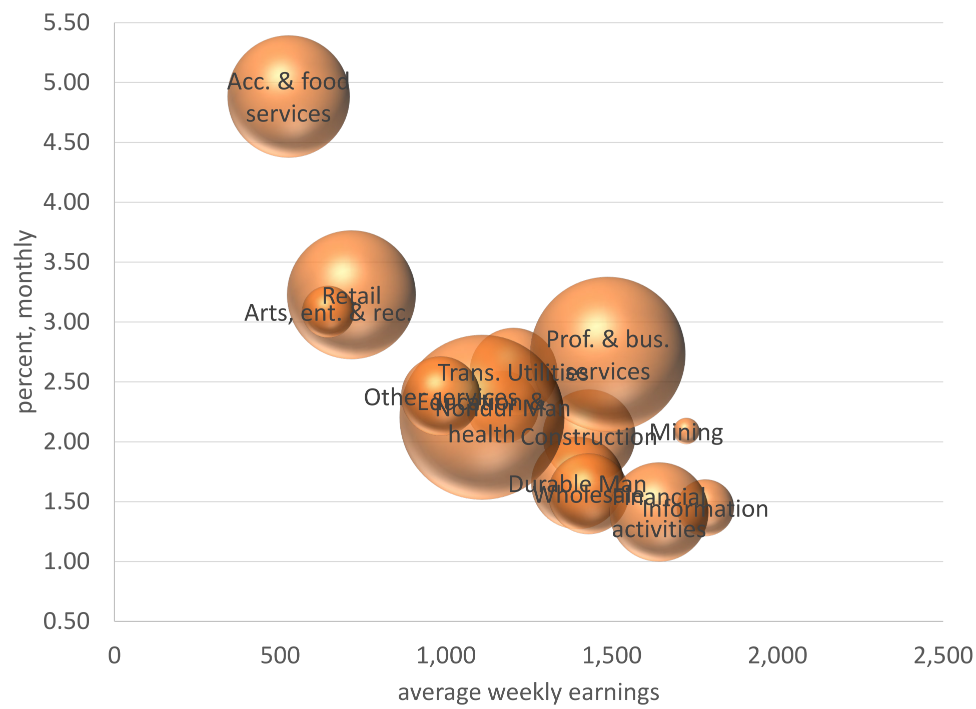

Figure 6: JOLTS Quit Rates by Industry, 2022-25. The bubble sizes reflect industry employment shares.