The Job Ladder, Unemployment Risk, and Incomplete Markets

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Abstract

We study a general equilibrium search model with jobs differing in productivity and unemployment risk. Risk-averse workers, searching off and on the job, self-insure against labor income risk via a non-state-contingent bond. On-the-job search mitigates, undoes, or even reverses the risk-aversion-induced inefficiency of search out of unemployment. The interplay of imperfect insurance and unemployment risk heterogeneity creates a new distortion: employed workers climb the job ladder over-cautiously. More generous unemployment insurance can *increase* job creation by kick-starting the job ladder. Quantitatively, these forces improve the equity-efficiency trade-off and we find the welfare-maximizing replacement rate to be high, in line with current US policy.

Keywords: Incomplete markets, Job ladder, Unemployment, Job safety
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1 Introduction

Besides allocating workers between employment and nonemployment, the labor market reallocates a comparable number of already-employed workers between different jobs and firms (Davis and Haltiwanger, 1999), and on-the-job search appears three times as effective as search while unemployed (Faberman et al., 2022). Such direct job-to-job transitions are a crucial factor in wage growth through job ladders (Topel and Ward, 1992; Karahan, Ozkan, and Song, 2022; Haltiwanger, Hyatt, and McEntarfer, 2018), and fill and trigger around half of job openings (Mercan and Schoefer, 2020). This job mobility may also affect macroeconomic performance (e.g., Davis and Haltiwanger, 2014; Moscarini and Postel-Vinay, 2016). However, while there is ample theoretical, empirical and policy focus on inefficient job choices of the unemployed, search models are built almost universally around one assumption: conditional on having received an outside offer, employed workers always make the *efficient* choice—in a sense we will explicitly clarify—between staying put and switching jobs.[1]

In this paper we explore the idea that workers forgo some job-to-job moves that would increase their wages but expose them to higher unemployment risk. If workers are risk averse and insurance markets are incomplete, then unemployment risk looms *inefficiently* large in this tradeoff. Workers *overvalue* job security over wages: staying put in safe but low productivity jobs while rejecting high productivity-high risk offers—they "climb to safety." At the aggregate level, their excessive caution on the job ladder reduces aggregate productivity and is a form of misallocation. All this, in turn, raises a new role for unemployment insurance, by kickstarting the job ladder. We explore these issues qualitatively and quantitatively in a search model with three key features: (i) on-the-job search, (ii) job offers with heterogeneity in productivity but also in separation (unemployment) risk, and (iii) risk aversion and incomplete markets.

The idea that risk aversion and incomplete markets may distort one of the most important economic choices individuals can make—who to work for—is intuitive. For instance, there is emerging evidence on how wealth and liquidity constraints may distort behavior of *unemployed* job seekers (e.g., Bloemen and Stancanelli, 2001; Algan, Chéron, Hairault, and Langot, 2003; Chetty, 2008; Herkenhoff, 2019a; Griffy, 2021; Herkenhoff, Phillips, and Cohen-Cole, 2023). For employed workers, we are not aware of similar existing evidence.

[1]This consideration between two jobs conditional on an outside offer is distinct from existing analyses on whether there is an efficient amount or direction of on-the-job search (Menzio and Shi, 2011), and whether workers appropriate the social value of a given job in bargaining with associated standard search externalities (Jarosch, 2023). Another exception is presented in Flinn and Mullins (2021), where rigid-wage and flexible-wage firms compete for workers.

Hence, we present in Figure **??** Panel (a) new motivating evidence from a survey of employed workers conducted in Germany. Asked why workers prefer to stay put rather than switching to a *similar* job with a wage premium, the most popular answer is: "I have a very safe job at my current employer. If I start at a different company the risk of losing the job would be higher."[2] In our model, this consideration arises naturally when jobs carry *heterogeneous* separation risk—an intuitive property, and consistent with empirical evidence. For instance, drawing on the U.S. Survey of Consumer Expectations, Figure **??** Panel (b) displays the substantial variation in (subjective) job loss risk the same individual perceives across different jobs she holds. Consistent with risk aversion and incomplete markets, Panels (c) and (d) provide suggestive empirical evidence for the channel we advance in this paper: workers with higher willingness to take risks engage in more job to job transitions (blue solid circles), and there is some evidence that they hold jobs with higher unemployment risk (red hollow diamonds) (for similar evidence, see Argaw et al., 2017; van Huizen and Alessie, 2019). We pick up in Section 5 the need for further direct evidence, and devote this paper to a qualitative and quantitative theoretical exploration of this channel. In ongoing work, we are fielding a survey in the US to directly elicit the wage-risk preferences of workers while searching on the job.

Surprisingly, the inefficiency arising from a risky job ladder appears to not have been studied in the theoretical literature either. Specifically, while there are existing models with some of the three aforementioned required features *separately*, ours is the first model to feature them *jointly*.

First, our channel is distinct from the canonical way the search literature has linked incomplete markets and risk aversion with aggregate productivity. Specifically, existing research abstracts from on-the-job search and has emphasized the insufficient selectivity of *unemployed* job seekers and the resulting role for unemployment insurance to restore efficiency (e.g., Acemoglu and Shimer, 1999; Marimon and Zilibotti, 1999).[3] In fact, we show that adding on the job search can neutralize or even reverse the main results in this literature.

Second, there exist models that combine on the job search and risk aversion (e.g. Lise, 2013; Krusell et al., 2017; Hubmer, 2018; Griffy, 2021; Chaumont and Shi, 2022). But

[2]Appendix Figure **??** plots the same figure for the 2020 panel. Appendix Figures **??** and **??** display correlations between the probability of giving job security as a reason to not switch to a higher wage job, against proxies for the value of the current job and unemployment.

[3]These papers sit in a larger literature studying how incomplete markets affect unemployed search. Additional theoretical and quantitative work focusing on incomplete markets and unemployment includes Lentz and Tranæs (2005), Krusell et al. (2010), Herkenhoff et al. (2023), Ravn and Sterk (2017), den Haan et al. (2018), Herkenhoff (2019a), Braxton et al. (2020), Ravn and Sterk (2021), Eeckhout and Sepahsalari (2021), and Huang and Qiu (2021)

these papers feature *homogeneous* separation risk and hence no matter the degree of risk aversion or market completeness, workers simply take a job whenever it pays more. In such one-dimensional job ladder models, choices between jobs are always efficient. By this we mean that, conditional on receiving an offer, workers accept any job-to-job move to a higher productivity match, as would the social planner. This simple idea means that the policy functions on the EE margin are unaffected by market incompleteness or government policy.[4]

Third, models with on-the-job search that do feature separation risk heterogeneity (e.g., Pinheiro and Visschers, 2015; Krolikowski, 2017; Jarosch, 2023) exclusively assume *risk neutrality*, equivalently, they assume *complete markets*, sidestepping the consequences of market incompleteness.[5,6,7] By construction, such models thereby miss our key results qualitatively and quantitatively. We show that the main effect of heterogeneous separation risk kicks in with risk aversion and incomplete markets: Excessive caution of employed workers is more important than insufficient selectivity of unemployed workers in driving aggregate productivity losses from incomplete markets.

Qualitatively, the incomplete markets setup in a setting with heterogeneous separation risk generates novel room for inefficient job choices *conditional* on an offer. We demonstrate this precisely using a comparison to a planner's problem in a partial equilibrium version of our model.[8] We make assumptions such that the competitive allocation coincides with the planner's—i.e. is productively efficient—under risk neutrality. This rules out the inefficiency studied by Jarosch (2023) where risk-neutral workers may overvalue

[4]Instead, Lise (2013) studies the consequences of the job ladder for savings behavior, and Griffy (2021) shows that wealthier agents search less intensively. Hubmer (2018) studies the role of the job ladder and wealth in explaining life-cycle earning dynamics. Chaumont and Shi (2022) study how wealth affects the trade off between wages and job finding rates in a directed search model.

[5]Pinheiro and Visschers (2015) focus on the compensating differentials mechanism (see our analogous Equation (B.7) below) in a wage posting setting. Jarosch (2023), also features risk neutrality, and uses wage bargaining, and focuses on a positive analysis of the effect of the risky job ladder on persistent earnings losses following job displacement.

[6]There is also a small literature which features EU risk heterogeneity and incomplete markets, but without on-the-job search. Birinci and See (2023) study an incomplete markets model with income-specific EU rates. Baley et al. (2023) study a "turbulent" labor market with two forms of labor market risk (transitory unemployment risk and more permanent risk associated with skill obsolescence) in an incomplete markets model. Both papers study, among other things, the effects of UI benefits. Clymo et al. (2023) show that the EU rate features a U-shape in wealth using PSID data and build a model to explain this fact.

[7]Another strand of the literature studies learning in the labour market (Jovanovic, 1979; Miller, 1984; McCall, 1990; Moscarini, 2005; Papageorgiou, 2013), and hence features a notion of riskiness about match quality. This literature typically assumes risk neutral preferences: choices are constrained efficient subject to imperfect information.

[8]Our focus on partial equilibrium rules out inefficiencies on the vacancy posting margin which are studied in a job-ladder context by Fukui and Mukoyama (2024) (and references therein). We allow for general equilibrium in our quantitative work.

job security relative to the planner depending on how wages are bargained. In the presence of risk aversion, we prove that positive UI benefits can restore productive efficiency by influencing the unemployment-to-employment (UE) and employer-to-employer (EE) margins. However, the more workers are able to search on the job the less important the inefficiency on the UE margin becomes. Further, it is only with heterogeneity in EU risk that positive UI benefits are needed to restore efficiency to the EE margin. Thus, given the evidence that on-the-job search appears three times as effective as search while unemployed (Faberman et al., 2022), we argue that heterogeneity in EU risk is crucial for generating a productive-efficiency motivation for high UI benefits.

Quantitatively, using our full general equilibrium model we find that the current generosity of unemployment insurance in the US is nearly optimal. This is in contrast to a version of the model in which we shut down the heterogeneity in unemployment risk, where the generosity of UI should be slashed by about ten percentage points. Many existing studies find that near-zero unemployment benefits are optimal in general equilibrium (e.g. Krusell et al., 2010). Our model shows that this need not be the case in the presence of sufficiently rich heterogeneity, and an incomplete markets model calibrated to hit the average marginal propensity to consume. By unsticking the job ladder, raising UI benefits has another novel effect in general equilibrium: it makes it easier for firms to hire employed workers, which encourages vacancy posting creating a non-monotonic relationship between UI benefits and market tightness. These production-side gains from kickstarting the job ladder improve the equity-efficiency trade-off and allow the government to provide more generous UI benefits.

Two contemporaneous papers contain all three features and come closest to our setup. Firstly Larkin (2024), whose partial-equilibrium model links the secular decline in the US job separation rate to the increasing share of illiquid assets in household portfolios, studies how trends in the labor market amplifies the aggregate consumption drop in economic downturns. His model also features a two-dimensional job ladder and risk averse households under incomplete markets, but employs a richer asset structure, additionally tying cross-sectional heterogeneity in separation risk to portfolio choices. Secondly Caratelli (2024) builds a model where EU risk declines in job tenure in a one-asset incomplete markets job ladder model. He provides evidence that EE moves increase EU risk in the data, and studies (as we do) how risk slows down the job ladder via what he calls a precautionary job-keeping motive. His focus is different to ours, and he studies how this motive causes a gap in earnings to open up between low and high wealth workers following a business cycle shock. Among many differences in focus, model structure and applications, neither paper studies the efficiency properties of job mobility and its

aggregate productivity consequences, which are our main focus.

Finally, we note that while our paper explicitly treats heterogeneity in match-specific separation risk, we also experimented and obtained similar results with a model in which job switching as such boosts unemployment risk (e.g., due to loss of employment protection and seniority, or as job quality is revealed slowly on the job). By generating additional unemployment risk following an EE transition, those features would amplify the role of risk aversion and unemployment value in job mobility. Quantitatively, our results are similar in this model variant (see Appendix B.4 for a replication of our main experiment in this alternative model).[9]

The rest of the paper proceeds as follows. In Section 2, we empirically study .... In Section 3, build a quantitative model featuring firm entry and worker consumption-saving decisions in the presence of borrowing constraints. In Section 4, we calibrate the model and assess the quantitative implications of our channel, including for optimal unemployment insurance. Section 5 concludes.

2 Empirical analysis

We start by presenting descriptive evidence that in the U.S. labor market, jobs exhibit substantial heterogeneity in their unemployment risk and that workers trade off this job dimension with the wage.

2.1 Evidence from publicly available datasets

Our analysis in this section is based on the Current Population Survey (CPS) and the Survey of Consumer Expectations (SCE). We relegate the details of data construction, sample selection, and measurement to Appendix A.1.

EU-job tenure profiles. Heterogeneity in separation risk between potential jobs a given worker may accept is crucial to the mechanism we highlight. An easily observable implication of this feature would be a downward-sloping raw relationship between employment-to-unemployment (EU) separation rates and job tenure. Such a pattern may arise from compositional effects (as high separation risk jobs leave the sample early) or duration

[9]Recent research emphasises how the labor market is segmented, with different groups of workers having vastly different labor market experiences (Hall and Kudlyak, 2019; Morchio, 2020; Gregory et al., 2021; Karahan et al., 2022; Ahn et al., 2023). See Section **??** for a discussion of how our findings mesh with this approach.

dependence (whereby jobs become stable over time). While incomplete markets may curb job transitions in either case, the data leave substantial room for compositional effects.

To show this, we compute average EU rates by job tenure in the CPS. To account for composition effects, we run the regression below

$$\mathbb{I}(EU_{it}) = \alpha_\tau + \gamma_t + \beta X_{it} + \varepsilon_{it}, \tag{1}$$

where $\mathbb{I}(EU_{it})$ is an indicator for an EU separation event between months t and $t+1$, α_τ are job tenure dummies, γ_t are time fixed effects and X_{it} are time varying observables. The coefficients of interest are the tenure effects α_τ. In the observables X_{it}, we incrementally include a set of worker and job control variables, and average wages. The *worker controls* include a quartic in potential experience, education dummies, race dummies, a gender dummy, marital status dummies, the number of own children and the number of own children under age five in the household. *Job controls* include industry, occupation and state dummies. The *wage control* is the log of the average real wage across (up to) two earnings observations for each worker. Finally, for each specification, we adjust the tenure-specific EU rates so that their employment-weighted averages are aligned with the unconditional average EU rate among jobs over the tenure range we study here (0 to 45 months).

Figure 1 Panel (a) plots the resulting raw (no controls) and composition-adjusted tenure dummies α_τ. The main takeaway is that EU risk falls sharply in tenure. Controlling for worker characteristics hardly changes this picture. Adding in job and employer characteristics lead to a flattening of the profile, especially once we control for the wage. It is precisely this joint determination of wages and unemployment risk is what we quantitatively study in Section 4. Overall, we conclude that basic EU separation-tenure gradients are consistent with heterogeneity in separation rates across jobs.

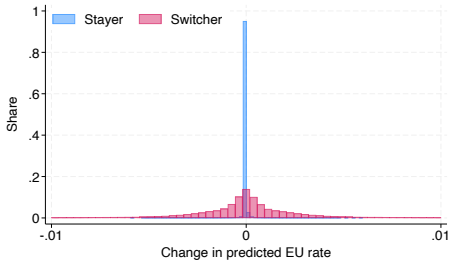
Change in predicted EU probability upon job change. To further highlight how workers' job opportunities may feature heterogeneity in separation risk, we present an event study of the effect of job changing on EU risk. To do so, we construct the *predicted* EU probability on a given job given observables. To this end, we run a probit regression of the EU separation indicator on the set of worker, job, and wage controls discussed above, as well as time fixed effects, drawing again on the CPS. We then predict the EU rate while fixing the calendar time effects to a baseline. Finally, we calculate the change in the predicted worker-level EU probabilities between two months a worker is in the sample, separately for job stayers (continuing jobs) and movers (where a worker has two different jobs across two months).

Figure 1: Unemployment risk, job tenure, job switching and wages.

(a) EU rate-tenure profiles



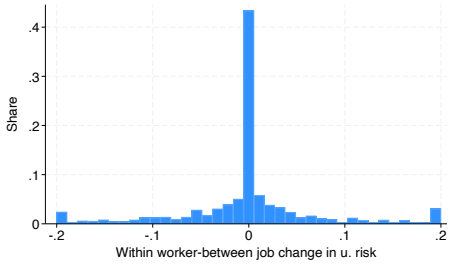
(b) ΔEU for job stayers vs switchers



(c) Job-specific EU rates vs wages



(d) Subjective EU prob. across jobs



Notes: Panel (a) plots the tenure dummies from Equation (1). Tenure-specific EU rates are rescaled so that the employment-weighted EU rate in each specification matches the unconditional average EU rate for jobs with less than 45 months of tenure. See the main text for details. Panel (b) shows a histogram of predicted EU probabilities from a probit regression of an EU indicator on worker, job, and wage controls for job stayers and switchers, holding time effects at a baseline value. Panel (c) plots job-specific (industry–occupation–state) EU rates against predicted wages from Equation (2), fixing time effects and worker observables at baseline. Marker size reflects job employment shares; the line is the weighted OLS fit of predicted EU on predicted log wage. Source: CPS. Panel (d) is a histogram of job fixed effects from a regression of perceived 12-month job-loss probability on worker and job fixed effects (winsorized at ±0.2). Source: SCE.

Figure 1 Panel (b) plots the histogram of these EU probability changes for job stayers (blue bars) and job switchers (red bars). Not surprisingly, the change in the unemployment risk for job stayers is centered around zero, i.e., there is little change in the predicted unemployment risk for workers who do not change jobs. However, compared to stayers, there is substantial variation in the change in unemployment risk for job switchers. Importantly, there is mass both to the left and right of zero change. This suggests that workers switch to both safer and riskier jobs, consistent with our theory that workers climb up the job ladder along the wage and safety dimensions simultaneously. Our model will feature exactly such moves, with workers trading off job security and wages.

Prevalence of high-wage, high-risk jobs. To reiterate, our theory is based on the idea that workers may sometimes be forced to trade off job safety against wages. To test for the existence of high-wage, high-risk jobs, we define a job as an industry–occupation–state

combination and estimate

$$y_{it} = \gamma_t + \eta_j + \zeta_o + \omega_s + \beta X_{it} + \varepsilon_{it}, \tag{2}$$

where the left-hand-side variable $y_{it} \in \{\mathbb{I}(EU_{it}), \log(w_{it})\}$ is either an indicator for an EU separation or the log real wage, γ_t are time fixed effects, $\eta_j, \zeta_o, \omega_s$ are industry, occupation and state dummies, respectively, and X_{it} are the *worker controls* defined in the context of the EU-tenure regressions above. We then predict job-specific EU rates and wages by fixing the time effects and worker controls in Equation (2) to a baseline value and only using the variation in industry-occupation-state dummies.

Figure 1 Panel (c) shows a negative relationship between these predicted EU rates and wages: higher-wage jobs exhibit lower unemployment risk on average. At the same time, there is substantial heterogeneity in unemployment risk among jobs with similar wage levels, indicated by the dispersion around the downward-sloping regression line. Importantly, the figure is based on realized outcomes and hence reflects an equilibrium relationship rather than the distribution from which workers sample offers. Our model is consistent with both this negative relationship and the equilibrium dispersion in unemployment risk at similar wage levels, while allowing for high-risk, high-wage job offers. We caveat that some of this dispersion within wage groups may feature measurement error or omitted variables related to worker heterogeneity.

Do workers perceive unemployment risk differently across jobs? Finally, using data from the SCE, Figure 1 Panel (d) displays the substantial variation in the subjective job loss risk an individual perceives across different jobs she holds. This is consistent with our findings in Panel (b) based on realized EU separations: workers switch jobs in both directions that they think are less or more risky as they climb the wage-job safety ladder.[10]

Taking stock. Our analysis shows that (i) unemployment risk declines with job tenure (consistent with compositional effects from permanent job heterogeneity), (ii) workers switch to both safer and riskier jobs (consistent with a two-dimensional job ladder), and (iii) while higher-wage jobs are generally safer, unemployment risk varies substantially across jobs with similar wage levels. Our model presented in Section 3 and calibrated in Section 4 matches all these patterns.

[10]We note that a similar analyses we experimented with restricting this measure to job stayers also showed substantial dispersion in this subjective measure, consistent with measurement error or transitory risk shocks.

2.2 Results from our own custom survey

We now provide direct evidence on how worjers

To complement our analysis of publicly available data and to test our mechanism directly, we fielded a custom survey in May–June 2025 of 3,096 respondents, as part of three bi-weekly waves of the nationally representative AmeriSpeak Omnibus survey administered by NORC at the University of Chicago. To preview, focusing on those age 18–64 and after removing outliers, our sample contains 718 employed respondents and roughly 3200 individual reservation pay responses. Appendix A.2 provides additional details, including data cleaning procedures, and robustness checks.

To gauge the wage-job safety trade-off directly, we asked employed respondents about their perceived layoff probability in the next 12 months. We then elicited their reservation pay for a job with otherwise identical characteristics—in particular, the *same layoff risk*. This stepping stone was supposed to "de-anchor" our subsequent scenarios, which would vary layoff risk only, from job switching costs. We then asked respondents to report their reservation pay for hypothetical job offers, which kept all dimensions fixed except for the layoff risk. Respondents considered layoff probabilities of 2, 5, 10, 20 and 50 percent (all again over the next 12 months).[11] By comparing reservation pay against layoff risks (and having netted out switching costs), these responses allow us to trace out individual wage-job safety indifference curves (ICs).

Formally, an individual i currently occupies job j, which is characterized by attributes $\{w_{j(i)}, \delta_{j(i)}, \mathbf{x}_{j(i)}\}$, where $\mathbf{x}$ denotes attributes of the job other than pay $w_{j(i)}$ and layoff risk $\delta_{j(i)}$—the subjective 12-month probability of job loss. Let $w^*_{i,j(i)}$ denote respondent i's reservation pay for an offer identical to their current job j—which may differ from the actual wage $w_{j(i)}$ due to switching costs that are unrelated to job characteristics. This reservation pay is our base to trace out indifference curves. Then, for each hypothetical offer with an annual layoff probability of $\widetilde{\delta} \in \{2, 5, 10, 20, 50\}$ percent, let $\widetilde{w}^*_{i,j(i),\widetilde{\delta}}$ denote the elicited reservation pay as we consider alternative separation rates while holding job characteristics $\mathbf{x}_{j(i)}$ fixed. As baseline layoff risks in the original job $\delta_i, j(i))$ are heterogeneous and elicited, we also define the change in unemployment risk in scenario $\widetilde{\delta}$ as $\Delta\delta_{i,j(i),\widetilde{\delta}} = \widetilde{\delta} - \delta_{i,j(i)}$. We further define the *reservation pay ratio* as $r_{i,j(i),\widetilde{\delta}} = \widetilde{w}^*_{i,j(i),\widetilde{\delta}}/w^*_{i,j(i)}$, which allows us to include full-time and part-time respondents in the sample.[12]

[11] We did not specify UI levels. In a separate hypothetical, we informed respondents on current UI generosity and asked them to revise their answers. We then further asked the respondents to revisit their answers under a hypothetical increase in UI generosity. We discuss the results of this exercise in Section 4 in the context of the quantitative predictions of our model.

[12] We lack information on hours worked for part-time respondents, which complicates converting their

Table 1: Average job safety vs pay trade-off

	(1) $(\tilde{w}_{ij} - w_i^*)/w_i^*$	(2) $(\tilde{w}_{ij} - w_i^*)/w_i^*$	(3) $(\tilde{w}_{ij} - w_i^*)/w_i^*$	(4) $(\tilde{w}_{ij} - w_i^*)/w_i^*$
$\Delta\delta_{ij}$	0.810***	0.871***	1.475***	1.491***
	(0.044)	(0.048)	(0.044)	(0.048)
Observations	3226	2740	3226	2740
R-sq	0.302	0.323		
Within R-sq			0.592	0.592
N of Respondents	722	614	722	614
Individual FE	No	No	Yes	Yes
Full-time only	No	Yes	No	Yes

Notes: The table reports coefficients from regressing the relative change in reservation pay on the change in job loss probability in Equation (3).

Job safety-pay indifference curves. To pinpoint the empirically job safety versus pay trade-off, we regress the percentage difference between the reservation pay $\widetilde{w}^*_{i,j(i),\widetilde{\delta}}$ for unemployment scenario $\widetilde{\delta}$ and reservation pay for an otherwise identical job to the current job, $w^*_{i,j(i)}$, on the change in unemployment risk in each of the five scenarios:

$$100 \times \underbrace{\left(\frac{\widetilde{w}_{ij} - w_i^*}{w_i^*}\right)}_{\equiv r_{ij}-1} = \alpha + \beta\Delta\delta_{ij} + \varepsilon_{ij}. \tag{3}$$

The coefficient β—which we call *the relative price of risk (RPR)*—measures the percentage increase in reservation pay required to keep respondent i indifferent between their current job (adjusted for switching costs) and a hypothetical job whose probability of job loss is higher by one percentage point.

We estimate Equation (3) on the full sample and a subsample of full-time employees, with and without individual fixed effects. The results are reported in Table 1. The pooled OLS β estimate (Column (1)) implies that workers on average require around an 8% pay increase to accept a job offer that increases their job loss risk by 10 pp. on an annual basis. When we additionally include respondent fixed effects (Column (3), the estimated β coefficient nearly doubles: workers require almost 15% of current pay for a 10 pp. increase in job loss risk. Full-time employees require slightly higher compensation

earnings into full-time equivalents.

Table 2: Heterogeneity in job safety-pay indifference curves

	(1)	(2)	(3)
	β_i	β_i	β_i
Safe Job	0.7241***		
	(0.0867)		
High Pay		0.2587***	
		(0.0925)	
Job Loss Spend Much Less			0.5539***
			(0.1457)
Job Loss Spend Bit Less			0.5303***
			(0.1783)
Constant	1.0791***	1.3447***	0.9493***
	(0.0563)	(0.0647)	(0.1355)
R-sq	0.097	0.012	0.013
N	618	618	601
Full-time only	Yes	Yes	Yes

Notes: The table reports coefficients from regressing the relative price of risk on indicators for being in the bottom half of the perceived EU-risk distribution (column 1), the upper half of the annual pay distribution among full-time workers (column 2), and self-reported consumption drops following job loss (column 3).

for unemployment risk in the pooled OLS and FE regressions (Columns (2) and (4), respectively).

We further assess the heterogeneity in the RPR at the individual level. To this end, we estimate an individual-level counterpart to Equation (3) (hence the β_i):

$$100 \times \left(\frac{\widetilde{w}_{ij} - w_i^*}{w_i^*} \right) = \alpha_i + \beta_i \Delta\delta_{ij} + \varepsilon_{ij}. \tag{4}$$

The average individual RPR is 1.50 in the full sample (1.53 for full-time employees) and is significantly dispersed, the standard deviation of β_i is 1.19 (1.21 for full time).

We then examine what drives the variation in the individual RPR. We divide both the distribution of perceived unemployment risk and the distribution of gross pay among full-time workers into upper and lower halves. We refer to the lower half of the job loss risk as *safe* jobs and to the upper half of the pay distribution as *high-pay* jobs, respectively. In addition, we draw on our custom survey question about the expected consumption drop following a job loss, constructing indicators for respondents who reported they would consume "much less" or "a bit less", lumping those who would not decrease

consumption (or even increase it) into the baseline category. These variables serve as proxies for liquidity constraints: individuals who anticipate larger consumption cuts are likely less able to smooth income fluctuations, and thus may place greater value on job security.

Table 2 presents the results. The first column shows that workers in safe jobs require a 1.8% increase in pay (1.08 + 0.72) to compensate for a 1–percentage-point rise in EU risk, whereas workers in riskier jobs exhibit a trade-off that is roughly one-third weaker. The second column indicates that workers in the upper half of the annual pay distribution require an additional 0.26% compensation, relative to the 1.35% required by workers in the lower half, for a 1–percentage-point increase in δ. Finally, the third column shows that workers' financial position also shapes their indifference curves: respondents who report being financially constrained—those who would cut consumption substantially following job loss—demand higher compensation to accept jobs with greater layoff risk.

Taking stock. Analysis of our custom survey on how workers trade off hypothetical job security and wages yields two findings. First, and perhaps unsurprisingly, workers demand higher wages to compensate for higher job-loss risk. More specifically, we estimate the average wage premium for accepting higher job loss risk to be roughly 1.5% of the current pay for a 1 pp. increase in job loss risk across a 12 month horizon. Second, the magnitude of this wage premium varies systematically with job characteristics and with workers' ability to self-insure against unemployment risk. Our model, which we turn to next, captures our empirical findings both qualitatively and quantitatively.

3 Model

Our quantitative model features a frictional labor market with a two-dimensional job ladder along match productivity and safety, where workers can partially self insure against idiosyncratic labor market shocks using a risk-free bond.

3.1 Environment

Time is continuous and indexed by $t \in [0, \infty)$, and there are three types of agents in the economy: workers, entrepreneurs, and the government.

