Worker Selectivity and Fiscal Externalities from Unemployment Insurance*

Benjamin Griffy†
University at Albany, SUNY

Stanislav Rabinovich‡
UNC Chapel Hill

November 14, 2022

Abstract

A robust prediction of job search models is that unemployment insurance (UI) makes workers more selective about which jobs they accept, thereby raising average accepted wages. We provide a sufficient-statistics formula for evaluating the size of this selectivity effect and argue theoretically that it is likely to be small. In a standard sequential search model, the effect of UI on wages is linked to its effect on the job-finding hazard; the slope of the relationship between these elasticities depends on a small number of estimable statistics, key among them observed worker flows. Plausible calibrations of the model imply that the magnitude of the wage elasticity is small relative to the job-finding elasticity. Although ignoring the wage effect of UI would over-estimate its fiscal cost and under-estimate its welfare benefit, the model-implied formula predicts the magnitude of this bias to be small.

*We would like to thank Christine Braun, Axel Gottfries, Fatih Karahan, Paolo Martellini, Benjamin Schoefer, Ronald Wolthoff, and participants at the Society for Economic Dynamics, the European Search and Matching Workshop, the I-85 Macro Conference, and the COCONUTS Search and Matching Virtual Seminar Series, for their comments and suggestions.

†Correspondence: Department of Economics, SUNY Albany, Room BA110, 1400 Washington Ave., Albany, NY, 12222. Tel.: (503)-341-3950. Email: bgriffy@albany.edu. Web: https://www.bengriffy.com

‡Correspondence: Department of Economics, University of North Carolina Chapel Hill, 107 Gardner Hall, CB 3305, Chapel Hill, NC 27599. Email: srabinov@email.unc.edu. Web: https://sites.google.com/site/stanrabinovicheconomics

1 Introduction

A key theoretical prediction of labor market search theory (McCall (1970), Mortensen (1970)) is that, by raising unemployed workers' reservation wages, unemployment insurance (UI) affects not only their re-employment probabilities but also their re-employment wages. The purpose of this paper is to shed light on the magnitude of the latter effect, which we term the *selectivity effect*. Such a wage-enhancing effect of UI has profound policy implications, which have long been recognized (see e.g. Marimon and Zilibotti (1999)). In particular, it adds an additional dimension to the insurance-incentives tradeoff that has guided the analysis of optimal UI. In this paper we show that labor market search theory disciplines the magnitude of the selectivity effect, and assess how much it matters quantitatively.

We show that the standard search model not only implies the *existence* of a selectivity effect, but also places quite particular restrictions on its *magnitude*, given the values of other observables. We consider a classic framework: workers sample wage offers sequentially, decide to accept or reject, and search on the job while employed. The central insight is that, in such a framework, workers face a tradeoff between the rate at which they expect to find an acceptable job and the wage that they expect to receive. Unemployment insurance alters this tradeoff by making workers more selective about the wages they accept, thereby raising the average accepted wage and lowering the job-finding probability. This immediately implies that, to the extent that an increase in UI raises re-employment wages, it must also lower the job-finding probability. We confirm that intuition by deriving a simple sufficient statistics formula that links the effect of UI on average wages (henceforth the *wage elasticity*) to its effect on the job-finding probability (*job-finding elasticity*). In other words, our formula gives the *slope* of the wage/job-finding tradeoff faced by workers.

We show analytically that two channels determine the slope of this tradeoff. The first determinant is the dispersion of wage offers. If wages are very dispersed, a small increase in the worker's reservation wage can generate a large increase in the average accepted wage without a large accompanying drop in the job-finding rate. The opposite occurs when wages are very concentrated. Our formula shows, in fact, that the slope of the wage/job-finding tradeoff is directly linked to the *mean-min ratio* of wages highlighted by Hornstein *et al.* (2011). This is important for our subsequent analytical characterization, because, as shown in Hornstein *et al.* (2011), this particular measure of wage dispersion itself admits a simple sufficient statistics formula, depending on the replacement rate of UI and easily estimable worker flows. In fact, these values put an upper bound on the model-implied mean-min ratio. In our setting this implies, all else equal, an upper bound on the wage elasticity for a given job-finding elasticity. Intuitively, workers find jobs rather quickly in the data. Disciplined by this statistic, the model implies that workers do not have much to be selective about. Hornstein *et al.* (2011) use this "unpleasant search arithmetic" to argue that frictional wage dispersion cannot be very large. We show that this logic has important implications for the effects of unemployment insurance, which, to our knowledge, have not been pointed out previously.

The second determinant of the slope of the wage/job-finding tradeoff is the efficacy of on-the-job search. Unemployment insurance raises initial re-employment wages through increased worker selectivity, but its impact on the average wage is muted by the speed with which workers subsequently progress up the job ladder. If on-the-job search is fast relative to separations from unemployment - as is the case in the data - the model predicts that initial wages for workers have a rather small effect on their steady-state wages. This second channel (on-the-job search) is of crucial importance because of how it interacts with the first (wage dispersion). Our formula implies that all else equal, the wage elasticity is larger (i) the larger is wage dispersion, and (ii) the smaller is the efficacy of on-the-job search. As was shown by Hornstein *et al.* (2011), on-the-job search goes a long way in helping the model generate larger wage dispersion. Our result implies that this *does not* translate into a larger wage elasticity, precisely because faster on-the-job search also generates the second, offsetting effect. On-the-job search allows for higher wage dispersion, hence a higher effect of UI on accepted wages, but it also mutes the long-term effect of higher initial wages. On net, therefore, our formula implies that the wage elasticity cannot be too large, regardless of whether on-the-job search is fast or slow.

We next apply our result to the normative analysis of unemployment insurance. Our approach extends the canonical Baily-Chetty (Baily (1978), Chetty (2006)) formula, which expresses the welfare gain from an increase in UI in terms of two sufficient statistics: the consumption-smoothing benefit of UI and its fiscal cost. The selectivity effect of UI alters the fiscal cost relative to the conventional Baily-Chetty analysis. In the absence of a wage effect of UI, the fiscal cost of UI would be determined by the job-finding elasticity. However, when UI affects wages and is financed by proportional taxes, it also generates a positive fiscal externality through the selectivity effect. As a consequence, the fiscal cost of UI now depends on both the job-finding elasticity and the wage elasticity, but our main result shows that the latter can be expressed in terms of the former. The selectivity effect of UI, and hence its positive fiscal externality, thus shows up simply as a wedge on the job-finding elasticity; this wedge depends on a number of estimable statistics but does *not* require estimating the wage elasticity directly.

We numerically assess the importance of this wedge. In doing so, we seek to answer the following hypothetical question. Suppose that a researcher computed the fiscal cost of UI and its resulting welfare benefit by applying the Baily-Chetty formula, but mistakenly assumed that UI had no effect on wages. By how much would they overstate the fiscal cost of UI, and thereby understate its welfare benefit? For a plausible range of parameter values, we find that the wage elasticity is about 1/10 of the job-finding elasticity. As a result, ignoring the wage effect of UI would overestimate the fiscal cost of increasing UI by 3-6%, and underestimate the welfare gain from increasing UI by 1-7%. Our results suggest that the wage effect, while non-trivial under some parameter values, is of limited impact for optimal UI. Moreover, our numerical results imply that worker ability to search on the job dampens the magnitude of the wage effect, by making initial job placement less consequential for average wages.

1.1 Relationship to literature

The theoretical insight that UI affects not only re-employment probabilities but also re-employment outcomes has long been recognized in the labor search literature (see e.g. Marimon and Zilibotti (1999), Acemoglu and Shimer (1999, 2000), Lagos (2006)). This is a natural implication of the rudimentary sequential search model (McCall (1970), Mortensen (1970)) and environments building on it, since unemployed workers have a tradeoff between the average wage they accept and their job-finding rate. The challenge, which we take up in this paper, is to put quantitative discipline on the magnitude of this channel. The insight we uncover is that the rudimentary search model in fact puts quite a tight restriction on the wage elasticity given the magnitude of job-finding elasticity. To put it differently, our result implies that the standard search model cannot be consistent with arbitrary combinations of the two elasticities.

Our result establishes a clear connection between the fiscal externality from UI and the characterization of frictional wage dispersion in Hornstein *et al.* (2011): a connection that, to our knowledge, is new to the literature. Hornstein *et al.* (2011) showed that the mean-min ratio of wages admits a sufficient-statistics characterization in the standard sequential search model; moreover, this characterization implies that the model-implied mean-min ratio cannot be too large, given plausible values for observed worker flows. Our result uncovers a direct role for the mean-min ratio in disciplining the slope of the wage/job-finding tradeoff, which pins down the wage elasticity for any given job-finding elasticity. If wages are not very dispersed, then workers do not have much to be selective about; as a consequence, little can be gained by making workers more selective. Thus, the same "unpleasant search arithmetic" that led Hornstein *et al.* (2011) to conclude that frictional wage dispersion is not very large also implies that the wage gains from UI are not very large.

