Self-Insurance and Welfare in Turbulent Labor Markets *

Isaac Baley† Ana Figueiredo‡
Cristiano Mantovani§ Alireza Sepahsalari¶

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Abstract

We investigate the welfare consequences of turbulence risk—the risk of skill loss coinciding with involuntary layoffs—on the labour market outcomes in the presence of imperfect financial markets and search frictions. We build a tractable dynamic heterogeneous agents model with directed search, imperfect financial markets, and uninsurable persistent labor market risk. We calibrate our model to the US economy, matching new empirical facts on the joint impact of turbulence risk and wealth on re-employment wages and unemployment duration. We measure the welfare loss of unemployment transitions and quantify the impact of each channel. We find the fall in wealth upon re-employment has the highest impact on welfare changes among the other channels. Finally, we examine the welfare gain from alternative policies.

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†Universitat Pompeu Fabra, CREi, Barcelona School of Economics and CEPR, isaac.baley@upf.edu
‡Erasmus School of Economics Rotterdam, figueiredo@ese.eur.nl
§Universitat Pompeu Fabra, cristiano.mantovani@upf.edu
¶University of Bristol, alireza.sepahsalari@bristol.ac.uk

1 Introduction

The negative impact of involuntary job loss on future earnings has been well documented (Jacobson, LaLonde and Sullivan, 1993; Davis and Von Wachter, 2011; Jarosch, 2021). This effect is particularly sizable when accompanied by occupational displacement (Kambourov and Manovskii, 2008, 2009; Huckfeldt, 2021; Postel-Vinay and Sepahsalari, 2021). In this paper, we ask: What is the welfare cost of EUE transitions? More importantly, we investigate whether the change in wages is the biggest source of welfare loss. To do this, we quantify the impact of different channels through which the welfare is affected. Under that light, we study the welfare of different policies when workers can only partially self-insure.

We model workers saving and job search decision in a labour market where workers can direct their search toward jobs with different wages, with firms posting wages to attract applicants. The worker's incentive is thus to trade off wage with the probability of job findings, precautionary job search. In this environment workers wealth plays a crucial role buy determining the workers risk bearing threshold. In addition, the risk of losing experiences upon unemployment, turbulence, adds to the importance of self-insurance. When a workers gets unemployed depending on her wealth and whether she has lost her experiences, she will have different trajectories for unemployment duration and wage she will apply for. This will affect her consumption both during her unemployment and re-employment. We disentangle the channels through which consumption is affected and quantify the welfare importance of each compared to a workers who is not affected by unemployment shock.

First, we document new stylised facts on the impact of wealth on unemployment duration and reemployment wages. To do this, we use the NLSY79 monthly worker panel and restrict our attention to the transitions from employment to unemployment and back to employment. This panel is particularly well-suited for our analysis because it contains information on workers' labor market experiences and asset holdings. Following Fujita (2018), we identify *turbulent* workers as those suffering job loss together with occupational displacement, conditional on having long tenure in an occupation. We document those turbulent workers experience nearly 12% fall in wages and 60% longer unemployment duration relative to *tranquil* workers, namely, workers who did not switch their occupation. Additionally, we document that longer unemployment duration and higher reemployment wages are positively associated with initial wealth upon unemployment. Though this association is considerably larger for turbulent workers. These fact suggest that workers use both precautionary savings and search as insurance devices and bridge the evidence on the consequences of occupational switching following an unemployment spell (Huckfeldt, 2021).

Next, we build a stochastic dynamic heterogenous-agent model with imperfect financial markets, labor market frictions, and skill dynamics. We consider two types of exogenous and uninsurable earnings risks: (i) the risk of a *transitory* earnings loss associated with unemployment, and (ii) a risk of a *persistent* earnings loss associated with skill obsolescence. Following Ljungqvist and Sargent (1998, 2007, 2008) we label the persistent risk as *turbulence risk*. Our framework embeds two mechanisms that allow workers to cope with these risks. First, workers engage in *precautionary savings* by accumulating a risk-free asset. This allows them to smooth consumption across different employment status. Second, workers to apply for low paying jobs which offer them higher likelihood of getting reemployed; this mechanism is labeled *precautionary search* by Eeckhout and Sepahsalari (2019). This trade-off between wage and unemployment duration caused by asset depletion is key for understanding the change in wages for both turbulent and tranquil workers.

Last, we use the calibrated model to conduct a novel quantitative analysis to quantify the welfare costs of EUE transitions. We first compute the welfare loss of workers who have gone through unemployment compared to the benchmark workers who did not go through unemployment at the same time. Then, we measure the welfare losses during unemployment and employment and finally isolate the welfare effect of change in wealth and change in wages during reemployment for every level of asset holding. We show that workers welfare in reemployment is considerably larger for every level of asset holding compared to the welfare loss during unemployment. However, this difference narrows down with the level of asset holdings. Interestingly, we also find that the majority of welfare loss during reemployment is caused by the change in wealth upon reemployment and change in wages plays only a little role.

Related Literature. Our work contributes to several strands of the macro labor literature.

On the empirical front, we show that the duration of unemployment spells and the subsequent reemployment wages vary significantly across two margins: (i) the type of unemployment transition (tranquil or turbulent) and (ii) the position in the wealth distribution. Moreover, we show that these two margins interact and reinforce each other.

In this respect, our findings bridge two literatures. On the one hand, we speak to the literature that explores human capital depreciation as a determinant of labor market experiences. Following the evidence pointing towards occupational tenure as the key instance of human capital (Kambourov and Manovskii, 2009; Fujita, 2018; Huckfeldt, 2021; Jarosch, 2021; Postel-Vinay and Sepahsalari, 2021) , we confirm that the loss of occupational tenure—a turbulence shock—generates sizeable losses in reemployment wages and excess unemployment duration. On the other hand, we speak to the empirical literature documenting the effect of asset holdings on job search behavior (Rendón, 2006; Lise, 2012; Herkenhoff, Phillips and Cohen-Cole, 2016). In line with this literature, we find that lower asset holdings upon unemployment decrease unemployment duration on average. Our key contribution is to consider jointly these two margins and show that the negative effects of losing occupational tenure are amplified for workers at the bottom of the wealth distribution, and viceversa, that the effects of lower assets on job search behavior are stronger for workers that go through a turbulence transition.

With regards to the theory, our model combines elements from various strands of the literature. First, we borrow from the turbulence literature (Ljungqvist and Sargent, 1998, 2007, 2008; den Haan, Haefke and Ramey, 2005; Baley, Ljungqvist and Sargent, 2021) and consider that upon layoff workers face the the risk of losing their occupational experience. Additionally, we introduce search frictions and incomplete markets (Danforth, 1979; Hopenhayn and Nicolini, 1997; Shimer and Werning, 2007, 2008). Our framework closely follows the general equilibrium model by Krusell, Mukoyama and Sahin (2010); however, instead of random search, we use the directed search protocol (Shi, 2009; Menzio and Shi, 2011). Directed search allows us to explain the observed heterogeneity in unemployment duration, and moreover, renders a tractable block-recursive model. Our model is also close to Eeckhout and Sepahsalari (2019), who investigate the interaction between precautionary savings and job search behavior in a framework with sorting. While we abstract from sorting by assuming homogenous jobs, our model introduces two dimensions of worker heterogeneity (wealth and skills). Lastly, our model relates to the work by Krusell *et al.* (2021) and Chaumont and Shi (2018). While those papers consider on-the-job search, we abstract from this dimensions but introduce skill dynamics.

Instead, Michelacci and Ruffo (2014), Griffy (2021), Bartal (2020) and Hubmer (2018) focus on the life cycle aspects of skills dynamics. Michelacci and Ruffo (2014) mostly focus on the optimal UI in a market with risk and hazard of job finding and loosing are exogenous. Griffy (2021), shows differences in initial wealth cause larger differences in life time earnings than initial human capital or ability. Bartal (2020) offers and explanation for why highly constrained workers suffer persistent income loss after displacement. Hubmer (2018) looks at the impact of job ladder on the earning risk. Instead, our main focus of attention is on characterising the interaction between wealth, job search and skill dynamics. This allows us to carefully quantify the main channels through which an unemployment transition results in welfare loss.

Lastly, we contribute to the literature studying the welfare consequences of unemployment. Our analysis is closely related to Rogerson and Schindler (2002), who examine the welfare costs of persistent earnings risk in an environment without access to any insurance markets. They conclude that the welfare cost of turbulence risk is the same order of magnitude as the cost associated with unemployment risk. We build on their work and introduce two channels for self-insurance: savings and job search. We find that welfare losses associated with the persistent earnings risk are now sizeable. Additionally, we put forward new cross-sectional welfare measures that assess the welfare impact of job loss when workers can partially insure against labor market risks, and additionally, we develop a novel methodology to quantify the impact of various channels (wages vs. wealth) affecting workers welfare who go through EUE transitions.

2 Empirical Facts

This section presents new facts on the effects of turbulence and asset holdings in explaining the duration of unemployment spells and the changes in earnings upon re-employment.

2.1 Data and variables

Sources. We use the cross-sectional sample of the National Longitudinal Survey of Youth for the 1979 Cohort (NLSY79). This dataset is particularly suited for the purposes of this study because it contains information on individuals' labor market history, including wages and occupation for each employer, as well as detailed information on asset holdings.[1] As in Baley, Figueiredo and Ulbricht (2022), we first use the Work History Data file to build a monthly panel and then we identify workers making employment to unemployment to employment transitions (EUE). This sample covers the years 1979 to 2016. We use the CPI reported by the BLS to convert the market value of wages and assets to 2000 dollars.[2]

Turbulent transitions. We identify a EUE transition if the worker was non-employed in month T_0 (i.e., reported to be not working, unemployed or out of the labor force), after being previously employed, and employed in month T_1. Additionally, we define a worker making an occupational switch when the occupation at month T_1 is different from the one in the last reported job. We use Dorn (2009)'s three-digit occupational classification system, which has the advantage of being consistent over time. We follow the view that human capital is largely occupation specific and thus labor market turbulence—the risk of skill depreciation—is linked to occupational mobility upon job switches. Following Kambourov and Manovskii (2008, 2009) and Fujita (2018), we use occupational switching and occupational tenure to measure the loss of human capital occurred when a worker experiences a EUE transition.[3] In this spirit, we define "turbulent" workers as those individuals that switch their occupation upon re-employment and had an occupational tenure longer than k years:

$$\text{turbulent} = \mathbb{1}_{\{\text{occupational tenure} \geq k \text{ years } \times \text{ occupational switch}\}}. \tag{1}$$

[1]The Survey of Income and Program Participation (SIPP) also has information on respondents' assets and employment history. However, the NLSY79 provides consistent job identifiers across waves, which allows us to build employment spells for each job reported by the respondent. In contrast, the SIPP resets employment records for individuals who leave employment for an entire wave.

[2]The Data Appendix provides further details on the construction and definition of the variables as well as on the characteristics of the sample (race, gender, education, among other).

[3]This is in line with Kambourov and Manovskii (2008, 2009), who envision the notion of occupation as a label for the kind of work individuals do and not as a label for the wage they receive. They show that once occupational tenure is taken into account, tenure in an industry or with an employer has relatively little importance in accounting for wage differences across workers.