Preferences. There is a unit mass of risk-averse workers, whose preferences over consumption flow are described by a strictly increasing, twice-differentiable concave utility

function $u(c)$. Workers can self-insure against labor income fluctuations using a risk-free bond a with real return r. Risk-neutral entrepreneurs own all the firms in the economy. The workers and entrepreneurs discount the future at rates $\rho \geq 0$ and $\rho_f \geq 0$, respectively.

The labor market. Workers and firms meet randomly in a frictional labor market. Firms enter the labor market freely to post vacancies for single-worker matches at a flow cost of κ. When a worker and firm meet, they draw a match productivity-unemployment risk pair (z, δ) from CDF $F(z, \delta)$ with support $\left[\underline{z}, \overline{z}\right] \times \left[\underline{\delta}, \overline{\delta}\right] \subset \mathbb{R}^2_+$. These characteristics are observed before each party decides whether to accept the match or reject it without recall. Productivity z is constant over the life of the match unless it drops to zero at rate δ, i.e., the job separation rate, triggering a match destruction. Besides these exogenous separations, the worker and the firm can unilaterally terminate the match. The worker-firm pair agrees on a wage $w(z)$ to split their bilateral match surplus, which we microfound in Section 3.3.

Let $g^u(a)$ denote the endogenous mass of unemployed workers with assets a, and $g^e(a, z, \delta)$ denote the mass of employed workers further indexed by their job characteristics (z, δ). Thus $n = \int g^e(a, z, \delta) da dz d\delta$ is total employment, $u = \int g^u(a) da$ is total unemployment, and $u + n = 1$ is the total mass of workers normalized to unity. The search efficiency of the unemployed is normalized to $s_u = 1$, and s_e denotes the relative search efficiency of the employed. Aggregate search effort is $S = u + s_e(1 - u)$. Given the aggregate mass of vacancies V and the aggregate search effort, the rate of matches per unit of time is governed by a matching function $m = M(V, S)$ which satisfies standard properties.[13] Labor market tightness is the ratio of vacancies to search effort $\theta = V/S$. Workers meet a vacancy at rate $\lambda(\theta) = m/S$ per unit of search effort and vacancies meet workers at rate $q(\theta) = m/V$. Under random search, the type of worker a vacancy meets depends on the worker distribution across employment states and job characteristics.

Government. The government levies progressive income taxes to finance flat unemployment insurance (UI) benefits b, and an exogenous spending commitment G. Both labor and UI benefit income are taxed; capital income is not. Specifically, given gross income y, the after-tax income is $\widehat{y} = \tau y^{1-\Upsilon}$, where τ governs the average level and $\Upsilon \geq 0$ governs the progressivity of the tax scheme, as in Benabou (2002) and Heathcote et al. (2014).[14]

[13] Namely, $M(V, S)$ is increasing in both arguments and concave, and it exhibits constant returns to scale. This last assumption allows us to write contact probabilities as a function of labor market tightness alone.

[14] Parameter τ is inversely related to the average tax rate. For example, under $\Upsilon = 0$, i.e., no progressivity in the tax schedule, the proportional tax rate becomes $1 - \tau$.

3.2 Worker choices

There are two choices the workers face given the job offer arrival rate $\lambda(\theta)$: how much to consume and save, and which job offers to accept. For what follows, let the value of an employed worker in a job with productivity z and separation rate δ holding assets a be $W(a, z, \delta)$ and the value of an unemployed worker with assets a be $U(a)$.

Consumption and saving. Assets a held at instant t yield an endogenous instantaneous interest rate r. Given consumption c, savings evolve according to the law of motion

$$\dot{a} \equiv \frac{da}{dt} = \tau y^{1-\Upsilon} + ra - c, \tag{5}$$

where gross income is either a wage (described in Section 3.3) or UI benefits:

$$y = \begin{cases} w(z) & \text{if employed in job with with productivity } z \\ b & \text{if unemployed.} \end{cases}$$

The worker also faces a borrowing constraint $a \geq \underline{a}$. Since consumption flow is finite, this constraint only binds when $a = \underline{a}$, implying $c \leq \tau y^{1-\Upsilon} + r\underline{a}$ (equivalently $\dot{a} \geq 0$).[15]

Job acceptance and reservation sets. Workers accept job offers which increase their value relative to their current state. We define job offer acceptance sets as job productivity-separation rate combinations $(\widetilde{z}, \widetilde{\delta})$ that a worker with assets a accepts for two cases: $A_U(a)$ for the unemployment-to-employment (UE) margin, i.e., a currently unemployed job seeker presented with a job offer, and $A(a, z, \delta)$ for the employment-to-employment (EE) margin, i.e., a currently employed worker with (z, δ) considering an outside offer. Accordingly, we define the set of *reservation jobs*—$R_U(a)$ for the unemployed and $R(a, z, \delta)$ for the employed in (z, δ)—as those jobs which leave them indifferent between accepting the offer and remaining in their current state:

$$A_U(a) = \left\{(\widetilde{z}, \widetilde{\delta}) : W(a, \widetilde{z}, \widetilde{\delta}) \geq U(a)\right\} \qquad R_U(a) = \left\{(\widetilde{z}, \widetilde{\delta}) : W(\widetilde{z}, \widetilde{\delta}) = U(a)\right\}$$
$$A(a, z, \delta) = \left\{(\widetilde{w}, \widetilde{\delta}) : W(a, \widetilde{z}, \widetilde{\delta}) \geq W(a, z, \delta)\right\} \quad R(a, z, \delta) = \left\{(\widetilde{w}, \widetilde{\delta}) : W(a, \widetilde{z}, \widetilde{\delta}) = W(a, z, \delta)\right\}.$$

These reservation sets trace out worker indifference curves for each level of assets a.

[15] The borrowing constraint implies that there are parameter restrictions needed to ensure that consumption remains positive: UI benefits and wages must be sufficiently large, $\tau y^{1-\Upsilon} > -r\underline{a}$ for $y \in \{b, w\}$. Since r is small and $\underline{a}$ will be ultimately calibrated to equal quarterly earnings, this constraint is very loose.

Unemployment value. Value of unemployment for a worker with assets a solves the following Hamilton-Jacobi-Bellman (HJB) equation:

$$\rho U(a) = \max_c \; u(c) + U_a(a)\dot{a} + \lambda(\theta) \int_{A_u(a)} \left[W\left(a, \widetilde{z}, \widetilde{\delta}\right) - U(a) \right] dF(\widetilde{z}, \widetilde{\delta}) \tag{6}$$

subject to the borrowing constraint $a \geq \underline{a}$, where U_a denotes the derivative of $U(a)$ and $\dot{a}$ follows Equation (5) with $y = b$. The first two terms capture the worker's consumption-saving problem. The last term is the value of finding a job that the worker accepts.[16]

Employment value. The value of employment for a worker with assets a in a job with characteristics (z, δ), who does not wish to quit to unemployment is:

$$\begin{aligned} \rho W(a, z, \delta) = &\max_c \; u(c) + W_a(a, z, \delta)\dot{a} + \delta \left[U(a) - W(a, z, \delta) \right] \\ &+ s_e \lambda(\theta) \int_{A(a,z,\delta)} \left[W(a, \widetilde{z}, \widetilde{\delta}) - W(a, z, \delta) \right] dF(\widetilde{z}, \widetilde{\delta}) \end{aligned} \tag{7}$$

subject to the borrowing constraint $a \geq \underline{a}$. Here, the first two terms again capture the consumption-saving problem, where $W_a(a, z, \delta)$ is the partial derivative of the value function with respect to a and and $\dot{a}$ follows Equation (5) with $y = w(z)$. The third term captures exogenous job destruction at rate δ, and the last term captures on-the-job search.[17] Clearly, $W(a, z, \delta)$ is increasing in assets and productivity, but decreasing in unemployment risk.

Wage-job safety trade-off. Let $c^*_U(a)$ denote optimal consumption for an unemployed worker with assets a and $c^*(a, z, \delta)$ denote the consumption of an employed worker with job (z, δ). Further, let the Hamiltonians at these optimal consumption levels be denoted by $H_U(a) = u(c^*_U(a)) + U_a(a)\dot{a}$ and $H(a, z, \delta) = u(c^*(a, z, \delta)) + W_a(a, z, \delta)\dot{a}$, respectively.

For unemployed workers, reservation jobs satisfy the following indifference condition:

$$H_U(a) - H(a, \widetilde{z}, \widetilde{\delta}) = (s_e - 1)\lambda(\theta) \int_{A_u(a)} \left[W\left(a, \widehat{z}, \widehat{\delta}\right) - U(a) \right] dF(\widehat{z}, \widehat{\delta}). \tag{8}$$

For any unemployed worker with assets a, Equation (8) implicitly defines the minimum productivity $\widetilde{z}$ required for them to accept a job with risk $\widetilde{\delta}$, denoted by $z^u(a, \widetilde{\delta})$. The term on the right-hand side captures the change in the job offer arrival rate when a worker moves

[16] Implicit in this notation is that a firm will never choose not to accept a match that a worker would accept. This result follows from the bilaterally efficient wage setting, as we discuss further below.

[17] Furthermore, the worker has the option to quit to unemployment at any time. Since such jobs do not prevail in steady state, we omit this option for notational brevity. However, we account for unemployment quits in our quantitative exercises that involve aggregate shocks, where the option might become binding.

from unemployment to employment. When $s_e < 1$, the worker will only move to jobs that sufficiently improve consumption and asset accumulation relative to unemployment. When $s_e > 1$ the worker is willing to accept a job with a lower Hamiltonian as she is compensated with a higher on-the-job offer arrival rate. Here, the term that involves the value loss upon exogenous job separation in Equation (7) drops out. Therefore, unemployed workers do not directly care about the safety of a reservation job offer, but care only about δ through its impact on consumption.

For employed workers, reservation jobs satisfy the following indifference condition:

$$H(a,z,\delta) - H(a,\widetilde{z},\widetilde{\delta}) = \underbrace{\left(\widetilde{\delta} - \delta\right)}_{\text{EU risk differential}} \times \underbrace{[W(a,z,\delta) - U(a)]}_{\text{price of unemployment risk}}. \tag{9}$$

Here, the on-the-job search terms cancel out as the reservation job offer yields an identical value to the current job. For any worker with assets a currently in a job with characteristics (z,δ), Equation (9) impliclty defines the minimum productivity $\widetilde{z}$ required for them to accept an EE move to a new job with risk $\widetilde{\delta}$, we we denote by $z^r(a,z,\delta,\widetilde{\delta})$. The difference between current job value $W(a,z,\delta)$ and unemployment value $U(a)$ governs how much the worker cares about unemployment risk relative to the current job, $\widetilde{\delta} - \delta$, and hence is what we call the price of unemployment risk.

To better connect ICs to worker behavior, we express them in terms of wages instead of productivity. Let $\hat{w}(z) = \tau w(z)^{1-\Upsilon}$ denote wages net of taxes, and let $\hat{w}^r(a,z,\delta,\widetilde{\delta}) = \tau w(z^r(a,z,\delta,\widetilde{\delta}))^{1-\Upsilon}$. Differentiating Equation (9) and using the definition of the Hamiltonian $H(a,\widetilde{z},\widetilde{\delta})$, the slope of the net wage-risk IC around risk $\widetilde{\delta}$ can be expressed as[18]

$$\frac{\partial \hat{w}^r(a,z,\delta,\widetilde{\delta})}{\partial \widetilde{\delta}} = \frac{W(a,z,\delta) - U(a) + \frac{\partial^2 W(a,\widetilde{z},\widetilde{\delta})}{\partial \delta \partial a}\dot{a}}{u'(c^*(a,\widetilde{z},\widetilde{\delta})) + \frac{\partial^2 W(a,\widetilde{z},\widetilde{\delta})}{\partial \widehat{w} \partial a}\dot{a}}. \tag{10}$$

In situations where the asset drift is zero, $\dot{a} = 0$—i.e., the worker would consume their income entirely—this condition implies that the rate at which net wages must increase to compensate for a further increase in $\widetilde{\delta}$ is the consumption equivalent of the price of risk, $(W(a,z,\delta) - U(a))/u'(c^*)$, highlighting two important ideas. First, the price of risk plays a key role in determining the slope of worker ICs. Since $W(a,z,\delta)$ is increasing in productivity and decreasing in risk, it follows that (ceteris paribus) workers in higher wage

[18] In our quantitative application we focus on gross wages, consistent with our survey questionnaire. To ease notation, it is taken as implied in this expression that $\widetilde{z} = z^r(a,z,\delta,\widetilde{\delta})$, $\dot{a}$ is evaluated at state $(a,\widetilde{z},\widetilde{\delta})$, and $\frac{\partial^2 W(a,\widetilde{z},\widetilde{\delta})}{\partial \widehat{w} \partial a} = \frac{\partial^2 W(a,\hat{w}^{-1}(\hat{w}),\widetilde{\delta})}{\partial \widehat{w} \partial a}$ where $\hat{w}^{-1}(\hat{w})$ is the inverse of $\hat{w}(z) = \tau w(z)^{1-\Upsilon}$.

and lower risk jobs have a higher price of risk and so steeper indifference curves. Second, risk aversion and imperfect insurance then further affect the IC slope, both by indirectly affecting the price of risk and through the remaining terms in the IC slope expression.[19]

Market completeness and job search. To understand how workers trade-off income and job safety, it is useful to consider two extreme cases of market incompleteness. For ease of exposition, we set income taxes to zero ($\tau = 1, \Upsilon = 0$, so that $\hat{w}(z) = w(z)$) and focus directly on reservation wages rather than productivities. The first case is when workers are *hand-to-mouth* (HtM), i.e., they cannot self-insure at all. Then, Equation (8) becomes

$$u(b) - u(w^u) = (s_e - 1)\lambda(\theta) \int_{A_u} \left[W_{\text{HtM}}\left(\widehat{z}, \widehat{\delta}\right) - U_{\text{HtM}} \right] dF(\widehat{z}, \widehat{\delta}), \tag{11}$$

since value functions and job acceptance sets no longer depend on assets. Given the option value of search on the right hand side is a scalar, this condition defines a unique reservation wage for unemployed workers w^u independent of the unemployment risk $\widehat{\delta}$ of a specific job offer the worker receives. Similarly, with HtM workers, Equation (9) defines a reservation wage for employed workers $w^r(z, \delta, \widetilde{\delta})$ that satisfies

$$u(w(z)) - u(w^r(z, \delta, \widetilde{\delta})) = \left(\widetilde{\delta} - \delta\right) \left[W_{\text{HtM}}(z, \delta) - U_{\text{HtM}} \right]. \tag{12}$$

At the other extreme is the case of perfect consumption insurance, which simply corresponds to Equations (11)–(12) under linear utility, $u(c) = c$, i.e., risk neutrality (RN).[20] In this case, the EE reservation wage is analogous to Pinheiro and Visschers (2015):

$$w(z) - w^r(z, \delta, \widetilde{\delta}) = \left(\widetilde{\delta} - \delta\right) \left[W_{\text{RN}}(z, \delta) - U_{\text{RN}} \right]. \tag{13}$$

Similarly, the wage-job safety indifference curve slopes depend on the degree of self-insurance. Equation (10) in the HtM case becomes $\partial w^r(z, \delta, \widetilde{\delta})/\partial \widetilde{\delta} = (W_{\text{HtM}}(z, \delta) - U_{\text{HtM}})/u'(w^r(z, \delta, \widetilde{\delta}))$ and under RN it is simply $\partial w^r(z, \delta, \widetilde{\delta})/\partial \widetilde{\delta} = W_{\text{RN}}(z, \delta) - U_{\text{RN}}$. It also directly follows that, for a given (z, δ), the indifference curves under risk neutrality are linear in $(w^r, \widetilde{\delta})$ space and are strictly convex when workers are hand-to-mouth. In-

[19] The ability to adjust saving and consumption affects the slope through the worker's choice of c^*. If a worker finds it optimal to adjust their current asset position (i.e., save or dissave), two additional terms, each involving asset drift induced by optimal consumption choice, matter for this trade-off. The term in the numerator captures the change in precautionary savings induced by the change in the job destruction rate, whereas the term in the denominator corresponds to how a higher wage improves future self-insurance.

[20] The perfect insurance case can be rationalized by assuming workers can sign state-contingent insurance contracts with perfectly competitive, risk-neutral insurers who share their discount rate. Those insurers, in turn, get to observe and dictate job acceptance decisions to workers.

tuitively, the partial self-insurance baseline we consider is in between these two extremes and we will use our quantitative model to assess the cost of limits to self-insurance for job mobility. Crucially, we can use these EE reservation wages $w^r(a, z, \delta, \widetilde{\delta})$ to build model counterparts to the individual RPR coefficients we estimate in Section 2.2.

3.3 Firm values and wage determination

We introduce additional notation for workers' job acceptance decisions to define firm value functions. Let $\mathbf{1}^e(\widetilde{z}, \widetilde{\delta}|a, z, \delta)$ denote whether an offer $\left(\widetilde{z}, \widetilde{\delta}\right)$ is accepted by an employed worker with (a, z, δ). Let $\mu^e(a, z, \delta)$ denote the fraction of those job offers accepted. Then:

$$\mathbf{1}^e(\widetilde{z}, \widetilde{\delta}|a, z, \delta) = \begin{cases} 1 \text{ if } W\left(a, \widetilde{z}, \widetilde{\delta}\right) > W(a, z, \delta) \\ 0 \text{ otherwise} \end{cases} \quad \text{and} \quad \mu^e(a, z, \delta) = \int_{\widetilde{z},\widetilde{\delta}} \mathbf{1}^e(\widetilde{z}, \widetilde{\delta}|a, z, \delta) dF(\widetilde{z}, \widetilde{\delta}). \tag{14}$$

Similarly, let $\mathbf{1}^u(\widetilde{z}, \widetilde{\delta}|a)$ indicate whether an unemployed worker with assets a accepts an offer $\left(\widetilde{z}, \widetilde{\delta}\right)$ and let $\mu^u(a)$ denote the fraction of those offers accepted:

$$\mathbf{1}^u(\widetilde{z}, \widetilde{\delta}|a) = \begin{cases} 1 \text{ if } W\left(a, \widetilde{z}, \widetilde{\delta}\right) > U(a) \\ 0 \text{ otherwise} \end{cases} \quad \text{and } \mu^u(a) = \int_{\widetilde{z},\widetilde{\delta}} \mathbf{1}^u(\widetilde{z}, \widetilde{\delta}|a) dF(\widetilde{z}, \widetilde{\delta}). \tag{15}$$

Production value. We assume that asset markets are segmented so that entrepreneurs, who own the firms, finance vacancies using only their own equity. Profits are therefore discounted at rate ρ_f. The value of a firm employing a worker with assets a in a match with productivity z and unemployment risk δ satisfies the following HJB equation:

$$\rho_f J(a, z, \delta) = z - w(z) + J_a(a, z, \delta)\dot{a} - (\delta + s_e \lambda(\theta)\mu^e(a, z, \delta))J(a, z, \delta), \tag{16}$$

where $J_a(a, z, \delta)$ is the partial derivative of the value function with respect to assets and asset drift $\dot{a}$ follows Equation (5) according to the worker's optimal consumption choice. The firm keeps the residual productivity after paying wages. The match terminates either exogenously at rate δ or because the worker quits to another job at rate $s_e \lambda(\theta)\mu^e$. The firm value depends on assets through how they affect worker decisions.[21] Here, we already assume a free-entry condition that pushes the firm's outside value to zero discussed below.

[21] We assume the firm discounts profits at the entrepreneur's discount rate ρ_f. However, a firm with unconstrained access to borrowing would instead discount the future at the interest rate r. We have experimented with both options and found very similar results. Appendix Figure **??** compares our general equilibrium experiment in Section 4.5 when firms discount at either ρ or r.

Free entry. Due to random matching, firms meet workers in proportion to their search effort as a fraction of total effort. Therefore, conditional on contact, the probability of meeting an unemployed worker with assets a is $g^u(a)/S$, and the probability of meeting an employed worker with characteristics (a, z, δ) is $s_e g(a, z, \delta)/S$. Free entry equates the cost and expected benefit of vacancy posting, accounting for worker acceptance decisions:

$$\kappa = q(\theta)\frac{1}{S}\int_{\widetilde{z},\widetilde{\delta}}\left[\int_a J(a,\widetilde{z},\widetilde{\delta})\mathbf{1}^u(\widetilde{z},\widetilde{\delta}|a)g^u(a)da + s_e\int_{a,z,\delta} J(a,\widetilde{z},\widetilde{\delta})\mathbf{1}^e(\widetilde{z},\widetilde{\delta}|a,z,\delta)g^e(a,z,\delta)dadzd\delta\right]dF(\widetilde{z},\widetilde{\delta}). \tag{17}$$

Wage determination. Wages are continuously renegotiated to overcome the issue of on-the-job search giving rise to a non-convex bargaining set (Shimer, 2006).[22] We also assume that the threat to terminate the match in the absence of a wage agreement is not credible whenever the surplus remains positive, as argued by Hall and Milgrom (2008). Hence, bargaining happens over the instantaneous flow surplus. To this end, we construct a non-cooperative bargaining game that yields a simple wage rule building on the insights by Gottfries (2023) and Elsby and Gottfries (2021).[23]

The game is as follows. At each instant dt the worker prepares two offers w_{W1} and w_{W2}, for stage 1 and stage 2, respectively. The firm anticipates all possible stage-1 offers and commits to an acceptance/rejection rule and also commits to its counter-offer w_F in case it rejects w_{W1}. Crucially, the worker's second-stage offer and the firm's counter-offer are take-it-or-leave-it, and with probability ψ it is w_{W2} that is selected.[24] In case of no agreement in stage 1, the worker receives a strike support payment χ, whereas the firm gets nothing. If stage 2 ends in disagreement, no output is produced and the worker receives strike-payment χ while the firm receives nothing. The parties then return to their outside options.

With these disagreement payoffs, backward induction implies the following stage-2 offers. If the worker starts, she chooses w_{W2} to maximize her flow payoff, subject to the firm weakly preferring acceptance over disagreement, setting $w_{W2} = z$. If the firm starts, it chooses the smallest wage the worker would accept, which is $w_F = \chi$. Hence, the expected stage-2 payoffs are $\psi z + (1-\psi)\chi$ and $(1-\psi)(z-\chi)$ for the worker and firm, respectively.

[22] We keep the wage structure deliberately simple to focus on how risk affects job search. How risk interacts with and shapes the wage structure is a secondary issue left for future research.

[23] We thank Axel Gottfries for conversations which were instrumental in designing this wage rule.

[24] The game can be viewed as each side submitting two labeled envelopes: the worker lists w_{W1} in the first and w_{W2} in the second, while the firm provides a yes/no for each w_{W1} in the first and lists w_F in the second.

Given these stage-2 continuation values, the firm accepts a stage-1 offer w_{W1} whenever $z - w_{W1} \geq (1-\psi)(z-\chi)$. For the worker, any $w_{W1} \geq \psi z + (1-\psi)\chi$ is better than the expected stage-2 payoff. Therefore, the unique wage that both parties accept in stage 1 is $w = \psi z + (1-\psi)\chi$, which the worker proposes in equilibrium.

3.4 The asset market, government budget constraint and equilibrium

Asset market. The risk free bond is traded by households and the government, and is in net zero supply. Letting A_g denote government savings and $A_h = \int a g^e(a,z,\delta) da dz d\delta + \int a g^u(a) da$ denote private household savings, market clearing requires that $A_h + A_g = 0$.

Government budget constraint. The government runs a balanced budget where tax revenues and interest income from savings cover government spending and UI outlays:

$$G + b \cdot u = \int \left(w(z) - \tau w(z)^{1-\Upsilon}\right) g^e(a,z,\delta) da dz d\delta + \left(b - \tau b^{1-\Upsilon}\right) u + r A_g. \tag{18}$$

We can now define a steady-state equilibrium of our model.

Definition 1 (Steady-state equilibrium)**.** *A steady-state equilibrium is a collection of value functions $U(a)$, $W(a,z,\delta)$, $J(a,z,\delta)$, and associated policy functions, wage function $w(z)$, worker distributions $g^u(a)$, $g^e(a,z,\delta)$, labor market tightness θ and real interest rate r such that, given exogenous model parameters:*

- *Worker values $U(a)$ and $W(a,z,\delta)$ solve Equations (6) and (7),*
- *firm value $J(a,z,\delta)$ solves Equation (16),*
- *$w(z) = \psi z + (1-\psi)\chi$ is the subgame-perfect equilibrium of the alternating offers game,*
- *labor market tightness θ satisfies the free-entry condition in Equation (17),*
- *the ergodic worker distributions $(g^u(a), g^e(a,z,\delta))$ follow the adjoint of the infinitesimal generator of the HJB equations (Achdou et al., 2022),*
- *the government adjusts either taxes, spending, or debt to balance its budget in Equation (18),*
- *the real interest rate clears the bond market so that $A_h + A_g = 0$.*

4 Quantitative analysis

We now describe our calibration strategy and then use the calibrated model to show that the wage–job safety tradeoff is quantitatively important for job mobility and productivity.

4.1 Calibration

We calibrate the model at a monthly frequency. We set a subset of parameters exogenously and jointly calibrate the remaining ones to exactly match a set of targeted moments, assigning one moment to each parameter. Table 3 reports the calibrated parameters, and Table 4 shows that the model matches the targeted moments well.

Pre-set parameters. We assume CRRA utility, $u(c) = c^{1-\sigma}/(1-\sigma)$, and set the coefficient of relative risk aversion to $\sigma = 2$.[25] We set the monthly risk-free rate to $r = 0.0017$ to generate a 2% annual interest rate. This is supported by choosing government savings to clear the asset market at this interest rate given equilibrium household savings: $A_g = -A_h$. Following Kaplan et al. (2018), we set the borrowing limit to $\underline{a} = -3.175$, which corresponds to 100% of the average quarterly wage. We discretize assets on a grid with $H = 50$ nodes.[26]

We specify the matching function as $M(S, V) = \alpha S^{\eta} V^{1-\eta}$, implying a worker contact rate $\lambda(\theta) = \alpha\theta^{1-\eta}$ and a firm contact rate $q(\theta) = \alpha\theta^{-\eta}$. We set the matching function elasticity to $\eta = 0.5$, as is standard, and choose matching efficiency α to normalize labor market tightness to $\theta = 1$ in steady state. We set the strike payment to $\chi = 0$, which simplifies the wage rule to $w(z) = \psi z$. We set $\psi = 2/3$ to match a labor share of 2/3. We set the tax shifter to $1 - \tau = 0.2$, close to the average personal income tax rate in the data. We set tax progressivity to $\Upsilon = 0.18$ following Heathcote et al. (2017).

Estimated parameters. We allow the match-specific productivity z and unemployment risk δ to be correlated. Specifically, we set $(z, \delta) = e^x$, where x is a 2 by 1 vector drawn from a bivariate normal distribution with means (μ_z, μ_δ), standard deviations $(\sigma_z, \sigma_\delta)$, and correlation coefficient $\rho_{z,\delta}$. The joint distribution $F(z, \delta)$ induces two marginal distributions for job risk $F^D(\delta)$ and productivity $F^Z(z)$, respectively. We discretize the distribution with $I = 20$ productivity nodes, $J = 15$ risk nodes, evenly spaced on a logarithmic scale. We choose μ_z to normalize the expected value of z for an offer to 1. The parameter σ_z governs

[25] This value is standard in the literature (Hornstein et al., 2011), lies within the range considered by Aiyagari (1994) in theoretical work and of empirical estimates. A recent meta-analysis by Elminejad et al. (2022) reports estimated and calibrated values of relative risk aversion that typically lie between 0 and 10.

[26] Specifically, the asset grid is equi-spaced between the borrowing limit $\underline{a}$ and an upper bound $\overline{a} = 9$, which leaves near-zero mass at the boundary (in our calibration 0.1%) in the ergodic distribution.

Table 3: Calibrated Model Parameters

Parameter	Description	Value	Source/Target
	Pre-determined		
r	Interest rate	0.0017	Risk-free interest rate of 2%
σ	Risk aversion	2	Standard
$\underline{a}$	Borrowing limit	-3.175	Kaplan et al. (2018)
τ	Tax shifter	0.8	Personal income tax $\simeq$ 20%
Υ	Tax progressivity	0.18	Heathcote et al. (2017)
η	Matching elasticity	0.5	Standard
ψ	Bargaining weight	2/3	Labor share of 2/3
χ	Strike payment	0	See text
	Estimated		
ρ	Discounting	0.0147	Average quarterly MPC
b	Unemployment benefit	0.423	Average replacement rate
s_e	Search efficiency on the job	1.35	Average EE rate
μ_δ	Unemployment risk mean parameter	-3.59	Average EU rate
σ_δ	Unemployment risk std parameter	0.868	EU tenure slope
μ_z	Mean of marginal density of z_0	-0.039	Average z_0 normalised to 1
σ_z	Std. dev. of marginal density of z_0	0.278	Mean-Min ratio
$\rho_{z,\delta}$	Correlation EU risk and productivity	-0.20	See text
κ	Vacancy posting cost	0.281	Unemployment rate
A_g	Government saving	0.171	Asset market clearing
G	Wasteful gov. spending	0.197	Government budget

Notes: This table summarizes the model parameters that are exogenously set and jointly estimated.

the dispersion of *offered* wages, which we discipline by matching the mean-minimum ratio of *observed* wages found in the data. We define the minimum wage as the 5th percentile of the wage distribution and target a ratio of 1.6 for residualized wages, consistent with the estimates of Tjaden and Wellschmied (2012) and standard values in the literature.