Importantly, however, a low mean-min ratio is only a part of our argument. Hornstein *et al.* (2011) and the subsequent literature identify a natural mechanism for enabling the model to generate larger wage dispersion: on-the-job search. If workers can continue to search on the job even while employed, they will be willing to accept jobs quickly even if there are much better jobs available. As a result, a high rate of on-the-job search can reconcile a high job-finding rate with high wage dispersion. However, in spite of this, we show that a high rate of on-the-job search *does not* imply a high wage elasticity. This is because a high rate of on-the-job search also has an independent, offsetting effect: it mutes the importance of initially accepted wages for average steady-state wages. So, while wage dispersion is of crucial importance for the magnitude of the wage elasticity, a high value of the former is not sufficient for a high value of the latter.

Our analysis is also highly complementary to the empirical literature that seeks to estimate the wage effect of UI in the data. This literature has obtained widely varying and often conflicting results. For example, Nekoei and Weber (2017) and Griffy (2021) find significant positive effects of UI on re-employment wages; Card *et al.* (2007), Lalive (2007), and Van Ours and Vodopivec (2008) estimate wage effects of UI close to zero; on the other hand, Schmieder *et al.* (2016) estimate negative wage effects. Using cross-state data in the Great Recession, Hagedorn *et al.* (2013) find a positive effect of UI extensions on wages, though they attribute it to Nash bargaining rather than a selectivity effect. Moreover, a growing literature has empirically investigated the effect of UI on proxies for re-employment match quality other than wages, such as job tenure (Centeno (2004), Tatsiramos (2009), Caliendo *et al.* (2013)) and occupational switching (Lyshol (2020), Houstecka and Parkhomenko (2020)). While this literature has sought to estimate the effects of UI empirically, we instead study them theoretically, asking what magnitudes of the wage elasticity can plausibly be expected according to the standard model. We see our analysis as both a complementary alternative to the empirical literature and as a way of interpreting existing empirical results. With regard to the former, obtaining reliable estimates of the wage elasticity is often difficult as it requires data on re-employment wage outcomes - more difficult still to estimate the long-run effects of UI on wages, which are of relevance for optimal policy analysis. Our approach is an alternative, which provides a researcher with a model-based prediction and does not require estimating the wage elasticity directly. With regard to the latter, our result also has the potential to shed light on the existing empirical estimates. As mentioned above, empirical studies have reached conflicting results. One compelling explanation, as suggested by Schmieder *et al.* (2016) and Nekoei and Weber (2017), is that UI may also affect wages through channels other than the selectivity effect: in particular, UI increases unemployment duration, which *itself* may have an adverse effect on average wages, e.g. through human capital depreciation (Ortego-Marti (2016)). Our results imply that, even without such adverse effects through duration dependence, one should not be surprised by an absence of large positive wage effects, because the selectivity effect itself is not very large. This discussion also highlights, more broadly, that empirical studies may find a wage effect of UI for a variety of reasons, not only the selectivity effect. Our theoretical approach enables isolating the magnitude of the selectivity effect.

More broadly, our paper contributes to the agenda trying to quantify the importance of search frictions in the labor market (see e.g. Gautier and Teulings (2015) and the recent work by Martellini and Menzio(2020, 2021)), and their impact on optimal UI (for recent work, see e.g. Braxton *et al.* (2020), Chao *et al.* (2021), de Souza *et al.* (2022), among many others). The wage/job-finding tradeoff can be conceived as a measure of how costly (in terms of reduces job-finding probability) it is to slightly increase the average wage. Our approach to calculating the slope of this tradeoff, has applicability beyond UI: at a fundamental level, it relies on the fact that a change in the worker's reservation wage (itself due to some exogenous event, such as UI) affects the average wage and the job-finding rate in a particular proportion.

This paper proceeds as follows. In section 2, we lay out the basic model environment. Section 3 contains our main result. Section 4 draws its implications for welfare gains from UI, and section 5 describes our parameter calibration and numerical results. Section 6 concludes and discusses the implications of our results in context of the existing literature.

2 Environment and preliminaries

In this section we lay out the model environment, which largely follows the conventional sequential search model.[1] Time is continuous, and the time horizon is infinite. There is a continuum of workers, each of whom evaluates consumption streams according to

$$\mathbb{E}\int_0^\infty e^{-rt}v\left(c\left(t\right)\right)dt \tag{1}$$

where $r > 0$ is the discount rate, and the flow utility of consumption v satisfies $v' > 0$, $v'' \leq 0$. When unemployed, the worker receives wage offers at Poisson rate λ_u, which are drawn from a cumulative distribution F with density f. When employed, the worker receives wage offers at Poisson rate $\lambda_e < \lambda_u$, which are also drawn from F. An employed worker becomes unemployed at Poisson rate δ. Workers do not save or borrow. An unemployed worker receives government-provided unemployment benefits b. Employed workers are taxed at a proportional rate τ, so that a worker employed at wage w receives consumption $(1-\tau)\,w$. Note that risk aversion and proportional taxes on wages are not essential for our main result: we introduce them because they will be relevant for the welfare analysis that follows it.

Let U be the value of an unemployed worker, and let $W(w)$ be the value of a worker employed at wage w. These values are given, respectively, by the Bellman equations

$$rU = v\left(b\right) + \lambda_u \int_0^\infty \max\left\{W\left(w\right) - U, 0\right\} dF\left(w\right) \tag{2}$$

and

$$\left(r+\delta\right)W\left(w\right) = v\left(\left(1-\tau\right)w\right) + \delta U + \lambda_e \int_0^\infty \max\left\{W\left(w'\right) - W\left(w\right), 0\right\} dF\left(w'\right) \tag{3}$$

It is standard to show that $W(w)$ is increasing in w, and therefore an employed worker switches jobs whenever $w' > w$, and the unemployed worker's job acceptance decision rule is characterized by a reservation wage, denoted by w_R. This reservation wage is the solution to $W(w_R) = U$. We show in Appendix A.1 that this reservation wage satisfies

$$v\left(\left(1-\tau\right)w_R\right) = v\left(b\right) + \left(\lambda_u - \lambda_e\right)\int_{w_R}^\infty \frac{\left(1-\tau\right)v'\left(\left(1-\tau\right)x\right)\left(1-F\left(x\right)\right)}{r+\delta+\lambda_e\left(1-F\left(x\right)\right)}dx \tag{4}$$

Given w_R, we can proceed to define several key equilibrium objects. First, the job-finding rate, denoted by h_u, is equal to

$$h_u = \lambda_u\left(1 - F\left(w_R\right)\right) \tag{5}$$

[1] All the derivations are included in the Appendix to make the analysis self-contained, but these derivations are standard in the literature.

and the steady-state unemployment rate is then given by

$$u = \frac{\delta}{\delta + \lambda_u \left(1 - F\left(w_R\right)\right)} \tag{6}$$

Next, define G to be the steady-state cumulative distribution of wages among employed workers. We show in Appendix A.2 that G is given by

$$G\left(w\right) = \frac{\delta}{\delta + \lambda_e \left(1 - F\left(w\right)\right)} \cdot \frac{F\left(w\right) - F\left(w_R\right)}{1 - F\left(w_R\right)} \tag{7}$$

The average steady-state wage across employed workers, denoted $\overline{w}$, is then given by

$$\overline{w} = \int_{w_R}^{\infty} w dG\left(w\right) \tag{8}$$

3 The wage/job-finding tradeoff: a sufficient statistic

Our main result concerns the comparative statics of $\overline{w}$ and h_u with respect to b. Define the elasticities

$$\epsilon_{h,b} \equiv \frac{\partial \ln h_u}{\partial \ln b}; \quad \epsilon_{w,b} \equiv \frac{\partial \ln \overline{w}}{\partial \ln b}$$

Differentiation of (5) and (8) then gives

Proposition 1 *The elasticities of the job-finding rate and average wage with respect to b satisfy*

$$\epsilon_{w,b} = -\frac{1}{1+\kappa_e}\left(\frac{\mu - 1}{\mu}\right)\epsilon_{h,b}, \tag{9}$$

where $\mu = \overline{w}/w_R$ is the mean-min ratio of wages, and $\kappa_e = \lambda_e \left(1 - F\left(w_R\right)\right)/\delta$.