Workers with an occupational tenure above k years but that after an EUE transition are reemployed in the same occupation are labeled as "tranquil":

$$\text{tranquil} = \mathbb{1}_{\{\text{occupational tenure} \geq k \text{ years } \times \text{ no occupational switch}\}}. \tag{2}$$

Finally, workers with occupational tenure below the threshold of k years are labeled as "non-tenured":

$$\text{non-tenured} = \mathbb{1}_{\{\text{occupational tenure} < k \text{ years}\}}. \tag{3}$$

For our baseline results, we follow the literature, namely Fujita (2018), and focus on an occupational tenure threshold of $k = 2$ years, which is the average tenure in an occupation in the sample of EUE transitions (the Appendix shows robustness for alternative thresholds k).

Outcomes. Our two key outcomes of interest are the changes in the wages in a transition and the unemployment duration. We define Δw as the log difference between pre-unemployment and post-employment real wage (in 2000 dollars) and τ as the length of the unemployment spell measured in months, where T_0 is the month entering unemployment and T_1 is the month in which the worker gets reemployed:

$$\Delta w \equiv \log(w_1/w_0), \tag{4}$$

$$\tau \equiv T_1 - T_0. \tag{5}$$

Liquid wealth. While the NLSY survey includes information on all assets of the workers, we focus on liquid wealth, since, by definition, it allows workers to better insure against shocks given the relative ease to sell and purchase these assets. Concretely, following Lise (2012), we define *Liquid Wealth* as the sum of financial assets (saving accounts, stocks, bonds and mutual funds), farm and business assets, vehicles, and then subtract all the debts in these categories. With this definition, liquid wealth does not take into account the value of housing—a highly illiquid asset. Respondents report the expected market value of their assets at the moment of the interview.

One challenge with the asset data in NLSY is that it is not observed at the same frequency as the labor market data; asset data are collected at interview dates, providing at most one observation on assets per year. In spite of this limitation, we consider the closest observation of wealth as a proxy of the wealth level upon a transition. In this way, we construct the initial log of assets upon unemployment a_0, as the asset holds observed immediately *before* a worker enters into unemployment. In order to take logs, we first add a constant to all asset holdings equal to one minus the minimum asset level (which is negative).

Table 1: Summary Statistics of EUE Transitions

	All Transitions	Non-Tenured	Tranquil	Turbulent
% of total transitions	100	69.4	19.0	11.6
Age (years)	29.7	26.8	36.6	36.0
Last Job Duration (years)	1.4	0.5	3.0	3.6
Occupational Tenure (years)	2.5	0.7	7.2	5.8
Labor Market Experience (years)	8.3	5.7	14.8	13.5
Wage Change	0.01	0.04	0.00	-0.12
Unemployment Duration (months)	7.7	8.0	4.0	12.0
Liquid Wealth (000's, 2000 dollars)	28.9	20.1	43.0	35.2
Observations	37,324	25,910	7,102	4,212

Notes: NLSY data. EUE transitions running over the period from 1979 and 2016. Turbulent refers to transitions in which the worker switches occupation upon reemployment and had tenure in the previous occupation above or equal to 2 years.

2.2 Summary statistics

Table 1 shows key summary statistics about labor market experiences for EUE transitions in our NLSY sample. Column 1 considers the entire sample of EUE transitions, while Columns 2, 3 and 4 show statistics for the subsamples of non-tenured, tranquil and turbulence transitions, which represent 69.4%, 19.0% and 11.6% of transitions, respectively. We observe that, on average, tenured workers (both experiencing turbulent and tranquil transitions) are older, wealthier, and more experienced—both in terms of their tenure in their previous job, their occupation, and their labor market participation—compared to non-tenured workers. For turbulent workers, a EUE transition entails an average earning loss of 12% and an average unemployment duration of 12 months; for tranquil workers, there is an average earning change of 0% and an average unemployment duration of 4 months.

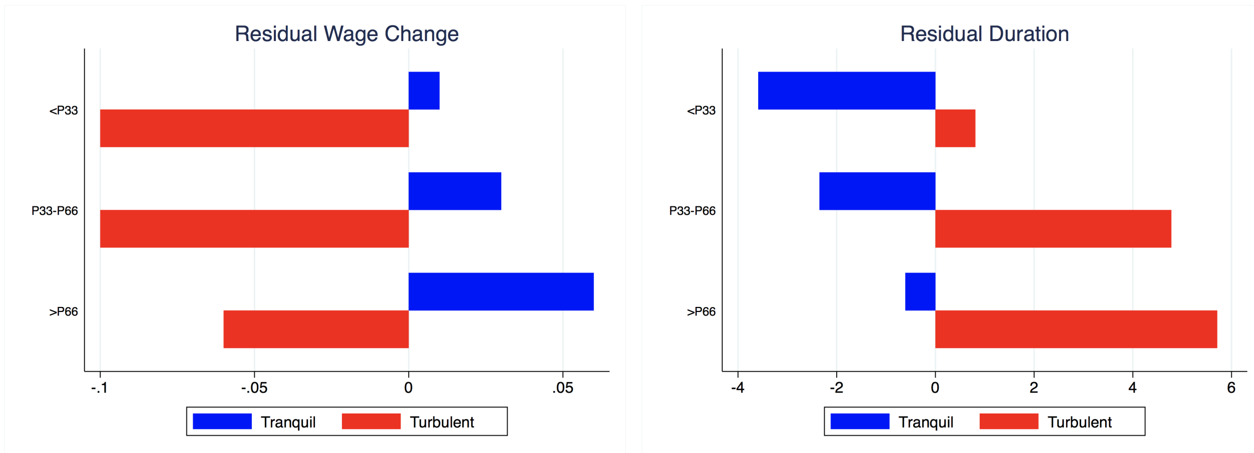
2.3 Reemployment wages and unemployment duration

As a first step in the analysis, we construct *residual* unemployment duration and reemployment wage change in order to clean the data from sources of heterogeneity that may potentially contaminate our assessment of the role of turbulence and liquid wealth. To do this, we regress the two key outcomes $y \in \{\tau, \Delta w\}$ on a set of individual and aggregate controls, including age, labor market experience, race, gender, educational attainment, ability, occupation, industry, as well as year and month fixed effects.[4] Additionally, we control the log wage in the last job held by the worker w_0.[5]

[4] Labor market experience refers to the cumulative number of months an individual has worked since her first job. Ability is proxied through the individual's scores in the ASVAB test.

[5] Including the previous wage is important to account for omitted variable bias: As the previous wage is

Figure 1: Residual Wage Change and Unemployment Duration: By Turbulence and Wealth



Notes: NLSY79 data. Residual re-employment wage growth ($\epsilon^{\Delta w}$) is the log difference of pre-unemployment and current real wage and residual unemployment duration (ϵ^{τ}) is the length of the unemployment spell in months. The left and right panel plot, respectively, the mean of $\epsilon^{\Delta w}$ and ϵ^{τ} for *Turbulent* and *tranquil* workers at different parts of the liquid wealth distribution. P33, P33-P66 and >P66 correspond to percentiles of the (household) liquid wealth distribution at the start of the unemployment spell.

The specification is as follows:

$$y \;=\; \gamma_0 \;+\; \gamma_1 \cdot controls \;+\; \varepsilon^y. \tag{6}$$

Then the residual earning loses and unemployment duration are recovered as ε^y. These residuals ε^y capture the expected outcomes conditional on the set of individual and aggregate controls.[6]

Once we have cleaned the data from observed heterogeneity, we turned the attention to the effect of wealth and turbulence. Figure 1 plots the residuals for wage growth $\varepsilon^{\Delta w}$ in Panel A and the residuals of unemployment duration ε^{τ} in Panel B. We split the residual sample along the transition type—turbulent or tranquil—and the position in the wealth distribution at the moment of falling into unemployment: We split the distribution of liquid wealth at the start of the unemployment spell into three equal sized groups: below the 33^{rd} percentile, between the 33^{rd} and 66^{th} percentile, and above the 66^{th} percentile.[7]

With respect to the residual wage change, we observe wage loses for turbulent workers and wage gains for tranquil workers across all wealth levels. However interestingly, the loses and

positively correlated with wealth (correlation between these two variables is around 0.2), not including it in the vector of controls would lead to a downward bias when estimating the effect of wealth on wage growth. This is because the wage in the previous job is negatively associated with wage growth upon reemployment after a non-employment spell.

[6] Table A.1 in the Data Appendix reports the estimated coefficients for the controls. For instance, being female or black is associated with a lower effect on reemployment wages and a higher unemployment duration; in contrast, a college degree is associated with a wage gain and lower unemployment duration.

[7] The average wealth (in 2000 dollars) for workers below the 33^{rd} percentile is -\$2,368, while the average wealth for workers above the 66^{th} percentile is \$80,000.

gains are both increasing in initial wealth. There is a larger wage loss for turbulent workers in the bottom of the wealth distribution than the wage loss of workers at the top of the distribution; similarly, for tranquil workers, the wage gain is increasing in wealth. Regarding the residual duration, we observe that the turbulent workers have longer duration than tranquil workers, and that this additional duration is increasing in their wealth, ranging from 1 month for turbulent workers in the bottom of the wealth distribution to 6 months at the top of the wealth distribution. For tranquil workers residual duration also increases in wealth. Therefore, turbulence and wealth increase unemployment duration on their own and also they interact positively. Overall, higher initial wealth upon unemployment amplifies the wage changes and increase unemployment duration for all workers.

Effects of turbulence and initial wealth on labour market outcomes. We proceed to quantify the role played by turbulence and initial wealth upon unemployment on the residual duration and residual wage changes. To do so, we run a regression of the residuals from equation (6) on the dummy variable *turbulent* in (1), the dummy variable *tranquil* in (2), and two dummy variables indicating the position of the worker on the distribution of liquid log wealth at the start of the unemployment spell: $a_{0,m} = 1$ if the worker is between the 33^{rd} and 66^{th} percentile and $a_{0,h} = 1$ if the worker is at the top of the initial wealth distribution. The baseline groups in the regression are the *non-tenured* in (3) and the workers with assets below the 33^{rd} percentile; therefore, regression results should be interpreted relative to these groups.

Let $y \in \{\epsilon^{\Delta w}, \epsilon^{\tau}\}$ denote the wage and duration residuals, respectively, then we estimate:

$$y \;=\; \beta_0 \;+\; \beta_1\, turbulent \;+\; \beta_2\, tranquil \;+\; \beta_3 a_{0,m} \;+\; \beta_4 a_{0,h} \;+\; \eta. \tag{7}$$

The results are given in Table 2. Column 1 shows that turbulent workers suffer a large and statistically significant decrease in real earnings (around $-12\% = -9\% - 3\%$) when compared to tranquil workers, in line with Fujita (2018)'s findings.[8] Liquid wealth at the start of the unemployment spell generates, on average and conditional on finding a job, a wage gain for those at the top of the wealth distribution. The point estimate (β_4) implies that, when compared to workers at the bottom of the initial wealth distribution, wage growth is 4% higher for workers at the top of the wealth distribution.