To discipline heterogeneity in EU risk, we target the EU-tenure hazard profiles in the data, which measure the probability that an employed worker transitions to unemployment in the next month at each level of job tenure. We construct these hazards from the CPS in Section 2 and condition on worker characteristics. EU hazards decline with tenure. The model explains this pattern through composition effects: riskier jobs end earlier, either because they carry higher intrinsic EU risk or because workers quit them sooner. We choose the mean μ_δ to match the average EU rate in the CPS, and the dispersion σ_δ to match the downward slope of the EU-tenure hazard. In particular, we target a difference of 1.3 percentage points in the mean EU rate for tenures 0–4 relative to tenures 40–44. Figure 2 Panel (a) plots the model and data EU–tenure hazards and shows that the model also fits hazards at untargeted tenures well.

We calibrate a negative correlation between job productivity and separation risk of $\rho_{z,\delta} = -0.2$. This value balances two distinct measures of the wage-job safety relationship

Table 4: Model Fit

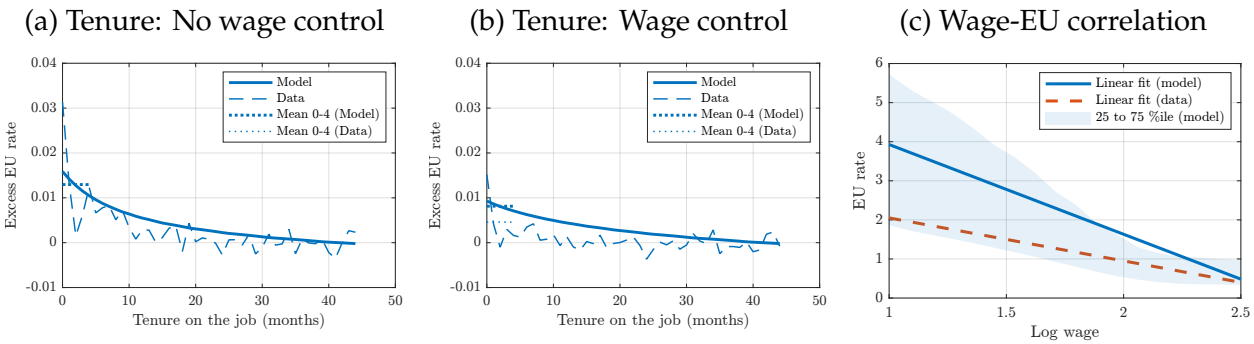
Moment	Target	Model
Replacement rate	0.400	0.400
Unemployment rate	0.050	0.050
EE rate	0.026	0.026
EU rate	0.013	0.013
Relative EU rate at tenure 0-4	0.013	0.013
Mean-Min wage ratio	1.600	1.599
Average quarterly MPC	0.200	0.202

Notes: This table presents the calibration targets and corresponding model values.

in the data, both explored in Section 2. First, we measure the relationship between current wages and EU risk in the model's ergodic distribution by regressing $\log w$ on δ, which yields a coefficient of -0.0230. We run the same regression in the CPS, where each observation corresponds to an industry–occupation–state cell with an associated average wage and EU risk, and obtain a coefficient of -0.011. We plot both lines of best fit in Figure 2(c). The model generates a stronger wage–safety correlation than the data, though the coarse definition of jobs in the CPS likely masks within–cell heterogeneity in job risk. Second, revisiting the EU-tenure hazards and additionally controlling for wages in the CPS, the excess EU rate at tenures 0-4 relative to 40-44 drops by 64%, from 1.3pp to 0.5pp. Controlling for current wage in our model, the drop is only 37%. Figure 2(b) plots the corresponding model and data hazards. By this measure, our model generates too-low of a correlation between wages and safety, since controlling for wages eliminates less of the EU-tenure slope than in the data. However, the CPS wage measure reflects the average of the two observed wages per worker—as the survey elicits wages only at the end of each rotation—rather than the wage of the current job. Taken together, these two moments provide informative but imperfect guidance. Setting $\rho_{z,\delta} = -0.2$ strikes a medium between the overestimation of the wage–safety correlation implied by the first measure and the underestimation implied by the second.

We match aggregate labor flows to their CPS means between 1996 and 2007. We target the monthly EU rate, the adjusted EE rate following Fujita et al. (2024), and the unemployment rate. Given an average EU rate of 1.31%, we choose the worker offer arrival rate per unit of search efficiency, $\lambda(\theta)$, to match an unemployment rate of $u = 0.05$. This target pins down market tightness θ and hence the firm contact rate $q(\theta)$ through the matching function. The implied θ is achieved by choosing the vacancy posting cost, κ,

Figure 2: EU Rate by Tenure and Wage



Notes: Panel (a) plots the EU-tenure hazard in the model and data, relative to their mean values at tenures 40–44. Panel (b) plots a version which controls for wages. The data are unsmoothed, and the horizontal dashed lines show the mean at tenure 0-4 in the model and data. Panel (c) plots EU rates against log wages. The lines show linear best fits in the model and data, and the shaded region denotes the interquartile range of EU rates at each wage level in the model's ergodic distribution. XXX GET DATA FOR PANEL C

such that the value of posting a vacancy is zero in steady state. We set the search efficiency of employed workers, s_e, to match a monthly EE transition rate of 2.6%. The value of unemployment benefits b is set to generate an average replacement rate of 40% of the mean wage. We choose the amount of wasteful government spending, G, to balance the government's budget in steady state, given tax revenues, savings, and UI expenditures.

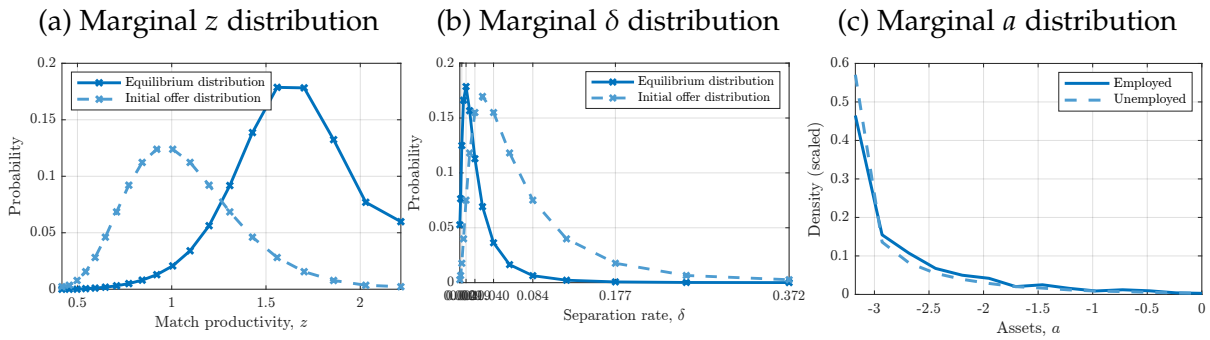
We estimate the discount rate at $\rho = 0.0147$ to match an average quarterly, income-weighted marginal propensity to consume (MPC) out of a \$500 transfer of 20% following Auclert et al. (2020, 2024). Matching MPCs has become a crucial input into the calibration of incomplete markets models, making this target especially important. This value implies an annual discount rate of 16%.[27] Despite the high discount rate, our model generates sensible consumption and asset distributions, as we discuss in the next section.

4.2 Evaluating the calibration and untargeted moments

Before exploring our model's ability to match the wage–job safety indifference curves elicited in our custom survey, we describe the properties of the calibrated steady state and assess its performance along untargeted moments.

[27] Following Kaplan et al. (2018), we discipline the discount rate using MPCs, since one-asset models such as ours require relatively high impatience to generate empirically plausible MPCs. Nonetheless, our discount rate exceeds theirs: Kaplan et al. (2018) match an MPC of 15% with only a 9% discount rate (including mortality). This difference could reflect that wages are fixed during the life of a match in our model, which could reduce the amount of labor income risk—especially in safe jobs—relative to their model.

Figure 3: Steady state: Marginal distributions



Notes: This figure plots the steady-state marginal distributions obtained by integrating the joint distribution $g^e(a, z, \delta)$ over each dimension, alongside the corresponding offer distribution for each job characteristic. The asset distributions are scaled to sum to one for both employed and unemployed to improve legibility.

Marginal and joint distributions. Worker and firm decisions jointly determine the equilibrium distribution of workers across jobs. Figure 3 plots the resulting marginal distributions. Panel (a) shows the equilibrium distribution of employed workers over job productivity and the offer distribution for comparison. The equilibrium distribution is shifted to the right as employed workers move up the productivity ladder by moving—on average—to higher productivity jobs through EE transitions. Panel (b) plots the marginal distribution of employed workers over their job's separation rate, again alongside the offer distribution. The difference between the two distributions is striking. Around 75% of workers, but only 25% of job offers, lie in jobs with monthly EU rates of 1.3% or less. Two forces generate this gap. First, safer jobs survive longer. Second, workers escape higher-risk jobs more quickly via EE moves, and reject high risk offers, as they search for safety alongside higher wages. As a result, the average worker holds a substantially safer job than the average job offer. Our calibration strategy establishes that the joint equilibrium wage-job safety distribution is reasonable. As discussed before, Figure 2(c) shows the interquartile range of EU risk at each wage level in the ergodic distribution. At any given wage, the model generates substantial dispersion in separation risk, mirroring the heterogeneity observed in the CPS shown in Figure 1(c).

Finally, Figure 3(c) plots the marginal asset distributions for employed and unemployed workers. As expected, the high discount rate keeps people close to the borrowing constraint, and the level of liquid wealth is too low relative to the data.[28] However, only 43% and 57% of employed and unemployed are borrowing constrained, respectively.

[28] Kaplan et al. (2018) report that aggregate liquid wealth is 26% of yearly GDP in the US and argue that liquid wealth is the appropriate notion to use in a single-asset model. In contrast, our model generates liquid wealth that is -15 percent of annual GDP.

This explains why the model produces sensible MPCs well below 100 percent implied by a hand-to-mouth model. These shares are in line with empirical estimates of hand-to-mouth households, which range from 30–40% once wealthy hand-to-mouth households are accounted for (Kaplan et al., 2014). Furthermore, and perhaps more importantly, our model generates a sensible consumption drop on job loss, which we turn to next.

Consumption fall upon job loss (untargeted). An important aspect of our mechanism is the consumption fall upon job loss. Especially under risk aversion, this response captures the immediate welfare cost of unemployment and therefore governs workers' willingness to trade off wages against risk during job search. This is why it is crucial to incorporate assets into the quantitative model. With a UI replacement rate of 40%, a hand-to-mouth model implies a 60% consumption drop upon job loss—far above empirical estimates. Despite being untargeted in the estimation, our model does much better, and is close to the empirical estimates in Browning and Crossley (2001). Using Canadian data, they find an average 14% decline in monthly consumption expenditures and 25% income loss at unemployment. To facilitate comparison with other countries—where income losses may differ—Low et al. (2010) interpret these figures as a 14/25 = 56% passthrough from income losses to consumption drops.[29] We compute the same objects in our model and find a close match despite not targeting them in the estimation, with details relegated to Appendix B.2. The model generates an average income loss of 47% and a consumption decline of 33% upon unemployment. This is around 1/2 of the 60% consumption fall that would happen in a hand to mouth model, pointing to the high degree of self insurance in the model. The implied passthrough from income to consumption is 33/47 = 69%, which is close to the 56% estimate in the data.[30] These results give us confidence that the cost of unemployment to workers in our model is reasonable, which is a key input into the price of risk embodied in their EE wage-safety indifference curves.

High estimated on-the-job search efficiency (untargeted). We estimate a high employed search efficiency, $s_e = 1.35$. For reference, $s_e = 1$ corresponds to employed and unemployed facing the same job offer arrival rates and $s_e = 0$ rules out on-the-job search. This high estimate contrasts with standard models featuring homogeneous separation risk, which often require $s_e \simeq 0.1$ to match an EE rate that is an order of magnitude lower

[29] Other studies find similar numbers, as discussed in den Haan et al. (2018) Appendix A.

[30] Recalibrating the model with the standard 5% annual discount rate leads to a counterfactually low passthrough of only XXX% and a lower MPC of XXX. These underscore the importance of properly matching consumption dynamics when incorporating incomplete markets into search models.

than the UE rate.[31] Our estimate instead is closer to the recent evidence from Faberman et al. (2022), who show that employed workers are 3.2 times more efficient at search than the unemployed. For intuition, let A_e and A_u denote the average match acceptance rates of employed and unemployed workers, respectively. Then the job finding and switching rates are $ue = A_u\lambda$ and $ee = s_e A_e \lambda$. These imply an on-the-job search efficiency $s_e = (ee/ue)\times(A_u/A_e)$. Our calibration targets give $ee/ue = 0.104$. We therefore estimate a high value of $s_e = 1.35$ only because employed workers accept offers at only $A_e/A_u = 7.7\%$ of the rate that unemployed workers accept offers. This low relative job acceptance rate reflects heterogeneity in job safety and risk aversion, so employed workers—who occupy safe jobs in equilibrium—value safety and turn down many job offers they deem too risky.

EE moves with wage cuts (untargeted). Workers climb up both the productivity and safety ladders, but may trade off one dimension against the other when doing so moves them to a higher indifference curve. In equilibrium 6.2% of EE transitions involve a wage cut, moving to a job with lower separation risk in return. This margin is absent in a homogeneous unemployment risk model in which all EE moves come with a wage increase. In the data, 34% of EE moves feature a wage cut (Tjaden and Wellschmied, 2012), which standard models rationalize by introducing a so-called *godfather shock* that forces workers to switch jobs or by other features such as a bargaining protocol that back loads wages (Cahuc et al., 2006). In our model, safety-enhancing EE moves could therefore account for around 18% of the EE moves with wage cuts observed in the data.

4.3 EE wage-safety indifference curves in the model and data

A key question is how workers trade off wages against unemployment risk when making job-to-job switches. We elicit these preferences empirically by estimating wage-safety indifference curves from our custom survey in Section 2.2 and derive their theoretical counterparts in Section 3.2. We now turn to studying whether the indifference curves from our model, despite being untargeted, provide a good quantitative fit to the data.

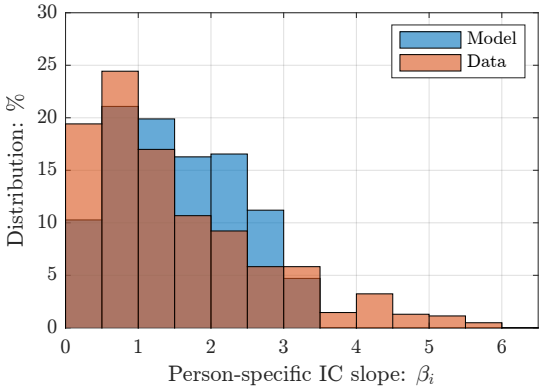
To this end, we replicate the empirical analysis of Section 2.2 using simulated data from the model. For brevity and with a slight abuse of notation, we express worker value functions in terms of wage w rather than productivity z, $W(a, w, \delta)$.[32] For an employed worker with state (a, w, δ), we compute the reservation wage $w^r(a, w, \delta, \widetilde{\delta})$ which makes

[31] We assume exogenous search effort. Recent examples that maintain this assumption but estimate lower values for on-the-job search efficiency are Elsby and Gottfries (2022) ($s_e = 0.148$), Mercan and Schoefer (2020) ($s_e = 0.056$), and Carrillo-Tudela et al. (2022) ($s_e = 0.103$).

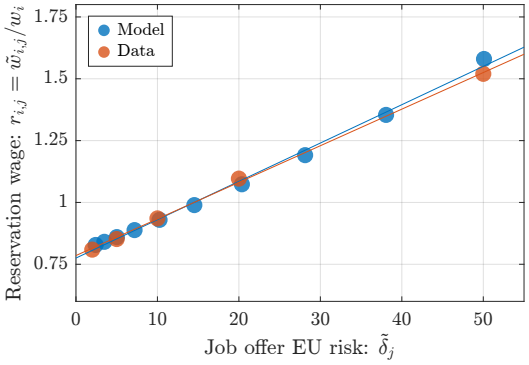
[32] Since $w(z) = \psi z$, the mapping from wage to productivity is trivial, which allows us to work with reservation wages rather than reservation productivities.

Figure 4: Indifference curves in the model and data

(a) IC slope distribution



(b) Average within-worker IC



Notes: Panel (a) plots the distribution of wage-risk indifference curve slopes across employed workers in the model and data. Each worker's indifference curve slope is the estimated coefficient β_i from Equation (4). The distribution in the data is across respondents and in the model across the ergodic distribution. Panel (b) computes the average within-worker indifference curve slope using the coefficient β from the regression specification in Equation (3) with worker fixed effects. These are plotted as the solid lines (intercepts normalized s.t. $r_{i,j} = 1$ for $\tilde{\delta}_j = 14.5\%$) with the dots giving the equivalent non-parametric visualization using a binscatter which first removes worker fixed effects from $r_{i,j}$.

them indifferent between their current job and an offer with separation rate $\widetilde{\delta}$, defined by

$$W(a, w, \delta) = W(a, w^r(a, w, \delta, \widetilde{\delta}), \widetilde{\delta}). \tag{19}$$

For each worker state (a, w, δ), this yields a reservation wage for each value of $\widetilde{\delta}$. The resulting simulated data structure is therefore analogous to the indifference curve elicitation question in our survey. We restrict attention to $\widetilde{\delta}$ values spanning the range of hypothetical risks asked in the survey, and weight workers using the ergodic distribution of employed workers over (a, w, δ) in the analysis of simulated model data.

We first compute worker-specific indifference curve slopes, β_i, by estimating the linear specification in Equation (4) for each worker state. Figure 4(a) plots the distribution of these slopes in the model and data. In the model, IC slopes depend on assets, wage, and separation risk, generating—consistent with the data—a wide range of slopes in equilibrium. While the upper tail of the distribution in the data is fatter than in the model, the fit across the interquartile range is fairly close: the 25th percentile IC slope is 0.62 in the data and 0.85 in the model, and the 75th percentiles are 2.15 and 2.12, respectively.

Most importantly, the model generates an *average* IC slope which is close to the data. Averaging β_i across workers in our survey yields a mean slope of 1.53, compared with 1.55 in the model. Hence, in both the model and the data, employed workers require

approximately a 1.5% wage increase to compensate for a 1 percentage point increase in job loss risk across a 12-month horizon.[33,34] We further corroborate this result in Figure 4(b), where we replicate the regression analysis in Equation (3) in the model. Specifically, for a worker i considering a move to a job with risk $\widetilde{\delta}_j$, we regress the reservation pay ratio on the risk in the new job, including worker fixed effects. The estimated coefficient β captures the average indifference curve slope, which is equal to 1.49 in the data, as previously reported in Table 1.[35] Repeating the analysis in the model yields a slope of 1.55, and the figure shows that the implied ICs are visually indistinguishable across the range of unemployment risk changes considered by workers in the sample. We additionally visualize indifference curves non-parametrically using binned scatter plots, shown by the dots, to investigate the fit of the model and data across the whole range of possible risk changes. We partition the risk changes into bins and compute average risk changes and reservation wage ratios within each bin after removing worker fixed effects.[36] The model again matches the data well, as the average indifference curve is quite linear with respect to risk changes in both the model and the data.

Next, we investigate how IC slopes vary with worker and job characteristics, comparing the model to the data. Table 2 column (1) shows that workers in safe jobs have an IC slope of 1.80 while those in risky jobs only have a slope of 0.72. Doing the same in the model—defining safe jobs as those with below-median EU risk as in the data—we find that workers in safe jobs have an IC slope of 2.14 and those in risky jobs have a slope of 1.12. Thus the model similarly generates steeper indifference curves for workers in safe jobs.

The model explains this heterogeneity through differences in the price of risk. As shown in Equations (9) and (10), employed workers with a higher value relative to un-

[33] XXX TO THINK ABOUT: The median IC slope is also similar, at 1.17 in the data and 1.47 in the model.

[34] XXX DELETE OR APPENDIX? For jobs near the edges of the wage or safety grids the true reservation wage might lie outside of the grid on which we solve the model. In this case, we compute the reservation wage using extrapolation. To avoid sensitivities induced by extrapolation, in our baseline results we use linear interpolation and extrapolation. Simply dropping any individual where we need to extrapolate to compute their IC, the average IC in the model drops from 1.55 to 1.21, because this requires dropping workers mostly with steep ICs. Switching to shape-preserving piecewise cubic interpolation (`pchip` in Matlab) causes the extrapolated values to rise slightly so the average IC rises to 1.70. Switching to Modified Akima cubic Hermite interpolation (`makima`) or spline interpolation (`spline`) causes the average IC to change to 1.54 and 2.11 respectively. However, these nonlinear extrapolation methods all cause spurious nonlinear ICs when extrapolating in the risk neutral model (when using δ_j on the x axis, so we know analytically that ICs must be linear) leading us to take linear interpolation/extrapolation as our baseline.

[35] The estimate 1.49 is slightly different from the 1.53 computed by simply averaging over each worker's β_i. In a balanced panel, i.e. complete j data for each worker i, the two would be identical. This difference reflects some missing j data for individual workers. In the model, where the panel is balanced by construction, the two estimates coincide at 1.55.

[36] As we remove worker fixed effects, we study the slope rather than the level of these curves. We normalize the level of each IC to have a reservation ratio of one at the model's average EU risk level (14.5% annual).

employment, $W(a, w, \delta) - U(a)$, have steeper indifference curves. Since safer jobs have higher value, i.e., $W_\delta(a, w, \delta) < 0$, workers in such jobs demand a larger wage premium for increases in risk, consistent with the data. The model also qualitatively replicates the finding that workers in high wage jobs have steeper indifference curves, again because high wage jobs have higher value (i.e., $W_w(a, w, \delta) > 0$) and hence price of risk. Table 2 column (2) shows that, in the data, workers in above-median wage jobs have an average IC slope of 1.60 while those in below-median wage jobs have a slope of only 1.34. The equivalent numbers in the model are 2.01 and 0.77.[37]

Finally, the model matches the empirical pattern that workers with higher perceived consumption drops upon job loss have steeper indifference curves. Table 2 column (3) shows that workers reporting that their consumption would stay the same or increase following job loss have an average IC slope of 0.95, while those reporting their consumption would fall by a bit or much have slopes of 1.48 and 1.50, respectively. In the model, workers with below median consumption declines upon unemployment have an average IC slope of 1.11, compared with 2.03 for those above-median declines. While these magnitudes are somewhat larger in the model, the qualitative patterns closely mirror those in the data.[38]

4.4 Incomplete markets and the wage-safety trade off in job switching

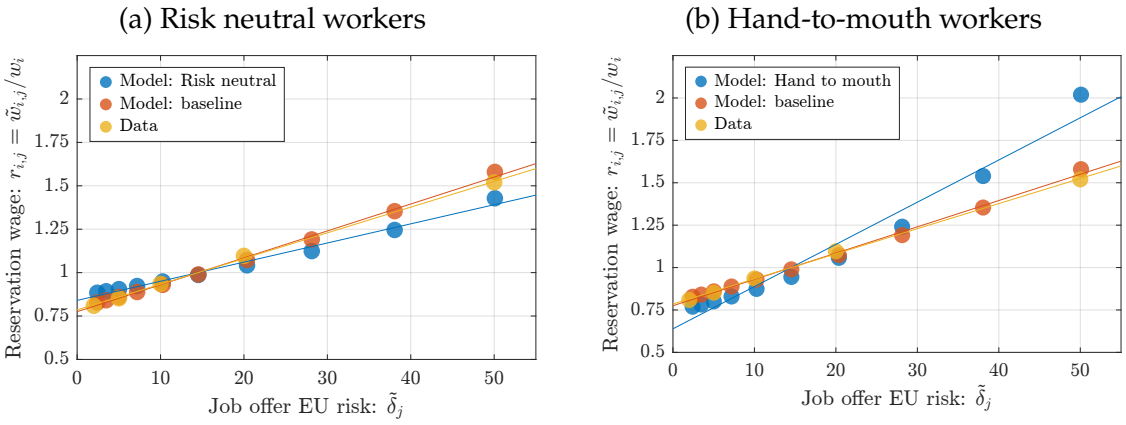
Imperfect insurance and worker ICs. Having established that our model indifference curves match the data well, we turn to the role of incomplete markets in determining their slope and shape. To this end, we perform counterfactual experiments where we make workers in the model first risk neutral, and then risk averse but hand to mouth consumers. The former case can be thought of as one where workers are perfectly insured (but still discount future income at rate ρ) against income shocks while the second case is the limit of no insurance.[39] In these experiments, we hold all the parameters at their baseline calibrated values and operate in partial equilibrium, i.e., we hold prices (r, λ) and taxes (τ, Υ) fixed, and change only the workers' utility function or ability to insure. Thus, these results show the role of insurance within our calibrated model.

[37] Interestingly, the model finds a greater sensitivity of IC slope to wage than in the data. This suggests that workers may value wage differences less in the data than in the model, perhaps due to unmodeled forms of household insurance or non-wage amenities. XXX not sure if / what to say here.

[38] Exact comparison with the data is challenging since in the model essentially 0% of workers have unchanged or increased consumption following job loss. XXX again not sure if / what to say. Again the model seems to have stronger effect than in the data?

[39] The full insurance case corresponds to, for example, all workers forming an insurance union where they pool all income in order to maintain constant consumption across all states. The union is not allowed to invest in outside assets, so discounts the future at rate ρ, and makes job acceptance decisions on behalf of its member workers. This construction allows us to isolate the role of insurance from that of discounting.

Figure 5: Indifference curves under risk-neutral and hand-to-mouth workers



Notes: This figure plots the average within-worker indifference curve slopes (β from the regression specification in Equation (3) with worker fixed effects) in the data and various model variants. Solid lines denote the slope estimated by β and dots show the binscatters residualized using worker fixed effects, with intercepts normalized s.t. $r_{i,j} = 1$ for $\widetilde{\delta}_j = 14.5\%$. Both panels display the data and the baseline model. Panel (a) additionally plots the the model IC under risk neutrality, holding all other parameters fixed, and panel (b) does the same for hand-to-mouth workers with risk aversion kept at the baseline value.

In Figure 5 we repeat the model and data indifference curves in Figure 4(b), but additionally plot ICs for each counterfactual model.[40] Since the calibrated model matches the data well, each counterfactual moves the model further from the data in opposing directions. Panel (a) plots the average indifference curve under risk neutrality, which reveals that ICs flatten on average under linear preferences with the slope dropping from 1.55 to 1.10. This is intuitive, as employed workers demand a lower wage premium to move to riskier jobs as they care less about job safety. Importantly, this exercise demonstrates that workers in the baseline model do not act as if they are risk neutral when evaluating risks, despite the opportunity to self-insure through the risk-free asset while employed.[41]

Figure 5(b) instead plots the average indifference curve when workers are risk averse but hand-to-mouth consumers. The indifference curve becomes steeper, with its slope rising from 1.55 in the calibrated model to 2.49. This reflects that absent self insurance workers become effectively more risk averse, and hence demand higher wage premia to move to riskier jobs. In addition, the average indifference curve with hand-to-mouth

[40] To isolate the role of preference changes, we run the average IC curve regressions using the worker distribution from the baseline model as weights, not the resulting ergodic distributions of the counterfactual models. However, the results are almost identical if we instead use the new distributions.

[41] Section 3.2 shows analytically that the indifference curve is linear under risk neutrality, as in Pinheiro and Visschers (2015), which is true only for the true monthly job separation rate $\widetilde{\delta}$. Figure 5(a) plots the IC for yearly EU rates, $\widetilde{\delta}^Y = 1 - e^{-12\widetilde{\delta}}$, where the compounding introduces a mild convexity.

workers becomes visibly convex, as shown in the binned scatterplot, in contrast to the data and calibrated model which are approximately linear. This convexity follows directly from Section 3.2, where the HtM ICs are characterized by Equation (12). The concave utility function applied to the reservation wage, $u(w^r(w, \delta, \widetilde{\delta}))$, makes the IC convex by requiring ever larger wage increases to compensate for marginal increases in unemployment risk. This effect is also present in the baseline model, but is dampened by self insurance so that the average indifference curve is effectively linear, albeit steeper than under risk neutrality.

In summary, these two counterfactual exercises demonstrate that risk aversion and imperfect insurance play an important role in shaping the wage-risk trade off in our model. This, in turn, opens the door to studying how policy interventions or structural changes that impact effective risk aversion propagate into workers' on-the-job search behavior. We now turn to the implications of the extent of self insurance for aggregate outcomes.

Aggregate effects of imperfect insurance. In our baseline calibration, workers are reasonably well insured when making EE switches: the calibrated model's IC slope of 1.55 is closer to the RN model's 1.10 than it is to the HtM model's 2.49. To contextualize these numbers, we study how the extent of self insurance shapes aggregate outcomes such as productivity, unemployment, or the EE rate. We maintain the partial equilibrium analysis, i.e., we focus on the first-round effects of how workers' risk preferences determine the aggregates without price adjustments.[42] Table 5 presents our results.