Proof. See Appendix A.3. ■

Interpretation of the result. While simple, the formula in (9) is rich in economic intuition. To start with, it shows that the positive elasticity $\epsilon_{w,b}$ is tightly linked to the negative elasticity $\epsilon_{h,b}$. This indicates that the worker faces a wage/job-finding tradeoff: to the extent that an increase in b raises the accepted wage, it must also lower the job-finding probability. In turn, the ratio between the wage elasticity $\epsilon_{w,b}$ and the job-finding elasticity $\epsilon_{h,b}$ is shown to depend on two key statistics. First, it depends on how dispersed wages are, as captured by the mean-min ratio μ. All else equal, if wages are very concentrated, a given increase in b would lead to a lower job-finding rate without much of an increase in the average accepted wage; the opposite is true if wages are very dispersed. Second, it depends on the efficacy of on-the-job search relative to the job separation rate, as captured by the quantity κ_e. After an unemployed worker finds a job, they climb the job ladder via on-the-job search, a process interrupted by job separations. If κ_e is large, upward job switches are frequent relative to separations back into unemployment; in this case, the average steady-state wage is not very sensitive to the initially accepted re-employment wage, and hence not very sensitive to unemployment insurance.

Discussion of assumptions. It is instructive to note that the formula (9) relies on a rather minimal set of assumptions. In particular, it uses the fact that workers follow a reservation-wage rule, but not the fact that the reservation wage satisfies (4) (which we do, however, use below to characterize μ). In essence, equation (9) follows from the mathematical link between the objects $Prob\,(w \geq w_R)$ and $\mathbb{E}\,(w|w \geq w_R)$, which implies that the comparative statics of these two objects are also linked.

The crucial assumption is that unemployment benefits affect both $\overline{w}$ and h_u only through the reservation wage. In the discussion below, we consider the most prominent violations of this assumption in the literature (e.g. endogenous search effort). Most of them would imply that UI has an adverse (or, at least, less positive) effect on average wages given the same effect on job-finding probabilities. If this is the case, our formula is likely to provide an upper bound on the wage elasticity, given the job-finding elasticity. Since we will ultimately argue that the wage elasticity implied by (9) cannot be very large, such violations of our main assumption are likely to only strengthen this argument.

Characterizing the mean-min ratio. To make further progress, we derive an expression for μ following the procedure in Hornstein *et al.* (2011). That paper shows that, in a sequential search setting, the mean-min ratio of wages is tightly linked in equilibrium to several estimable statistics, notably the replacement rate of non-market activity and the magnitudes of worker flows. Hornstein *et al.* (2011) derive their formula for μ for a model with risk-neutral workers, as well as for a model with risk-averse workers and no on-the-job search. Fortunately, their technique extends in a straightforward way to the environment with both risk aversion and on-the-job search, which yields the following result.

Lemma 1 *Assume that utility takes the CRRA form,*

$$v\,(x) = \frac{x^{1-\gamma} - 1}{1-\gamma}, \quad \gamma \geq 0 \tag{10}$$

If $r \approx 0$, then the mean-min ratio $\mu = \overline{w}/w_R$ satisfies

$$\mu \approx \left[\frac{1 + \frac{\kappa_u - \kappa_e}{1+\kappa_e}}{\rho^{1-\gamma} + \frac{\kappa_u - \kappa_e}{1+\kappa_e}\left(1 + \frac{1}{2}\gamma\,(\gamma - 1)\,\xi^2\right)} \right]^{\frac{1}{1-\gamma}}, \tag{11}$$

where $\rho = b/\left((1-\tau)\,\overline{w}\right)$, $\kappa_u = \lambda_u\,(1 - F\,(w_R))\,/\delta$, $\kappa_e = \lambda_e\,(1 - F\,(w_R))\,/\delta$, and

$$\xi = \frac{\sqrt{var\,(w)}}{\overline{w}}$$

is the coefficient of variation of wages.

Proof. See Appendix A.4. ■

As in Hornstein *et al.* (2011), the key lesson from the expression in (11) is that observed worker flows put a lot of discipline on the model-implied mean-min ratio. If workers find jobs relatively quickly (as would be represented by a high κ_u), this indicates that they do not have much to be selective about, which implies that wages are not very dispersed. In turn, if this is the case, our formula (9) would imply that making workers slightly more selective would not raise their wages much, or in other words, a given decrease in h_u would be associated with only a modest increase in $\overline{w}$.

On-the-job search, as captured by κ_e, works in the opposite direction: if workers can continue to search on the job even while employed, they will be willing to accept jobs quickly even if there are much better jobs available. As a result, a higher κ_e can reconcile a high κ_u with a high μ. Importantly, however, while fast on-the-job search, all else equal, implies a higher mean-min ratio, it does not imply a higher $\epsilon_{w,b}$. This is precisely because, as shown in (9), a higher κ_e also has an independent, offsetting effect on the wage elasticity. It allows the model to be consistent with wider wage dispersion, but it also mutes the importance of initially accepted wages for average steady-state wages. So, while wage dispersion is of crucial importance for the magnitude of the wage elasticity, a high value of the former is not sufficient for a high value of the latter.

4 Fiscal cost and welfare gain from UI

In this section, we apply the formula derived above to quantify the fiscal externality from an increase in unemployment insurance and, consequently, its effect on welfare. We follow the approach of Baily (1978) and Chetty (2006) by expressing local welfare effect from a small increase in b in terms of a small set of easily estimable statistics, key among them the two elasticities $\epsilon_{h,b}$ and $\epsilon_{w,b}$.[2] We then assess the quantitative importance of $\epsilon_{w,b}$.

Consider a worker who starts out unemployed. A benevolent government is maximizing the discounted expected utility U of the worker by choosing τ and b, subject to the worker's optimal behavior, captured by (4), and subject to the budget constraint. The budget constraint states that the present discounted value of taxes collected from the worker must equal in expectation to the present discounted value of unemployment benefits paid to the worker. When $r \approx 0$, this problem is equivalent to maximizing the average steady-state flow utility,

$$uv(b) + (1-u)\int_0^\infty v((1-\tau)w)dG(w) \tag{12}$$

[2]The sufficient statistics formula derived here is, as usual in the literature, a local result; therefore, we are making local statements about the effects of a UI increase rather than statements about the globally optimal UI level.

subject to the steady-state budget constraint

$$(1-u)\,\tau\overline{w}\approx ub \tag{13}$$

and subject to (4), (7), and (8). We show this equivalence formally in Appendix A.5. The approximation holds because the present discounted utility of an individual worker is approximately equal to steady-state average flow utility; similarly, the value of wages the worker expects to receive over the lifetime is approximately the same as the average wage in the cross-section in steady state.[3] From the expression (6) for the steady-state unemployment rate, (13) can further be rewritten as

$$h_u\tau\overline{w}\approx\delta b \tag{14}$$

We are interested in calculating $\frac{dU}{db}$, the welfare gain from an increase in b, taking into account that τ is a function of b through (14) and w_R is a function of b and τ through (4). In Appendix A.6, we show that the welfare gain per unemployed worker satisfies

$$\frac{1}{u}\frac{dU}{db}\approx v'(b)-\epsilon_{\tau,b}\int_{w_R}^{\infty}\left(\frac{w}{\overline{w}}\right)v'\left((1-\tau)\,w\right)dG(w) \tag{15}$$

where the elasticity $\epsilon_{\tau,b}=\frac{b}{\tau}\frac{d\tau}{db}$ is obtained by treating τ as a function of b in (14). This formula, similar to the prior literature, shows that the welfare gain from increasing UI equals to its consumption benefit minus its average consumption cost to the employed due to increased taxes. To get a welfare metric in consumption terms that is comparable across calibrations, we normalize by the average marginal utility of the employed, defining the normalized welfare gain as

$$\mathcal{W}_b=\frac{v'(b)-\epsilon_{\tau,b}\int_{w_R}^{\infty}\left(\frac{w}{\overline{w}}\right)v'\left((1-\tau)\,w\right)dG(w)}{\int_{w_R}^{\infty}v'\left((1-\tau)\,w\right)dG(w)} \tag{16}$$

In order to compute $\mathcal{W}_b$, we must first compute $\epsilon_{\tau,b}$, the fiscal cost of an increase in UI. We note from (14) that

$$\epsilon_{\tau,b}=1-\epsilon_{h,b}-\epsilon_{w,b} \tag{17}$$

Rather than separately estimate both $\epsilon_{h,b}$ and $\epsilon_{w,b}$ directly, we can now take advantage of the fact that $\epsilon_{h,b}$ and $\epsilon_{w,b}$ are linked analytically by (9). It follows that we can rewrite (17) as

$$\epsilon_{\tau,b}=1-(1-\Phi)\,\epsilon_{h,b}, \tag{18}$$

where $\Phi=\frac{1}{1+\kappa_e}\left(\frac{\mu-1}{\mu}\right)$ from Proposition 1, and μ is furthermore described by the characterization in Lemma 1. The key components necessary for computing the wedge Φ are the

[3] In particular, this means that focusing on a worker who is initially unemployed is without loss of generality.

replacement rate of unemployment benefits and measures of worker flows, as well as the coefficient of variation of wages, all of which can be calibrated from available data. With regard to elasticities, only $\epsilon_{h,b}$ needs to be estimated.