Now let us focus on the effects of turbulence and initial wealth on residual unemployment duration. Our findings in Column 2 show that, all else equal, unemployment spells of turbulent

[8]While our specification is inspired by Fujita (2018), it differs in two dimensions: First, we take into account the role of individual wealth at the start of the unemployment spell, and second, we control for the previous wage. For completeness, we also estimate Fujita (2018)'s specification, i.e., a regression of wage growth on the turbulence dummy, controlling for age, gender and unemployment duration, and we replicate his findings: Earnings losses of 13% for turbulent workers.

Table 2: Labor Market Outcomes: By Turbulence and Wealth

	Residual Wage Change	Residual Duration
	(1)	(2)
turbulent	-0.089***	5.974***
	(0.013)	(0.413)
non-turbulent	0.032***	-0.082
	(0.007)	(0.196)
$a_{0,m}$	0.009	1.877***
	(0.008)	(0.269)
$a_{0,h}$	0.038***	2.352***
	(0.009)	(0.260)
Observations	14042	14639
R^2	0.010	0.031

Notes: The table reports coefficients from an OLS regression with robust standard errors reported in parentheses. Dependent variable: Columns 1 to 2 is the residual wage growth ($\epsilon^{\Delta w}$); Columns 3 to 4 is the residual duration of non-employment in months (ϵ^{τ}) . The omitted categories are $a_{0,l}$ and *non-tenured*. The sample includes all EUE transitions between 1979 and 2016. ***, ** and * represent statistical significance at 1%, 5% and 10% levels, respectively.

workers are around 6 months larger when compared to tranquil workers, and that liquid wealth is positively associated with the duration of unemployment: in comparison to poor workers, unemployment durations is larger in 1.8 months and 2.3 months for workers with medium and high wealth, respectively. In summary, unemployment duration is positively and significantly related to turbulence and initial wealth.

Robustness. In order to assess the validity of our results, the Data Appendix conducts a series of robustness exercises. Table A.1 introduces two additional controls, namely the unemployment benefit and spousal income. Table A.2 consider different thresholds on occupational tenure $k = \{1, 2, 3\}$ to define turbulent workers. As expected, the larger is the tenure threshold, the larger are wage loses upon reemployment and the longer the unemployment duration, consistent with a larger loss of experience upon a layoff. Table A.3 excludes short-term unemployment spells from the main sample to address the potential concern that EUE transitions with very short jobless spells may be, in fact, transitions of job-changers taking a short break between jobs. Lastly, following Koehne and Kuhn (2015), we consider various definitions of liquid wealth. Our results are robust to all these different specifications.

3 Theoretical framework

In this section we develop a Bewley-type model with uninsurable unemployment risk and human capital dynamics contingent on the job status and transitions between employment and unemployment. The three key elements of the model are: (i) experience dynamics, (ii) imperfect financial markets and (iii) directed search in the labour markets. We show how the interaction of these elements give rise to precautionary savings and precautionary search behavior, which in turn shapes the labour market experience of workers and their response to turbulence.

3.1 Environment

Time is infinite and discrete. There is a continuum of workers, a continuum of potentially operating firms, and a government.

Workers. Consider a continuum of risk averse workers of measure one who are all ex-ante identical. Workers value consumption, with preferences ordered according to

$$\mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t u(c_t), \tag{8}$$

where future utilities are discounted at a rate $\beta \equiv \hat{\beta}(1-\rho_r)$, which consists of a subjective time discount factor $\hat{\beta} \in (0,1)$ and a constant probability of retirement $\rho_r \in (0,1)$. Workers can be employed or unemployed. If unemployed, they receive unemployment benefits b that are linked to the wage on the previous job and they search for a new job in a frictional labour market. If employed, they supply one unit of labour inelastically, receive a wage, and pay a proportional tax on wages ν. Besides employment status, workers differ in three dimensions: the current experience level i, that can be either low (l) or high (h), the experience level j during the last employment spell that determines their benefit entitlement, and the asset holdings a. We assume that all workers jointly own all firms, and thus receive an equal share of dividends d every period.

Firms, vacancies and labour market. Firms are homogenous in every dimension. To enter a market, a firm posts a vacancy at the cost κ. The job search in the labour market is directed. At the beginning of each period firms simultaneously announce wages. Workers observe the bundle of wage and job finding probability and decide to which job they want to apply to. Then workers and firms form the submarket $\theta = v/u$. Within each submarket a worker finds a job with probability $m(\theta)$ which pays $w(\theta)$ and a firm fills a vacancy with probability $q(\theta) = m(\theta)/\theta$.

Worker-firm relationships and productivity processes. A worker-firm relationship produces output x_i, that is indexed by the worker's experience level i. Workers gain or lose experience stochastically depending on their employment status and instances of layoffs. At the beginning of each period, a job is exogenously terminated with probability λ_i. If not terminated, an employed worker's experience may get upgraded from low to high with probability γ^u. In that case, they also get a wage increase equal to the difference between their wage and the wage they would have applied to if they were high skilled upon employment.

Following Ljungqvist and Sargent (1998, 2007, 2008), we define turbulence as the risk of losing experience after an exogenous job separation. Upon a layoff, experienced worker suffers an experience loss with probability γ^d. As in Baley, Ljungqvist and Sargent (2021), we label this risk, *layoff turbulence*. While the model does not consider explicitly a notion of occupation, the experience dynamics mimic the loss of occupational specific experience (γ^d) for those workers with sufficiently long average tenure in that occupation (γ^u).

Financial markets. We consider a small open economy with exogenous returns. Workers have access exclusively to a non-contingent risk-free bond that pays an exogenous gross return R per period. There is an exogenous borrowing constraint

$$a' \geq \underline{a}, \tag{9}$$

which reflects the severity of financial market imperfections. A retired worker exits the economy and is replaced by a newborn worker, who is born inexperienced. The assets of retired workers are being distributed equally among new-born workers.

3.2 Problems of workers, firms, and government

Value of an unemployed worker. Let $U(a, x_{ij})$ be the value of an unemployed worker with assets a, and an experience type x_{ij}, which includes her current experience x_i and the experience in previous job x_j. The experience in the previous job enters the worker's state as it determines her benefit entitlement. Additionally, let $E(a, w, x_{ij})$ be the value of an employed worker with assets a, wage w, and type x_{ij}. An unemployed worker chooses asset holdings for next period a' and a submarket θ to maximize:

$$\begin{aligned} U(a, x_{ij}) &= \max_{a',\theta} \; u(c) + \beta \left[m(\theta) E(a', w(\theta), x_{ij}) + (1 - m(\theta)) U(a', x_{ij}) \right] \\ \text{s.t.} \quad c &= Ra + b_j - a' + d, \qquad a' \geq \underline{a}, \qquad \text{and} \;\; i, j \in \{l, h\}. \end{aligned} \tag{10}$$

The submarket choice of an unemployed worker depends on her experience level, her benefit entitlement, and her level of assets, i.e., $\theta(a, x_{ij})$, but for brevity we drop the arguments. For instance, an unemployed worker with higher levels of asset holdings applies for better paying jobs which are more difficult to get (with lower market tightness) everything else equal, compared to a poorer worker.

Value of an employed worker. Employed workers only make decisions about their saving. The value of being an inexperienced employed worker x_{lj} (previously non-tenured or turbulent), who is subject to the risk of an experience upgrade with probability γ^u, is given by:

$$
\begin{aligned}
(11) \qquad E(a, w_l, x_{lj}) &= \max_{a'} \; u(c) \\
&+ \beta \lambda_l U(a', x_{ll}) \\
&+ \beta (1 - \lambda_l)[(1 - \gamma^u) E(a', w, x_{lj}) + \gamma^u E(a', w_l + \Delta_{lj}, x_{hl})] \\
\text{s.t.} \quad c &= Ra + (1 - \nu) w_l - a' + d \quad \text{and} \quad a' \geq \underline{a}
\end{aligned}
$$

An employed worker with low experience is subject to the risk of experience upgrade, γ^d. In that case not only her experience increases, but also she gets a rise in her wage equal to the difference between her wage and the wage she would have applied for if she was high experience upon employment, $\Delta_{lj} \equiv w_h(\theta) - w_l(\theta)$, where j indicates whether this worker in her previous unemployment spell was non-tenured or turbulent. Note that, wages of inexperienced workers are increasing in the upgrade probability γ^u but bounded above by the wage of the experienced workers, as we show below.[9] Moreover, expression (11) shows that upon an experience upgrade the benefit entitlement also changes and it is linked to the current experience level. This captures the idea that benefits are proportional to the average wage of the experience group (which takes into account the upgrade probability, as just explained).

The value for an experienced employed worker with benefit entitlement j takes into account turbulent risk. With probability γ^d she suffers an experience downgrade after an exogenous layoff. This value is given by:

$$
\begin{aligned}
(12) \qquad E(a, w_h, x_{hj}) &= \max_{a'} \; u(c) \\
&+ \beta \lambda_h [\gamma^d U(a', x_{lj}) + (1 - \gamma^d) U(a', x_{hj})] \\
&+ \beta (1 - \lambda_h) E(a', w_h, x_{hj}) \\
\text{s.t.} \quad c &= Ra + (1 - \nu) w_h - a' + d, \quad a' \geq \underline{a}, \quad \text{and} \quad j \in \{l, h\}.
\end{aligned}
$$

[9]We check that ex-post all matches have positive surplus and that the value of employment is higher that the value of unemployment, i.e. $E > U$, so that workers do not want to quit to increase their wage.

Value of a vacant job. Firms pay a per period cost of vacancy κ to open a vacancy. A vacancy posted in the submarket θ for experience x_i is given by

$$V(x_i) = -\kappa + \beta \max_{\theta} \{q(\theta)J(w(\theta), x_i) + (1 - q(\theta))V(x_i)\} \qquad \forall i. \tag{13}$$

Since firms are all ex-ante identical, the tradeoff between the market tightness (affecting the probability of filling a vacancy) and the wage offered to the workers makes them indifferent to hire workers with different levels of assets, benefits, or experiences.

Value of a filled job. A worker-firm relationship produces output proportional to the worker's experience x_i. The value of a filled job with a worker with experience x_i is given respectively by:

$$J(w_h, x_h) = x_h - w_h + \beta \left[\lambda_h V + (1 - \lambda_h) J(w_h, x_h)\right], \tag{14}$$

$$J(w_l, x_{lj}) = x_l - w_l + \beta \left[\lambda_l V + (1 - \lambda_l)(\gamma^u J(w_l + \Delta_{lj}, x_h) + (1 - \gamma^u) J(w_l, x_{lj})\right]. \tag{15}$$

where $\Delta_{lj}(\theta) = w_h(\theta) - w_l(\theta)$. Note that the match value of hiring an experienced worker can only be affected by exogenous separation, λ. However, if a firm hires an inexperienced worker, it takes into account the likelihood with which the experience of workers is upgraded from low to high. As a result, this firms also factors in the rise in the productivity of match in that case as well as the change in the wage it is paying to the worker.