Starting with the EE rate, moving to risk neutrality has a significant effect on the overall EE rate, which rises by 10.4% relative to the baseline calibration, as workers in safe jobs make riskier EE moves. Moving to the hand-to-mouth economy reduces EE moves to fall by 2.8%, but the magnitude of the change is smaller. Hence, by this metric, the calibrated economy appears further from a world of risk neutrality than it is to one of hand-to-mouth behavior. This theme carries over to the other variables, apart from average labor productivity (Y/n) which moves relatively symmetrically around the steady state.

The table reveals the main mechanisms by which changing workers' risk tolerance affects the aggregate economy: when risk aversion falls, employed workers are willing to accept riskier job offers, raising the overall EE rate. As workers take riskier jobs, the overall EU rate increases, resulting in a higher unemployment rate. At the same time, productivity rises because workers accept higher wage (i.e., productivity) jobs in exchange for the increase in risk. Changing risk tolerance also affects the equilibrium by changing workers' job acceptance behavior out of unemployment, as stressed in the previous lit-

[42] The results are similar in general equilibrium, but introduce additional channels that do not add to the discussion of the core mechanisms here. These channels are studied in Section 4.5 where we perform our optimal UI experiment in general equilibrium.

Table 5: Partial equilibrium effects of varying consumption insurance

	Y/n	u rate	EE rate	EU rate	UE rate
Calibration	1.587	0.050	0.026	0.013	0.250
Risk neutral	1.590	0.054	0.029	0.015	0.252
% difference	0.14%	9.67%	10.39%	11.41%	1.08%
Hand to mouth	1.585	0.048	0.025	0.013	0.249
% difference	-0.15%	-2.94%	-2.80%	-3.36%	-0.29%

Notes: The table compares the equilibrium of the calibrated model with incomplete markets (top row) to the counterfactuals where workers are risk neutral (second row) or hand to mouth (fourth row). Rows three and five give the percent difference of each counterfactual from the calibration. These are partial equilibrium experiments, illustrating the effects of worker decisions on aggregates but where prices and taxes are not allowed to adjust.

erature (Herkenhoff, 2019b). However, this effect is quantitatively much smaller than on the EE rate, as suggested both by the smaller percentage changes in the UE rate than the EE rate, and by further counterfactual decompositions.[43] This reflects that the estimated job search efficiency s_e is high and close to one as discussed in Section 4.2, which makes unemployed workers' reservation wages close to the flow value of unemployment, b, and hence insensitive to changes in risk tolerance or indeed other parameters.

4.5 (Optimal) unemployment insurance and the wage-safety tradeoff

In this section, we investigate what the risk-taking incentives of employed workers imply for UI policy. The key mechanism is that higher UI benefits provide partial insurance, limiting the downside risk of income loss when unemployed, and shape on-the-job search.

The role of UI in shaping ICs. As shown in Section 4.4, comparing risk-neutrality to hand-to-mouth behavior, more insurance induces more frequent and riskier EE moves in our model. We now show that more generous UI benefits have the same effect, consistent with the results from our custom survey.

[43]Specifically, making workers risk averse raises productivity by 0.14%. We perform another exercise where we leave workers as risk averse as in incomplete markets, but force them to use the EE job acceptance policy function from the risk neutral counterfactual, allowing them to reoptimize their UE (and other) choices following their risk averse preferences. Doing so increases productivity by 0.17%, which is very similar (and indeed slightly higher) than the 0.14% increase when both EE and EU policies are risk neutral. This confirms that the bulk of the productivity fall in our model from moving away from complete markets is driven by changing EE, and not UE, decisions.

In our survey, we ask respondents to report their EE reservation wages again under a hypothetical \$100 increase in weekly UI benefits.[44] We then reestimate worker-specific indifference curve slopes, β_i, in Equation (4) for each worker under the UI increase. On average, the IC slope falls from 1.5252 to 1.4946, a 3.1pp decline. In the model, we replicate this experiment by increasing b by \$100 per week.[45] The average IC slope falls from 1.550 to 1.469, an 8.1pp decline. In both the model and data, higher UI benefits reduce the wage premium workers ask to accept higher risk in EE moves. The model response is larger, but it is in the same direction and of comparable magnitude compared with the data.

In the survey, we also elicit workers' perceived probability of making an EE move over the next year, both under the baseline and the hypothetical \$100 increase in UI benefits. On average, respondents report a 21% probability at baseline, which rises by 3.5pp to a 24.5% probability with higher UI. In the model, the calibrated annual EE rate is 27%, which rises by 0.22pp—holding the worker distribution fixed—in the higher UI counterfactual.[46] A key implication is that in a version of the model with no EU risk heterogeneity, an increase in UI leaves the perceived EE rate unchanged—holding the worker distribution fixed. This is because workers always accept any EE offer with higher productivity, regardless of the level of UI benefits, making the EE rate invariant to the benefit level.[47]

In summary, this counterfactual confirms two findings in both the data and model: higher UI benefits makes workers more willing to take riskier EE moves, and this higher risk tolerance increases the number of EE moves they are willing to make—and thus the EE rate. We now turn to the implications for optimal UI level.

Optimal UI in general equilibrium. We also compute the welfare-maximizing level of UI in the model, accounting for general equilibrium effects and the funding of the policy. We vary b over a wide range around its calibrated value, recompute the steady-state equilibrium, and evaluate average worker welfare using a utilitirian welfare metric expressed in equivalent consumption units, described in Appendix B.1.2. We adjust the income tax shifter, τ, to finance the change in government spending so that the program is budget balanced, while the incidence falls on workers. Market tightness θ adjusts to

[44] This corresponds to around a 20% increase in average monthly UI payments in both the data and model.

[45] Appendix B.2 details the calculation of \$ units in the model. We implement the change in partial equilibrium to isolate the effect of UI on worker choices. To mirror the survey—where the sample is fixed by construction—we compute the counterfactual average model slope using the baseline worker distribution.

[46] Despite generating a large increase in the average IC slope, the model implies a smaller rise in the EE rate than workers perceive they will make in the survey with higher UI benefits. Nonetheless, the model-implied change in the EE rate is quantitatively meaningful for the optimal UI exercise below.

[47] In general equilibrium, allowing the worker distribution to adjust, the homogeneous risk model predicts a decrease in the EE rate following a benefit increase, while our full model predicts an increase. We revisit this difference in the optimal UI analysis below.

respect the free entry condition for vacancies.[48] We note that our bargaining assumption keeps wage markdowns fixed, ruling out passthrough from UI benefits to wages. This may constitute an additional general equilibrium channel we abstract from, although evidence suggests it is muted (Jäger et al., 2020). Finally, the interest rate clears the asset market. As the results are insensitive to how the asset market adjusts, we present the baseline under the assumption that the government adjusts its savings, A_g, so that the asset market clears at the original 2% interest rate.[49]

Our main results are summarized in Figure 6, where we vary the replacement rate around its baseline value of 40%. We report key model outcomes for the full model (blue lines) and for an alternative calibration with homogeneous EU risk (red dashed lines).[50]

Panel (a) plots average welfare, measured in consumption equivalent variation relative to baseline.We find that the welfare-maximizing replacement rate in our full model is 50%, slightly above current US policy. Surprisingly, this is close to the 49% optimum in the homogeneous EU risk model, even though the mechanisms through which UI affects the economy differ across the two models. In the remaining panels, dots mark the welfare-maximizing benefit level in each model. Finally, the high optimal benefit level in the model is a direct consequence of risk aversion and incomplete markets: in a risk-neutral version of the model, the optimal replacement rate is only 17%.[51]

In general, raising UI benefits increases welfare because workers are risk averse and cannot fully self-insure, while it decreases welfare through other distortions in the economy. First, UI must be financed by higher taxes (Panel e): moving from near-zero to a 40% replacement rate raises the income tax by around one percentage point in the full model. Second, higher benefits may crowd out private insurance by increasing the interest rate (Appendix B.3). Our focus, however, is the key policy tradeoff: higher UI distorts the production side, leading to a race between higher unemployment and higher productivity.

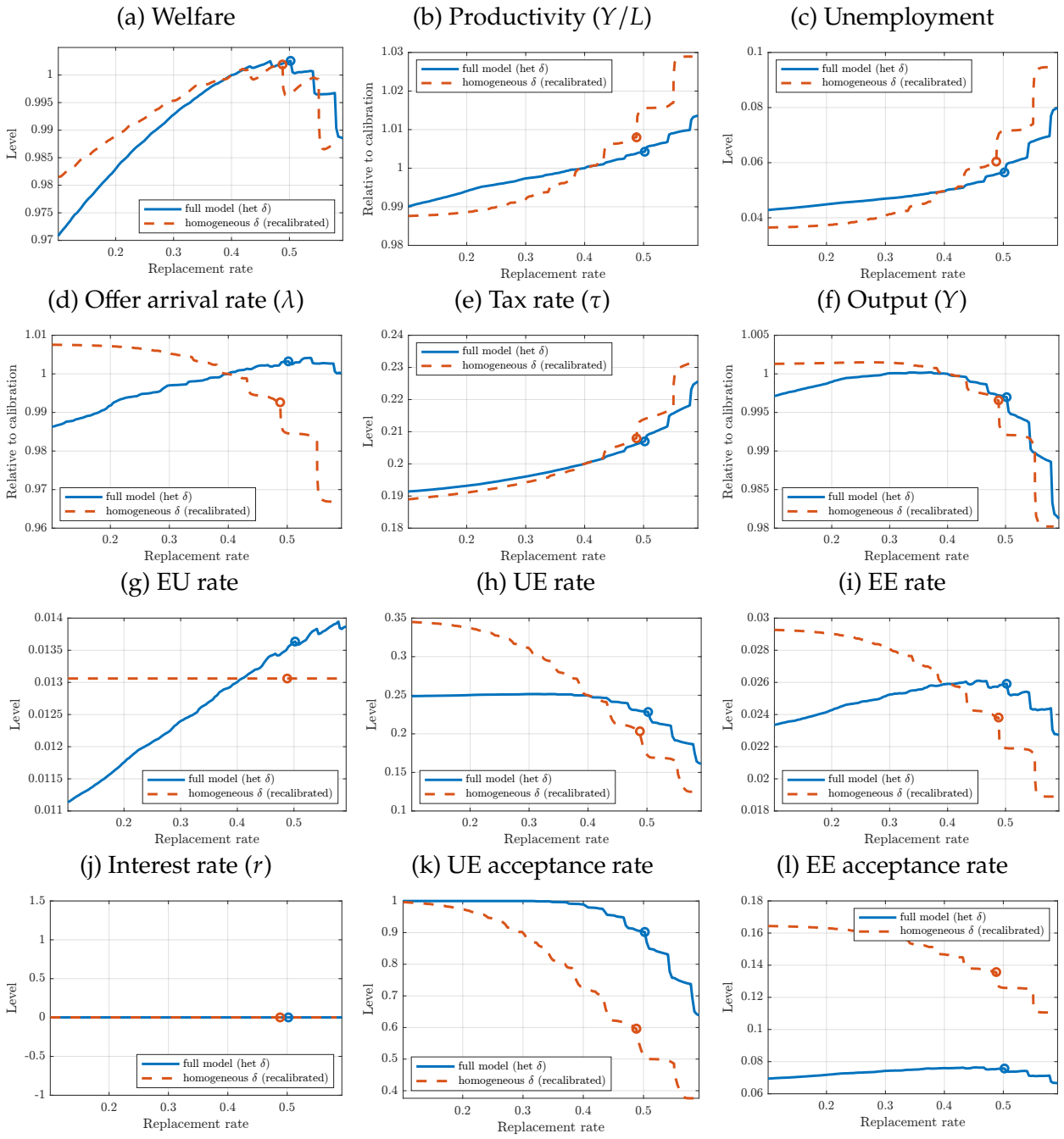
[48] We find modest general equilibrium effects on tightness, so many outcomes resemble the partial equilibrium experiment. While the size of UI general equilibrium effects remains an active research area, this is consistent with the meta-analysis of Cohen and Ganong (2024), who find small effects.

[49] Importantly, this is not equivalent to simply ignoring asset market clearing and fixing r. Allowing A_g to adjust to clear the asset market impacts the government budget constraint and hence the taxes to finance the UI changes. As a robustness check, we instead hold A_g fixed and let the interest rate adjust. The main result is unchanged across the two approaches, with the welfare-maximizing replacement rate being 50% in both. Beyond small quantitative differences, the only substantive difference is in the response of taxes. With fixed r, higher benefits require higher taxes. With endogenous r, higher benefits raise the interest rate. Since the government is a net saver, this increases the government's asset income and can partially offset the tax increase, and even in some cases allows taxes to fall. We compare and discuss these in Appendix B.3.

[50] In this model version, δ is constant across jobs, so we drop the EU-tenure profile and risk-wage calibration targets. The remaining parameters are recalibrated to hit the same moments.

[51] We recalibrate the risk neutral model by setting the discount rate to a standard annual 5% and reestimating all other parameters to match the original moments. Optimal UI is not zero when agents are risk neutral because vacancy posting is not efficient—i.e. a Hosios-type condition does not hold—in our calibration.

Figure 6: Effect of varying UI benefits in general equilibrium



Notes: This figure plots outcomes for various levels of unemployment benefits, b. The solid blue line corresponds to the full model with heterogeneous δ and the red dashed line corresponds to the variant with homogeneous δ, both in general equilibrium. Each panel shows a different variable, in either deviations from the original steady state or levels. The dots denote values at the welfare-maximizing level of benefits.

Unemployment effect: A cost of raising benefits is that it increases unemployment (Panel c). Unemployment is less sensitive to UI in our model than in the model with homogeneous risk, allowing for higher benefits without causing disruptive increases in unemployment. Decomposing this response into flows, higher benefits raise unemployment both because the UE rate falls (Panel h), and because workers select into riskier jobs through EE moves, raising the EU rate (Panel g). Quantitatively, the equilibrium EU rate rises from around 1.1% per month at lower UI levels to more than 1.35% at the optimal UI level—an effect absent in models with homogeneous EU risk. This selection into riskier jobs is consistent with flattening ICs documented in our survey under a hypothetical increase in UI benefits.

Although the EU rate is—by construction—more sensitive to UI in our model than in the homogeneous risk model, the opposite is true for the UE rate. In our model, the UE rate is essentially flat for a wide range of replacement rates, whereas in the homogeneous risk model it falls from roughly 35% per month to 15% per month over the same range. As a result, unemployment is less responsive to benefits in our model. This difference reflects two mechanisms tightly linked to the new risky EE channel of the model.

First, a higher replacement rate reduces the fraction of job offers accepted out of unemployment (Panel k), which lowers the UE rate for a given offer arrival rate, λ. This effect is very strong in the homogeneous risk model, where the fraction of offers accepted drops from 100% down to 60% at the optimal UI level. In the full model, the effect is much weaker, with the acceptance rate dropping to only 90% at the optimal UI level. This difference reflects the estimated value of s_e close to one, which makes unemployed workers less selective over productivity while unemployed. Unemployed workers accept all job offers at the original 40% steady-state replacement rate, where the reservation wage is strictly above the level of UI benefits. Consequently, moderate benefit increases do not immediately truncate the accepted offer distribution. In the homogeneous risk model, we estimate $s_e = 0.51$, which implies that only around 70% of jobs at the calibrated replacement rate are accepted out of unemployment. Therefore, raising benefits further sharply reduces job acceptance and, in turn, the UE rate.[52]

Second, the UE rate is also driven by the offer arrival rate, λ. Panel (d) highlights a new mechanism through which higher benefits may be less costly then typically assumed: in our model, raising UI *increases* the equilibrium offer arrival rate, while it *decreases* it in the homogeneous EU risk model. Although higher benefits are often viewed as making hiring harder for firms, the opposite can be true in our model. Intuitively, when benefits

[52]This is higher than $s_e = 0.1$ often found in other calibrations in the literature because we target an EU rate of 1.3% in the CPS. This low level allows workers to climb higher up the job ladder before being fired, and hence the average worker rejects more outside offers, requiring a higher value of s_e in our model. Targeting instead a higher EU rate, e.g., 2.5% consistent with other data sources, yields an s_e close to 0.1.

rise, employed workers are more willing to take risk, leading them to accept a larger fraction of outside offers (Panel l). Vacancies are therefore more likely to be filled by employed workers, making it *easier* for firms to hire. This effect offsets the difficulty in hiring unemployed workers, who now turn down more offers. The net impact on λ depends on which margin dominates. In our model, there is a hump-shaped response: up to around a 55 percent replacement rate, the additional ease of hiring employed workers dominates the increased difficulty of hiring unemployed workers, so free entry implies that λ rises. By contrast, in the homogeneous EU model, λ falls monotonically with UI, because EE decisions are invariant to UI policy. Thus, raising the replacement rate can actually be a benefit, rather than a hindrance, to firms.[53] This general equilibrium channel has important implications for optimal UI policy. First, it supports a higher optimal replacement rate by limiting the increase in the unemployment rate. Second, it amplifies the productive efficiency gains from higher UI: a higher offer arrival rate raises the EE rate, generating additional reallocation that boosts aggregate productivity.

Productivity effect: Turning to productivity, the UI distortions are balanced by gains in productive efficiency. Higher UI increases productivity (Panel b), counteracting the increase in unemployment and delivering a hump-shaped output response (Panel f) to UI.

There are two channels through which productivity increases. First, unemployed workers become more selective and only accept higher productivity jobs out of unemployment. As discussed, this effect is muted in our model, which explains why average labor productivity is less responsive to UI in our model relative to the homogeneous risk model.

Second, productivity can rise if employed workers become more willing to take risk. This encourages productivity enhancing EE moves—at the expense of taking on higher risk as implied by flattening ICs in our custom survey. Panel (i) shows that the EE rate is non-monotonic in benefits in our model. At low UI levels, raising UI increases the EE rate. This is because employed workers accept a larger fraction of job offers (Panel l), and this effect is amplified by the increase in the offer arrival rate. Eventually, raising benefits further reduces the EE rate. In contrast, raising benefits monotonically lowers the EE rate in the homogeneous risk model. This is because employed workers accept any offer with a marginally higher wage, and higher benefits imply that unemployed workers' first job is higher up the ladder, meaning they turn down more outside offers once employed. This patterns aligns with our survey evidence that raising benefits increases workers perceived EE probability, in line with our model, but not with the standard homogeneous risk model.

[53] This effect is amplified by our high estimated search efficiency of the employed, s_e. With a lower s_e, the employed workers' search behavior has smaller effects on the vacancy filling rate.

Summary. Taken together, our results show that introducing heterogeneous job risk—consistent with many important aspects of the labor market—fundamentally changes how unemployment benefits feed through into the economy and hence into optimal policy. In standard job ladder models, the EE acceptance margin is invariant to UI policy since employed workers accept any outside offer which raises productivity even marginally. As a result, benefits affect unemployment and productivity primarily via the UE margin, by discouraging unemployed workers from accepting job offers when the value of unemployment rises with UI. By contrast, in our model, the EE margin becomes a key transmission channel. With high estimated search efficiency of the employed, the UE margin becomes muted. Raising benefits instead makes employed workers more willing to take productivity-enhancing risks. This gives rise to a novel productive-efficiency argument in favor of positive UI benefits, in addition to the standard insurance motive.

4.6 Tax progressivity and the wage-safety trade off in job switching

As a final experiment, we consider how tax progressivity interacts with on the job search. Our model suggests a new distortion introduced by progressive taxes: by reducing the upside net wage gain from productivity-enhancing EE moves, they make these moves less desirable relative to any risk increases they incur. We show that this distortion is quantitatively irrelevant once changes in the price of risk are taken into account.

We present the results in Table 6. The first row presents the tax parameters and equilibrium aggregates in the baseline calibration. In the second row, we increase tax progressivity from $\Upsilon = 0.18$ to $\Upsilon = 0.5$. We do so first in partial equilibrium, and adjust the tax shifter τ so that total government revenue is unchanged, and just collected in a more progressive manner. Perhaps surprisingly, the equilibrium is essentially unchanged despite higher progressivity, with no meaningful changes in the EE, EU, and unemployment rates, nor labor productivity. We confirm in the fourth row that this continues to be true in general equilibrium.

To understand why progressivity does not affect the equilibrium, recall that—in the model and US tax code—workers pay income tax on their unemployment benefits. Hence, increasing progressivity has two effects on income. First, it compresses gains from higher wages, which dampens the incentives to take risks to climb the ladder. On the other hand, it raises net income while unemployed, $\hat{b} \equiv \tau b^{1-\Upsilon}$, so net benefits rise from 0.395 to 0.527 with higher progressivity. This makes agents less afraid to take risks along the ladder. It turns out that these two forces quantitatively cancel out, with little change in the aggregates. To demonstrate this, in the third column we consider the high progressivity

Table 6: Effect of varying tax progressivity

	Υ	τ	b	net b	EE rate	EU rate	UE rate	u rate	Y/L
Calibration	0.18	0.200	0.423	0.395	0.026	0.013	0.250	0.050	1.587
Raise progressivity (PE)	0.50	0.190	0.423	0.527	0.026	0.013	0.249	0.050	1.587
... & adjust b (PE)	0.50	0.190	0.238	0.395	0.024	0.012	0.252	0.044	1.579
Raise progressivity (GE)	0.50	0.190	0.423	0.527	0.026	0.013	0.249	0.050	1.588

Notes: The table compares the calibrated model (top row) to counterfactuals where the tax progressivity parameter is raised. In the second row Υ is raised to 0.5 and the tax shifter τ is adjusted so that total tax revenue is unchanged. In the third row, b is adjusted to return UI benefits net of taxes to their level in the original calibration. These are partial equilibrium experiments, illustrating the effects of worker decisions on aggregates but holding prices fixed. The final row adjusts τ to balance the budget in general equilibrium.

economy, but lower gross UI benefits to return net benefits back to their original level. With the UI effect neutralized, we see that raising progressivity now causes the EE and EU rates to fall. This reflects that agents now value gross wage increases less, and so take fewer EE moves, tilted towards safer jobs that lower the EU rate. This, combined with a mild decrease in the UE rate, leads to a fall in unemployment and aggregate labor productivity. In summary, this experiment stresses the delicate interplay between tax progressivity on the upside and UI generosity on the downside in determining agents' willingness to perform risky experimentation on the job ladder.

5 Conclusion

This paper has shown that incomplete insurance of unemployment risk leads workers to climb the job ladder inefficiently slowly, because they apply a distorted valuation of job safety over productivity. That is, workers prefer to stay put in safe but low productivity jobs, and reject high productivity-high risk offers. The resulting misallocation curbs aggregate productivity and provides a new role for unemployment insurance. We formalize this channel in a general equilibrium job search model. Besides standard wage (match productivity) differences, the combination of three additional features is crucial in our channel: on-the-job search, separation risk heterogeneity across jobs, and incomplete markets.

Besides presenting a new labor market inefficiency and showing its aggregate productivity effects, several additional implications arise in our model. Most importantly, unemployment insurance plays an additional role: it speeds up the job ladder and subsidizes risky rungs by cushioning the fall off the job ladder into unemployment. We provide a sharp characterization of this risk-aversion-induced inefficiency by comparison

to a planner's problem which clarifies that a positive replacement rate can be optimal to restore productive efficiency. By adding on the job search, we show how previous efficiency results which focused on the UE margin (Acemoglu and Shimer, 1999) can be dampened. On the other hand, the EE margin is only inefficient in the presence of heterogeneous EU risk. Hence, in a world with prevelant and efficient on the job search (Faberman et al., 2022) the combination of all three of our features is crucial for motivating a productivity role for UI benefits.

Quantitatively, our general equilibrium model reveals another channel: by unsticking the job ladder, higher UI benefits make it easier for firms to hire employed workers. This can encourage job creation, and combined with the above productivity effects, these forces improve the equity-efficiency tradeoff faced by a government wishing to provide unemployment insurance. Consequently, we find the welfare maximizing UI replacement rate to be high (around 40%), in contrast to many existing theories which often prescribe near-zero replacement rates.

We close by cautioning that our study remains theoretical. We are not aware of direct empirical evidence that definitively establishes the role of risk aversion and incomplete markets in shaping employed workers' search behavior and job mobility decisions. However, the idea that risk aversion and incomplete markets may distort the most important economic choices individuals can make—job choices—is intuitive. E.g., there is emerging evidence on how wealth and liquidity constraints may distort the behavior of *unemployed* job seekers. Institutional features in many countries make staying in a long tenure job safer than moving to a new position. For employed workers, we are not aware of similar existing evidence, but in the introduction presented suggestive survey evidence on workers' own account of their job mobility considerations. TO make progress on this additional open question our paper raised, our custom survey in this paper additionally aimed to directly elicit information about how workers value risk when considering job-to-job moves and presented a suggestive information treatment that showed evidence for how UI-induced job loss considerations impede job mobility.

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Appendix to:

Job Mobility, Unemployment Risk, and Incomplete Markets

By Alex Clymo, Piotr Denderski, Yusuf Mercan and Benjamin Schoefer

A Empirical appendix

A.1 Details on the publicly available datasets

In this section we elaborate on data construction, measurement and sample selection in the Current Population Survey (CPS) and the Survey of Consumer Expectations (SCE).

A.1.1 Current Population Survey

The CPS has a rotating-panel design, in which households are surveyed for four consecutive months, then they rotate out for eight months and then are surveyed for another four months, after which they permanently leave the sample. This structure allows us to match at most three-fourths of the sample in one month to the next.

Worker flows. We start with the monthly micro data using the CPS samples provided by IPUMS. We categorize each individual in each month t into one of three employment states: employed (E), unemployed (U) and out of the labor force (N). Using individual identifiers—using the IPUMS provided unique individual ID, CPSIDP, which uses rotation groups, household identifiers, individual line numbers, race, sex, and age to identify individuals—, we calculate individual-level transition events between consecutive months. For example, the employment-to-unemployment (EU) indicator $\mathbb{I}(EU_{it})$ takes on the value 1 if a worker is employed in month t, but is observed to be unemployed in month $t+1$, otherwise it is 0. We similarly construct indicators for all other possible labor market flows between employment, unemployment and nonparticipation, as well as employer-to-employer (EE) transitions.[54]

Job tenure. We complement the core monthly data with the biennial Job Tenure & Occupational Mobility Supplement. We use the length of time worked at current job as our measure of job tenure. For jobs that start within sample (via UE, NE or EE transitions), we set job tenure to 0. For both types of jobs with a tenure observation, we increment the tenure variable by a month as long as the worker stays in the same job, i.e., there is no EU, EN or EE separation.

Worker and job controls. For job controls we include industry and occupation dummies. We use the 1990 Census Bureau industrial classification system (IND1990) and the Census Bureau 2010 occupation codes (OCC2010), as harmonized over time by IPUMS. We

[54] For employer-to-employer switches, we use the IPUMS variable EMPSAME that asks an employed worker whether they are with the same employer as last month.

aggregate these industries and occupations to broad categories, resulting in 13 industries and 25 occupations.

As for worker-side observables, we assign individuals to 5 education categories: less than high school, high school graduate, some college/vocational school/associate degree, college graduate, and advanced degree. We use three broad race categories: white, black and other. We define potential experience as age - 25 and include quartics of this variable in our controls. We further include marital status dummies, number of own children in the household and the number of own children under age 5 in the household as part of the worker control variables.

Wages. We calculate hourly wages using information on weekly earnings and hours worked in the outgoing rotation groups reported up to twice per worker. First, for workers who are paid hourly, we take their reported hourly wages. Second, for salary workers, we divide their reported weekly earnings by usual hours worked or—if their hours vary—by hours worked last week at their main job. Finally, we deflate hourly wages by the CPI to calculate real wages. We trim real wages at the lowest and highest 0.3th percentile.

Sample selection. We restrict our sample to individuals aged 25 to 55 and keep only the head of household. We keep observations between 1987 and 2007. We drop workers who report being self-employed, in the armed forces or an unpaid family worker. We further exclude individuals in school from our sample. We only keep workers who reside in the 50 states and Washington D.C.

A.1.2 Survey of Consumer Expectations

The SCE is a nationally representative survey of a rotating panel of approximately 1,300 household heads conducted by the Federal Reserve Bank of New York. Respondents participate in the panel for up to twelve months, with a roughly equal number rotating in and out of the panel each month. We use the core monthly files in our analysis.