5 Numerical analysis

We now proceed to implement the formulas in (18) and (16) numerically in order to evaluate the two key objects of interest: the marginal fiscal cost of UI, measured by $\epsilon_{\tau,b}$, and the marginal welfare gain from UI, measured by $\mathcal{W}_b$. We then use our numerical results to conduct the following counterfactual thought experiment. Suppose that a researcher computed the marginal fiscal cost and marginal welfare gain from UI by directly using equation (17) for $\epsilon_{\tau,b}$, but mistakenly assumed that $\epsilon_{w,b} = 0$. Such a calculation would overstate the marginal fiscal cost of UI and understate its marginal welfare benefit. How large would the magnitude of this bias be?

We assume, as above, that the utility function v is of the CRRA form (10), with risk-aversion parameter γ. A Taylor expansion procedure standard in the literature[4] gives

$$\mathcal{W}_b \approx 1 + \gamma \left(1 - \rho\right) - \epsilon_{\tau,b} \tag{19}$$

where $\rho = b / \left(\left(1 - \tau\right) \overline{w}\right)$ is the replacement rate of UI with respect to the average after-tax wage. As explained above, $\epsilon_{\tau,b}$ can be computed according to the formula (18). We then compute, for the same parameter values, the "mis-specified" welfare gain

$$\widetilde{\mathcal{W}}_b \approx 1 + \gamma \left(1 - \rho\right) - \widetilde{\epsilon}_{\tau,b} \tag{20}$$

where $\widetilde{\epsilon}_{\tau,b}$ is the fiscal externality a researcher would compute if ignoring the effect of UI on wages, i.e. if they used the same $\epsilon_{h,b}$ but setting $\epsilon_{w,b} = 0$:

$$\widetilde{\epsilon}_{\tau,b} = 1 - \epsilon_{h,b} \tag{21}$$

We then measure the importance of the wage effect by inspecting the magnitudes of $\epsilon_{\tau,b}/\widetilde{\epsilon}_{\tau,b}$ for the fiscal cost, and $\mathcal{W}_b/\widetilde{\mathcal{W}}_b$ for the welfare gain.

5.1 Calibration

Our baseline choices of parameter values come from observed worker flows and the existing empirical literature. Using data on monthly job-finding rates, job separation rates, and job-to-job transitions, we estimate $\kappa_u = 14.3$ and $\kappa_e = 2.3$ as defined in Lemma 1. Details of the calibration of these two parameters are provided in Appendix B. The coefficient of variation of

[4] See e.g. Baily (1978), Gruber (1997), Chetty (2006, 2009). Appendix A.6 contains the derivation of the approximate expression (19).

wages, ξ, is set to 0.5, consistent with the upper bound of the range of estimates in Hornstein *et al.* (2007). For the baseline value of the replacement rate, we adopt the commonly used value of $\rho = 0.4$.[5] We set the elasticity of unemployment duration with respect to UI to the standard estimate from Chetty (2008): a 10% increase in unemployment benefits is associated with a 5% decrease in the job-finding hazard, so that $\epsilon_{h,b} = -0.5$. Our baseline value for the risk aversion parameter is $\gamma = 2$. Nonetheless, since there is not a consensus on the appropriate value of risk aversion, we conduct sensitivity analysis for a wide range of values for γ. Similarly, we conduct robustness checks with respect to the other model parameters; when varying each parameter, the others are kept at their baseline values.

5.2 Numerical results

For our baseline parameter calibration described above, we obtain a wedge of $\Phi \equiv -\epsilon_{w,b}/\epsilon_{h,b} = 0.1$, implying a wage elasticity equal to $\epsilon_{w,b} = 0.05$. This then implies a fiscal elasticity of $\epsilon_{\tau,b} = 1.44$ and a welfare gain of $\mathcal{W}_b = 0.75$. The mis-specified model ignoring the wage effect of UI, as described above, would result in $\tilde{\epsilon}_{\tau,b} = 1.5$ and a corresponding welfare gain of $\widetilde{\mathcal{W}}_b = 0.7$. In other words, a 1% increase in b raises the average steady-state wage by approximately 0.05%, or about 1/10 the amount by which it lowers the job-finding probability. A researcher mistakenly assuming a zero wage effect of UI would overestimate the marginal fiscal cost of UI by about 3.5% and underestimate its marginal welfare benefit by about 6.8%.

Figure 1 illustrates the model-implied effects of UI for alternative model parameterizations. The top-left graph, figure 1a, displays the model-implied elasticity of taxes with respect to b under various values of risk aversion, keeping all other parameters fixed. The curve labeled "True" displays the tax elasticity $\epsilon_{\tau,b}$ given by (18). The curve labeled "Misspecified" displays the tax elasticity $\tilde{\epsilon}_{\tau,b}$ given by (21), i.e. the tax elasticity implied by the model if ignoring the effect of UI on wages. The wedge resulting from the wage effect is small, even for very large values of risk aversion; a researcher ignoring the effect of UI on wages would overestimate its marginal fiscal cost by at most 6%. The size of the wedge is even smaller for more conservative values of risk aversion. Figure 1b displays the implications for welfare. The curves labeled "True" and "Misspecified" display the values of $\mathcal{W}_b$ (given by (19)) and $\widetilde{\mathcal{W}}_b$ (given by (20)), respectively. The bias resulting from neglecting the wage effect of UI is likewise small in this case. Figures 1c and 1d illustrate that this result is also robust to the chosen value of the replacement rate ρ.[6]

[5]Setting $\rho = 0.4$ amounts to assuming, as we did in this paper, that the only source of consumption during unemployment is unemployment insurance. We note that higher values of ρ would only imply lower values of μ and therefore lower values of the wage elasticity, all else equal. See the discussion of figures 1c and 1d below.

[6]Note that the wedge is lower for higher values of ρ. Our chosen value of $\rho = 0.4$ is likely to be a conservative (i.e. lower-bound) value for unemployment consumption, both in light of the business cycle literature (Hagedorn and Manovskii (2008), Hall and Milgrom (2008), Hornstein *et al.* (2011)) and because it abstracts from sources of unemployment consumption other than UI (see e.g. Aguiar and Hurst (2005)).

Of particular interest are Figures 1e and 1f, which show how the model-implied effect of UI depends on the relative efficacy of on-the-job search, κ_e. They illustrate, in particular, that the wage effect of UI and the welfare gain from UI are largest when this efficacy of on-the-job search is low. Intuitively, when κ_e is small, a better initial re-employment wage is more consequential since it persists for a longer period of time. Note that this occurs despite the fact that a higher κ_e would make the model consistent with higher wage dispersion, which, as explained above, would (all else equal) amplify the effect of UI on wages. This numerical result indicates that the former effect outweighs the latter, showcasing a tension between the model's ability to generate large wage dispersion and its ability to generate a large wage elasticity.

6 Discussion

The potential of UI to improve re-employment job quality has long been recognized in principle, and is an important part of the discussion of its optimal design. A growing literature, described above, has addressed the wage effects of UI empirically. This paper complements this literature by more deeply examining the selectivity effect theoretically. Our focus is on the relationship between two elasticities: the wage elasticity and the job-finding elasticity. The main message is that the standard search framework puts sharp restrictions on what *combinations* of the two elasticities are consistent with the theory. Among other things, our result implies that - from a theoretical point of view - one should not be surprised to find small wage elasticities in the data. Importantly, however, the search framework does not rule out a large wage elasticity per se; instead, it puts bounds on the wage elasticity for any given job-finding elasticity. This is important, since, as we have shown, the *relative* magnitude of the two elasticities is important for the welfare gain from UI. On the normative side, our results suggest that the selectivity effect is not very consequential for this welfare gain.