Worker distributions. Let $\Gamma^{e_{ij}}(a, w)$ be the joint distribution of employed workers over asset and wages and $\Gamma^{u_{ij}}(a)$ be the distribution of unemployed workers over assets, conditional on the worker type (i, j). Then employment and unemployment masses by experience/benefit type are computed as

$$e_{ij} \equiv \int_a \int_w d\Gamma^{e_{ij}}(w, a), \quad u_{ij} \equiv \int_a d\Gamma^{u_{ij}}(a). \tag{16}$$

Government. The government balances its budget every period. Its expenditures are unemployment benefits $b(x_j)$, which depend on the experience level of the worker during its last job. Benefits are set as a constant fraction ϕ of the average wage of the experience group j. Thus the benefit is equal:

$$\mathit{expenditure} = (u_{ll} + u_{hl}) b(\bar{w}_l) + (u_{lh} + u_{hh}) b(\bar{w}_h) = \phi(\bar{w}_l + \bar{w}_h), \tag{17}$$

where average wages are

$$\bar{w}_l = \int_a w \frac{d\Gamma^{e_l}(a,w) + d\Gamma^{e_{lh}}(a,w)}{e_l + e_{hl}}, \qquad \bar{w}_h = \int_a w \frac{d\Gamma^{e_h}(a,w)}{e_h}. \tag{18}$$

In order to pay for benefits, the government sets a proportional wage tax ν such that the total benefits and taxes are equal. Then, the government's revenue is given by

$$revenue = \nu(\bar{w}_l(e_l + e_{hl}) + \bar{w}_h e_{hh}). \tag{19}$$

3.3 Stationary Equilibrium

The next step is to characterise the model at the steady state. We use the same tools as Shi (2009) and Menzio and Shi (2011) to solve for a Block-Recursive Equilibrium in which policy functions and prices do not depend on the distribution of workers across submarkets.

Equilibrium. *Given an exogenous interest rate R, a steady-state equilibrium consists of consumption $c(a, x_{i,j})$ and saving $a'(a, x_{i,j})$ policies for all workers; submarket choice for the unemployed workers $\theta(a, x_{i,j})$, a wage-tightness profile (w, θ), an income-tax rate ν, and a distribution of employed and unemployed workers over wages, assets, and types, $\Gamma^{e_{ij}}(w, a)$ and $\Gamma^{u_{ij}}(a)$ such that:*

1. *Consumption and saving policies maximize workers' utility;*
2. *Unemployed workers chose the submarket $\theta(a, x_{i,j})$ that maximizes their utility;*
3. *Free entry condition holds for firms;*
4. *The tax rate ν balances the government budget;*
5. *The distributions $\Gamma^{u_{ij}}(a)$ and $\Gamma^{e_{ij}}(w, a)$ are stationary and consistent with policies.*

3.4 Characterization

The directed search protocol, together with the free entry condition, implies that we can solve for the firms' problem independently of the workers' problem and the distribution of workers over asset holdings and experience [10]. Using this block-recursive structure, we find a relationship between wages and market tightness using firms' Bellman equations at the steady-state. Then, using this relationship, we solve for the policy functions of workers, and finally, we can

[10] this is for a given tax level. However, we solve for the distribution to make sure the government budget is balanced

back out the distributions of households over assets and wages after solving for the Bellman equations.

Free entry condition and wage-tightness profile Free entry of firms implies that the steady state value of posting a vacancy in all submarkets is equal to zero $V(x_i) = 0$ for all i. This implies that since all firms are identical, they are indifferent between hiring different type of workers ex-ante. This is because of the trade-off between the probability of filling the vacancy and the wages firms offer. Thus we obtain the following zero profit condition:

$$J(w, x_i) = \frac{\kappa}{\beta q(\theta)} \quad \text{where} \quad \theta = \theta(a, x_{ij}). \tag{20}$$

Now, using (14) and (15), we express the value of a filled job $J(w, x_i)$ in terms of wages:

$$J(w, x_h) = \frac{x_h - w_h}{1 - \beta(1 - \lambda_h)} \tag{21}$$

$$J(w, x_l) = \frac{x_l - w_l + \hat{\gamma}^u(x_h - w_l - \Delta_{lj})}{1 - \beta(1 - \lambda_l)(1 - \gamma^u)} \tag{22}$$

where $\hat{\gamma}^u \equiv \frac{\beta(1-\lambda_l)\gamma^u}{1-\beta(1-\lambda)}$. Substituting (20) into the values of filled jobs and solving for wages we get the firm indifference conditions that relate tightness θ and wages w:

$$w(x_h) = x_h - \frac{\kappa_h}{q(\theta(x_h))} \tag{23}$$

$$w(x_l) = \left[x_l + \hat{\gamma}^u(x_h - w_l - \Delta_{lj}) - \frac{\kappa_l}{q(\theta(x_l))}\right] \tag{24}$$

$$q(\theta_h) = \frac{\kappa[1 - \beta(1 - \lambda_h)]}{\beta(x_h - w_h)} \tag{25}$$

$$q(\theta_l) = \frac{\kappa[1 - \beta(1 - \lambda_l)(1 - \gamma^u)]}{\beta\big[x_l - w_l + \hat{\gamma}^u(x_h - w_l - \Delta_{lj}))\big]} \tag{26}$$

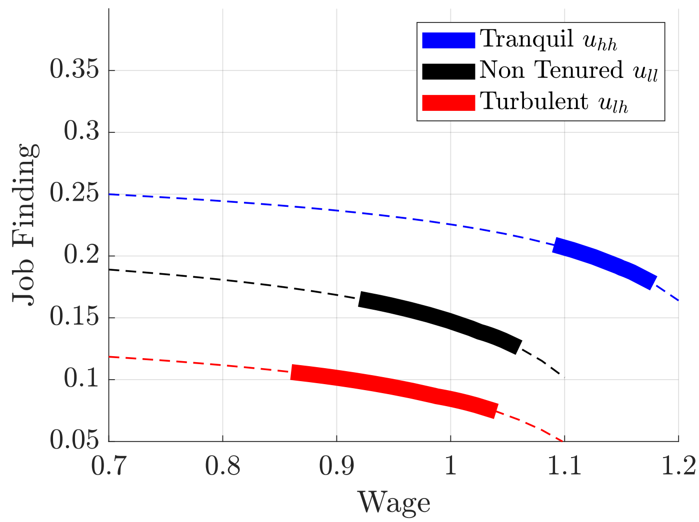
where $\kappa_h \equiv \frac{(1-\beta(1-\lambda_h))\kappa}{\beta}$ and $\kappa_l \equiv \frac{(1-\beta(1-\lambda_l)(1-\gamma^u))\kappa}{\beta}$.

Figure 2 shows the wage and job finding probability profile that arises from the firms' free entry condition (the dashed lines).[11] The job finding probability $m(\theta)$ is decreasing in the wage, or from the firms' perspective, the job filling rate $q(\theta)$ is increasing in the wage. Firms are indifferent between paying high wages and hiring fast and paying low wages but hiring slow. Recall that there are many labour markets, indexed by the workers' experience, benefit entitlement, and level of asset holdings. Workers optimally choose the submarket where they apply for jobs given their type, as explained below. In each figure, we show in with a dark

[11] Figures consider the steady state calibration described in Section 4, unless noted otherwise.

solid segment the actual range of job finding rates and wages that are optimally chosen by the workers.

Figure 2: Wage-Job Finding Rate Profile



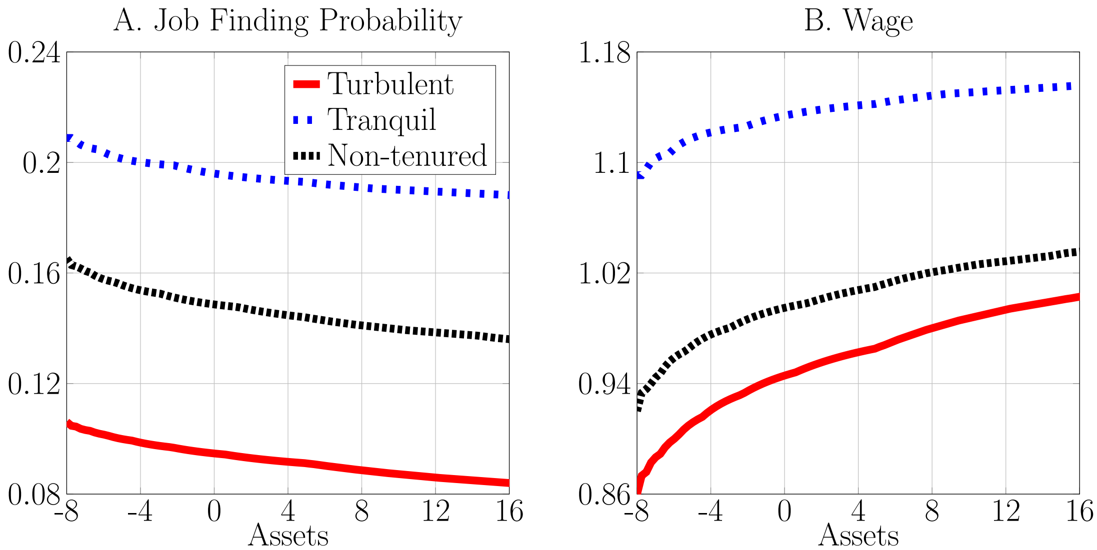
Notes: Dashed lines = Wage-tightness schedule derived from firms' free entry condition, for tenured and non-tenured workers. Solid lines = Equilibrium submarket choice.

Job search choice. Now we turn into the job search policies of the unemployed workers as a function of their wealth and experience. The optimal choice of submarket (tightness) equalizes the marginal benefits and costs of choosing a market with larger tightness. Let $\mathcal{E}_{m,\theta}$ be the elasticity of the finding probability with respect to tightness, $\mathcal{E}_{w,\theta}$ be the elasticity of the wage profile with respect to tightness, and $\mathcal{E}_{E,w}$ be the elasticity of the value of being employed with respect to the wage. Then the FOC for tightness for an unemployed worker that chooses θ_{ij} is as follows:

$$\underbrace{\mathcal{E}_{m,\theta}}_{\text{increase in finding prob}} \underbrace{\frac{E_i - U_{ij}}{E_i}}_{\text{gains from entering employment}} = \underbrace{-\mathcal{E}_{w,\theta}}_{\text{wages lost}} \underbrace{\mathcal{E}_{E_i,w}}_{\text{sensitivity of utility to wages}} \tag{27}$$

The benefits of choosing a larger θ (in the LHS) are a higher finding probability times the relative increase in utility from entering employment, and the costs (in the RHS) are lower wages times the sensitivity of the continuation value to wages. As an example, consider the CES matching function that delivers a finding probability $m(\theta) = \theta(1+\theta^{\alpha})^{-\frac{1}{\alpha}}$. In this case, the finding rate's elasticity with tightness is $\mathcal{E}_{m,\theta} = 1/(1+\theta^{\alpha})$. The equilibrium experienced wages as a function of tightness are $w(\theta, x_h) = x_h - \kappa_h(1+\theta^{\alpha})^{1/\alpha}$, which yield a wage-tightness elasticity of $\mathcal{E}_{w,\theta} = -\frac{\kappa_h \theta^{\alpha}}{q(\theta) w(x_h)} \mathcal{E}_{m,\theta}$. Substituting these expressions into (27), we find that:

Figure 3: Job search policy as a function of current assets



Notes: Equilibrium search and wage policies for each type of unemployed worker. Turbulent unemployment workers have the lowest job finding probabilities and lowest wages for all levels of assets.