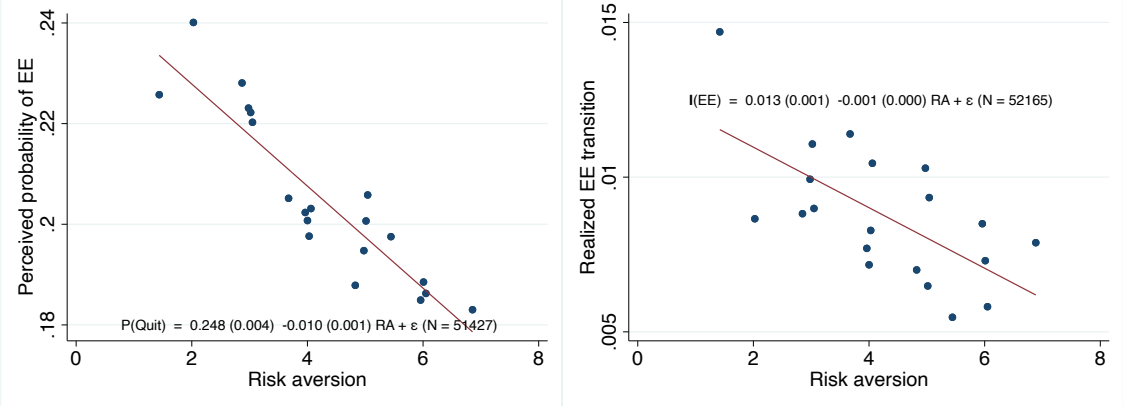
Worker flows. To measure worker flows, we use a similar approach to the CPS. We determine respondents' employment status in each month and then calculate worker transition indicators using the panel structure of the survey.

Subjective transition probabilities. In the survey, respondents provide their subjective beliefs of expected labor market transitions. In particular, for the probability of a job loss, we use the answer to the question "What do you think is the percent chance that you will lose your main/current job during the next 12 months?" (variable Q13new). For the probability of quitting we use the answer to "What do you think is the percent chance that you will leave your main/current job voluntarily during the next 12 months?" (variable Q14new).

Sample selection. We restrict our sample to those aged 20 to 65 and to dates after June 2014 when the survey begins asking about EE transitions. We exclude the self employed.

Figure A.1: Actual and perceived unemployment risk and risk attitude.

(a) Subj. P(EU) and P(EE) vs risk attitude (b) EE and EU transitions vs risk attitude



Notes: Panel (a) plots the perceived probability of voluntarily quitting from and losing one's job in the next 12 months against the respondent's (inverted) willingness to take risks in daily activities (ranging from 1—not willing at all to 7—very willing) controlling for time fixed effects. Panel (b) plots realized monthly EE and EU transition indicators against risk taking, using the panel structure of the survey. Source: SCE.

If an individual ever skips a survey month, we drop the observations subsequent to the first skip.

Risk attitudes, perceived and realized flows. We now turn to studying the role of risk attitude in shaping perceived and realized labor market transitions.

Figure A.1 Panel (a) plots the subjective probability of voluntarily quitting or losing one's job in the next 12 months against the self-reported willingness to take risks in daily activities (ranging from 1—not willing at all to 7—very willing).[55] The figure suggests that worker's who report to be more risk averse are less willing to switch jobs (blue circles), and there is some evidence pointing to risk averse workers being less likely to lose their jobs (red diamonds).

These self-reported subjective transition probabilities are consistent with realized worker transitions. Figure A.1 Panel (b) plots the monthly EE and EU rates against the same risk aversion measure. Similar to the subjective probabilities, workers who report higher risk aversion are less likely to switch jobs (blue circles) and there is some evidence pointing them to be in safer jobs (red diamonds).

A.2 Details on our custom survey

In this section, we provide more information on the estimation sample in our custom survey. Details of survey questions are provided in Appendix XXX.

[55] We invert this measure by subtracting it from 8 to get a measure of risk aversion.

A.2.1 Descriptive Statistics

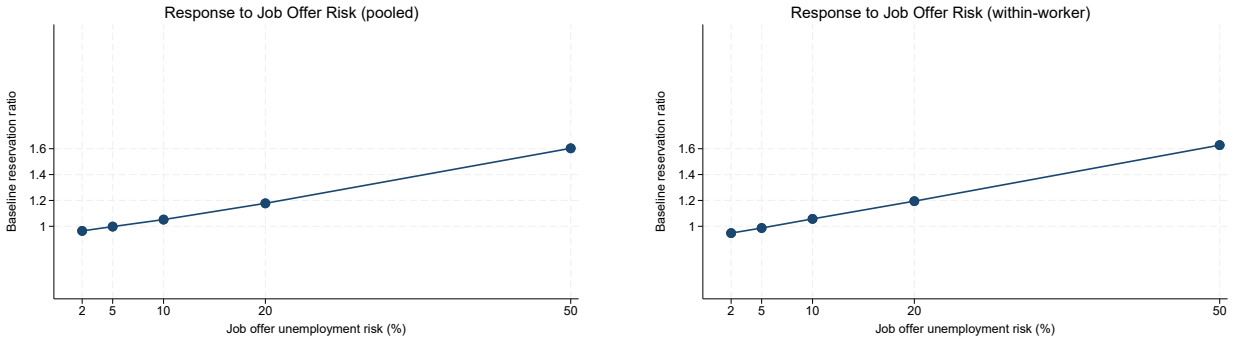
A.2.2 Reservation ratios and job offer risk.

As an alternative to the specification in the main text, we report the pooled and fixed-effect version of the following regression:

$$\frac{\widetilde{w}_{ij} - w_i^*}{w_i^*} = \alpha + \beta_j \delta_j + \varepsilon_{ij}.$$

We present the estimated β_j coefficients on Figure A.2. We use these estimates to assess the fit of the model to the data.

Figure A.2: Reservation ratio and job offer risk



(a) Pooled

(b) Within-worker

B Quantitative model appendix

B.1 Further definitions and derivations

B.1.1 Tenure distributions

We are interested in $g^e(a, z, \delta, l)$, which we define as the mass of employed with characteristics a, z, δ and tenure of current job l. Note that $l \geq 0$ is measured in calendar time, i.e. in the same units as time itself.

First, how do we determine $g^e(a, z, \delta, 0)$? This is the mass of people who just found a job. Split this into distributions for jobs starting from employment and unemployment: $g^e(a, z, \delta, 0) = g^{e,e}(a, z, \delta, 0) + g^{e,u}(a, z, \delta, 0)$. Starting with $g^{e,u}(a, z, \delta, 0)$, this is defined by, for each a, z, δ:

$$g^{e,u}(a, z, \delta, 0) = \lambda(\theta)\pi(z, \delta)\mathbf{1}^u(z, \delta|a)g^u(a) \tag{A.1}$$

For employed, $g^{e,e}(a, z, \delta, 0)$, this is defined by, for each a, z, δ:

$$g^{e,e}(a, z, \delta, 0) = s_e\lambda(\theta)\pi(z, \delta)\sum_{z'}\sum_{\delta'}\mathbf{1}^e(z, \delta|a, z', \delta')g^e(a, z', \delta') \tag{A.2}$$

Second, how does $g^e(a, z, \delta, l)$ evolve? Intuitively, fix the current l. The distribution of jobs at $l + \Delta l$ features: 1) any jobs which terminated due to EU and EE moves are removed, and 2) any jobs which survive then have their state variables a, z, δ adjusted according to any within-job changes. This follows a similar logic to the evolution of the stationary distribution, just focusing on employed workers:

$$g^e_l(a, z, \delta, l) = -\frac{\partial}{\partial a}\left[\dot{a}^e(a, z, \delta)g^e(a, z, \delta, l)\right] - (\delta + s_e\lambda(\theta)\mu^e(a, z, \delta))g^e(a, z, \delta, l) \tag{A.3}$$

We can simulate forward $g^{e,e}(a, z, \delta, l)$ and $g^{e,u}(a, z, \delta, l)$ using the same equation, just replacing the $g^e(a, z, \delta, l)$ densities.

B.1.2 Welfare comparisons

Our welfare measure is steady-state utilitarian welfare, i.e. the integral across workers of the value function weighted by the ergodic distribution:

$$SW = \int v^e(a, z, \delta)g^e(a, z, \delta)dadzd\delta + \int v^u(a)g^u(a)da$$

The welfare of firm owners is irrelevant since they are have linear utility and always make zero profit due to free entry. Since discounted utility is time separable this can equivalently be expressed as $SW = \int u(c^e(a, z, \delta))g^e(a, z, \delta)dadzd\delta + \int u(c^u(a))g^u(a)da$.

We express welfare comparisons as the equivalent proportional consumption change from the steady state which would yield the same change in welfare. Let SW_0 denote social welfare in the calibrated steady state, and SW_1 welfare in an alternative equilibrium. In our numerical work we assume a CRRA utility function $u(c) = c^{1-\sigma}/(1-\sigma)$, so if we scale

all consumptions by a factor Δ_{ev}, then social welfare would rise to $\Delta_{ev}^{1-\sigma} SW_0$. Hence the consumption equivalent welfare change can be easily computed using $SW_1 = \Delta_{ev}^{1-\sigma} SW_0$ giving $\Delta_{ev} = (SW_1/SW_0)^{\frac{1}{1-\sigma}}$.

B.2 Consumption dynamics in the model

Marginal propensity to consume We compute MPCs to a discrete increase in income. To be close to the data we compute the MPC over a given horizon, e.g. total consumption increase over the next quarter. This follows the approach in Achdou et al. (2022). Define $C^e(a, z, \delta, l)$ as the sum of the total expected consumption flow over the next l units of time of a worker who is currently employed with current characteristics a, z, δ. Similarly define $C^u(a, l)$ for a currently unemployed worker with assets a.[56] Note that $l \geq 0$ is measured in calendar time, i.e. in the same units as time itself. Clearly $C^e(a, z, \delta, 0) = C^u(a, 0) = 0$. For $l > 0$ they can be solved using the pair of equations

$$\begin{aligned} 0 = & c^u(a) + C^u_x(a, l)\dot{a}^u(a) \\ & + \lambda(\theta)\mathrm{E}_{\widetilde{z},\widetilde{\delta}}\left[\left(\mathbf{1}^u(\widetilde{z}, \widetilde{\delta}|a)C^e(a, \widetilde{z}, \widetilde{\delta}, l) + (1 - \mathbf{1}^u(\widetilde{z}, \widetilde{\delta}|a))C^u(a, l)\right) - C^u(a, l)\right] \\ & - C^u_l(a, l) \end{aligned} \tag{A.4}$$

$$\begin{aligned} 0 = & c^e(a, z, \delta) + C^e_x(a, z, \delta, l)\dot{a}^e(a, z, \delta) \\ & + s_e\lambda(\theta)\mathbb{E}_{\widetilde{z},\widetilde{\delta}}\left[\left(\mathbf{1}^e(\widetilde{z}, \widetilde{\delta}|a, z, \delta)C^e(a, \widetilde{z}, \widetilde{\delta}, l) + (1 - \mathbf{1}^e(\widetilde{z}, \widetilde{\delta}|a, z, \delta))C^e(a, z, \delta, l)\right) - C^e(a, z, \delta, l)\right] \\ & + \delta\left(C^u(a, l) - C^e(a, z, \delta, l)\right) - C^e_l(a, z, \delta, l) \end{aligned} \tag{A.5}$$

These are much like the HJBs, except rather than integrating over discounted future utility into an infinite horizon, they integrate over future undiscounted consumption over a finite horizon. This formulation works by starting at tenure l and working down towards zero. Therefore in numerical applications the derivative $C^e_l(a, z, \delta, l)$ must be calculated using the backwards difference.

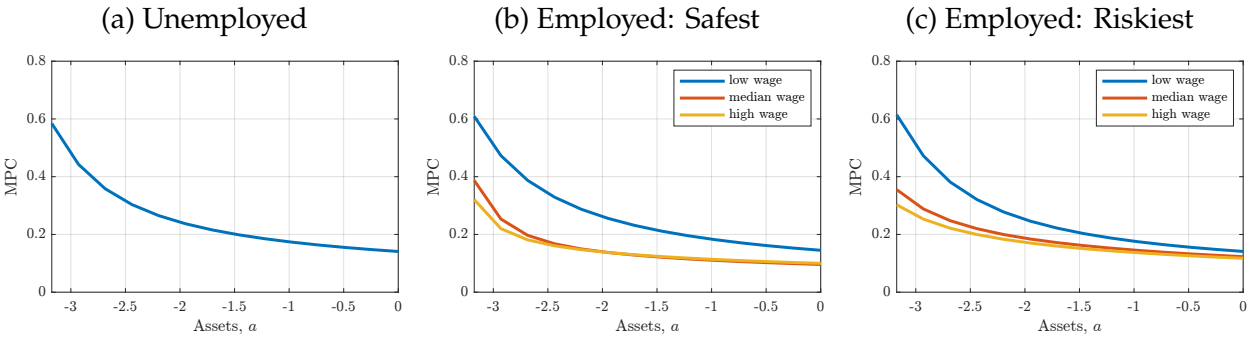
To convert \$500 into model wage units we use the following approach. We take quarterly mean labor income in the data to be \$16,500. Quarterly mean labor income in the model is $3((1-u)E[w]+ub)$, giving us a conversion factor $dlr = 16,500/(3((1-u)E[w]+ub))$ such that x wage units in the model are equivalent to $\$dlr \times x$ expressed in dollars.

In Figure A.3 we analyze the MPC distribution which underlies our average MPC. The quarterly MPCs to \$500 windfall are plotted for unemployed (panel a) and employed (b and c). They are decreasing in assets, highest for unemployed, decreasing in wages, and slightly increasing in risk. The average MPC is 19.5% for employed, 47.3% for unemployed, and 20.2% for the whole population. Hence, despite assets being very low for most employed workers, they are clearly very far from being hand to mouth, as in that case

[56] Formally, let $s = \{e, u\}$ denote the agent's current employment status. Then $C^e(a, z, \delta, l) = E\left[\int_0^l \left(\mathbf{1}(s_t = e)c^e(x_t, z_t, \delta_t) + \mathbf{1}(s_t = u)c^u(x_t)\right) dt \middle| (x_0, z_0, \delta_0, s_0) = (a, z, \delta, e)\right]$ and $C^u(a, l) = E\left[\int_0^l \left(\mathbf{1}(s_t = e)c^e(x_t, z_t, \delta_t) + \mathbf{1}(s_t = u)c^u(x_t)\right) dt \middle| (x_0, s_0) = (a, u)\right]$.

their MPC would be 100%.

Figure A.3: Quarterly MPCs to $500 windfall as a Function of Assets



Notes: MPC over one quarter to a $500 windfall payment. For employed each line corresponds to a different z, δ, with risky and safe corresponding to the lowest and highest δ. Within each employed panel, high wage jobs are those at the highest z, median are the median z, and low wage for a low z near the minimum accepted z.

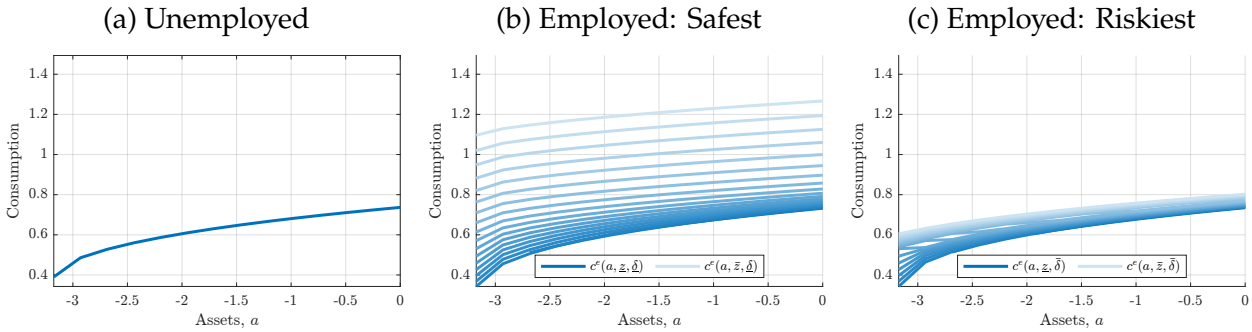
Consumption fall on unemployment Since the Browning and Crossley (2001) data measures monthly consumption, we can approximate this well using our consumption function directly (since the time period is monthly in our model).[57] We measure the percentage consumption fall on unemployment for an agent employed at a, z, δ as $dc(a, z, \delta) = (c^u(a) - c^e(a, z, \delta))/c^e(a, z, \delta)$. We measure the change in income as the UI level relative to their post tax wage: $dy(a, z, \delta) = (\tau b^{1-\Upsilon} - \tau w(a, z, \delta)^{1-\Upsilon})/(\tau w(a, z, \delta)^{1-\Upsilon})$. We compute the average of both of these numbers among laid off workers, and find an average consumption fall of 33% and income fall of 47%.[58]

Figure A.4 shows us why the consumption fall is not too large. Agents are able to consumption smooth using assets, so that the consumption policy function of the unemployed (panel a) is lower, but not dramatically so, to the consumption of employed (panels b and c). The employed at lower productivity jobs have low consumption similar to the employed, and consumption increases as the productivity of the job increases. Panel b plots consumption by a, z within the safest jobs, and panel c for the riskiest jobs. There is an interesting endogenous composition effect which helps here: Workers in risky jobs consume less, since they do more precautionary saving. They are also more likely to be fired, and hence become unemployed, which means the average consumption fall for those who become unemployed is lower. This can be seen because the consumption levels are lower in risky jobs (panel c) than in safe jobs (panel b).

[57] In reality, their data compares people before they were unemployed to their response at a first interview six months after becoming unemployed. The 14% consumption loss is the change in monthly consumption expenditure, i.e. $(C_u - C_e)/C_e = 14\%$, where the C_e and C_u are total monthly consumption expenditure.

[58] Specifically, we compute the layoff-rate weighted average, e.g. $\overline{dc} = \int_{a,z,\delta} dc(a, z, \delta) \left(\delta g^e(a, z, \delta)\right) dadzd\delta / \int_{a,z,\delta} \delta g^e(a, z, \delta) dadzd\delta$, and similar for $\overline{dy}$.

Figure A.4: Consumption as a Function of Assets



Notes: Unemployed consumption function $c^u(a)$ and slices of the employed consumption function $c^e(a, z, \delta)$. For the employed, right panel gives the riskiest jobs ($\delta = \bar{\delta}$), centre panel the safest ($\delta = \underline{\delta}$), and each line is a different productivity level with lighter lines corresponding to higher productivity.

Table A.1: Robustness: Optimal UI with different asset market clearing assumptions

Approach	Optimal RR	Δr	ΔA_g	τ	$\Delta Y/n$	Δ u rate
Adjust A_g, fix r	50.2%	–	7.92%	3.50%	0.43%	0.69pp
Fix A_g, adjust r	50.2%	3.39pp	–	-0.17%	0.43%	0.69pp

Notes: This table presents the results of the welfare-maximizing steady-state UI benefit experiment under two asset market clearing assumptions. Each row presents the optimal replacement rate for that approach, and then the change in the equilibrium value of each variable from the steady state with calibrated 40% replacement rate to the steady state with the optimal replacement rate. δr is the percentage point change in the annualized interest rate. ΔA_g is the percent change in government saving. $\delta\tau$ is the percent change in the tax function shifter. $\Delta Y/n$ is the percent change in aggregate labor productivity, and Δu the percentage point change in the unemployment rate.

B.3 Robustness: asset market clearing in optimal UI experiment

In this section we discuss the role of asset market clearing in our optimal UI experiment from Section 4.5. As mentioned in the text, the main results are robust to how we let the asset market clear, and we present results in the main text for the case where the government adjusts A_g to keep r fixed at 2% annual across all UI levels. In this section we compare the results to the opposite extreme assumption, where we suppose that the government keeps A_g fixed and we explicitly solve for the new market clearing r at each UI level. We present a summary of the results from the optimal UI experiment under these two market clearing approaches in Table A.1.

Recalling that we search for the optimal replacement rate on a grid of 1% increments of the steady state b, the first column shows that the optimal replacement rate is identical at this level of precision under the two assumptions at 50.2%. The final two columns show how the key endogenous outcomes productivity and unemployment all behave the identically under the two assumptions, up to two significant digits. The changes in worker flows (not shown) are also identical.

The only difference is in the behavior of the interest rate and how it interacts with the financing of the policy. As UI is made more generous, precautionary saving motives decrease and household saving falls. To clear the asset market this requires either A_g to rise by 7.92% (first row) or the interest to rise from 2% annualized to 5.39% annualized (second row). The key difference between the two scenarios is the behavior of taxes, since the rise in the interest rate in the second scenario has implications for the government budget. With a higher interest rate (and the fact that the government is a net saver in our calibration) the government makes more profits on its investments, which then reduces the tax rise needed to fund the increase in UI benefits. In this experiment, the government actually is able to cut taxes despite raising UI payments because it receives a more-than-offsetting rise in interest payments. This reflects that the interest rate is very sensitive to UI changes in our model. This is because workers saving choices are relatively interest insensitive due to the low MPC calibration, and there are no other savers or sources of saving in the model. Nonetheless, the key results are robust to either asset market clearing assumption, suggesting that they are robust to variations along this margin.

B.4 Discussion: model with within-job decline in EU risk

Another potential source of EU risk heterogeneity is within-job declines in EU risk as tenure increases. That is, the longer you stay in a job, the safer it becomes. This could be due to learning match quality (as in the model of Krolikowski (2017)), or due to institutional features such as probationary periods, last-in first-out, or academic tenure.

In this version of the model, all job offers come with the highest risk level $\delta_J = \bar{\delta}$ (i.e. the offer distribution is $\pi_J = 1$). Within a match, risk declines over time. Specifically, at rate s_δ the layoff risk drops from its current level δ_j to the next level down, δ_{j-1}, until it settles in the safest node $\delta_1 = \underline{\delta}$. This gives three parameters which can be calibrated to the same EU-tenure hazard we used in the main calibration. $\bar{\delta}$ now captures the EU risk for all jobs with zero tenure, and as a worker stays in the job, the layoff risk drops at rate s_δ towards the safest level $\underline{\delta}$. Workers no longer face a distribution of EU risks in their job offers, but workers currently in safe jobs ($j < J$) must weigh up the productivity gain of a job offer against the increase in risk from resetting tenure to zero and returning to risk $\bar{\delta}$.

We have investigated the implications of this setup and it turns out that our main quantitative findings are not affected by this alternative formulation of job loss heterogeneity. An important shortcoming of this version of the model, however, is that it is incompatible with empirical differences in layoff risk conditional on the origin of the job – whether a worker moved to their current job from employment, or unemployment. Indeed, in the data, jobs that originate from unemployment feature a higher job loss probability. In the model that we discuss here, all jobs have an identical EU-tenure risk profile, irrespective of their origin. The further quantitative details are available from the authors upon request.

Online Appendix to:
Job Mobility, Unemployment Risk, and Incomplete Markets

By Alex Clymo, Piotr Denderski, Yusuf Mercan and Benjamin Schoefer

March 27, 2026

A Empirical Appendix

B Analytical model of the risky job ladder

We now present a model that formalizes the role of unemployment risk and risk aversion in shaping job mobility decisions and, ultimately, in determining aggregate economic performance such as average wages and aggregate output. The model in this section remains qualitative and is presented in partial equilibrium with an exogenous offer distribution (McCall, 1970) but its mechanisms carry over to the full equilibrium model in Section 3 that we put to quantitative use in Section 4. Throughout, we highlight the productive efficiency effects of UI benefits, and delay treatment of the important role of UI in providing insurance to unemployed workers by means of consumption smoothing to the quantitative model.

B.1 Environment

Time is continuous and indexed by $t \in [0, \infty)$. Workers discount the future at rate ρ. Workers are hand-to-mouth consumers and obtain consumption utility $u(c)$ with $u'(c) > 0$ and $u''(c) \leq 0$.[59] Thus, workers consume $c = w$ when employed in a job paying wage w and in unemployment they consume $c = b = b_{HP} + b_{UI}$, with income in unemployment b being the sum of home production b_{HP} and unemployment insurance (UI) benefits b_{UI}.[60]

Job offers arrive at exogenous rates λ_U for the unemployed and λ_E for the employed. The offers are drawn from an exogenous distribution with cumulative density function $F(w, \delta)$ with support $\mathcal{S} = \left[\underline{w}, \overline{w}\right] \times \left[\underline{\delta}, \overline{\delta}\right] \subset \mathbb{R}^2_+$. Wages w are constant throughout the duration of the match. Worker-firm matches separate at a rate δ, where the worker becomes unemployed and the job vanishes. The value of being employed in a job with characteristics (w, δ) is denoted $W(w, \delta)$, and U is the value of unemployment.

Workers' value functions and acceptance decisions. Workers accept job offers which increase their value relative to their current situation. We define job offer acceptance sets as wage-separation rate combinations $(\widetilde{w}, \widetilde{\delta})$ that a worker accepts for two cases: A_U for the unemployment-to-employment (UE) margin, i.e., a currently unemployed job seeker presented with a job offer, and $A(w, \delta)$ for the employment-to-employment (EE) margin, i.e., a currently employed worker with wage w and separation rate δ considering an outside offer. We also define the set of *reservation jobs* R_U for the unemployed and $R(w, \delta)$ for the employed in (w, δ) jobs as those jobs which leave them indifferent relative to their current

[59] We relax the assumption that workers are hand to mouth in our quantitative model in Section 3.

[60] To clarify the direct effect of UI itself, in this section we abstract from how benefits are funded, implicitly assuming that they are financed by lump-sum taxes elsewhere in the model. In our quantitative analysis in the subsequent sections, we explicitly account for UI funding through distortionary taxes.

situation:

$$A_U = \left\{(\widetilde{w}, \widetilde{\delta}) \in \mathcal{S} : W(\widetilde{w}, \widetilde{\delta}) \geq U\right\} \qquad R_U = \left\{(\widetilde{w}, \widetilde{\delta}) \in \mathcal{S} : W(\widetilde{w}, \widetilde{\delta}) = U\right\}$$
$$A(w, \delta) = \left\{(\widetilde{w}, \widetilde{\delta}) \in \mathcal{S} : W(\widetilde{w}, \widetilde{\delta}) \geq W(w, \delta)\right\} \qquad R(w, \delta) = \left\{(\widetilde{w}, \widetilde{\delta}) \in \mathcal{S} : W(\widetilde{w}, \widetilde{\delta}) = W(w, \delta)\right\}.$$

Using the definition of these sets, the value of unemployment solves the following Hamilton-Jacobi-Bellman (HJB) equation:

$$\rho U = u(b) + \lambda_U \int_{A_U} \Big(W(\widetilde{w}, \widetilde{\delta}) - U\Big)\, dF(\widetilde{w}, \widetilde{\delta}). \tag{B.1}$$

The first term is the flow value of consumption, and the second term represents the value of finding a match which the unemployed worker would accept. The worker meets a vacancy at rate λ_U, then the match-specific wage and separation risk, $\widetilde{w}$ and $\widetilde{\delta}$, are drawn. The worker accepts the match if it delivers a value of employment, $W(\widetilde{w}, \widetilde{\delta})$, greater than the value of remaining unemployed, U.

Similarly, the value of employment in a job with wage w and separation rate δ is given by:

$$\rho W(w, \delta) = u(w) + \lambda_E \int_{A(w,\delta)} \Big(W(\widetilde{w}, \widetilde{\delta}) - W(w, \delta)\Big)\, dF(\widetilde{w}, \widetilde{\delta}) + \delta\big[U - W(w, \delta)\big]. \tag{B.2}$$

The first term is the flow utility of consuming wage w, and the second is the value from on the job search, where offers arrive at rate λ_E and a worker only moves to a job offering a strictly higher value than their current one. The final term is the value lost when transitioning to unemployment. We show that $W(w, \delta)$ is increasing in w and decreasing in δ in Appendix C.1.

The following defines the decentralized, i.e., market, allocation of the model.

Definition 2 (Decentralized allocation)**.** *The decentralized allocation consists of a set of value functions $\{U, W(w, \delta)\}$, the employment rate E and the distribution of workers across jobs $g_E(w, \delta)$ such that: U and $W(w, \delta)$ solve (B.1) – (B.2); the job acceptance sets A_U and $A(w, \delta)$ implied by them induce the distribution of workers described by E and $g_E(w, \delta)$ given job offer arrival and job destruction rates.*

Planner's problem: productive efficiency. To compare the market allocation, stated above in terms of wages, to the planner's problem, we need to take a stand on how underlying output is split between wages and profits. In this section, we make a stark assumption: wages are equal to match productivity, $w = z$. This assumption connects our results to the previous literature, since Jarosch (2023) discusses efficiency in his model with risk neutrality, and shows that the decentralized equilibrium is efficient if and only if workers have full bargaining power, in which case $w = z$. With this assumption, our model becomes identical to his under risk neutrality. Importantly, we show that the market equilibrium becomes inefficient under risk aversion even with $w = z$, thus clarifying that the inefficiencies we present here are distinct from those in Jarosch (2023). We relax this

assumption in our quantitative model, where wages are determined as the solution to a bargaining problem.

In the spirit of Acemoglu and Shimer (1999), we introduce a planner's problem that focuses on productive efficiency in our model with a two-dimensional job ladder. To this end, we consider a planner who can dictate all workers' job acceptance decisions and freely allocate consumption across agents. We formally set up this problem in Appendix C.2 and show that the timeless solution to the social planner's problem is captured by the following value functions U^{sp} and $W^{sp}(w,\delta)$:[61]

$$\rho U^{sp} = b_{HP} + \lambda_U \int_{A_U^{sp}} \left(W^{sp}(\widetilde{w},\widetilde{\delta}) - U^{sp} \right) dF(\widetilde{w},\widetilde{\delta}) \tag{B.3}$$

$$\rho W^{sp}(w,\delta) = w + \lambda_E \int_{A^{sp}(w,\delta)} \left(W^{sp}(\widetilde{w},\widetilde{\delta}) - W^{sp}(w,\delta) \right) dF(\widetilde{w},\widetilde{\delta}) + \delta \left[U^{sp} - W^{sp}(w,\delta) \right]. \tag{B.4}$$

Notice that the planner maximizes the net present value of output, including home production (since wages are assumed to be a direct measure of match output). We define the planner's allocation and productive efficiency as follows.