Our result has a very natural economic interpretation, tightly linked to the "unpleasant search arithmetic" of Hornstein *et al.* (2011). Because the standard search framework places bounds on model-implied wage dispersion (given observed worker flows), it also places bounds on the selectivity effect of UI. If workers do not have much to be selective about, little gain can be achieved by making them more selective. Finally, our formula draws attention to the central role of on-the-job search in driving the effects of UI on average wages. A high rate of on-the-job search relative to separations into unemployment mutes the importance of initial wages for steady-state wages, because workers manage to "escape" bad initial job placement quickly. This underscores the importance on accounting for job-to-job transitions in studying optimal UI.

All of these results beg the question of how the model would need to be modified in order to generate larger wage elasticities. First, we note that the most obvious modifications of the standard model would in fact imply that our formula provides an upper bound on the wage elasticity for a given job-finding elasticity. For example, if UI also reduces search intensity, this reduces the job-finding rate without an accompanying increase in wages. In addition, if human capital also depreciates over the unemployment spell (as in Ortego-Marti (2016)), the longer unemployment duration generates a negative effect on wages that would offset the positive match quality effect of higher selectivity (as argued by Schmieder *et al.* (2016) and Nekoei and Weber (2017)). In both cases, the model-implied wage elasticity, for a given job-finding elasticity, would be smaller than implied by our formula. Generating a higher wage elasticity would require UI to increase wages without an accompanying decrease in the job-finding rate. This may be the case, e.g. if wages are Nash-bargained, so that UI has a direct effect on wages through the worker's outside option, as argued in the empirical work of Hagedorn *et al.* (2013). We should note that such modifications of the standard model do not invalidate the argument per se. They would imply that UI has effects on wages through channels other than the selectivity effect. Our insight - that the selectivity effect itself is bounded above - should continue to hold in some form in extensions of the baseline model, as long as there is a tradeoff between accepted wages and job-finding probability. Finally, an intriguing question is how alternative models of job mobility would affect the conclusions here. As we have argued, the very classic search framework implies that on-the-job search dampens the long-run effects of initial job placement. Our findings suggest that alternative models of how workers climb the job ladder (e.g. Jung and Kuhn (2019), Krolikowski (2017), Jarosch (2021)) could potentially have interesting implications for optimal UI.

References

Acemoglu, D. and Shimer, R. (1999). Efficient unemployment insurance. *Journal of Political Economy*, **107** (5), 893–928.

— and — (2000). Productivity gains from unemployment insurance. *European Economic Review*, **44** (7), 1195–1224.

Aguiar, M. and Hurst, E. (2005). Consumption versus expenditure. *Journal of Political Economy*, **113** (5), 919–948.

Baily, M. N. (1978). Some aspects of optimal unemployment insurance. *Journal of Public Economics*, **10** (3), 379–402.

Braxton, J. C., Herkenhoff, K. F. and Phillips, G. M. (2020). *Can the unemployed borrow? implications for public insurance*. Tech. rep., National Bureau of Economic Research.

Caliendo, M., Tatsiramos, K. and Uhlendorff, A. (2013). Benefit duration, unemployment duration and job match quality: A regression-discontinuity approach. *Journal of Applied Econometrics*, **28** (4), 604–627.

Card, D., Chetty, R. and Weber, A. (2007). Cash-On-Hand and Competing Models of Intertemporal Behavior: New Evidence from the Labor Market. *The Quarterly Journal of Economics*, **122** (4), 1511–1560.

Centeno, M. (2004). The match quality gains from unemployment insurance. *The Journal of Human Resources*, **39** (3), 839–863.

Chao, Y. H., Griffy, B. S. and Wiczer, D. (2021). The effect of unemployment insurance eligibility in equilibrium.

Chetty, R. (2006). A general formula for the optimal level of social insurance. *Journal of Public Economics*, **90** (10-11), 1879–1901.

— (2008). Moral hazard versus liquidity and optimal unemployment insurance. *Journal of political Economy*, **116** (2), 173–234.

— (2009). Sufficient statistics for welfare analysis: A bridge between structural and reduced-form methods. *Annual Review of Economics*, **1** (1), 451–488.

de Souza, G., Luduvice, A. V. *et al.* (2022). Optimal unemployment insurance requirements.

Gautier, P. A. and Teulings, C. N. (2015). Sorting and the output loss due to search frictions. *Journal of the European Economic Association*, **13** (6), 1136–1166.

Griffy, B. S. (2021). Search and the sources of life-cycle inequality. *International Economic Review*.

Gruber, J. (1997). The consumption smoothing benefits of unemployment insurance. *American Economic Review*, **87** (1), 192–205.

Hagedorn, M., Karahan, F., Manovskii, I. and Mitman, K. (2013). *Unemployment benefits and unemployment in the great recession: the role of macro effects*. Tech. rep., National Bureau of Economic Research.

— and Manovskii, I. (2008). The cyclical behavior of equilibrium unemployment and vacancies revisited. *American Economic Review*, **98** (4), 1692–1706.

Hall, R. E. and Milgrom, P. R. (2008). The Limited Influence of Unemployment on the Wage Bargain. *American Economic Review*, **98** (4), 1653–74.

Hornstein, A., Krusell, P. and Violante, G. L. (2007). *Frictional Wage Dispersion in Search Models: A Quantitative Assessment*. Tech. rep., National Bureau of Economic Research.

—, — and — (2011). Frictional wage dispersion in search models: A quantitative assessment. *American Economic Review*, **101** (7), 2873–98.

Houstecka, A. and Parkhomenko, A. (2020). Unemployment insurance and occupational switching.

Jarosch, G. (2021). Searching for job security and the consequences of job loss.

Jung, P. and Kuhn, M. (2019). Earnings losses and labor mobility over the life cycle. *Journal of the European Economic Association*, **17** (3), 678–724.

Krolikowski, P. (2017). Job ladders and earnings of displaced workers. *American Economic Journal: Macroeconomics*, **9** (2), 1–31.

Lagos, R. (2006). A Model of TFP. *The Review of Economic Studies*, **73** (4), 983–1007.

Lalive, R. (2007). Unemployment benefits, unemployment duration, and post-unemployment jobs: A regression discontinuity approach. *American Economic Review*, **97** (2), 108–112.

Lyshol, A. (2020). Occupational mobility, occupational distance and unemployment insurance.

Marimon, R. and Zilibotti, F. (1999). Unemployment vs. mismatch of talents: Reconsidering unemployment benefits. *The Economic Journal*, **109** (455), 266–291.

Martellini, P. and Menzio, G. (2020). Declining search frictions, unemployment, and growth. *Journal of Political Economy*, **128** (12), 4387–4437.

— and — (2021). Jacks of all trades and masters of one: Declining search frictions and unequal growth. *American Economic Review: Insights*, **3** (3), 339–52.

McCall, J. J. (1970). Economics of information and job search. *The Quarterly Journal of Economics*, **84** (1), 113–126.

Mortensen, D. T. (1970). Job search, the duration of unemployment, and the phillips curve. *The American Economic Review*, **60** (5), 847–862.

Nagypal, E. (2008). Worker reallocation over the business cycle: The importance of job-to-job transitions.

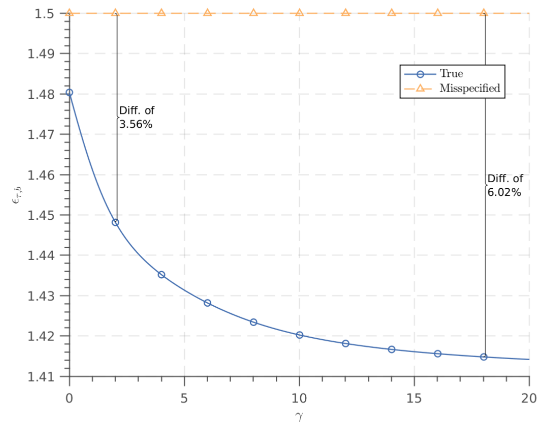
Nekoei, A. and Weber, A. (2017). Does extending unemployment benefits improve job quality? *American Economic Review*, **107** (2), 527–61.

Ortego-Marti, V. (2016). Unemployment history and frictional wage dispersion. *Journal of Monetary Economics*, **78**, 5–22.