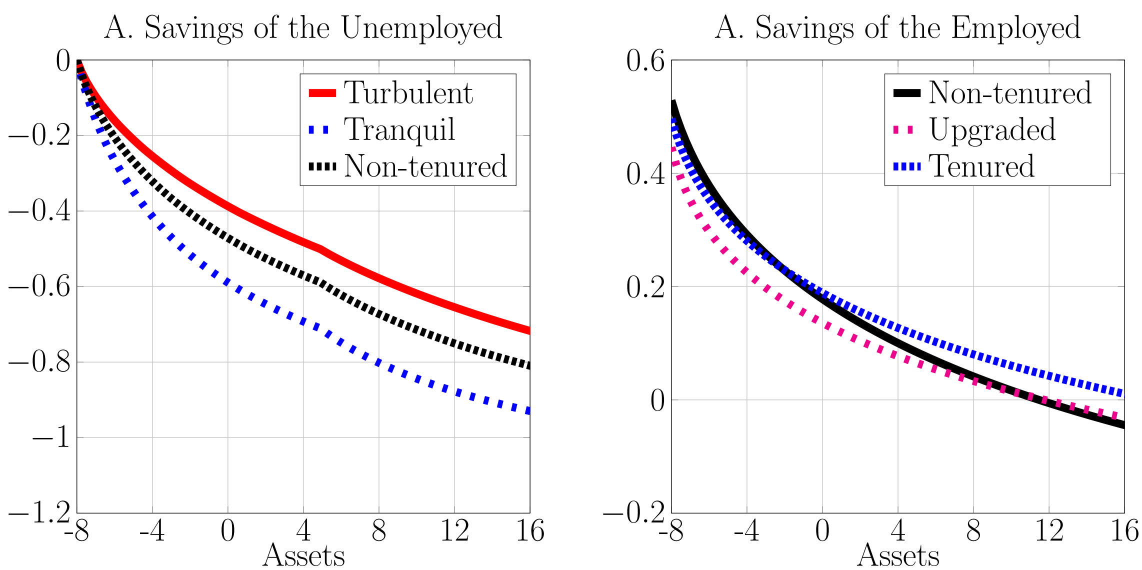
$$\theta^*_{ij}(a) = \Omega^{-1}\left(\frac{1}{k_i}\frac{E_i(a, w^*(a, x_i)) - U_{ij}(a)}{\partial E_i/\partial w}\right) \tag{28}$$

where $\Omega(s) \equiv (1 + s(a)^\alpha)^{1/\alpha} s^\alpha$ is increasing. Interpreting the previous expression in terms of vacancy posting, shows that the number of posted vacancies decreases with their posting cost κ_i, increases with the gains from employment $E - U$, and decreases with the sensitivity of E to wages $\partial E/\partial w$.

Figure 3 plots the equilibrium job search choice—wage and job finding probability—as a function of their current level of assets and their type (i, j). It is important to note that while assets are not directly observable by firms, workers with the same level of skills and benefits sort monotonically into different submarkets depending on their asset holdings.

Conditional on the level of assets, wages are lowest for the inexperienced unemployed workers u_{ll}, followed by the turbulent workers u_{lh}, and then the experienced u_{hh}, whose wages are significantly higher, reflecting their experience. The reason why the wage policies are very similar for the inexperienced and turbulent workers, is that in the calibration considered, the replacement rate is small, and therefore both groups are not only identical in terms of experience but also very similar in terms of their benefit entitlement. Still, in equilibrium there will be differences stemming from difference in their wealth. Regarding the job finding probability, the turbulent u_{lh} exhibit the lowest, followed by the u_{ll} and lastly the u_{hh}.

Figure 4: Saving policies as a function of current assets



Notes: Saving policy equals the change in asset holdings, $a' - a$. Savings policies of employed workers are evaluated at the average wage of each group.

Savings choice. In the presence of incomplete financial markets, risk averse agents engage in precautionary savings in order to smooth their consumption. For all workers, regardless of their job status, the asset choice yields standard Euler equations that link consumption across consecutive periods. Figure 4 plots the saving policy $(a' - a)$ for unemployed and employed workers against current asset holdings. Workers save during employment for most of the range of assets, and always borrow when unemployed. Inexperienced employed workers save more than experienced ones during employment. This is because they have lower wages and know that upon unemployment, they will receive lower benefits. Therefore, they build up a bigger buffer for the rainy days to come. Among the unemployed workers, experienced ones borrow the most. Although tranquil and turbulent workers receive the same amount of benefits, tranquil workers will receive higher wages when they get employed because of their higher experiences. Therefore, they borrow more while unemployed to smooth consumption.

4 Quantitative Analysis

In this section, we explore quantitatively the performance of the model. We first calibrate the steady state to match aggregate moments as well as statistics from the micro-data. Next, we report some non-targeted moments in particular those related to reemployment wages and unemployment duration for turbulent and tranquil workers. This is to study the ability of the model to account for the empirical evidences we document in the first section.

4.1 Calibration (Preliminary)

In the first step of the quantitative analysis, we set externally the value of several parameters, including data moments from the NLSY and other values which are standard in the literature. In the subsequent step, the remaining parameters are jointly calibrated though a simulated method of moments.

Externally calibrated parameters. One period is set to be a month. Given the model time period, we specify a discount factor $\hat{\beta} = 0.9955$ and a retirement probability $\rho^r = 0.0021$, which together imply an adjusted discount factor of $\beta = \hat{\beta}(1 - \rho^r) = 0.9934$. The retirement probability implies an average time of 40 years in the labour force. The utility function is CRRA, $u(c) = (c^{1-\sigma})/(1 - \sigma)$. We set the coefficient of relative risk aversion σ to 2, which is a standard value in the literature. The interest rate is set to $r = 0.0035$, which yields an annual risk-free rate of 4%. Following Menzio and Shi (2011), we pick a CES contact rate function, which implies a job finding probability of $m(\theta) = \chi\theta(1+\theta^{\alpha})^{\frac{-1}{\alpha}}$ and a vacancy filling probability $q(\theta) = m(\theta)/\theta$.

Other externally calibrated parameters are set using the NLSY. We set exogenous layoffs for high and low skilled workers to match the employment duration from the NLSY data, 8.3 and 1.8 years for the high and low experienced workers respectively, obtaining $\lambda_h = 0.01$ and $\lambda_l = 0.045$. For comparison, Shimer (2005) reports a monthly separation probability of 0.035 for all workers, which lies in between the two values. Following our empirical definition of turbulent workers—workers switching occupations following an EUE transition with occupational experience of more than 2 years—we set a probability of upgrading experience to $\gamma^u = 0.0417$ so that employed workers take on average 2 years to move from low to high experience, in line consistent with Fujita (2018).

Internally calibrated parameters. We use the simulated method of moments to calibrate the remaining seven parameters to match a set of six targets. All the parameters are jointly estimated in equilibrium using indirect inference but we can identify which parameter is most related to which target. To inform the estimation of productivity gap $\Delta = x_h - x_l$, we target the

Table 3: Summary of Parameters

Parameter	Definition	Value	Source
pre-calibrated			
$\hat{\beta}$	discount factor	0.9965	monthly frequency
ρ_r	retirement probability	0.0021	avg. worklife = 40 years
$\beta \equiv \hat{\beta}(1-\rho_r)$	adjusted discount	0.9944	—
σ	relative risk aversion	2	standard in the literature
r	interest rate	0.003	yearly risk-free rate = 4%
λ_h	separation tenured	0.01	NLSY
λ_l	separation untenured	0.045	NLSY
γ^u	experience upgrade	0.0417	experience = 2 years
calibrated			
$\Delta = x_h - x_l$	productivity gap	0.1	
α	matching elasticity	0.6	
γ^d	experience depreciation	0.1	
$\chi_{ll}, \chi_{lh}, \chi_{hh}$	matching efficiencies	0.17, 0.25, 0.30	
ϕ	replacement rate	0.1	
κ	vacancy creation cost	0.20	
$\underline{a}$	borrowing constraint	-8	

experience premium, namely the ratio of average wages between experienced and inexperienced workers which is equal to $\mathbb{E}[w_h]/\mathbb{E}[w_l] = 1.18$ in NLSY. To estimate the elasticity of matching function, α, we target the monthly elasticity of job finding to market tightness reported by Shimer (2005).

To discipline turbulence risk γ^d, we target the fraction of EUE transitions in the NLSY that are considered to be turbulent according to our definition, equal to 11.6%. To discipline the matching efficiencies, we target the excess unemployment duration of turbulent workers to tranquil and non-tenured in NLSY, as well as the average unemployment duration. These will help us to both replicate the level of unemployment duration as well as its relative difference across different unemployment groups. The median asset to income ratio from PSID (2007) helps us to inform the estimation of vacancy cost since this cost directly affects wages. Next, we estimate the borrowing constraint parameter by matching the share of workers with negative asset in the model with the figure we observe in NLSY. Finally, to capture the impact of wealth on job finding, we inform the estimation of replacement ϕ, by matching the OLS regression coefficient of asset on job finding probability reported in Lise (2012). Table 3 shows the baseline parameterization.

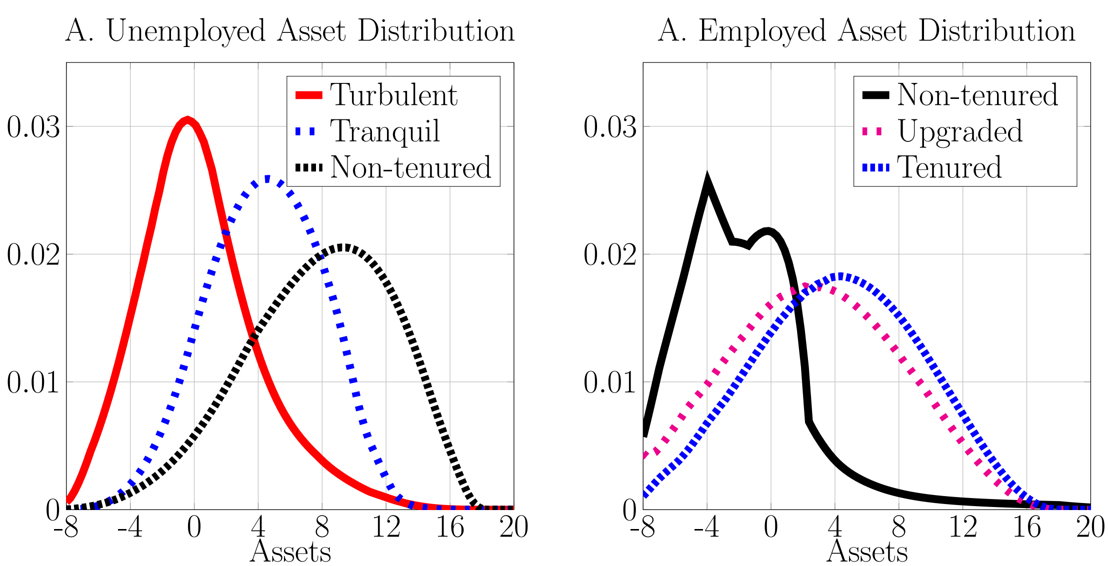
Table 4 shows the model fit by comparing model generated moments versus data. The overall fit of the model is quite satisfactory.