Definition 3 (Planner's allocation)**.** *The planner's allocation consists of the following objects: value functions* $\{U^{sp}, W^{sp}(w,\delta)\}$*, the employment rate* E^{sp} *and the distribution of workers across jobs* $g_E^{sp}(w,\delta)$ *such that* U^{sp} *and* $W^{sp}(w,\delta)$ *solve Equations (B.3) – (B.4); the job acceptance sets* A_U^{sp} *and* $A^{sp}(w,\delta)$ *implied by them induce the distribution of workers described by* E^{sp} *and* $g_E^{sp}(w,\delta)$ *given job offer arrival and job destruction rates.*

Definition 4 (Productive efficiency)**.** *Let* $\mathcal{E} = \left\{U, W(w,\delta), E, g_E(w,\delta)\right\}$ *be the decentralized equilibrium and let* $\mathcal{A}^{sp} = \left\{U^{sp}, W^{sp}(w,\delta), E^{sp}, g_E^{sp}(w,\delta)\right\}$ *be the planner's allocation.* $\mathcal{E}$ *achieves productive efficiency (i.e.,* $\mathcal{E}$ *is efficient) if, and only if,* $E = E^{sp}$ *and* $g_E(w,\delta) = g_E^{sp}(w,\delta)$*.*

Direct inspection of Equations (B.1) – (B.4) leads to the following result: the planner's problem and the worker's problem coincide when there is no unemployment insurance and workers are risk-neutral.

Lemma 1. *If* $b_{UI} = 0$ *and* $u(c) = c$*, then the decentralized allocation achieves productive efficiency.*

Thus, as in Acemoglu and Shimer (1999), in the absence of risk aversion there is no productive efficiency motivation for positive UI benefits in our model. This is true even with heterogeneity in EU risk across jobs. In the rest of the section, we explore how risk aversion shapes worker choices (Section B.2) and the motivation for UI benefits (Section B.3).

[61] We adopt the notational convention that all planner-problem-related objects are defined analogously to their decentralized equilibrium counterparts and distinguish them by the use of the superscript sp.

B.2 Individual job acceptance decisions

In this section we characterize workers' optimal choices in the market allocation of our model. To begin with, we show that a one-dimensional reservation wage is the full description of the search policy for *unemployed* workers. That is, unemployed workers—no matter their risk aversion or the UI level—do not exert any selectivity along job security in their acceptance decisions.[62] Hence, compositional implications from selectivity regarding job security exclusively emanate from job-to-job transitions, with no role for the UE margin. By contrast, unemployment risk and risk aversion matter separately and interactively for job-to-job transitions. We defer discussion of the planner's allocation to the next section, but note that everything we derive below regarding workers' choices nests the planner's allocation as a special case when workers are risk neutral, $\sigma = 0$, and there is no UI, $b_{UI} = 0$ so that $b = b_{HP}$, as per Lemma 1.

UE transitions. Evaluating Equation (B.2) at reservation jobs for unemployment reveals, since the last term $\delta\left(W(w,\delta) - U\right)$ drops out, that their value is independent of the riskiness of the offer δ:

$$\rho W\left(w,\delta\right) = u(w) + \lambda_E \int_{A_U} \left(W(\widetilde{w},\widetilde{\delta}) - U\right) dF(\widetilde{w},\widetilde{\delta}) \qquad \forall (w,\delta) \in R_U. \tag{B.5}$$

Moreover, using Equations (B.1) and (B.5), we can pin down a standard one-dimensional reservation wage w_r characterizing the unemployed worker's behavior, solving the equation:

$$u(w_r) = u(b) + (\lambda_U - \lambda_E) \int_{A_U} \left(W(\widetilde{w},\widetilde{\delta}) - U\right) dF(\widetilde{w},\widetilde{\delta}), \tag{B.6}$$

where unemployed workers accept any job which pays a wage $w \geq w_r$. Hence, the distribution of offers accepted out of unemployment is truncated below by a reservation wage that is independent of the individual riskiness of the jobs taken. Since the utility function $u(c)$ is a strictly increasing function, equation (B.6) immediately implies the following result.

Corollary 1 (Properties of the reservation wage w_r)**.** *The search efficiency in unemployment relative to that in employment determines the sign of $w_r - b$: $sgn(\lambda_U - \lambda_E) = sgn(w_r - b)$.*

When jobs arrive faster in unemployment, $\lambda_U > \lambda_E$, the unemployed demand a strictly higher reservation wage than the flow income in unemployment: $w_r > b$ as compensation. When the opposite is true, workers accept wages below b: $\lambda_E > \lambda_U \implies w_r < b$. Despite the reservation wage being independent of the riskiness of any individual job offer, risk aversion still shapes the level of this reservation wage: the utility function appears in Equation (B.6) directly and by influencing the value functions $W(\widetilde{w},\widetilde{\delta})$ and U. We will show in the next section how risk aversion lowers the reservation wage. Finally, when job search is equally effective in unemployment and employment, $\lambda_E = \lambda_U$, Equation (B.6) reduces to $u(w_r) = u(b) \implies w_r = b$. Hence the reservation wage is fixed at the flow

[62] This generalizes the result in Pinheiro and Visschers (2015), whose model does not feature risk aversion. In the (again, risk-neutral) model of Jarosch (2023) a similar result is pointed out in Footnote 15.

value of unemployment. This is true regardless of the level of risk aversion or separation risk heterogeneity.

EE transitions. The gains from moving from job (w, δ) to $(\widetilde{w}, \widetilde{\delta})$ can be seen using Equation (B.2). When contemplating the move to a new job, the worker incorporates in her decision both the utility gain from higher wages, $u(\widetilde{w})$ vs $u(w)$, as well as the separation risk difference, $\widetilde{\delta}$ vs δ. For all reservation jobs $(\widetilde{w}, \widetilde{\delta})$ of any given job (w, δ), we obtain the following expression for *indifference curves* between wages and separation risk:[63]

$$u(\widetilde{w}) - u(w) = \left(\widetilde{\delta} - \delta\right) \cdot \Big[W(w, \delta) - U\Big] \qquad \forall (\widetilde{w}, \widetilde{\delta}) \in R(w, \delta). \tag{B.7}$$

Equation (B.7) defines indifference curves in $(\widetilde{w}, \widetilde{\delta})$ space which fully characterize the EE move policy functions in our model. Since $W(w, \delta)$ is increasing in w and decreasing in δ, the left-hand side defines the minimum wage premium a job needs to offer to induce the worker to switch for a given change in risk. Defining $w_e(\widetilde{\delta}, w, \delta)$ as the value of $\widetilde{w}$ which solves Equation (B.7) gives the notion of a reservation wage for on the job moves: workers in a job with wage-separation rate pair (w, δ) will accept any new job offer which comes with risk $\widetilde{\delta}$ as long as it offers a wage of at least $w_e(\widetilde{\delta}, w, \delta)$.

For reference, it is helpful to study the derivatives of the indifference curves with respect to $\widetilde{\delta}$:

$$\frac{\partial w_e(\widetilde{\delta}, w, \delta)}{\partial \widetilde{\delta}} = \frac{W(w, \delta) - U}{u'(w_e(\widetilde{\delta}, w, \delta))}, \quad \text{and} \quad \frac{\partial^2 w_e(\widetilde{\delta}, w, \delta)}{\partial \widetilde{\delta}^2} = -\frac{u''(w_e(\widetilde{\delta}, w, \delta))}{u'(w_e(\widetilde{\delta}, w, \delta))} \left(\frac{\partial w_e(\widetilde{\delta}, w, \delta)}{\partial \widetilde{\delta}}\right)^2. \tag{B.8}$$

The indifference curves in Equation (B.7) have three important features. First, indifference curves are shaped by risk aversion, both directly by the utility functions on the left hand side, and indirectly through its effects on $W(w, \delta) - U$. As shown by Equation (B.8), for a given job (w, δ), indifference curves are linear in $(\widetilde{w}, \widetilde{\delta})$ space under risk neutrality since $u'(c) = 1$. However, under risk aversion ($u''(c) < 0$) they are strictly convex. Hence, even in the case of the workers and the planner assigning an identical price to risk, $W(w, \delta) - U = W^{sp}(w, \delta) - U^{sp}$, EE transitions chosen by the planner and the risk-averse workers will differ.

Second, the right hand side of Equation (B.7) features the difference in the separation rates, $\widetilde{\delta} - \delta$. Under homogeneous δ, as in the standard model, this term is always zero, and hence workers simply climb up the job ladder whenever the new job offers a higher wage: $w_e(\delta, w, \delta) = w$ *irrespective of risk aversion and the level of UI*. If unemployment risks are heterogeneous, then this term is non-zero and risk shapes acceptance decisions.

[63] To see this, evaluate Equation (B.2) for both (w, δ) and $(\widetilde{w}, \widetilde{\delta})$ and note that $W(w, \delta) = W(\widetilde{w}, \widetilde{\delta})$ along an indifference curve. Further, when two jobs offer the same utility their acceptance sets are identical, i.e., $A(\widetilde{w}, \widetilde{\delta}) = A(w, \delta)$. Our Equation (B.7) therefore extends prior work by Pinheiro and Visschers (2015) to a setting with risk aversion. Jarosch (2023) does not feature an analog of Equation (B.7) but does present indifference curves in his Figure 1. Neither paper features risk aversion and the resulting inefficiencies from incomplete markets.

Third, the difference in separation rates in Equation (B.7) is multiplied by the "price" of unemployment risk, $W(w,\delta) - U$. The higher this gap is—e.g., in high wage jobs—the larger the additional unemployment risk looms. For instance, for the reservation job out of unemployment, this price is zero as $W(w,\delta) = U$, confirming the earlier proof that the reservation wage for UE transitions is invariant to job safety. As shown by Equation (B.8), the indifference curves are upward-sloping for all jobs that are strictly better than unemployment, i.e. with $W(w,\delta) > U$. This is a simple but important insight: Workers in high wage jobs care more about unemployment risk than workers in low wage jobs, since they have more to lose. Hence, workers get increasingly selective about job security—i.e. reject more job offers with high $\widetilde{\delta}$ for a given wage increase—as they climb the wage ladder. Further, policies such as UI which change the value of unemployment U can affect this risk price and hence tilt workers' indifference curves and change their EE decisions.

We can summarize these ideas succinctly by defining the marginal rate of substitution between wages and risk. This is the slope of the indifference curve at *current job* characteristics ($\widetilde{\delta} = \delta$), showing the wage increase a worker would require to compensate them for a marginal increase in risk: $MRS_{w,\delta} \equiv \partial w_e(\delta, w, \delta)/\partial\widetilde{\delta} = (W(w,\delta) - U)/u'(w)$. Differentiation of the MRS and the monotonicity properties of $W(w,\delta)$ lead to the following result.

Corollary 2 (Monotonicity of $MRS_{w,\delta}$)**.** *The marginal rate of substitution between wage and job separation risk is strictly increasing in the wage and strictly decreasing in the separation risk.*

B.3 Risk aversion, policy, and efficiency

We have established that the market allocation achieves productive efficiency under risk-neutral preferences and no UI benefits. Furthermore, we have argued that risk aversion affects UE and EE transitions. Thus, a natural question arises about the feasibility of restoring efficiency through appropriate policy choices. We proceed in two steps, first studying the model with homogeneous unemployment risk, and then with heterogeneous risks.

B.3.1 Productive efficiency with no heterogeneity in job separation risk

We begin with an auxiliary model that abstracts from differences in job separation risk by making the distribution of separation rates degenerate: $\underline{\delta} = \overline{\delta} = \delta$. Under this assumption, the wage-job security trade-off is absent, and EE transitions are independent of risk aversion. Workers move from one job to another, provided the new job offers a (weakly) higher wage. This is true for both the planner and market allocations, meaning that EE decisions are always productively efficient in this model. Therefore, whether the decentralized allocation attains productive efficiency solely depends on the UE margin, allowing us to study how on-the-job search modifies the Acemoglu and Shimer (1999) insights on the efficiency properties of UE transitions. Since UE policies are completely characterized by the reservation wage, using only this condition we can sharply characterize the inefficiency brought by risk aversion and how policy can correct it.

Proposition 1 (Risk aversion and UE inefficiency.). *Let $\underline{\delta} = \overline{\delta} = \delta$. Assume further that $u''(c) < 0$, $\lambda_E \leq \lambda_U$, and $w_r^{sp} > \underline{w}$. Fix λ_U. Then:*

1. *If $\lambda_E < \lambda_U$ then the reservation wage in the decentralized equilibrium when $b_{UI} = 0$ is strictly below that of the social planner, $w_r < w_r^{sp}$. There exists a strictly positive level of UI, b_{UI}^*, that restores productive efficiency in the decentralized equilibrium.*
2. *The level of UI to restore productive efficiency is strictly decreasing in employed search efficiency, λ_E.*
3. *If $\lambda_E = \lambda_U$ then the market allocation is productively efficient when $b_{UI} = 0$, regardless of the degree of risk aversion.*

The proof can be found in Appendix C.3. Thus, when offers arrive faster in unemployment, risk-averse unemployed workers in the absence of UI accept some jobs the planner would refuse.[64] While this increases employment, it decreases average productivity, since the employed climb the ladder more slowly, and the latter effect dominates. Providing UI benefits can undo this inefficiency, as argued by Acemoglu and Shimer (1999). However, in stark contrast to their logic, the presence of on-the-job search mitigates or even nullifies the gap between decentralized equilibrium w_r and the social planner's reservation wage w_r^{sp} out of unemployment.

Holding all other parameters equal, the higher is on-the-job search efficiency, the lower is the need for positive UI benefits to restore productive efficiency. Intuitively, as λ_E rises towards λ_U, the reservation wage in the market economy shrinks towards b. Unemployed workers know they can continue to search for new jobs once employed, becoming less selective on the UE margin and reducing under-selectivity of the market relative to the planner. In the limit of $\lambda_E = \lambda_U$, $w_r = b = b_{UI} + b_{HP}$ and $w_r^{sp} = b_{HP}$ exactly, so equalizing the market and planner reservation wages requires UI benefits to be zero. In this case, positive UI would break efficiency by causing the market to reject jobs the planner would accept, regardless of the degree of risk aversion.

B.3.2 Productive efficiency with heterogeneity in job separation risk

We now show that heterogeneity in job separation risk reintroduces a role for UI in promoting productive efficiency, even in the limiting case of $\lambda_E = \lambda_U$. Fully restoring productive efficiency in the presence of heterogeneity in job separation risk is not always possible, as we discuss at the end of this section. Hence we use a special case of our model with only two jobs to analytically demonstrate this channel.

Special case: EE distortions and UI in a two job model. Suppose that there are two jobs, (w_1, δ_1) and (w_2, δ_2). When a worker receives a job offer, with probability ψ_1, job 1 is offered, and with $\psi_2 = 1 - \psi_1$ job 2 is offered. Suppose $\lambda_E \leq \lambda_U$. Let $W_1 = W(w_1, \delta_1)$ and $W_2 = W(w_2, \delta_2)$. Set up a generic notation where we let $u_0 = u(b)$, $u_1 = u(w_1)$ and $u_2 = u(w_2)$. Then for the planner we have $u_0 = b_{HP}$, $u_1 = w_1$, and $u_2 = w_2$ and for the

[64] The assumption that $w_r^{sp} > \underline{w}$ ensures that the planner rejects a positive mass of job offers out of unemployment.

decentralized equilibrium we have the generic values u_0, u_1, u_2 depending on the utility function. Thus, with appropriate (u_0, u_1, u_2) values, the value functions for either the planner or market solve:

$$\begin{aligned} \rho U &= u_0 + \lambda_U \psi_1 \max\{W_1 - U, 0\} + \lambda_U \psi_2 \max\{W_2 - U, 0\}, \\ \rho W_1 &= u_1 + \delta_1 (U - W_1) + \lambda_E \psi_2 \max\{W_2 - W_1, 0\}, \\ \rho W_2 &= u_2 + \delta_2 (U - W_2) + \lambda_E \psi_1 \max\{W_1 - W_2, 0\}. \end{aligned} \tag{B.9}$$

With only three consumption levels, we can use a positive affine transformation of the utility function to make comparison of the market and planner straightforward. We assume CRRA utility, $u(c) = c^{1-\sigma}/(1-\sigma)$ interpreted as $\log(c)$ when $\sigma = 1$, and discuss changes in the level of relative risk aversion, which is of course equal to σ.

Lemma 2. *Suppose agents have CRRA utility with $\sigma \geq 0$. Consider the two job model with $b < w_1 < w_2$. Then the agent's choices in the market equilibrium are identical to the choices of a modified problem where agents have the three utility levels $u_0 = b$, $u_1 = w_1$, and $u_2 = \widetilde{w}_2$, where $w_1 < \widetilde{w}_2 \leq w_2$. For given b, w_1, w_2, the level of risk aversion σ defines a unique $\widetilde{w}_2$, with higher risk aversion implying a lower $\widetilde{w}_2$. For $\sigma = 0$ we have $\widetilde{w}_2 = w_2$, and as $\sigma \to \infty$, $\widetilde{w}_2 \to w_1$.*

The proof can be found in Appendix C.4. Using this lemma and the generic notation in Equation (B.9), we see that the problems of the planner and market are identical except that the planner values the consumption stream of the high wage job at w_2, while risk aversion causes the market to value it at the lower value of $\widetilde{w}_2$ where $w_1 < \widetilde{w}_2 \leq w_2$.

Next, consider the following thought experiment. For the planner, assume that both jobs are preferred to unemployment. Assume that job 2 is higher pay but weakly higher risk: $w_2 > w_1$ and $\delta_2 \geq \delta_1$. Suppose the planner ranks the risky job above the safe job: $W_2^{sp} > W_1^{sp} > U^{sp}$. Lemma 4 in Appendix C.5 establishes parameter restrictions for this equilibrium to be valid. Thus, in the planner's allocation unemployed workers accept either job, and workers move on the job from the safe job to the risky but high paying job.

Our main result from this section is established in the following proposition:

Proposition 2. *Consider the two job model above where the planner prefers the risky job to the safe job, and both jobs to unemployment.*

1. *Suppose that both jobs are equally risky: $\delta_2 = \delta_1$. Then the market allocation without unemployment insurance ($b_{UI} = 0$) is productively efficient regardless of the level of risk aversion.*

2. *Suppose that job 2 is strictly riskier than job 1: $\delta_2 > \delta_1$.*

   (a) *If workers are sufficiently risk averse, then in the market allocation without unemployment insurance ($b_{UI} = 0$) workers prefer the safe job to the risky job. Workers make on-the-job moves from the risky job to the safe job, accept both jobs from unemployment, and the market allocation does not attain production efficiency.*

   (b) *For any level of risk aversion there exists a positive level of unemployment benefits $b_{UI} > 0$ which restores the planner's allocation by making workers prefer the risky job.*

The proof can be found in Appendix C.6. This proposition encompasses the new insights from our framework. Point 1 shows that in the absence of heterogeneity in EU risk, there is no motivation for UI even with risk aversion, as the market allocation is production efficient with $b_{UI} = 0$. This follows from Proposition 1, since the UE margin is undistorted, by construction, in this parameter configuration, and without heterogeneity in EU risk, the EE margin is always undistorted.[65]

On the other hand, point 2(a) shows that when there is heterogeneity in EU risk, incomplete markets and risk aversion can distort the EE margin. If workers are sufficiently risk averse, they will prefer a safe but low productivity job, even though the social planner prefers the risky high productivity job. The UE margin remains undistorted, but since workers make EE moves in opposite directions in the market and planner solutions, the allocation differs with the ratio of safe but lower productivity jobs higher in the market allocation. This leads to lower productivity, EU rates, and unemployment in the market allocation than the productively efficient allocation. See the proof for explicit solutions for these allocations.

Point 2(b) shows that UI can play a role in correcting this distortion in the EE margin. Intuitively, by raising the value of unemployment, higher UI makes employed workers less afraid of unemployment and hence more willing to accept risks, pushing them to prefer the high wage high risk job, as desired by the planner.[66] Crucially, this motivation for positive UI exists because of, not despite of, on the job search, and holds even when $\lambda_E = \lambda_U$.

These results are illustrated in Figure B.1, for a numerical example where $\delta_2 > \delta_1$ and $\lambda_E = \lambda_U$. We plot indifference curves from job 1 in δ, w space, with job 1 and 2 illustrated by the points marked with a circle and cross respectively.[67] Panel (a) compares the planner's preferences to the preferences of the market in the absence of UI ($b_{UI} = 0$), where the level of risk aversion is sufficiently high to make their allocations differ. The planner's indifference curve (blue line) is linear and relatively flat, reflecting the planner's relatively limited need for compensation against risk. Since job 2 lies above the planner's indifference curve, job 2 is preferred to job 1 by the planner. The market's indifference curve (red line) is convex and steeper than the planner's, reflecting the agent's larger distaste for risk with incomplete markets. This means that job 2 lies below the market's indifference curve, so job 1 is preferred to job 2 by the market for this level of risk aversion. Panel (b) shows the role of UI in correcting this distortion, and plots the market's indifference curve for a sufficiently positive level of UI. Higher UI insulates agents against UI risk, reducing the "price" of risk in the indifference curve. This flattens the market indifference curve, bringing job 2 above the indifference curve and hence aligning the market's preferences with the planner.

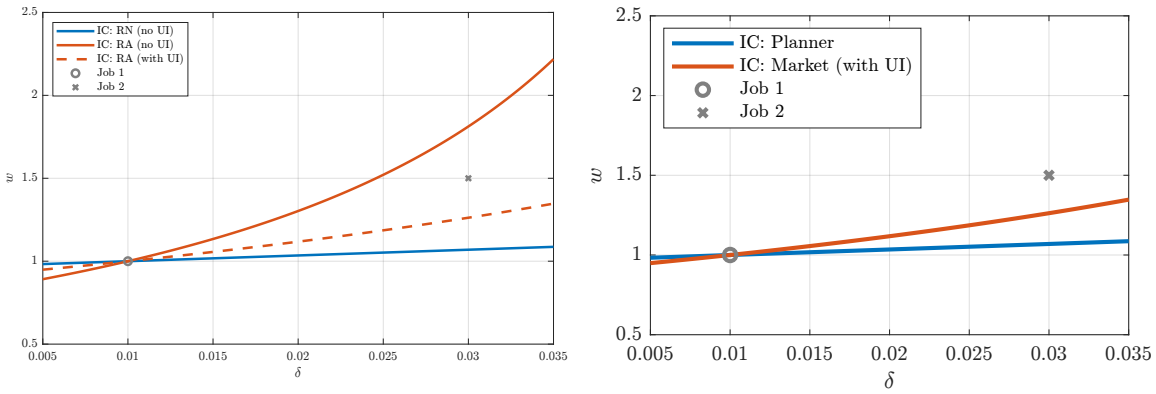
[65] In the language of Proposition 1, $w_r^{sp} \leq \underline{w}$, since the planner rejects no jobs from unemployment in this model.

[66] In the proof we show that there exists some level of b_{UI} which restores the planner's allocation. One can also show that there is in fact a range of values that will restore the planner's allocation, which includes this value.

[67] The indifference curves are computed using the formula in Equation (B.7).

Figure B.1: Indifference curves: Planner vs. market

(a) Market with $b_{UI} = 0$ (b) Market with $b_{UI} > 0$



Notes: Indifference curves in the two job model of Section B.3.2. Value is increasing in the north-west direction. The plots give a numerical example to illustrate the ideas established in the proofs. There are two jobs in the model denoted by the two points on the plots. The indifference curves use equation (B.7) to find the wage required to exactly compensate for a change in risk relative to job 1. Parameter values are $w_1 = 1, w_2 = 1.5, \delta_1 = 0.01, \delta_2 = 0.03, b_{HP} = 0.1, \rho = 0.05, \sigma = 1.75, \lambda_U = \lambda_E = 0.2$ and $\psi_1 = 0.5$. The blue line in each panel is the planner's indifference curve. The red line plots the indifference curve for the market with $b_{UI} = 0$ (left panel) and $b_{UI} = 0.1$ (right panel).

Impossibility of fully recovering productive efficiency in general when $\underline{\delta} < \bar{\delta}$. The two job example illustrated how UI pushes risk averse workers' EE decisions back towards those of the planner. This logic holds in with models more than two jobs, with the caveat that it is no longer possible to *fully* replicate the planner's solution in general using just a single instrument, unemployment insurance. This result follows immediately, since indifference curves under risk aversion are strictly convex in the market allocation while they are linear in the planner's allocation.[68] In this rich setting with two-dimensional match heterogeneity, it is not reasonable to expect a single instrument to exactly restore efficiency. However, as we show in our quantitative work, positive UI is still helpful because it pushes the economy closer to the productively efficient allocation.

B.4 Summary

The seminal work of Acemoglu and Shimer (1999) gave a productive efficiency argument in favor of UI: positive benefits stop risk averse unemployed workers accepting inefficiently unproductive jobs. However, the productive efficiency properties of UI in the presence of on-the-job search are much less understood.

We summarize our analytical results in Table B.1. We focus on the special cases of no OJS ($\lambda_E = 0$) and OJS as efficient as unemployed search ($\lambda_E = \lambda_U$), although we stress that our proofs also cover the general cases of $0 \leq \lambda_E \leq \lambda_U$. Cells shaded in green are models where positive UI is justified to promote productive efficiency, and in red where

[68] Hence for sufficiently dense offer distributions it is not possible for $A(w, \delta)$ and $A^{sp}(w, \delta)$ to coincide for all (w, δ), since these sets are generated from indifference curves with different shapes.

Table B.1: Summary of theoretical results: UI and production efficiency

	$\lambda_E = 0$	$\lambda_E = \lambda_U$
Risk Neutral	$b_{UI} = 0$ [Lemma 1]	$b_{UI} = 0$ [Lemma 1]
Risk Averse	$b_{UI} > 0$ to correct UE [Proposition 1]	$b_{UI} = 0$ [Proposition 1]

(a) Homogenous δ

	$\lambda_E = 0$	$\lambda_E = \lambda_U$
Risk Neutral	$b_{UI} = 0$ [Lemma 1]	$b_{UI} = 0$ [Lemma 1]
Risk Averse	$b_{UI} > 0$ to correct UE [Proposition 3]	$b_{UI} > 0$ to correct EE [Proposition 2]

(b) Heterogeneous δ

Notes: Tabulation of optimal unemployment insurance to restore production efficiency. Cells with green (red) shading indicate models where optimal UI benefits are positive (zero). Panel (a) considers models with homogenous EU risk, and panel (b) with heterogeneous EU risk. Top row considers models where agents are risk neutral, and bottom where they are risk averse. The columns consider two special cases of EE search efficiency: The left column features no EE moves ($\lambda_E = 0$), and the right EE search which is as efficient as UE search ($\lambda_E = \lambda_U$). Our main result is that in the presence of very efficient on the job search ($\lambda_E = \lambda_U$), positive UI benefits are only not optimal, even in the presence of risk aversion, unless EU risk is heterogeneous.

no UI is optimal. In our framework, positive UI is never optimal under risk neutrality (top rows), highlighting that the inefficiencies we study are distinct from those in the risk neutral model of Jarosch (2023). In the absence of on the job search (left columns) positive UI is always optimal to offset the inefficiency risk aversion introduces to unemployed job search.[69] However, this inefficiency is diminished in the presence of on the job search, and vanishes if OJS is as efficient as unemployed search (right columns). Our main result is that OJS introduces a new motivation for positive UI to correct the inefficiency in how risk-averse workers trade off wages and risk when making EE moves, but this channel can only operate in models with heterogeneous risk (panel b, bottom-right cell). Since recent evidence suggests that workers can indeed search on the job relatively efficiently, we argue that this new channel is perhaps the most relevant when considering the productive efficiency effects of unemployment insurance. In the remainder of the paper, we embed these ideas into a quantitative model where we additionally consider the redistribution motive for UI.

C Proofs for Section B.

C.1 Monotonicity of $W(w, \delta)$.

To begin with and using standard techniques, the monotonicity properties of $W(w, \delta)$ can be derived, as encapsulated in the following result which we prove below.