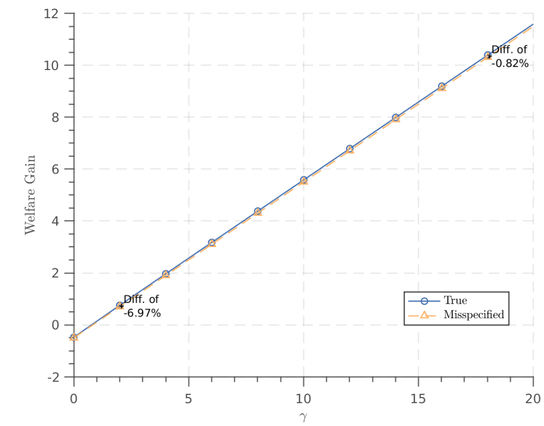
Schmieder, J. F., von Wachter, T. and Bender, S. (2016). The effect of unemployment benefits and nonemployment durations on wages. *American Economic Review*, **106** (3), 739–77.

Tatsiramos, K. (2009). Unemployment insurance in europe: Unemployment duration and subsequent employment stability. *Journal of the European Economic Association*, **7** (6), 1225–1260.

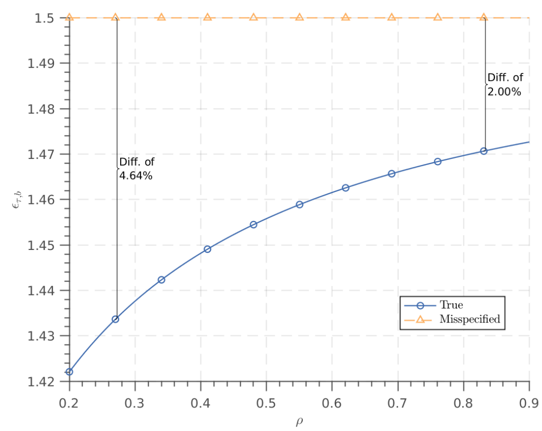
Van Ours, J. C. and Vodopivec, M. (2008). Does reducing unemployment insurance generosity reduce job match quality? *Journal of Public Economics*, **92** (3-4), 684–695.



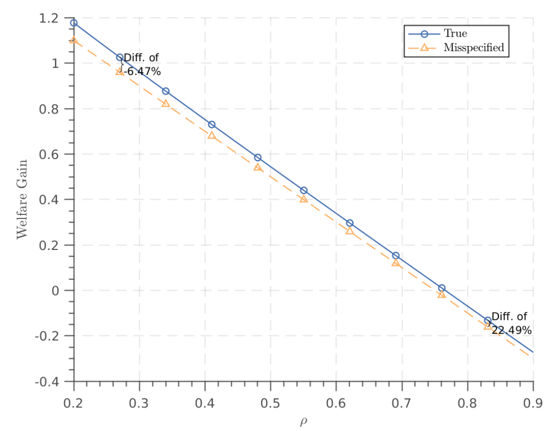
(a) Fiscal cost of UI, different values of γ.



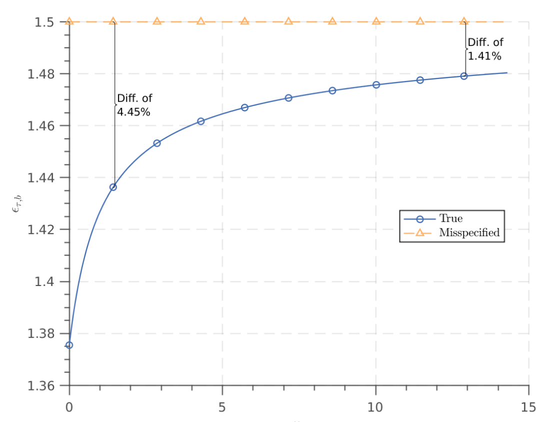
(b) Welfare gains from UI, different values of γ.



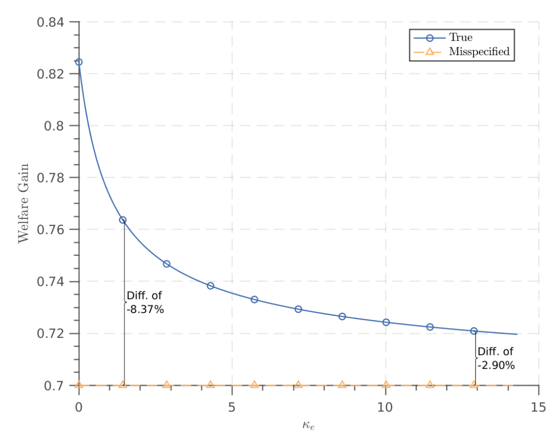
(c) Fiscal cost of UI, different values of ρ.



(d) Welfare gains from UI, different values of ρ.



(e) Fiscal cost of UI, different values of κ_e.



(f) Welfare gains from UI, different values of κ_e.

Figure 1: The effects of accounting for worker selectivity under various parameter values.

A Proofs and derivations

A.1 The reservation wage equation

Derivation of (4). Since $W(w)$ is strictly increasing in w, we can rewrite (2) and (3) as

$$rU = v(b) + \lambda_u \int_{w_R}^{\infty} W(w) - U dF(w) \tag{22}$$

and

$$(r+\delta) W(w) = v((1-\tau) w) + \delta U + \lambda_e \int_{w}^{\infty} W(w') - W(w) dF(w') \tag{23}$$

Differentiating (23) with respect to w and rearranging, we obtain

$$W'(w) = \frac{(1-\tau) v'((1-\tau) w)}{r+\delta+\lambda_e (1-F(w))} \tag{24}$$

and therefore

$$W(w') - W(w) = \int_{w}^{w'} \frac{(1-\tau) v'((1-\tau) x)}{r+\delta+\lambda_e (1-F(x))} dx \tag{25}$$

It then follows that

$$\begin{aligned} \int_{w_R}^{\infty} W(w') - W(w_R) dF(w') &= \int_{w_R}^{\infty} \int_{w_R}^{w'} \frac{(1-\tau) v'((1-\tau) x)}{r+\delta+\lambda_e (1-F(x))} dx dF(w') \\ &= \int_{w_R}^{\infty} \int_{x}^{\infty} \frac{(1-\tau) v'((1-\tau) x)}{r+\delta+\lambda_e (1-F(x))} dF(w') dx \\ &= \int_{w_R}^{\infty} \frac{(1-\tau) v'((1-\tau) x)(1-F(x))}{r+\delta+\lambda_e (1-F(x))} dx \end{aligned} \tag{26}$$

Using $U = W(w_R)$ and using (26) in (22), we obtain

$$rW(w_R) = v(b) + \lambda_u \int_{w_R}^{\infty} \frac{(1-\tau) v'((1-\tau) x)(1-F(x))}{r+\delta+\lambda_e (1-F(x))} dx \tag{27}$$

Similarly, using (26) in (23) evaluated at $w = w_R$, we obtain

$$rW(w_R) = v((1-\tau) w_R) + \lambda_e \int_{w_R}^{\infty} \frac{(1-\tau) v'((1-\tau) x)(1-F(x))}{r+\delta+\lambda_e (1-F(x))} dx \tag{28}$$

Combining (27) with (28) gives (4). ■

A.2 Steady-state wage distribution

Derivation of (7). In steady state, inflows into employment at wages less than or equal to w equal outflows. Inflows are equal to

$$\lambda_u \left(F\left(w\right) - F\left(w_R\right)\right) u.$$

Outflows, into both unemployment and higher-wage jobs, are equal to

$$\left(\delta + \lambda_e \left(1 - F\left(w\right)\right)\right) G\left(w\right) \left(1 - u\right).$$

Setting the two expressions equal to each other, and substituting for u from (6), gives (7). ■

A.3 Wage/job-finding tradeoff

Proof of Proposition 1. Differentiating (5) with respect to b gives

$$\epsilon_{h,b} = \frac{d \ln h_u}{d \ln w_R} \frac{\partial \ln w_R}{\partial \ln b} = -\frac{w_R f\left(w_R\right)}{1 - F\left(w_R\right)} \frac{\partial \ln w_R}{\partial \ln b} \tag{29}$$