Table 4: Model Fit

Moment	Source	Data	Model
Targeted			
Experience premium $\mathbb{E}[w_h]/\mathbb{E}[w_l]$	NLSY	1.18	1.15
Proportion of turbulent transitions EUE'	NLSY	0.12	0.12
Elasticity of job finding to tightness	Shimer (2005)	0.72	0.66
Excess duration $\mathbb{E}[\tau_{lh}]/\mathbb{E}[\tau_{hh}]$	NLSY	3	2.1
Excess duration $\mathbb{E}[\tau_{lh}]/\mathbb{E}[\tau_{ll}]$	NLSY	1.6	1.5
Avg. unemployment duration (months)	NLSY	7.7	6.4
Assets/Annual Income (Median)	PSID	0.62	0.63
Fraction with negative assets	NLSY	0.16	0.15
OLS coefficients (assets of jobfinding on assets)	Lise (2012)	-0.08	-0.03

Notes: Data from NLSY. Coefficient of regression of jobfinding probability on assets from Lise (2013). Model calibrated at monthly frequency.

Figure 5: Wealth Distributions

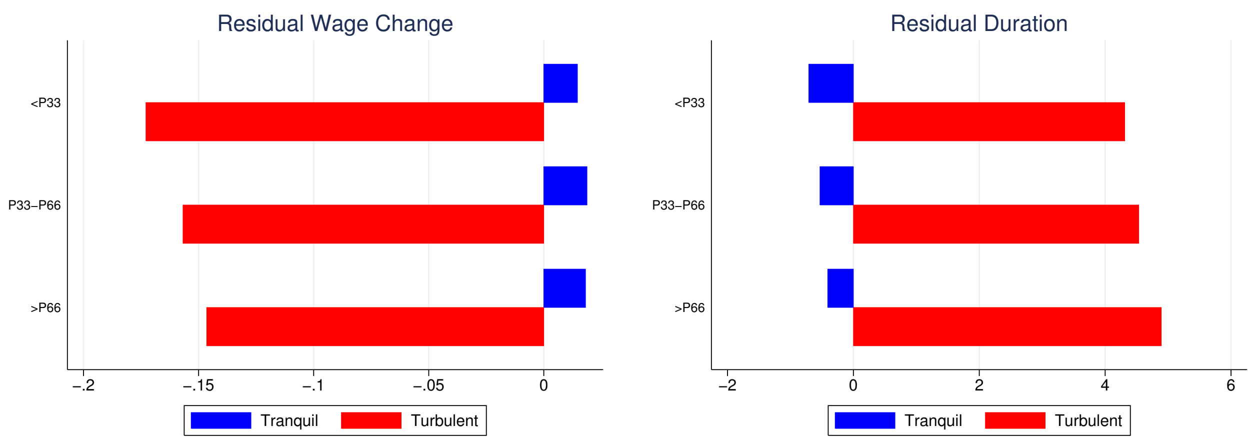


Notes: Wealth distributions by employment and experience status.

4.2 Reemployment wages and unemployment duration

Next, we look at the model's prediction for unemployment duration and reemployment wages. For this purpose, we simulate a panel of workers, isolate the EUE transitions, and then compute the length of unemployment spells and reemployment wages.[12] Figure 6 is the analogous to Figure 1 in the data [13] Regarding to wage changes, turbulent workers face a substantial fall in their reemployment wages while on average tranquil workers face a modest rise. Given the long unemployment duration of turbulent workers, they dissave their wealth to smooth consumption during unemployment and therefore they tend to apply for jobs with lower wages. On the other hand, tranquil workers who started their previous employment spell with low wealth, accumulate assets while employed and therefore when they get unemployed they apply for better paying jobs which results in them getting better wages when they get out of unemployment. Moreover, for both groups, the change in wages increases with wealth in line with what we observe in the data.

Figure 6: Residual Wage Growth and Unemployment Duration in the Model



Additionally, we run the same regressions in the NLSY data using model generated data:

$$y = \beta_0 + \beta_1\, turbulent + \beta_2\, tranquil + \beta_3 a_{0,m} + \beta_4 a_{0,h} + \eta. \tag{29}$$

Given that workers in the model are ex-ante identical and the environment is stationary, there

[12] We run a Monte Carlo simulation of the model for 24,000 agents and 500 periods. We exclude the first 200 periods.

[13] In the model the only control we use is the wage in the previous job. Both in the NLSY and the model simulated data, the duration of unemployment is longer for turbulent workers compared with tranquil ones and for both groups unemployment duration increases monotonically as a function of asset holdings. Both rich turbulent and tranquil workers have longer unemployment duration compared to workers with less wealth in their category and conditional on wealth the duration of unemployment is higher for turbulent workers compared to tranquil ones.

is no need for individual or time controls. The only control we include is the log of the wage during the previous employment spell. Results are reported in the Table 5 below, which is analogous to Table 2 in the data. The model we developed is able to reproduce qualitatively salient features of the data from NLSY, both in terms of aggregate moments as well as evidences from the micro data. Relative to the non-tenured workers (the baseline group in the regression), a turbulent transition is associated, on average, with lower re-employment wages (β_1) and longer unemployment duration, while a tranquil transition is associated, on average, with higher reemployment wages and lower unemployment duration (β_2). Higher initial wealth upon unemployment is associated with longer unemployment duration for all levels of assets (β_3 and β_4); and its effect on reemployment wages is positive and increasing in assets.

Table 5: Labor Market Outcomes By Turbulence and Wealth: Model Results

	Residual Wage Change	Residual Duration
	(1)	(2)
turbulent	-0.156***	4.355***
	(0.000)	(0.094)
non-turbulent	0.017***	-0.798***
	(0.000)	(0.042)
$a_{0,m}$	0.007***	0.240***
	(0.000)	(0.037)
$a_{0,h}$	0.007***	0.370***
	(0.000)	(0.037)
Observations	159745	159745
R^2	0.892	0.062

Notes: The table reports coefficients from an OLS regression with robust standard errors reported in parentheses, for EUE transitions simulated from the model, controlling for the log wage in the previous job in column 1. Dependent variable: Column is the residual wage growth; Column 2 is the residual duration of non-employment in months. ***, ** and * represent statistical significance at 1%, 5% and 10% levels, respectively.

Figure 6 highlights the interaction between assets and skills in affecting unemployment duration and change in re-employment wages. Modelling labour market with directed search allows to reproduce the negative association of wealth and unemployment duration as well as positive correlation between re-employment wages and workers asset holdings. Both of which have been observed in the data. The loss of experience upon unemployment amplifies the above mentioned associations through the role of self-insurance during unemployment, in line with stylized facts from data.

5 Welfare Costs

What are the welfare implications of transitions through unemployment? In this section we first quantify the welfare loss of EUE transitions. Second, study how much of these welfare losses are caused by change in consumption during unemployment and employment. Finally, we decompose the welfare loss caused by change in employment consumption to disentangle the role of wealth and wage with which workers start their new spell of employment. Longer unemployment durations results in further depletion of assets which in turn affect the wages workers apply to and as results their sequence of consumption when employed. By studying the main channels through which the welfare is affected, we also highlight the role of human capital loss in welfare changes for workers going through EUE transitions.

Total welfare loss. Consider two consumption sequences $\{c_t\}_{t=0}^{\infty}$ and $\{\tilde{c}_t\}_{t=0}^{\infty}$ of employed workers who both have (a_0, w_0). Where c_t is the consumption of an employed worker at time $t = 0$ who does not become unemployed at time $t = 1$. We consider him as the benchmark worker. $\tilde{c}_t$ is the consumption sequence of our counterfactual who is the employed workers falling into unemployment at time $t = 1$.

Our welfare measure , λ, quantifies the consumption change required to deliver our counterfactual worker the same life time utility as the benchmark one.

$$(30) \qquad \mathbb{E}_0\left[\sum_{t=0}^{\infty} \beta^t \frac{((1+\lambda(a_0,w_0))c_t)^{1-\sigma}}{1-\sigma}\right] = \mathbb{E}_0\left[\sum_{t=0}^{\infty} \beta^t \frac{\tilde{c}_t^{1-\sigma}}{1-\sigma}\right].$$

This is evident that the magnitude of λ depends on several important factors such as the initial wealth (a_0), wage (w_0) and weather the counterfactual worker has lost her experience upon unemployment.

$$(31) \qquad \lambda(a_0, w_0) \ = \ \left(\frac{\mathbb{E}_0\left[\sum_{t=0}^{\infty} \beta^t \frac{\tilde{c}_t^{1-\sigma}}{1-\sigma}\right]}{\mathbb{E}_0\left[\sum_{t=0}^{\infty} \beta^t \frac{c_t^{1-\sigma}}{1-\sigma}\right]}\right)^{\frac{1}{1-\sigma}} - 1.$$

Therefore, to capture the aggregate welfare loss of workers going through EUE transitions, we first re-arrange the above expression and then the using the distribution of workers at the steady state we aggregate the consumption equivalence measure.

$$(32) \qquad \lambda(a_0) \equiv \int \lambda(a_0, w_0) f(w_0|a_0) dw_0,$$

where the conditional density is $f(w_0|a_0) = \frac{f(w_0,a_0)}{f(a_0)}$ by Bayes' Law.

Welfare channels. To quantify the welfare loss during unemployment and employment, we split EUE transitions into two stages: stage I $= [0, T-1]$, where a worker is unemployed and stage II $= [T, \infty]$, when he starts his next employment spell. Then, to measure the welfare loss during the unemployment, λ_u, we equate the consumption sequence of our counterfactual from period T onward to the consumption of our benchmark worker. That is $\{\tilde{c}_t\}_{t=T}^{\infty} = \{c_t\}_{t=T}^{\infty}$. This implies that λ_u measure the amount of change in consumption needed during unemployment such that life time utility of counterfactual and benchmark workers are equal. Likewise, to capture the impact of change in re-employment consumption on welfare, λ_e, we equate the consumption of counterfactual worker to the benchmark one in stage I $= [0, T-1]$. So, λ_e measure the magnitude of welfare loss caused by change in sequence of consumptions after re-employment[14].

In a similar way, we decompose the welfare loss during employment, λ_e, to welfare losses caused by the change in wages (λ_{ew}) and assets (λ_{ea}) upon re-employment. In the first case, we keep the asset level of the counterfactual to the same level prior to her unemployment and let her start the new employment spell with her new wage [15]. To isolate the impact of change in assets on welfare during re-employment, we let our counterfactual worker to commence her re-employment with the depleted level of assets after unemployment but, we keep her wage to the same level as what it was during her past employment spell[16].