Lemma 3 (Monotonicity of $W(w, \delta)$)**.** *For all $W(w, \delta) \geq U$, $W(w, \delta)$ is strictly increasing in w and strictly decreasing in δ.*

Proof of Lemma 3. *1. $W(w, \delta)$ is decreasing in δ.* We will show that $\delta_H > \delta_L \implies W(w, \delta_L) > W(w, \delta_H)$. Let's assume the opposite, so that $W(w, \delta_L) \leq W(w, \delta_H)$. From the

[69] The proof of this when risk is heterogeneous is given in Proposition 3 in Appendix C.7.

definition of the acceptance set and our assumption, we obtain that $A(w, \delta_H) \subseteq A(w, \delta_L)$. Thus:

$$
\begin{aligned}
rW(w, \delta_L) &= u(w) + \lambda_E \int_{A(w,\delta_L)} \Big(W(\widetilde{w}, \widetilde{\delta}) - W(w, \delta_L)\Big)\, dF(\widetilde{w}, \widetilde{\delta}) + \delta\big[U - W(w, \delta_L)\big] \\
&= u(w) + \lambda_E \int_{A(w,\delta_L)\setminus A(w,\delta_H)} \Big(W(\widetilde{w}, \widetilde{\delta}) - W(w, \delta_L)\Big)\, dF(\widetilde{w}, \widetilde{\delta}) \\
&\quad + \lambda_E \int_{A(w,\delta_H)} \Big(W(\widetilde{w}, \widetilde{\delta}) - W(w, \delta_L)\Big)\, dF(\widetilde{w}, \widetilde{\delta}) + \delta_L\big[U - W(w, \delta_L)\big] \geq \\
&\quad u(w) + \lambda_E \int_{A(w,\delta_H)} \Big(W(\widetilde{w}, \widetilde{\delta}) - W(w, \delta_H)\Big)\, dF(\widetilde{w}, \widetilde{\delta}) + \delta_L\big[U - W(w, \delta_H)\big] > \\
&\quad u(w) + \lambda_E \int_{A(w,\delta_H)} \Big(W(\widetilde{w}, \widetilde{\delta}) - W(w, \delta_H)\Big)\, dF(\widetilde{w}, \widetilde{\delta}) + \delta_H\big[U - W(w, \delta_H)\big] = rW(w, \delta_H)
\end{aligned}
\tag{C.1}
$$

We have used that $\int_{A(w,\delta_L)\setminus A(w,\delta_H)} \Big(W(\widetilde{w}, \widetilde{\delta}) - W(w, \delta_L)\Big)\, dF(\widetilde{w}, \widetilde{\delta}) \geq 0, \delta_H > \delta_L, W(w, \delta_H) \geq U$ and the assumed $W(w, \delta_H) \geq W(w, \delta_L)$ leading to contradiction.

2. $W(w, \delta)$ is increasing in w. Now we show that $w_H > w_L \implies W(w_H, \delta) > W(w_L, \delta)$. Again, we use proof by contradiction and assume $w_H > w_L \implies W(w_L, \delta) \geq W(w_H, \delta)$. Thus $A(w_L, \delta) \subseteq A(w_H, \delta)$.

$$
\begin{aligned}
rW(w_H, \delta) &= u(w_H) + \lambda_E \int_{A(w_H,\delta)} \Big(W(\widetilde{w}, \widetilde{\delta}) - W(w_H, \delta)\Big)\, dF(\widetilde{w}, \widetilde{\delta}) + \delta\big[U - W(w_H, \delta)\big] \\
&= u(w_H) + \lambda_E \int_{A(w_H,\delta)\setminus A(w_L,\delta)} \Big(W(\widetilde{w}, \widetilde{\delta}) - W(w_H, \delta)\Big)\, dF(\widetilde{w}, \widetilde{\delta}) \\
&\quad + \lambda_E \int_{A(w_L,\delta)} \Big(W(\widetilde{w}, \widetilde{\delta}) - W(w_H, \delta)\Big)\, dF(\widetilde{w}, \widetilde{\delta}) \\
&\quad + \delta\big[U - W(w_L, \delta)\big] \geq \\
&\quad u(w_H) + \lambda_E \int_{A(w,\delta_L)} \Big(W(\widetilde{w}, \widetilde{\delta}) - W(w_L, \delta)\Big)\, dF(\widetilde{w}, \widetilde{\delta}) + \delta\big[U - W(w_L, \delta)\big] > \\
&\quad u(w_L) + \lambda_E \int_{A(w_L,\delta)} \Big(W(\widetilde{w}, \widetilde{\delta}) - W(w_L, \delta)\Big)\, dF(\widetilde{w}, \widetilde{\delta}) + \delta\big[U - W(w_L, \delta)\big] = rW(w_L, \delta)
\end{aligned}
\tag{C.2}
$$

We followed similar logic using $\int_{A(w_H,\delta)\setminus A(w_L,\delta)} \Big(W(\widetilde{w}, \widetilde{\delta}) - W(w_H, \delta)\Big)\, dF(\widetilde{w}, \widetilde{\delta}) \geq 0$ and the assumed $W(w_L, \delta) \geq W(w_H, \delta)$ together with $w_H > w_L$ leading to contradiction.

C.2 Planner's problem representation.

Since we only consider the planner's problem in this section, we drop the sp superscript denoting the planner's allocation for notational ease. We need to explicitly account for time in the notation, indexed by t. We additionally modify the notation for the distribution

of workers: at time t, $g_t(w,\delta)$ is the density of employed workers and u_t the mass of unemployed workers, where $\int g_t(w,\delta)dwd\delta + u_t = 1$. We use g_t as shorthand for the whole distribution $g_t(w,\delta)$. We assume that w and δ are continuously distributed, to allow for the use of differential calculus in defining the optimality conditions.

The planner can freely allocate consumption across agents, while respecting the resource constraint each period. The planner receives job offers at rate λ_U and λ_E, and decides if workers accept or reject them. Suppose the planner has utilitarian preferences and values the utility of each agent identically. Standard arguments imply that since agents are risk averse the planner equalizes consumption across all agents within a period. Let Y_t denote total output (including home production) at time t, which is endogenously determined by the planner's production choices. Since consumption is the only use of output in the simple model and there is a unit mass of agents, consumption of each agents is simply $c_t = Y_t$. The resource constraint gives output as

$$Y_t = \int_{w,\delta} w g_t(w,\delta)dwd\delta + b_{HP}u_t \tag{C.3}$$

The distributions evolve according to Kolmogorov Forward (Fokker-Planck) equations. For employed workers, for each w, δ:

$$\dot{g}_t(w,\delta) = \lambda_U \mathbf{1}_t^u(w,\delta)u_t + \lambda_E \int_{w',\delta'} \mathbf{1}_t^e(w,\delta|w',\delta')g_t(w',\delta')f(w',\delta')dw'd\delta' - (\delta + \lambda_E \mu_t^e(w,\delta))g_t(w,\delta) \tag{C.4}$$

Here, $\mathbf{1}_t^u(w,\delta)$ is a choice variable for the planner equal to one if he would allow an unemployed worker to accept a job with characteristics w, δ at time t. Similarly, $\mathbf{1}_t^e(w,\delta|w',\delta')$ is a choice, equal to one if he allows an employed worker at wage w', δ' to accept an EE move opportunity to a job with characteristics w, δ at time t. Finally,

$$\mu_t^e(w,\delta) = \int_{\widetilde{w},\widetilde{\delta}} \mathbf{1}_t^e(\widetilde{w},\widetilde{\delta}|w,\delta)f(\widetilde{w},\widetilde{\delta})d\widetilde{w} \tag{C.5}$$

For unemployed workers:

$$\dot{u}_t = \int_{w,\delta} \delta g_t(w,\delta)dwd\delta - \lambda_U \mu_t^u u_t \tag{C.6}$$

where

$$\mu_t^u = \int_{\widetilde{w},\widetilde{\delta}} \mathbf{1}^u(\widetilde{w},\widetilde{\delta})f(\widetilde{w},\widetilde{\delta})d\widetilde{w}d\widetilde{\delta} \tag{C.7}$$

The planner's problem starting at some time t_0 can therefore be represented as

$$\max_{\left\{Y_t, \dot{g}_t(w,\delta), \dot{u}_t, \mathbf{1}_t^e(w,\delta|w',\delta'), \mathbf{1}_t^u(w,\delta)\right\}_{t_0}^{\infty}} \int_{t_0}^{\infty} e^{-\rho(t-t_0)}u(Y_t) \tag{C.8}$$

subject to the initial distribution (g_{t_0}, u_{t_0}), the resource constraint (C.3), and evolution of

the distribution via (C.4) and (C.6). Following Lucas and Moll (2014), we can express the planner's problem recursively, where the state variable of the planner is the infinite-dimensional current distribution (g_t, u_t), which we denote by $s_t = (g_t, u_t)$. Dropping the time subscripts, the planner's HJB is

$$\rho V(s) = \max_{\mathbf{1}^u(\widetilde{w},\widetilde{\delta}),\mathbf{1}^e(\widetilde{w},\widetilde{\delta}|w,\delta)} u(y(s)) + \int_{w',\delta'} V_{g(w',\delta')}(s)\dot{g}(w',\delta')dw'd\delta' + V_u(s)\dot{u} \tag{C.9}$$

The notation is understood as follows. We let the function $Y = y(s)$ subsume the resource constraint (C.3). $V_u(s)$ is the partial derivative of $V(s)$ with respect to the state u, and $V_{g(w,\delta)}(s)$ the partial with respect to the (w,δ) element of $g(w,\delta)$. The final term is an integral over the derivatives with respect to values of (w,δ), which should formally be understood as a Frechet derivative. Finally, it is understood that the drift terms $\dot{g}(w,\delta)$ and $\dot{u}$ are substituted out using (C.4) and (C.6), restated below without time subscripts:

$$\begin{aligned}\dot{g}(w',\delta') &= \lambda_U \mathbf{1}^u(w',\delta')u \\ &+ \lambda_E \int_{w'',\delta''} \mathbf{1}^e(w',\delta'|w'',\delta'')g(w'',\delta'')f(w'',\delta'')dw''d\delta'' - (\delta' + \lambda_E \mu^e(w',\delta'))g(w',\delta')\end{aligned} \tag{C.10}$$

$$\dot{u} = \int_{w',\delta'} \delta' g(w',\delta')dw'd\delta' - \lambda_U \mu^u u \tag{C.11}$$

Notice that as long as the initial state satisfies the adding up constraint $\int g(w,\delta)dwd\delta + u = 1$ then the evolution equations preserve the total mass at one (since $\int \dot{g}(w,\delta)dwd\delta + \dot{u} = 0$) and this constraint can be ignored in the recursive formulation.

The key idea in Lucas and Moll (2014) is to derive the "marginal social value" (MSV) of each type of worker, and to show that these correspond to equations which are closely related to the HJBs of the competitive equilibrium. The marginal social value is the increase in the planner's value $V(s)$ from marginally increasing the number of workers in a given state. We define the MSV of an employed worker in a (w,δ) job as $W(w,\delta;s) = V_{g(w,\delta)}(s)$, and the MSV of an unemployed worker as $U(s) = V_u(s)$. To derive these, take the derivative of (C.9) with respect to each element of $g(w,\delta)$ and to u and apply the envelope condition to yield:

$$\begin{aligned}\rho W(w,\delta;s) = u'(y(s))w + \lambda_E \int_{w',\delta'} \mathbf{1}^e(w',\delta'|w,\delta)\Big(W(w',\delta';s) - W(w,\delta;s)\Big)f(w,\delta)dw'd\delta' \\ + \delta\left[U(s) - W(w,\delta;s)\right] + \Delta^e(w,\delta;s)\end{aligned} \tag{C.12}$$

$$\rho U(s) = u'(y(s))b_{HP} + \lambda_U \int_{w',\delta'} \mathbf{1}^u(w',\delta')\Big(W(w',\delta';s) - U(s)\Big)dw'd\delta' + \Delta^u(s) \tag{C.13}$$

where we used that $\partial y(s)/\partial g(w,\delta) = w$ and $\partial y(s)/\partial u = b_{HP}$. It is understood that the policies $\mathbf{1}^e(w',\delta'|w,\delta)$ and $\mathbf{1}^u(w',\delta')$ are evaluated at the planner's optimal choices given the state s. The terms $\Delta^e(w,\delta;s)$ and $\Delta^u(s)$ contain first derivatives of the marginal values

multiplied by the drifts in the aggregate state:

$$\Delta^e(w,\delta;s) = \int_{w',\delta'} \frac{\partial W(w',\delta';s)}{\partial g(w,\delta)} \dot{g}(w',\delta') dw' d\delta' + \frac{\partial U(s)}{\partial g(w,\delta)} \dot{u} \tag{C.14}$$

$$\Delta^u(s) = \int_{w',\delta'} \frac{\partial W(w',\delta';s)}{\partial u} \dot{g}(w',\delta') dw' d\delta' + \frac{\partial U(s)}{\partial u} \dot{u} \tag{C.15}$$

Combined with the planner's choices for $\mathbf{1}^e(w',\delta'|w,\delta)$ and $\mathbf{1}^u(w',\delta')$, (C.12) and (C.13) fully characterize the planner's optimal allocation. These choices are derived as follows, with full proofs omitted. Guess that the indicators can be replaced with reservation wages $\underline{w}^u(\delta)$ and $\underline{w}^e(\delta,w',\delta')$. The planner accepts all offers with $w \geq \underline{w}^u(\delta)$ and $w \geq \underline{w}^e(\delta,w',\delta')$ and rejects all offers below the thresholds. This allows us to take first order conditions with respect to $\underline{w}^u(\delta)$ and $\underline{w}^e(\delta,w',\delta')$ directly, rather than optimizing over the indicator functions $\mathbf{1}^u(\widetilde{w},\widetilde{\delta})$ and $\mathbf{1}^e(\widetilde{w},\widetilde{\delta}|w,\delta)$. These yield the expected indifference conditions showing that the planner accepts jobs from unemployment (employment) if and only if $W(w,\delta) \geq U$ ($W(w,\delta) \geq W(w',\delta')$).

Notice that (C.12) and (C.13) look very similar to the competitive equilibrium HJBs in the case of risk neutrality and $b = b_{HP}$, with two exceptions. Firstly, the flow payoffs w and b_{HP} are multiplied by the marginal utility term $u'(y(s))$. However, notice that this term is common to all jobs, and identical for employed and unemployed workers. That is, it depends only on time (via the aggregate state s) and not on the individual job characteristic w,δ. Secondly, we have the first derivative terms $\Delta^e(w,\delta;s)$ and $\Delta^u(s)$.

However, both of these differences vanish in the steady state of the planner's problem. Thus, we restrict our analysis to a timeless perspective: we suppose that the planner's optimization started at some time $t_0 \to -\infty$ and hence consider only the steady state of the planner's problem (which we assume to exist). In this case, the aggregate state s converges to some steady state $\bar{s}$, and the drifts in the state are all zero: $\dot{g}(w,\delta) = \dot{u} = 0$. This implies that $\Delta^e(w,\delta) = \Delta^u(s) = 0$. Additionally, the marginal utility term converges to a constant $\bar{m} = u'(y(\bar{s}))$. Dropping the dependence on the state s, the steady state equivalents of (C.12) and (C.13) are therefore

$$\rho W(w,\delta) = \bar{m}w + \lambda_E \int_{w',\delta'} \mathbf{1}^e(w',\delta'|w,\delta)\Big(W(w',\delta') - W(w,\delta)\Big) f(w,\delta) dw' d\delta' + \delta\left[U - W(w,\delta)\right] \tag{C.16}$$

$$\rho U = \bar{m} b_{HP} + \lambda_U \int_{w',\delta'} \mathbf{1}^u(w',\delta')\Big(W(w',\delta') - U\Big) dw' d\delta' \tag{C.17}$$

By standard arguments, the choices from the optimal solution to (C.16) and (C.17) are invariant to any positive affine transformation of the underlying utility function. Hence, we can always redefine $u(.)$ so that $\bar{m} = 1$ in the steady state. This is the final step, and shows that (C.16) and (C.17) are equivalent to the planner's problem (B.4) as stated in the main text.

C.3 Proof of Proposition 1

We begin by deriving a useful formula for the reservation wage in the case of homogeneous EU risk. This is done for the market economy, and the approach for the planner is the special case of risk neutrality and $b = b_{HP}$.

Derivation of reservation wage. Recall the value functions

$$\rho U = u(b) + \lambda_U \int_{\underline{w}_r}^{\overline{w}} (W(\widetilde{w}) - U)\, f(\widetilde{w}) d\widetilde{w} \tag{C.18}$$

$$\rho W(w) = u(w) + \lambda_E \int_z (W(\widetilde{w}) - W(w))\, f(\widetilde{w}) d\widetilde{w} + \delta \left[U - W(w)\right]. \tag{C.19}$$

The reservation wage satisfies following condition $W(w_r) = U$, giving

$$u(w_r) = u(b) + (\lambda_U - \lambda_E) \int_{w_r}^{\overline{w}} (W(\widetilde{w}) - W(w_r))\, f(\widetilde{w}) d\widetilde{w}. \tag{C.20}$$

Integration by parts on the last term gives:

$$\int_{w_r}^{\overline{w}} (W(\widetilde{w}) - W(w_r))\, f(\widetilde{w}) d\widetilde{w} = (W(\overline{w}) - W(w_r)) - \int_{w_r}^{\overline{w}} \frac{dW(\widetilde{w})}{d\widetilde{w}} F(\widetilde{w}) d\widetilde{w}$$

Next, since $W(\overline{w}) - W(w_r) = \int_{w_r}^{\overline{w}} \frac{dW(\widetilde{w})}{d\widetilde{w}} d\widetilde{w}$ then:

$$\int_{w_r}^{\overline{w}} \left(W(\widetilde{w}) - W(\underline{z}^u)\right) f(\widetilde{w}) d\widetilde{w} = \int_{w_r}^{\overline{w}} (1 - F(\widetilde{w})) \frac{dW(\widetilde{w})}{d\widetilde{w}} d\widetilde{w}.$$

Differentiating (C.19) while applying the envelope theorem gives

$$(\rho + \delta + \lambda_E(w)) \frac{dW(w)}{dw} = u'(w) \implies \frac{dW(w)}{dw} = \frac{u'(w)}{\rho + \delta + \lambda_E(w)} \tag{C.21}$$

Where $\lambda_E(w) = \lambda_E \int_w^{\overline{w}} f(\widetilde{w}) d\widetilde{w} = \lambda_E (1 - F(w))$. Note this expression uses the result that the reservation productivity for EE moves is the current wage w. Note also $\lambda_E(\overline{w}) = 0$. Using (C.21) gives the final expression for the integral:

$$\int_{w_r}^{\overline{w}} (W(\widetilde{w}) - W(w_r))\, f(\widetilde{w}) d\widetilde{w} = \int_{w_r}^{\overline{w}} \frac{(1 - F(\widetilde{w})) u'(\widetilde{w})}{\rho + \delta + \lambda_E(\widetilde{w})} d\widetilde{w}. \tag{C.22}$$

Plugging this in to (C.20) gives the final result:

$$u(w_r) = u(b) + (\lambda_U - \lambda_E) \int_{w_r}^{\overline{w}} \frac{(1 - F(\widetilde{w})) u'(\widetilde{w})}{\rho + \delta + \lambda_E(\widetilde{w})} d\widetilde{w} \tag{C.23}$$

And the equivalent for the social planner is therefore:

$$w_r^{sp} = b_{HP} + (\lambda_U - \lambda_E) \int_{w_r^{sp}}^{\overline{w}} \frac{1 - F(\widetilde{w})}{\rho + \delta + \lambda_E(\widetilde{w})} d\widetilde{w}. \tag{C.24}$$

We now move on to the proof itself.

Part 1. As per the above, the reservation wage in the market allocation when $b_{UI} = 0$ is:

$$u(w_r) = u(b_{HP}) + (\lambda_U - \lambda_E) \int_{w_r}^{\overline{w}} \frac{(1 - F(\widetilde{w}))u'(\widetilde{w})}{\rho + \delta + \lambda_E(\widetilde{w})} d\widetilde{w} \tag{C.25}$$

Note, when $u(w) = 0$ this equation is identical to (C.24). Equations (C.24) and (C.25) can also be written as:

$$\int_{b_{HP}}^{w_r^{sp}} 1 d\widetilde{w} = (\lambda_U - \lambda_E) \int_{w_r^{sp}}^{\overline{w}} \frac{1 - F(\widetilde{w})}{\rho + \delta + \lambda_E(\widetilde{w})} d\widetilde{w} \tag{C.26}$$

$$\int_{b_{HP}}^{w_r} u'(\widetilde{w}) d\widetilde{w} = (\lambda_U - \lambda_E) \int_{w_r}^{\overline{w}} \frac{(1 - F(\widetilde{w}))u'(\widetilde{w})}{\rho + \delta + \lambda_E(\widetilde{w})} d\widetilde{w} \tag{C.27}$$

Let's assume that $w_r \geq w_r^{sp}$ to arrive at a contradiction. Then, the market allocation condition reads:

$$\int_{b_{HP}}^{w_r^{sp}} u'(\widetilde{w}) d\widetilde{w} + \epsilon = (\lambda_U - \lambda_E) \int_{w_r^{sp}}^{\overline{w}} \frac{(1 - F(\widetilde{w}))u'(\widetilde{w})}{\rho + \delta + \lambda_E(\widetilde{w})} d\widetilde{w}, \tag{C.28}$$

where:

$$\epsilon = \int_{w_r^{sp}}^{w_r} u'(\widetilde{w}) d\widetilde{w} + (\lambda_U - \lambda_E) \int_{w_r^{sp}}^{w_r} \frac{(1 - F(\widetilde{w}))u'(\widetilde{w})}{\rho + \delta + \lambda_E(\widetilde{w})} d\widetilde{w} \geq 0.$$

Define $\underline{F} = \int_{w_r^{sp}}^{\overline{w}} \frac{(1-F(\widetilde{w}))}{\rho+\delta+\lambda_E(\widetilde{w})} d\widetilde{w}$ and $g(\widetilde{w}) = \frac{(1-F(\widetilde{w}))}{\rho+\delta+\lambda_E(\widetilde{w})} / \underline{F}$. Note that $g(\widetilde{w})$ is a probability density function on $[w_r^{sp}, \overline{w}]$. Then the equations (C.26) - (C.27) become

$$\int_{b_{HP}}^{w_r^{sp}} 1 d\widetilde{w} = (\lambda_U - \lambda_E)\underline{F} \tag{C.29}$$

$$\int_{b_{HP}}^{w_r^{sp}} u'(\widetilde{w}) d\widetilde{w} + \epsilon = (\lambda_U - \lambda_E)\underline{F} \int_{w_r^{sp}}^{\overline{w}} u'(\widetilde{w}) g(\widetilde{w}) d\widetilde{w} \tag{C.30}$$

Since workers are strictly risk averse, $u'(c)$ is strictly decreasing. Therefore:

$$\int_{w_r^{sp}}^{\overline{w}} u'(\widetilde{w}) g(\widetilde{w}) d\widetilde{w} < u'(w_r^{sp}),$$

since the integral is a weighted average of $u'(\widetilde{w})$ from w_r^{sp} upwards. Based on this, and using (C.29) we can write (C.27) as:

$$\int_{b_{HP}}^{w_r^{sp}} u'(\widetilde{w})d\widetilde{w} + \epsilon < (\lambda_U - \lambda_E)\underline{F}u'(w_r^{sp}) = u'(w_r^{sp}) \int_{b_{HP}}^{w_r^{sp}} 1d\widetilde{w} = \int_{b_{HP}}^{w_r^{sp}} u'(w_r^{sp})d\widetilde{w} \quad \text{(C.31)}$$

This is a contradiction since $u'(\widetilde{w}) > u'(w_r^{sp})$ on $\left[b_{HP}, w_r^{sp}\right]$ under risk aversion. Hence, we have shown $w_r < w_r^{sp}$. We'll show next that $b_{UI} > 0$ restores efficiency. Starting with equation (C.25), and using $w_r < w_r^{sp}$:

$$\begin{aligned} u(w_r) + u(w_r^{sp}) - u(w_r^{sp}) &= u(b_{HP}) \\ &+ (\lambda_U - \lambda_E) \int_{w_r^{sp}}^{\overline{w}} \frac{(1 - F(\widetilde{w}))u'(\widetilde{w})}{\rho + \delta + \lambda_E(\widetilde{w})} d\widetilde{w} + (\lambda_U - \lambda_E) \int_{w_r}^{w_r^{sp}} \frac{(1 - F(\widetilde{w}))u'(\widetilde{w})}{\rho + \delta + \lambda_E(\widetilde{w})} d\widetilde{w}. \end{aligned}$$

Define b_{UI}^* implicitly from:

$$u(b_{HP} + b_{UI}^*) = u(b_{HP}) + \underbrace{u(w_r^{sp}) - u(w_r) + (\lambda_U - \lambda_E) \int_{w_r}^{w_r^{sp}} \frac{(1 - F(\widetilde{w}))u'(\widetilde{w})}{\rho + \delta + \lambda_E(\widetilde{w})} d\widetilde{w}}_{>0},$$

arriving at:

$$u(w_r^{sp}) = u(b_{HP} + b_{UI}^*) + (\lambda_U - \lambda_E) \int_{w_r^{sp}}^{\overline{w}} \frac{(1 - F(\widetilde{w}))u'(\widetilde{w})}{\rho + \delta + \lambda_E(\widetilde{w})} d\widetilde{w}.$$

This is a condition for w_r^{sp} to be the reservation wage in the market allocation. Note, b_{UI}^* is indeed positive and unique since $u(c)$ is strictly increasing. What remains is to ensure that $b = b_{HP} + b_{UI}^* < w_r^{sp}$. Using the condition for $u(w_r)$, we get:

$$u(b_{HP} + b_{UI}^*) = u(w_r^{sp}) - (\lambda_U - \lambda_E) \int_{w_r^{sp}}^{\overline{w}} \frac{(1 - F(\widetilde{w}))u'(\widetilde{w})}{\rho + \delta + \lambda_E(\widetilde{w})} d\widetilde{w} < u(w_r^{sp}).$$

Finally, the assumption that $w_r^{sp} > \underline{w}$ ensures that the planner rejects a positive mass of job offers out of unemployment. This means that $w_r < w_r^{sp}$ has bite in the equilibrium as the market now accepts more jobs than the planner. If $w_r^{sp} = \underline{w}$ then $w_r < w_r^{sp}$ would not affect the equilibrium as both the planner and market accept all jobs out of unemployment, and positive UI would not be necessary to restore productive efficiency.

Part 2. We differentiate the planner's and the market allocation reservation wage conditions with respect to λ_E. Note that since $\lambda_E(w) = \lambda_E \int_{\widetilde{w}} f(\widetilde{w})d\widetilde{w} = \lambda_E(1 - F(z))$,then

$d\lambda_E(w)/d\lambda_E = (1 - F(w))$. For the planner's condition we obtain:

$$\frac{dw_r^{sp}(\lambda_E)}{d\lambda_E} = -\int_{w_r^{sp}}^{\overline{w}} \frac{1 - F(\widetilde{w})}{\rho + \delta + \lambda_E(\widetilde{w})} d\widetilde{w} - (\lambda_U - \lambda_E)\left[\int_{w_r^{sp}}^{\overline{w}} \left(\frac{1 - F(\widetilde{w})}{\rho + \delta + \lambda_E(\widetilde{w})}\right)^2 d\widetilde{w} + \frac{dw_r^{sp}(\lambda_E)}{d\lambda_E} \frac{1 - F(w_r^{sp})}{\rho + \delta + \lambda_E(w_r^{sp})}\right], \quad \text{(C.32)}$$

while for the market allocation condition we get:

$$u'(w_r^{sp})\frac{dw_r^{sp}(\lambda_E)}{d\lambda_E} = u'(b)\frac{db(\lambda_E)}{d\lambda_E} - \int_{w_r^{sp}}^{\overline{w}} \frac{(1 - F(\widetilde{w}))u'(\widetilde{w})}{\rho + \delta + \lambda_E(\widetilde{w})} d\widetilde{w} - (\lambda_U - \lambda_E)\left[\int_{w_r^{sp}}^{\overline{w}} \left(\frac{1 - F(\widetilde{w})}{\rho + \delta + \lambda_E(\widetilde{w})}\right)^2 u'(\widetilde{w}) d\widetilde{w} + \frac{dw_r^{sp}(\lambda_E)}{d\lambda_E} \frac{(1 - F(w_r^{sp}))u'(w_r^{sp})}{\rho + \delta + \lambda_E(w_r^{sp})}\right] \quad \text{(C.33)}$$

Wlog normalize $u'(w_r^{sp}) = 1$ and rearrange:

$$u'(b)\frac{db(\lambda_E)}{d\lambda_E} = \frac{dw_r^{sp}(\lambda_E)}{d\lambda_E} + \int_{w_r^{sp}}^{\overline{w}} \frac{(1 - F(\widetilde{w}))u'(\widetilde{w})}{\rho + \delta + \lambda_E^*(\widetilde{w})} d\widetilde{w} + (\lambda_U - \lambda_E)\left[\int_{w_r^{sp}}^{\overline{w}} \left(\frac{1 - F(\widetilde{w})}{\rho + \delta + \lambda_E^*(\widetilde{w})}\right)^2 u'(\widetilde{w}) d\widetilde{w} + \frac{dw_r^{sp}(\lambda_E)}{d\lambda_E} \frac{(1 - F(w_r^{sp}))}{\rho + \delta + \lambda_E(w_r^{sp})}\right]. \quad \text{(C.34)}$$

Using the planner's condition to remove the derivative of w_{sp}^r with respect to λ_E to arrive, after some algebra, at:

$$u'(b)\frac{db(\lambda_E)}{d\lambda_E} = \underbrace{-\left[\int_{w_r^{sp}}^{\overline{w}} \frac{1 - F(\widetilde{w})}{\rho + \delta + \lambda_E^*(\widetilde{w})} d\widetilde{w} - \int_{w_r^{sp}}^{\overline{w}} \frac{(1 - F(\widetilde{w}))u'(\widetilde{w})}{\rho + \delta + \lambda_E^*(\widetilde{w})} d\widetilde{w}\right]}_{>0} - (\lambda_U - \lambda_E)\underbrace{\left[\int_{w_r^{sp}}^{\overline{w}} \left(\frac{1 - F(\widetilde{w})}{\rho + \delta + \lambda_E^*(\widetilde{w})}\right)^2 d\widetilde{w} - \int_{w_r^{sp}}^{\overline{w}} \left(\frac{1 - F(\widetilde{w})}{\rho + \delta + \lambda_E^*(\widetilde{w})}\right)^2 u'(\widetilde{w}) d\widetilde{w}\right]}_{>0} \quad \text{(C.35)}$$

Both of the two differences in integrals must be positive. This is so because after normalisation the integrands have the same value at their left limit. Then since $u'(c)$ is a decreasing function, the integrals with the $u'(c)$ in them must be smaller. If $\lambda_U \geq \lambda_E$ then the right hand side must be negative. Then since $u'(c) > 0$ everywhere, this proves that $b'(\lambda_E) < 0$.