Next, we note that

$$\begin{aligned} \overline{w} &= w_R + \int_{w_R}^{\infty} \left(w - w_R\right) dG\left(w\right) &\quad(30)\\ &= w_R + \int_{w_R}^{\infty} \left(1 - G\left(w\right)\right) dw &\quad(31)\\ &= w_R + \int_{w_R}^{\infty} \frac{\left[\delta + \lambda_e \left(1 - F\left(w_R\right)\right)\right]\left(1 - F\left(w\right)\right)}{\left[\delta + \lambda_e \left(1 - F\left(w\right)\right)\right]\left(1 - F\left(w_R\right)\right)} dw &\quad(32) \end{aligned}$$

where the second line is obtained from integrating by parts and the third line is obtained by substituting for G from (7). Differentiating (32) with respect to w_R gives us

$$\begin{aligned} \frac{d\overline{w}}{dw_R} &= \frac{f\left(w_R\right)}{1 - F\left(w_R\right)} \int_{w_R}^{\infty} \frac{1}{1 - F\left(w_R\right)} \cdot \frac{\delta \left(1 - F\left(w\right)\right)}{\delta + \lambda_e \left(1 - F\left(w\right)\right)} dw &\quad(33)\\ &= \frac{f\left(w_R\right)}{1 - F\left(w_R\right)} \left(\frac{\delta}{\delta + \lambda_e \left(1 - F\left(w_R\right)\right)}\right) \left(\overline{w} - w_R\right), &\quad(34) \end{aligned}$$

where the last line follows by substituting again from (32). Now, multiplying both sides by $\frac{w_R}{\overline{w}} \frac{\partial \ln w_R}{\partial \ln b}$ and using (29) gives (9). ■

A.4 Mean-min ratio of wages

Proof of Lemma 1. First, we observe that

$$\int_{w_R}^{\infty} \frac{(1-\tau)\, v'\left((1-\tau)\, x\right)(1-F(x))}{r+\delta+\lambda_e(1-F(x))} dx \approx \int_{w_R}^{\infty} \frac{(1-\tau)\, v'\left((1-\tau)\, x\right)(1-F(x))}{\delta+\lambda_e(1-F(x))} dx \tag{35}$$

$$= \frac{1-F(w_R)}{\delta+\lambda_e(1-F(w_R))} \int_{w_R}^{\infty} (1-G(x))\,(1-\tau)\, v'\left((1-\tau)\, x\right) dx \tag{36}$$

$$= \frac{1-F(w_R)}{\delta+\lambda_e(1-F(w_R))} \int_{w_R}^{\infty} \left[v\left((1-\tau)\, w\right) - v\left((1-\tau)\, w_R\right)\right] dG(x), \tag{37}$$

where the first line follows from the approximation $r \approx 0$, the second line substitutes G from (7), and the third line uses integration by parts. We can then re-write the reservation wage equation (4) as

$$v\left((1-\tau)\, w_R\right) \approx v(b) + \frac{\kappa_u-\kappa_e}{1+\kappa_e}\left[\mathbb{E}\left\{v\left((1-\tau)\, w\right)\right\} - v\left((1-\tau)\, w_R\right)\right] \tag{38}$$

where the expectation is taken over the distribution G. Next, we use a second-order Taylor approximation of $v(z)$ around $v(\overline{z})$,

$$v(z) \approx v(\overline{z}) + v'(\overline{z})(z-\overline{z}) + \frac{1}{2} v''(\overline{z})(z-\overline{z})^2 \tag{39}$$

Setting $z = (1-\tau)\, w$ and $\overline{z} = (1-\tau)\, \overline{w}$, taking expectations of (39) gives us

$$\mathbb{E}\left\{v\left((1-\tau)\, w\right)\right\} \approx v\left((1-\tau)\, \overline{w}\right) + \frac{1}{2}(1-\tau)^2\, v''\left((1-\tau)\, \overline{w}\right) var(w) \tag{40}$$

Substituting this expression for $\mathbb{E}\left\{v\left((1-\tau)\, w\right)\right\}$ into (38), assuming CRRA utility (10), and denoting $b = \rho(1-\tau)\, \overline{w}$ gives (11). ■

A.5 The government objective and budget constraint

This section formally confirms the approximate equivalence of the government's problem to maximizing (12) subject to (13). First, when $r \approx 0$, we have

$$\begin{aligned} rU &\approx v(b) + \lambda_u \int_{w_R}^{\infty} \frac{(1-\tau)v'((1-\tau)x)(1-F(x))}{\delta+\lambda_e(1-F(x))} dx \\ &= v(b) + \frac{\lambda_u(1-F(w_R))}{\delta+\lambda_u(1-F(w_R))}\left[(\lambda_u-\lambda_e) + \frac{\delta+\lambda_e(1-F(w_R))}{1-F(w_R))}\right] \int_{w_R}^{\infty} \frac{(1-\tau)v'((1-\tau)x)(1-F(x))}{\delta+\lambda_e(1-F(x))} dx \\ &= uv(b) + (1-u)\left[v(w_R) + \int_{w_R}^{\infty} (1-\tau)v'((1-\tau)x)(1-G(x))dx\right] \\ &= uv(b) + (1-u)\int_{w_R}^{\infty} v((1-\tau)w)dG(w), \end{aligned} \tag{41}$$

showing that the government objective is approximately equivalent to (12). Next, consider the budget constraint. Let Ω_u be the present discounted revenue to the government from an unemployed worker, and let Ω_e be the present discounted revenue from a worker employed at wage w, both for a given τ and b, and taking into account that the worker responds optimally to this τ and b via (4). These values then satisfy

$$r\Omega_u = -b + \lambda_u \int_{w_R}^{\infty} \left(\Omega_e\left(w\right) - \Omega_u\right) dF\left(w\right) \tag{42}$$

and

$$r\Omega_e\left(w\right) = \tau w + \delta\left(\Omega_u - \Omega_e\left(w\right)\right) + \lambda_e \int_{w}^{\infty} \left(\Omega_e\left(w'\right) - \Omega_e\left(w\right)\right) dF\left(w'\right) \tag{43}$$

Differentiation of (43) gives

$$\Omega_e'\left(w\right) = \frac{\tau}{r + \delta + \lambda_e\left(1 - F\left(w\right)\right)} \tag{44}$$

and therefore

$$\begin{aligned}
\left(r+\delta\right)\Omega_e\left(w\right) =& \tau w + \delta\Omega_u + \lambda_e \int_w^{\infty}\int_w^{w'} \frac{\tau}{r+\delta+\lambda_e\left(1-F\left(x\right)\right)} dx dF\left(w'\right) && (45)\\
=& \tau w + \delta\Omega_u + \lambda_e \int_w^{\infty}\int_x^{\infty} \frac{\tau}{r+\delta+\lambda_e\left(1-F\left(x\right)\right)} dF\left(w'\right) dx && (46)\\
=& \tau w + \delta\Omega_u + \lambda_e \int_w^{\infty} \frac{\tau\left(1-F\left(x\right)\right)}{r+\delta+\lambda_e\left(1-F\left(x\right)\right)} dx && (47)
\end{aligned}$$

Budget balance requires $\Omega_u = 0$. Setting this in (42) and (47), and substituting (47) into (42), we obtain

$$b = \frac{\lambda_u \tau}{r+\delta} \int_{w_R}^{\infty} \left[w + \lambda_e \int_w^{\infty} \frac{\left(1-F\left(x\right)\right)}{r+\delta+\lambda_e\left(1-F\left(x\right)\right)} dx \right] dF\left(w\right) \tag{48}$$

We will now show that (48) approaches (14) when $r \to 0$. Define

$$J\left(w\right) = w + \lambda_e \int_w^{\infty} \frac{\left(1-F\left(x\right)\right)}{r+\delta+\lambda_e\left(1-F\left(x\right)\right)} dx \tag{49}$$

It transpires, from differentiating J, that

$$J\left(w\right) = J\left(w_R\right) + \int_{w_R}^{w} \frac{\delta}{r+\delta+\lambda_e\left(1-F\left(x\right)\right)} dx \tag{50}$$

and therefore (48) can be written as

$$\begin{aligned}
b =& \frac{\lambda_u \tau}{r+\delta} \int_{w_R}^{\infty} \left[J(w_R) + \int_{w_R}^{w} \frac{\delta}{r+\delta+\lambda_e (1-F(x))} dx \right] dF(w) && (51)\\
=& \frac{\lambda_u (1-F(w_R))\tau}{r+\delta} \left[w_R + \lambda_e \int_{w_R}^{\infty} \frac{(1-F(x))}{r+\delta+\lambda_e(1-F(x))} dx \right] && (52)\\
&+ \frac{\lambda_u \tau}{r+\delta} \int_{w_R}^{\infty} \int_{w_R}^{w} \frac{\delta}{r+\delta+\lambda_e(1-F(x))} dx dF(w) && (53)\\
=& \frac{\lambda_u (1-F(w_R))\tau}{r+\delta} \left[w_R + \lambda_e \int_{w_R}^{\infty} \frac{(1-F(x))}{r+\delta+\lambda_e(1-F(x))} dx \right] && (54)\\
&+ \frac{\lambda_u \tau}{r+\delta} \int_{w_R}^{\infty} \frac{\delta(1-F(x))}{r+\delta+\lambda_e(1-F(x))} dx && (55)\\
=& \frac{\lambda_u (1-F(w_R))\tau}{r+\delta} \left[w_R + \frac{\lambda_e(1-F(w_R))+\delta}{1-F(w_R)} \int_{w_R}^{\infty} \frac{(1-F(x))}{r+\delta+\lambda_e(1-F(x))} dx \right] && (56)
\end{aligned}$$

When $r \approx 0$, this becomes

$$\begin{aligned}
b \approx& \frac{\lambda_u (1-F(w_R))\tau}{\delta} \left[w_R + \frac{\lambda_e(1-F(w_R))+\delta}{1-F(w_R)} \int_{w_R}^{\infty} \frac{(1-F(x))}{\delta+\lambda_e(1-F(x))} dx \right] && (57)\\
=& \frac{\lambda_u (1-F(w_R))\tau}{\delta} \left[w_R + \int_{w_R}^{\infty} (1-G(x))\, dx \right] && (58)\\
=& \frac{h_u \tau}{\delta} \overline{w} && (59)
\end{aligned}$$

from (5), (7), and (31).