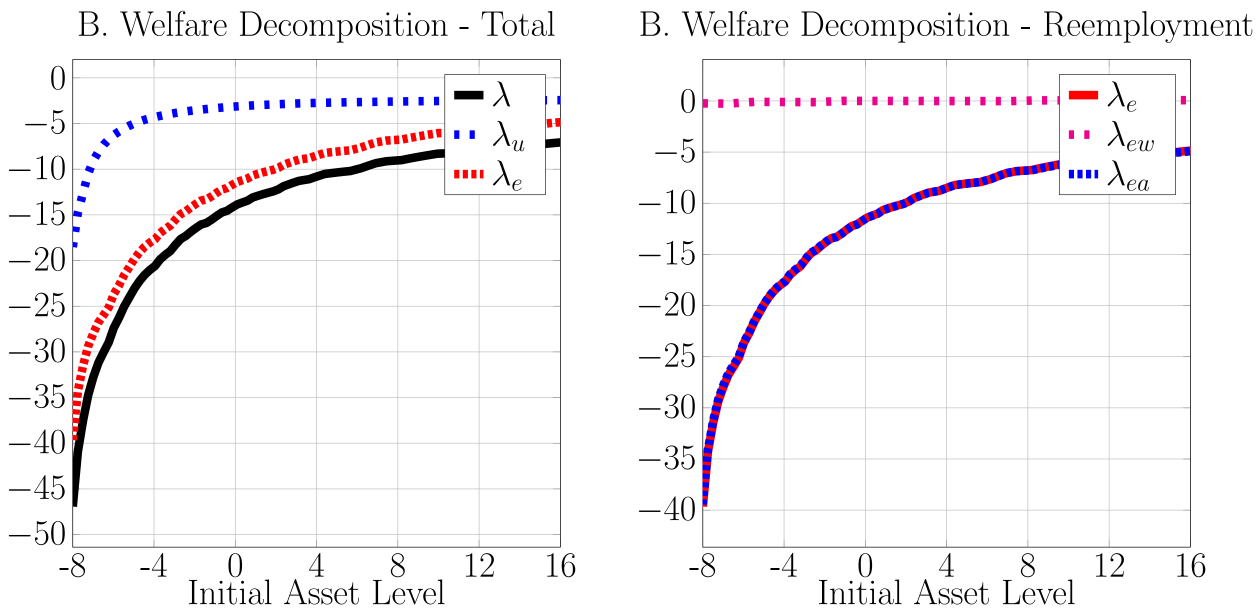
Figure 7 shows the welfare loss of a tranquil EUE transition. On the left panel, the black line shows the overall welfare loss (λ) of a worker who gets unemployed but does not lose her skills, as a function of wealth. Workers with lower asset holdings suffer substantially higher welfare losses when they get unemployed. This is indeed due to lack of self-insurance, particularly if they are at or close to the constraint. The red line shows the welfare loss due to the change only in unemployment consumption (λ_u) and green line shows the same for employment (λ_e). Interestingly, the welfare loss after re-employment is considerably higher compared to the welfare loss during unemployment. This is true for both, high and low asset holders. Though, since high asset holders have a higher chance of starting their re-employment with higher assets, their welfare loss during re-employment approaches to their welfare loss in unemployment. This is also depicted on the right panel of Figure 7 where we decompose the re-employment welfare loss by its causes: change in assets and wage during re-employment. For tranquil workers, the change in wealth upon re-employment is the main driver of their welfare loss. This is because

[14] We can re-write the total welfare change of going through EUE transitions as $(1+\lambda(a_0, w_0))^{1-\sigma} = \frac{\sum_{t=0}^{T-1} \beta^t u(\tilde{c}_t) + \beta^T E_{hh}(\tilde{a}_T, \tilde{w}_T)}{\sum_{t=0}^{T-1} \beta^t u(c_t) + \beta^T E_{hh}(a_T, w_0)}$. Therefore, we calculate λ_u from $(1+\lambda_u(a_0, w_0))^{1-\sigma} = \frac{\sum_{t=0}^{T-1} \beta^t u(\tilde{c}_t) + \beta^T E_{hh}(a_T, w_0)}{\sum_{t=0}^{T-1} \beta^t u(c_t) + \beta^T E_{hh}(a_T, w_0)}$ and λ_e from $(1+\lambda_e(a_0, w_0))^{1-\sigma} = \frac{\sum_{t=0}^{T-1} \beta^t u(c_t) + \beta^T E_{hh}(\tilde{a}_T, \tilde{w}_T)}{\sum_{t=0}^{T-1} \beta^t u(c_t) + \beta^T E_{hh}(a_T, w_0)}$.

[15] $(1+\lambda_{ew}(a_0, w_0))^{1-\sigma} = \frac{\sum_{t=0}^{T-1} \beta^t u(c_t) + \beta^T E_{hh}(a_T, \tilde{w}_T)}{\sum_{t=0}^{T-1} \beta^t u(c_t) + \beta^T E_{hh}(a_T, w_0)}$

[16] $(1+\lambda_{ea}(a_0, w_0))^{1-\sigma} = \frac{\sum_{t=0}^{T-1} \beta^t u(c_t) + \beta^T E_{hh}(\tilde{a}_T, w_0)}{\sum_{t=0}^{T-1} \beta^t u(c_t) + \beta^T E_{hh}(a_T, w_0)}$

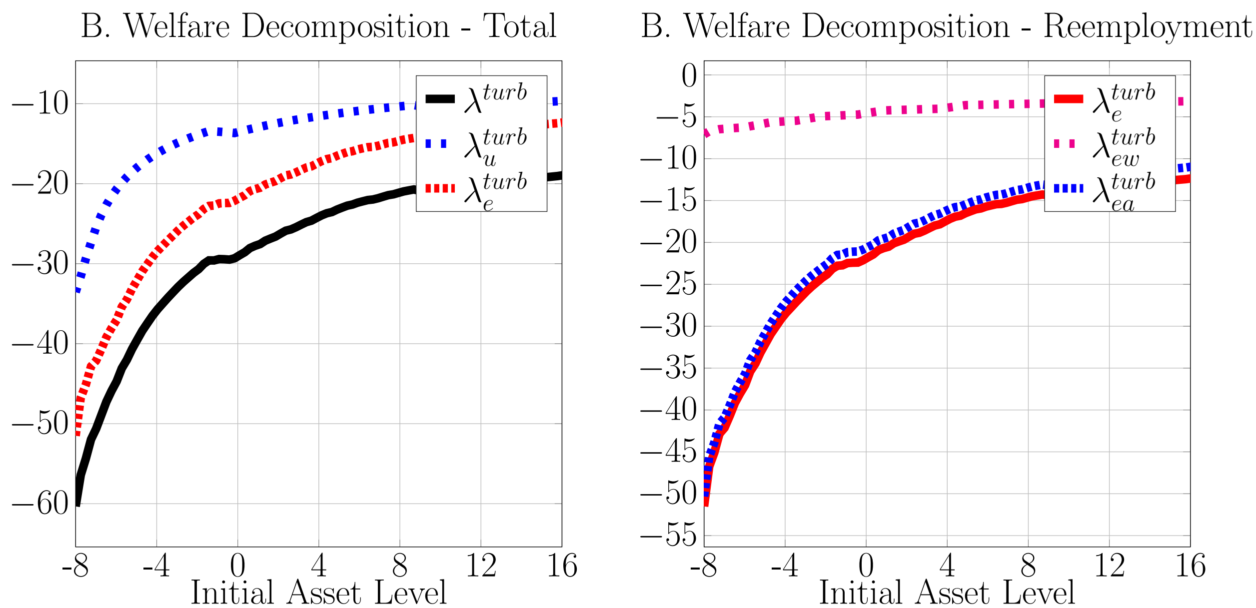
Figure 7: Welfare costs of tranquil transitions



these workers have not lost their skills and still get high wages.

Figure 8 depicts the same measures of welfare changes for turbulent workers. Although, the overall picture looks similar to the tranquil transition but, there are some significant differences. For every given level of asset holdings, turbulent workers substantially lose more welfare during both unemployment and re-employment. Interestingly, their welfare loss during unemployment relative to what they lose during re-employment is substantially higher compared to tranquil workers. Although both tranquil and turbulent workers are in the same category before entering unemployment, but the perception of longer unemployment duration caused by the loss of experience, affect their consumption during unemployment substantially more than their re-employment. Also, looking at the right panel of Figure 8, although the change in assets is the major cause of welfare loss after re-employment but, the change in wages due to the experience loss plays a more important role compared to tranquil workers. Turbulent workers with less asset holdings suffer the most from welfare changes caused by change in wages after re-employment. These workers not only lose the experience premium of their wages, but also will apply for lower wages due to pre-cautionary search motive. Therefore, their λ_{ew} is nearly twice bigger than workers on the other end of asset spectrum.

Figure 8: Welfare costs of turbulent transitions



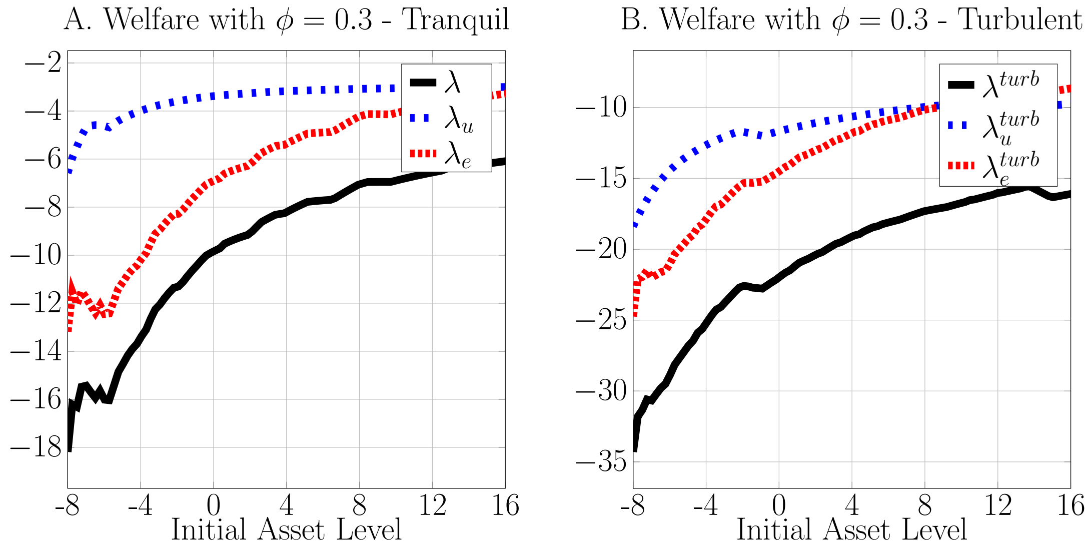
6 Policy analysis (In progress)

In this section, we explore the welfare implications of different unemployment benefit levels. In Section 6.1, we first analyze the results for two levels of benefits, highlighting the effects on the different welfare channels. Then, in Section 6.2, we analyze a range of unemployment benefits levels.