Part 3. Direct inspection of the reservation wage equations when $\lambda_E = \lambda_U$ shows that $w_r^{sp} = b_{HP}$ and $w_r = b_{HP} + b_{UI}$. Hence, $b_{UI} = 0$ equates the market and planner reservation wages.

C.4 Proof of Lemma 2

The choices in the market equilibrium with utility function $u(c)$ are identical to the choices under any positive affine transformation of the utility function. Consider a new utility function $\widetilde{u}(c) = A + Bu(c)$, with $B > 0$. For any A and $B > 0$ the choices under $\widetilde{u}(c)$ will be the same as the choices under $u(c)$. We choose A and B so that the new utility function $\widetilde{u}(c)$ delivers utility levels b and w_1 when consumption is b and w_1 respectively:

$$b = A + B \times b^{1-\sigma}/(1-\sigma) \tag{C.36}$$

$$w_1 = A + B \times (w_1)^{1-\sigma}/(1-\sigma) \tag{C.37}$$

This delivers values of A and B of

$$B = \frac{w_1 - b}{(w_1)^{1-\sigma}/(1-\sigma) - b^{1-\sigma}/(1-\sigma)} > 0 \tag{C.38}$$

$$A = w_1 - B \times (w_1)^{1-\sigma}/(1-\sigma) \tag{C.39}$$

since $w_1 > b$ and $u(c)$ is strictly increasing in c we have $B > 0$ as required. Finally, we can solve for the utility level associated with consuming w_2, which we denote $\widetilde{w}_2 = \widetilde{u}(w_2)$:

$$\widetilde{w}_2 = A + B \times (w_2)^{1-\sigma}/(1-\sigma) \implies \widetilde{w}_2 = w_1 + \frac{w_1 - b}{(w_1)^{1-\sigma} - b^{1-\sigma}} \left((w_2)^{1-\sigma} - (w_1)^{1-\sigma}\right) \tag{C.40}$$

The case of log utility is similar and omitted. From here we can see the limit cases. If $\sigma = 0$ then $\widetilde{w}_2 = w_2$. The limit as $\sigma \to \infty$ is harder. Normalising $w_1 = 1$ helps clarify the proof.[70] If $w_1 = 1$ then $(w_1)^{1-\sigma} = 1$ even as $\sigma \to \infty$. Then since $b < 1$ and $w_2 > 1$ we have that as $\sigma \to \infty$, $(b)^{1-\sigma} \to \infty$ and $(w_2)^{1-\sigma} \to 0$. Put together these limits mean that the final term $\frac{w_1 - b}{(w_1)^{1-\sigma} - b^{1-\sigma}} \left((w_2)^{1-\sigma} - (w_1)^{1-\sigma}\right) \to 0$ and hence $\widetilde{w}_2 \to w_1$.

The final part of the proof is to show that $\partial \widetilde{w}_2 / \partial \sigma < 0$. We use $w_1 = 1$ again which simplifies the formulas without loss of generality. For $\sigma \neq 1$ we have

$$\widetilde{w}_2 = 1 + (1-b)\frac{(w_2)^{1-\sigma} - 1}{1 - b^{1-\sigma}} \tag{C.41}$$

and for $\sigma = 1$:

$$\widetilde{w}_2 = 1 + (1-b)\frac{\log w_2}{\log(1/b)} \tag{C.42}$$

Trying to directly sign the derivative $\partial \widetilde{w}_2 / \partial \sigma$ is surprisingly fruitless. Instead, consider the inverted problem of solving for σ as a function of $\widetilde{w}_2$: $\sigma(\widetilde{w}_2)$ and computing the derivative

[70] The normalisation is not necessary and one can just divide everything by w_1 and express things relative to w_1 to get the same result.

$\partial\sigma/\partial\widetilde{w}_2$. If $\partial\sigma/\partial\widetilde{w}_2 < 0$ then $\partial\widetilde{w}_2/\partial\sigma < 0$, which delivers the proof.

To sign $\partial\sigma/\partial\widetilde{w}_2$, consider the case of $\sigma \neq 1$ and rearrange (C.41) to yield

$$(\widetilde{w}_2 - 1)(1 - b^{1-\sigma}) = (1 - b)((w_2)^{1-\sigma} - 1) \tag{C.43}$$

This has a trivial $0 = 0$ solution at $\sigma = 1$, but this is ruled out since the equation is only valid for $\sigma \neq 1$. This equation implicitly defines the solution $\sigma(\widetilde{w}_2)$ for σ as a function of $\widetilde{w}_2$. For given $\widetilde{w}_2$, imagine plotting the left hand side and right hand side of this equation on the vertical axis against σ on the horizontal axis. First consider the right hand side $RHS(\sigma) = (1 - b)((w_2)^{1-\sigma} - 1)$. This is strictly decreasing but strictly concave in σ, and independent of $\widetilde{w}_2$. Next consider the left hand side $LHS(\sigma) = (\widetilde{w}_2 - 1)(1 - b^{1-\sigma})$. This is strictly decreasing but strictly convex in σ. We have $RHS(1) = LHS(1) = 0$ and since both functions are strictly decreasing they are positive for $\sigma < 1$ and negative for $\sigma > 1$.

To complete the proof requires three steps. For the given parameter restrictions $0 < b < 1$, $w_2 > 1$, and $1 < \widetilde{w}_2 < w_2$, the following things are true (the cases $\widetilde{w}_2 \to 1$ and $\widetilde{w}_2 = w_2$ were already covered in the limit cases above):

Firstly, at $\sigma = 0$ we have $RHS(0) > LHS(0)$. This follows because $RHS(0) = (1-b)(w_2 - 1)$ and $LHS(0) = (\widetilde{w}_2 - 1)(1 - b)$, and $\widetilde{w}_2 < w_2$.

Secondly, we know that $LHS(\sigma)$ and $RHS(\sigma)$ cross once at $\sigma = 1$ since $LHS(1) = RHS(1)$. Since $RHS(0) > LHS(0)$ and the curves are convex and concave we know they must cross exactly twice, so there is another crossing which is the valid solution. If the curves cross for $\sigma > 1$ this occurs where $LHS(\sigma) = RHS(\sigma) < 0$, whereas if they cross for $\sigma < 1$ this occurs where $LHS(\sigma) = RHS(\sigma) > 0$.

Finally, $LHS(\sigma)$ is stretched away from zero as you raise $\widetilde{w}_2$. If the original crossing is at $\sigma > 1$ then $LHS(\sigma) < 0$ and stretching away from zero makes $LHS(\sigma)$ more negative, lowering the value of σ where the two lines cross. Conversely, if the original crossing is at $\sigma < 1$ then $LHS(\sigma) > 0$ and stretching away from zero makes $LHS(\sigma)$ more positive, lowering the value of σ where the two lines cross. Hence $\partial\sigma/\partial\widetilde{w}_2 < 0$, implying $\partial\widetilde{w}_2/\partial\sigma < 0$. The proof is illustrated in Figure C.1. *QED.*

C.5 Two job model parameter restrictions

Lemma 4. *Consider the two-job problem from Section B.3.2. Holding all other parameters constant, there is a threshold value $\underline{w}_2$ such that for $w_2 > \underline{w}_2$ the planner prefers job 2 to job 1. There is a threshold $\bar{w}_2$ such that for $w_2 < \bar{w}_2$ the planner prefers job 1 to unemployment. As $\lambda_E \to \lambda_U$, $\bar{w}_2 \to \infty$ and hence $\underline{w}_2 < \bar{w}_2$ meaning a positive range of w_2 values supports the proposed equilibrium.*

Proof of Lemma 4: Let's set up the planner values and find the parameter restrictions needed for this to be true. If $W_2^{sp} > W_1^{sp} > U^{sp}$ then:

$$\begin{aligned}
\rho U^{sp} &= b_{HP} + \lambda_U \left(\psi_1 W_1^{sp} + \psi_2 W_2^{sp} - U^{sp}\right) \\
\rho W_1^{sp} &= w_1 + \delta_1 \left(U^{sp} - W_1^{sp}\right) + \lambda_E \psi_2 \left(W_2^{sp} - W_1^{sp}\right) \\
\rho W_2^{sp} &= w_2 + \delta_2 \left(U^{sp} - W_2^{sp}\right)
\end{aligned} \tag{C.44}$$

Figure C.1: Illustration for proof that $\partial \widetilde{w}_2/\partial \sigma < 0$

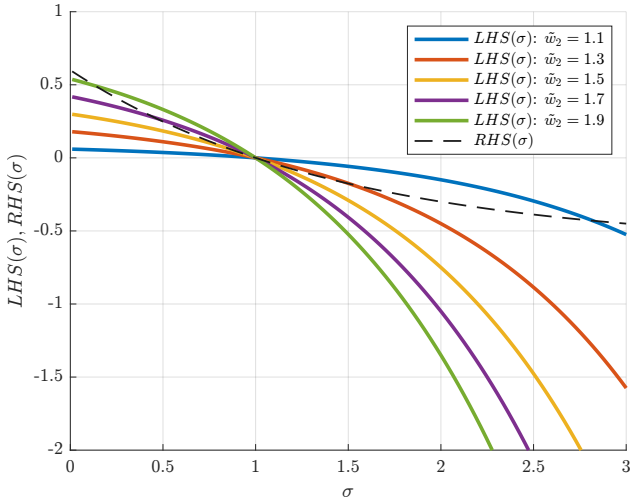


Illustration of the steps in the proof that $\partial \widetilde{w}_2/\partial \sigma < 0$ in Lemma 2. The figure is drawn for $b = 0.4, w_1 = 1$, and $w_2 = 2$.

Step 1. Suppose w_2 is such that the planner is indifferent over the two jobs: $W_2^{sp} = W_1^{sp} = W^{sp} > U^{sp}$. Then the equations reduce to

$$\begin{aligned}
\rho U^{sp} &= b_{HP} + \lambda_U \left(W^{sp} - U^{sp}\right) \\
\rho W^{sp} &= w_1 + \delta_1 \left(U^{sp} - W^{sp}\right) \\
\rho W^{sp} &= w_2 + \delta_2 \left(U^{sp} - W^{sp}\right)
\end{aligned}$$

Solve for the value of unemployment and employment using the first two equations:

$$U^{sp} = \frac{(\rho + \delta_1) b_{HP} + \lambda_U w_1}{\rho^2 + \delta_1 \rho + \rho \lambda_U} \tag{C.45}$$

$$W^{sp} = \frac{w_1 + \delta_1 U^{sp}}{\rho + \delta_1} \tag{C.46}$$

Then for $W_2^{sp} = W_1^{sp} = W^{sp}$ to be true it must be that

$$w_2 + \delta_2 \left(U^{sp} - W^{sp}\right) = w_1 + \delta_1 \left(U^{sp} - W^{sp}\right) \implies$$

$$w_2 = w_1 + (\delta_2 - \delta_1) \left(W^{sp} - U^{sp}\right) > w_1 \tag{C.47}$$

Given the other parameters $w_1, b_{HP}, \rho, \lambda_U, \delta_1, \delta_2$, this equation tells you the threshold wage $\underline{w}_2$ needed to make the planner indifferent between the risky and safe job.

Step 2. We show that raising w_2 increases $W_2^{sp} - W_1^{sp}$. Differentiate the equations in

(C.44) with respect to w_2:

$$\begin{aligned}(\rho+\lambda_U)U^{sp\prime}(w_2) &= \lambda_U\left(\psi_1 W_1^{sp\prime}(w_2)+\psi_2 W_2^{sp\prime}(w_2)\right)\\ (\rho+\delta_1+\lambda_E\psi_2)W_1^{sp\prime}(w_2) &= \delta_1 U^{sp\prime}(w_2)+\lambda_E\psi_2 W_2^{sp\prime}(w_2)\\ (\rho+\delta_2)W_2^{sp\prime}(w_2) &= 1+\delta_2 U^{sp\prime}(w_2)\end{aligned}$$

Notice that all three value functions are increasing in w_2: $U^{sp\prime}(w_2), W_1^{sp\prime}(w_2), W_2^{sp\prime}(w_2) > 0$, since there are no direct negative effects of increasing w_2 in the system of three equations above. To see that $W_2^{sp\prime}(w_2) > W_1^{sp\prime}(w_2)$, we use a contradiction proof. Guess that $W_1^{sp\prime}(w_2) = W_2^{sp\prime}(w_2)+\epsilon$ for $\epsilon > 0$. Then the second two equations give

$$\begin{aligned}W_1^{sp\prime}(w_2) &= -\frac{\lambda_E\psi_2\epsilon}{\rho+\delta_1}+\frac{\delta_1}{\rho+\delta_1}U^{sp\prime}(w_2)\\ W_2^{sp\prime}(w_2) &= \frac{1}{\rho+\delta_2}+\frac{\delta_2}{\rho+\delta_2}U^{sp\prime}(w_2)\end{aligned}$$

Since $\delta/(\rho+\delta)$ is increasing in δ, and $\delta_2 > \delta_1$, the last term is bigger in the second equation, since $U^{sp\prime}(w_2) > 0$. Combined with the negative term in the first equation, this is enough to provide the contradiction as these two equations imply that $W_2^{sp\prime}(w_2) > W_1^{sp\prime}(w_2)$. This implies that raising w_2 makes job 2 even more preferred to job 1.

Step 3. Next we need to find the maximum w_2 such that the planner is willing to accept job 1 from unemployment, rather than waiting for an offer for job 2. Suppose w_2 is such that the planner is indifferent about accepting job 1 from unemployment: $U^{sp} = W_1^{sp}$. Then U^{sp} and W_2^{sp} solve:

$$\begin{aligned}\rho U^{sp} &= b_{HP}+\psi_2\lambda_U\left(W_2^{sp}-U^{sp}\right)\\ \rho W_2^{sp} &= w_2+\delta_2\left(U^{sp}-W_2^{sp}\right)\end{aligned}$$

giving

$$U^{sp} = \frac{(\rho+\delta_2)b_{HP}+\psi_2\lambda_U w_2}{\rho^2+\delta_2\rho+\rho\psi_2\lambda_U} \tag{C.48}$$

$$W_2^{sp} = \frac{w_2+\delta_2 U^{sp}}{\rho+\delta_2} \tag{C.49}$$

Then, other given parameters given, $U^{sp} = W_1^{sp}$ requires that w_2 satisfies

$$\rho U^{sp} = w_1+\psi_2\lambda_E\left(W_2^{sp}-U^{sp}\right) \tag{C.50}$$

Plugging in the expressions for U^{sp} and W_2^{sp} gives

$$\rho(\lambda_U-\lambda_E)\frac{(\rho+\delta_2)b_{HP}+\psi_2\lambda_U w_2}{\rho^2+\delta_2\rho+\rho\psi_2\lambda_U} = \lambda_U w_1-\lambda_E b_{HP} \tag{C.51}$$

This equation implicitly defines the level $\bar{w}_2$ which makes the planner indifferent between unemployment and job 1. For $\lambda_U > \lambda_E$, the right hand side is positive, $\lambda_U - \lambda_E > 0$, and the equation implicitly defines a finite $\bar{w}_2$. However, notice that if $\lambda_U = \lambda_E$ then indifference just requires $w_1 = b_{HP}$, which is true for any w_2 implying that $\bar{w}_2 = \infty$. *QED.*

C.6 Proof of Proposition 2

Part 1. When $\delta_2 = \delta_1$, we return to the model with homogenous risks. Note that under the maintained assumptions of the parameter configuration of the two job model, the planner strictly prefers the lowest paying job to unemployment: $W_1^{sp} > U^{sp}$. Proposition 1 established that in this case, production efficiency is achieved with $b_{UI} = 0$. The proof is easily adapted to the two job setup here.

Part 2a. The proof of Lemma 4 already established that there was a threshold w_2 above which the planner preferred job 2 to job 1. Replacing w_2 with $\widetilde{w}_2$ in the proof immediately applies the proof to the market solution with no UI benefits, rather than planner's solution. Hence, it is also the case that $\widetilde{w}_2 \geq \underline{w}_2$ is necessary — meaning that risk aversion needs to be low enough — in order for the market solution with no UI to support the equilibrium where job 2 is preferred to job 1. Thus, there exists a threshold value of risk aversion $\bar{\sigma}$ (where $\sigma = \bar{\sigma}$ implies that $\widetilde{w}_2 = \underline{w}_2$) above which the planner's equilibrium is not longer supported.

The next step is to establish that for $\sigma > \bar{\sigma}$ the market solution with no UI supports an equilibrium where job 1 is preferred to job 2. In fact, the discrete job distribution implies the following: For $\sigma < \bar{\sigma}$ job 2 is preferred to job 1, for $\sigma = \bar{\sigma}$ the worker is indifferent over the two jobs and both equilibria are valid, and for $\sigma > \bar{\sigma}$ job 1 is preferred to job 2. The first two cases are already dealt with by reinterpreting Lemma 4, so we turn to the third case.

If the market solution with no UI prefers job 1 to job 2, i.e. $W_1^{ce} > W_2^{ce} > U^{ce}$, then:

$$\begin{aligned} \rho U^{ce} &= b_{HP} + \lambda_U \left(\psi_1 W_1^{ce} + \psi_2 W_2^{ce} - U^{ce}\right) \\ \rho W_1^{ce} &= w_1 + \delta_1 \left(U^{ce} - W_1^{ce}\right) \\ \rho W_2^{ce} &= \widetilde{w}_2 + \delta_2 \left(U^{ce} - W_2^{ce}\right) + \lambda_E \psi_1 \left(W_1^{ce} - W_2^{ce}\right) \end{aligned} \tag{C.52}$$

Following similar steps to Lemma 4, we can establish that there exists a maximum wage $\widetilde{w}_2 = \bar{\widetilde{w}}_2$ such that for $\widetilde{w}_2 \leq \bar{\widetilde{w}}_2$ this equilibrium where job 1 is preferred is valid. It is also easy to see that this upper limit $\bar{\widetilde{w}}_2$ is identical to the lower limit $\underline{w}_2$ where the other equilibrium (where job 2 is preferred) becomes valid.[71] Noting that raising risk aversion σ lowers the transformed wage $\widetilde{w}_2$ establishes the proof: For $\sigma = 0$, $\widetilde{w}_2 = w_2$ and the market

[71] $\widetilde{w}_2$ has a natural lower limit: as $\sigma \to \infty$, $\widetilde{w}_2 \to w_1$. For $\widetilde{w}_2 = w_1$ it must be that job 1 is strictly preferred to job 2, since both pay the same (transformed) wage, and job 2 has a higher rate of being laid off to unemployment ($\delta_2 > \delta_1$). Further, it is possible to prove that as long as $w_1 > b_{HP}$ (as maintained), then $\widetilde{w}_2 = w_1$ implies that job 1 is preferred to job 2 which is preferred to unemployment ($W_2^{ce} > W_1^{ce} > U^{ce}$).

solution is identical to the planner. As σ is raised, eventually the threshold $\bar{\sigma}$ is reached and the market solution flips to ranking job 1 over job 2 for any $\sigma \in [\bar{\sigma}, \infty)$.

The allocations can be characterized analytically since there are only three states. Let u denote the unemployment stock, and n_1 and n_2 employment in each job. Starting with the social planner, balancing inflows and outflows from each employment state gives:

$$\begin{aligned}(\delta_1 + \psi_2\lambda_E)n_1^{sp} &= \psi_1\lambda_U u^{sp} \\ \delta_2 n_2^{sp} &= \psi_2\lambda_U u^{sp} + \psi_2\lambda_E n_1^{sp}\end{aligned}$$

Let $\Delta^{sp} = n_1^{sp}/n_2^{sp}$ be the ratio of type 1 jobs to type 2 jobs. We can solve the above two equations to give

$$\Delta^{sp} = \frac{\psi_1}{\psi_2}\frac{\delta_2}{\delta_1 + \lambda_E} \tag{C.53}$$

Intuitively, the higher the fraction of offers to type 1 jobs, ψ_1/ψ_2, or EU rate in type 2 relative to type 1 jobs, the higher the fraction of type 1 jobs in equilibrium. The higher the EE offer rate λ_E the lower the fraction of type 1 jobs in equilibrium since EE flows are from type 1 to 2 in the planner's solution. To solve for the unemployment rate, let $\bar{\delta}$ be the overall average EU rate per job. Then flow balance gives $\lambda_U u^{sp} = \bar{\delta}(1 - u^{sp})$, giving the usual expression

$$u^{sp} = \frac{\bar{\delta}^{sp}}{\lambda_U + \bar{\delta}^{sp}} \tag{C.54}$$

where

$$\bar{\delta}^{sp} = \frac{\delta_1 n_1^{sp} + \delta_2 n_2^{sp}}{n_1^{sp} + n_2^{sp}} = \frac{\delta_1\Delta^{sp} + \delta_2}{\Delta^{sp} + 1} \tag{C.55}$$

How does this compare to the market allocation? If risk aversion is sufficiently low, the market allocation is the same as the planner and so $\Delta^{ce} = \Delta^{sp}$ and so on. If risk aversion is high enough then the market prefers job 1 to job 2, and allocation is different. In this case, following the same steps but allowing for EE moves from job 2 to job 1 yields the allocation:

$$\Delta^{ce} = \frac{\psi_1}{\psi_2}\frac{\delta_2 + \lambda_E}{\delta_1}, \qquad u^{ce} = \frac{\bar{\delta}^{ce}}{\lambda_U + \bar{\delta}^{ce}}, \qquad \bar{\delta}^{ce} = \frac{\delta_1\Delta^{ce} + \delta_2}{\Delta^{ce} + 1} \tag{C.56}$$

The key difference between the allocations is the employment share, where $\Delta^{ce} > \Delta^{sp}$ since $\lambda_E > 0$ so there are relatively more safe low paying jobs in the market allocation. This leads to a lower EU rate $\bar{\delta}^{ce} < \bar{\delta}^{sp}$ and thus a lower unemployment rate $u^{ce} < u^{sp}$. Average wages or labour productivity are lower in the market allocation since $\bar{w}^{ce} = \frac{w_1\Delta^{ce} + w_2}{\Delta^{ce}+1} < \frac{w_1\Delta^{sp} + w_2}{\Delta^{sp}+1} = \bar{w}^{sp}$.

Part 2b. To prove that there exists a positive level of unemployment benefits $b_{UI} > 0$ which restores the planner's allocation, we use a positive affine transformation of the utility function. The choices in the market equilibrium with utility function $u(c)$ are

identical to the choices under any positive affine transformation of the utility function. Consider a new utility function $\widetilde{u}(c) = A + Bu(c)$, with $B > 0$. For any A and $B > 0$ the choices under $\widetilde{u}(c)$ will be the same as the choices under $u(c)$. We choose A and B and the level of b_{UI} so that the new utility function $\widetilde{u}(c)$ delivers utility levels b_{HP}, w_1, and w_2 when consumption is b, w_1, and w_2 respectively. If this is possible, then this proves that the UI level b_{UI} must deliver choices in the market equilibrium identical to the planner's choices. This gives three equations:

$$b_{HP} = A + B \times (b_{HP} + b_{UI})^{1-\sigma}/(1-\sigma) \tag{C.57}$$

$$w_1 = A + B \times (w_1)^{1-\sigma}/(1-\sigma) \tag{C.58}$$

$$w_2 = A + B \times (w_2)^{1-\sigma}/(1-\sigma) \tag{C.59}$$

where the above are for $\sigma \neq 1$, and a similar equation holds for log utility. Using the last two equations delivers values of A and B of

$$B = \frac{w_2 - w_1}{(w_2)^{1-\sigma}/(1-\sigma) - (w_1)^{1-\sigma}/(1-\sigma)} > 0 \tag{C.60}$$

$$A = w_1 - B \times (w_1)^{1-\sigma}/(1-\sigma) \tag{C.61}$$

Use the first equation to solve for b_{UI}:

$$b_{UI} = \left((1-\sigma)\frac{b_{HP} - A}{B}\right)^{\frac{1}{1-\sigma}} - b_{HP} \tag{C.62}$$

Substitute in for A and B:

$$b_{UI} = \left(((w_2)^{1-\sigma} - (w_1)^{1-\sigma})\frac{b_{HP} - w_1}{w_2 - w_1} + (w_1)^{1-\sigma}\right)^{\frac{1}{1-\sigma}} - b_{HP} \tag{C.63}$$

To prove that $b_{UI} > 0$ for $\sigma > 0$ requires two steps. Firstly, note that the above equation gives $b_{UI} = 0$ when $\sigma = 0$. Secondly, following similar steps to the proof that $\partial \widetilde{w}_2/\partial\sigma < 0$ in the proof of Lemma 2, we can prove that $\partial b_{UI}/\partial\sigma > 0$.

C.7 Two wage model: UE margin configuration

Assume that $\lambda_E = 0$. Assume that job 2 is higher pay but strictly higher risk: $w_2 > w_1$ and $\delta_2 > \delta_1$. Assume that the planner ranks the risky job above unemployment, but the safe job below unemployment: $W_2^{sp} > U^{sp} > W_1^{sp}$. Thus, in the planner's allocation unemployed workers accept only job 2.

Proposition 3. *Consider the two job model above where the planner prefers the risky job to unemployment to the safe job.*

1. *If workers are sufficiently risk averse, then in the market allocation without unemployment insurance ($b_{UI} = 0$) workers accept both jobs from unemployment, and the allocation differs from the planner's allocation.*

2. *For any level of risk aversion there exists a positive level of unemployment benefits $b_{UI} > 0$ which restores the planner's allocation by making workers reject the safe job.*

Proof of Proposition 3: Let's set up the planner values and find the parameter restrictions needed for this to be true. If $W_2^{sp} > U^{sp} > W_1^{sp}$ then:

$$\begin{aligned} \rho U^{sp} &= b_{HP} + \psi_2 \lambda_U \left(W_2^{sp} - U^{sp} \right) \\ \rho W_1^{sp} &= w_1 + \delta_1 \left(U^{sp} - W_1^{sp} \right) \\ \rho W_2^{sp} &= w_2 + \delta_2 \left(U^{sp} - W_2^{sp} \right) \end{aligned} \tag{C.64}$$

Which gives

$$U^{sp} = \frac{(\rho + \delta_2) b_{HP} + \psi_2 \lambda_U w_2}{\rho^2 + \delta_2 \rho + \rho \psi_2 \lambda_U} \tag{C.65}$$

$$W_1^{sp} = \frac{w_1 + \delta_1 U^{sp}}{\rho + \delta_1} \tag{C.66}$$

$$W_2^{sp} = \frac{w_2 + \delta_2 U^{sp}}{\rho + \delta_2} \tag{C.67}$$

For this equilibrium to be valid it must be that $U^{sp} > W_1^{sp}$:

$$W_1^{sp} = \frac{w_1 + \delta_1 U^{sp}}{\rho + \delta_1} < U^{sp} \rightarrow w_1 < \rho U^{sp} \tag{C.68}$$

As long as w_2 is high enough, this will drive U^{sp} to be high enough so that $w_1 < \rho U^{sp}$ and $U^{sp} > W_1^{sp}$. Next consider the market solution with $b_{UI} = 0$, which is identical but replaces w_2 with $\widetilde{w}_2$. If $\widetilde{w}_2$ is low enough, this lowers U^{ce} enough to violate the condition $w_1 < \rho U^{ce}$, meaning that $U^{ce} > W_1^{ce}$ is contradicted. Similar steps to Proposition 2 establish that sufficiently high risk aversion drives $\widetilde{w}_2$ low enough to flip the equilibrium so that both jobs are preferred to unemployment. Similarly, a high enough value of b_{UI} can then be used to return the market equilibrium to the planner's allocation.