A.6 Welfare gains from unemployment insurance

From (27), the value of an unemployed worker U satisfies

$$rU = v(b) + \lambda_u \int_{w_R}^{\infty} (1-\tau) v'((1-\tau)x) A(x)\, dx \tag{60}$$

where, for convenience, we defined the function $A(x) = \frac{1-F(x)}{r+\delta+\lambda_e(1-F(x))}$. Totally differentiating with respect to b gives

$$\begin{aligned}
\frac{dU}{db} =& v'(b) - \lambda_u (1-\tau) v'((1-\tau) w_R) A(w_R) \left[\frac{\partial w_R}{\partial b} + \frac{\partial w_R}{\partial \tau} \frac{d\tau}{db} \right] \\
&- \lambda_u \frac{d\tau}{db} \int_{w_R}^{\infty} \left[(1-\tau) x v''((1-\tau)x) + v'((1-\tau)x) \right] A(x)\, dx
\end{aligned} \tag{61}$$

Next, we derive expressions for $\frac{\partial w_R}{\partial b}$ and $\frac{\partial w_R}{\partial \tau}$, which come from differentiating (4) with respect to b and τ, respectively. This gives

$$\frac{\partial w_R}{\partial b} = \frac{v'(b)}{(1-\tau)\,u'((1-\tau)\,w_R)\,[1+(\lambda_u-\lambda_e)\,A(w_R)]} \tag{62}$$

and

$$\frac{\partial w_R}{\partial \tau} = \frac{w_R v'((1-\tau)\,w_R) - (\lambda_u-\lambda_e)\int_{w_R}^{\infty}[(1-\tau)\,xv''((1-\tau)\,x) + v'((1-\tau)\,x)]\,A(x)\,dx}{(1-\tau)\,v'((1-\tau)\,w_R)\,[1+(\lambda_u-\lambda_e)\,A(w_R)]} \tag{63}$$

Substituting (62) and (63) into (61) and simplifying gives

$$\begin{aligned}\frac{dU}{db} =& \frac{r+\delta}{r+\delta+\lambda_u(1-F(w_R))}v'(b) - \frac{\lambda_u(1-F(w_R))}{r+\delta+\lambda_u(1-F(w_R))}\frac{d\tau}{db}w_R v'((1-\tau)\,w_R) \\ &-\lambda_u\frac{d\tau}{db}\frac{r+\delta+\lambda_e(1-F(w_R))}{r+\delta+\lambda_u(1-F(w_R))}\int_{w_R}^{\infty}\big[(1-\tau)\,xv''((1-\tau)\,x)+v'((1-\tau)\,x)\big]\,A(x)\,dx\end{aligned} \tag{64}$$

Next, we use integration by parts, together with $r \approx 0$, to get

$$\begin{aligned}&\int_{w_R}^{\infty}\big[(1-\tau)\,xv''((1-\tau)\,x)+v'((1-\tau)\,x)\big]\,A(x)\,dx \\ &\qquad \approx \frac{1-F(w_R)}{\delta+\lambda_u(1-F(w_R))}\left[-w_R v'((1-\tau)\,w_R) + \int_{w_R}^{\infty} wv'((1-\tau)\,w)\,dG(w)\right]\end{aligned} \tag{65}$$

Substituting back into (64) and imposing $r \approx 0$ everywhere, we get

$$\frac{dU}{db} \approx uv'(b) - (1-u)\,\frac{d\tau}{db}\int_{w_R}^{\infty} wv'((1-\tau)\,w)\,dG(w) \tag{66}$$

To get (16), we substitute in $\frac{b}{\tau}$ using the budget constraint (14).

Derivation of (19). To derive the approximation in (19), we proceed in two steps. First, for any w, we write the Taylor expansion

$$wv'((1-\tau)\,w) \approx \overline{w}v'((1-\tau)\,\overline{w}) + (w-\overline{w})\,[(1-\tau)\,\overline{w}v''((1-\tau)\,\overline{w}) + v'((1-\tau)\,\overline{w})] \tag{67}$$

Since $\overline{w} = \int_{w_R}^{\infty} wdG(w)$ by definition, we have

$$\int_{w_R}^{\infty} wv'((1-\tau)\,w)\,dG(w) \approx \overline{w}v'((1-\tau)\,\overline{w}) \tag{68}$$

A similar Taylor expansion establishes that

$$\int_{w_R}^{\infty} v'((1-\tau)w)dG(w) \approx v'((1-\tau)\,\overline{w}) \tag{69}$$

Next, we write the Taylor expansion

$$v'(b) \approx v'\left((1-\tau)\,\overline{w}\right) - ((1-\tau)\,\overline{w} - b)v''\left((1-\tau)\,\overline{w}\right) \tag{70}$$

Dividing both sides by $v'\left((1-\tau)\,\overline{w}\right)$ and using $\int_{w_R}^{\infty} v'((1-\tau)w)dG(w) \approx v'\left((1-\tau)\,\overline{w}\right)$, we obtain

$$\begin{aligned}
\frac{v'(b)}{\int_{w_R}^{\infty} v'((1-\tau)w)dG(w)} &\approx \frac{v'(b)}{v'\left((1-\tau)\,\overline{w}\right)} \\
&\approx 1 - \frac{(1-\tau)\,\overline{w} - b}{(1-\tau)\,\overline{w}} \cdot \frac{(1-\tau)\,\overline{w}v''((1-\tau)\,\overline{w})}{v'((1-\tau)\,\overline{w})} \\
&= 1 + \gamma(1-\rho)
\end{aligned} \tag{71}$$

Substituting (68), (69) and (71) into (16) gives (19).

B Additional details on the calibration

In this section we detail how we parameterize κ_u and κ_e. We can obtain $\kappa_u = h_u/\delta$ directly from the job-finding rate and the job separation rate. At a monthly frequency, we find $h_u = 0.43$, $\delta = 0.03$, and so $\kappa_u = 14.3$. It remains to calibrate $\kappa_e = \lambda_e^*/\delta$, where we define $\lambda_e^* = \lambda_e\left(1 - F\left(w_R\right)\right)$. Following Nagypal (2008) and Hornstein *et al.* (2011), this can be obtained from the job-to-job transition rate, denoted by h_{ee}. We can calculate

$$h_{ee} = \delta\left[\frac{\delta + \lambda_e^*}{\lambda_e^*}\ln\left(\frac{\delta + \lambda_e^*}{\delta}\right) - 1\right] \tag{72}$$

To arrive at this expression, we used integration by parts on

$$\begin{aligned}
h_{ee} &= \lambda_e \int_{w_R}^{\infty} \left(1 - F\left(w\right)\right) dG\left(w\right) \\
&= \lambda_e \int_{w_R}^{\infty} G\left(w\right) dF\left(w\right) \\
&= \lambda_e \int_{w_R}^{\infty} \frac{\delta}{\delta + \lambda_e\left(1 - F\left(w\right)\right)} \frac{F\left(w\right) - F\left(w_R\right)}{1 - F\left(w_R\right)} dF\left(w\right) \\
&= \delta\lambda_e^* \int_0^1 \frac{z}{\delta + \lambda_e^*\left(1 - z\right)} dz
\end{aligned} \tag{73}$$

where we used the change of variables

$$z = \frac{F\left(w\right) - F\left(w_R\right)}{1 - F\left(w_R\right)}$$

If $h_{ee} = 2.2\%$, we obtain $\lambda_e^* \approx 7\%$ and $\kappa_e \approx 2.3$.