6.1 The role of replacement rate.

In the benchmark economy most of the welfare losses, for every level of asset holding, comes from the change in assets with which workers start their re-employment. However, when UI changes to higher magnitudes, the reduction in pre-cautionary saving motive decreases the overall level of assets holdings. This implies, that workers rely more on the UI. As a result, this reduces the change in their asset holdings throughout unemployment. Although higher levels of benefits, considerably reduces the welfare cost of going through EUE but the more interesting consequences of more generous UI regimes is to change the relative importance of welfare losses during unemployment and employment. Figure 10 shows the welfare decomposition of tranquil (left panel) and turbulent workers (right panel) for an economy with three times higher level of benefits, otherwise identical to the benchmark. More insurance and less reliance on saving results in a considerably lower welfare loss during the re-employment compared to unemployment. Indeed, for higher asset holders, the welfare loss during unemployment overtakes those

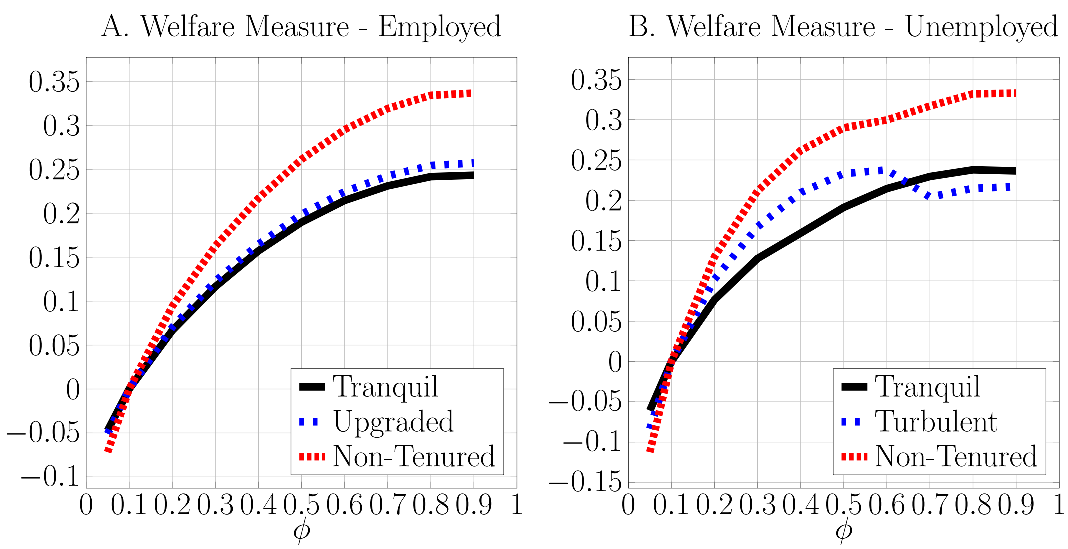
Figure 9: Welfare cost comparison, high benefits $\phi = 0.3$



during re-employment. Interestingly, the level of asset holding at which this happens is lower for tranquil workers. Higher benefits lowers everyone's probability of job finding in the economy, but much more so for tranquil workers. hence, higher benefits can considerably more prolong their unemployment duration and the welfare loss associated with it.

6.2 Change in UI

Figure 10: Welfare measure for different groups



7 Conclusion

In this paper, we have explored the role of turbulence risk in shaping aggregate economic outcomes. Using a panel of workers' labour market experiences, we provide novel evidence that turbulence risk associated to losing occupational experience substantially decreases reemployment wages and increases unemployment duration. Moreover, workers' initial level of wealth upon entering unemployment dampens the decrease in the wage but amplifies the increase in unemployment duration. Then, we set up an environment with search and financial frictions in which agents exploit two insurance tools to smooth their consumption: precautionary savings and precautionary search. We quantify the relative role of these mechanisms and find welfare loses from increased turbulence risk and welfare gains from a more generous unemployment insurance policy.

Our theoretical framework assumes exogenous job and occupational displacement. Theories that rationalize these rates include dual markets (Huckfeldt, 2021), life-cycle dynamics (Jung and Kuhn, 2019), job security (Jarosch, 2021), and learning about worker skills (Baley, Figueiredo and Ulbricht, 2022). Moving forward, it would be interesting to assess welfare when these various margins are considered.

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Self-Insurance and Welfare in Turbulent Labor Markets

Isaac Baley, Ana Figueiredo,
Cristiano Mantovani, and Alireza Sepahsalari

Data Appendix

A Data Description

For the empirical analysis, we use data from the NLSY79, a nationally longitudinal survey of 12,696 individuals who were between 14 and 22 years when they were first interviewed in 1979. We use the cross-sectional sample has 6,111 respondents and was designed to represent the non-institutionalized civilian segment of people living in the United States in 1979 with ages 14-22 as of December 31, 1978.

Worker's employment history The NLSY79 interviewed individuals on an annual basis in the years from 1979 to 1993, and on a biannual basis for the period 1994-2016. Information on labor force status is recorded at a weekly frequency throughout the sample period, even in the later period where interviews were at biannual frequency. Following Baley, Figueiredo and Ulbricht (2022), we use the NLSY79's Work History Data file to construct a monthly panel. This file is a week-by-week record of the working history for each respondent, which contains information about weekly labor status and hours worked. While an individual may hold more than one job, we focus on the primary job at a given month, which is defined as the one for which an individual worked the most hours in a given month. Using a mapping that links jobs across consecutive interviews, we build a panel report employment spells for the primary job and any individuals spent not working.

For each primary job, we retain information on the hourly wage, occupation and industry codes. Before merging occupation and industry information with the employment panel, we clean occupational and industry titles following Guvenen, Kuruscu, Tanaka and Wiczer (2018)'s approach: to each job, we assign the occupation and industry code that is most often observed during the employment spell. In the NLSY79, occupation titles are described by the three-digit Census occupation code. Because this classification system changed over time[17], before cleaning we converted all the occupational codes across the years into the *occ1990dd* occupation system developed by Dorn (2009), which has the advantage of being time-consistent.[18]

Wages correspond to the hourly wage, which include tips, overtime and bonuses, and are measured in 2000 dollars (we use the consumer price index from the BLS to deflate wages).

Labor market transitions Our empirical exercise focus only on employment to unemployment to employment transitions, which we label as EUE'. We identify a *EUE'* transition if the worker was non-employed in month T_0, the start of the unemployment spell, (i.e. reported to be not working, unemployed or out of the labor force), after being being previously employed,

[17]Until 2000, NLSY79 reports occupation codes in the Census 1970 three-digit occupation code. After this year, occupation codes are reported in the Census 2000 three-digit occupation code.

[18]The crosswalk files between the Census classification codes and the *occ1990dd* occupation aggregates created by Autor and Dorn (2013) can be found at http://www.ddorn.net/data.

and employed in month T_1, meaning that she reported a job. These transitions include *recalls*, workers that return to their previous employer after a jobless spell. Moreover, we define a worker making an occupational switch when the occupation upon reemployment at month t is different from the one reported in the previous job.

Assets The NLSY79 contains detailed questions on the asset holdings and liabilities at the household level, from 1985 onwards. The welth information is not observed at the same frequency as the labor market data; asset data are collected at interview dates, providing at most one observation on assets per year. All assets are defined by the NLSY79 as the amount the respondent would reasonably expect someone to pay if the asset were sold in its current condition. Respondents report the market value of their assets at the moment of the interview; this information is thus assigned to its particular calendar month, leaving blank all others. We use the CPI reported by the BLS to convert the market value of each asset to 2000 dollars. From the detailed information reported by NLSY, ee create five categories of net assets—residential property, financial assets, business assets, vehicles and others—as follows:

- Residencial Property = "Market value of residential property r/spouse own" - "Amount of mortgages and back taxes r/spouse owe on residential property"

- Financial assets = "Total market value of stocks/bonds/mutual funds" + "Total amount of money assets like savings accounts of r/spouse"+ "Total amount of money in assets like IRAS or KEOUGH of r/spouse"+"Total amount of money in assets like CDS, loans or mortages of r/spouse"'

- Business assets = "Total market value of farm/business/other property r/spouse own"- "Total amount of debts on farm/business/other property r/spouse owe"

- Vehicles = "Total market value of vehicles including automobiles r/spouse own"- "Total amount of money r/spouse owe on vehicles including automobiles"

- Others = "Total market value of all other assets each worth more than \$500"-"Total amount of other debts over \$500 r/spouse owe"

We then define *Liquid Wealth* as the sum of business assets, financial assets, vehicles, and other assets, all net of debts, minus all debts on residential property. Following Lise (2012), we trim the top and bottom one-half-of-one percent of the assets distribution to reduce the influence of outliers.

Table A.1: Wage Change and Unemployment Duration:

	Wage Change	Duration
	(1)	(2)
previous wage (log)	-0.349***	-0.177
	(0.009)	(0.146)
age	0.017***	0.414***
	(0.004)	(0.136)
age $\times$ age	-0.000***	0.004
	(0.000)	(0.003)
experience	0.001***	-0.154***
	(0.000)	(0.006)
black	-0.000	0.191
	(0.009)	(0.316)
hispanic	0.006	0.666*
	(0.010)	(0.378)
female	-0.026***	0.384**
	(0.006)	(0.168)
$\geq$ college degree	0.058***	-1.167***
	(0.010)	(0.269)
ability	0.001***	-0.014***
	(0.000)	(0.003)
Observations	25101	26648
R^2	0.201	0.181

Notes: The table reports coefficients from an OLS regression with robust standard errors clustered level reported in parentheses.The sample includes all *EUE'* transitions between 1979 and 2016 . ***, ** and * represent statistical significance at 1%, 5% and 10% levels, respectively.

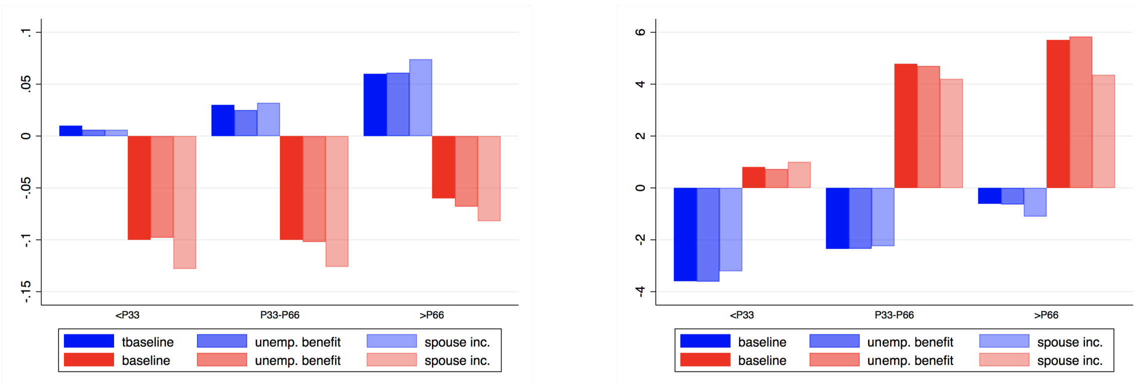
B Robustness Checks

In this section, we show the empirical findings are robust to (i) adding additional controls when estimating equation 6 to recover residual wage change and residual unemployment (Figure A.1), namely the unemployment benefit received during the unemployment spell and spousal income, (ii) different thresholds on occupational tenure k to define turbulent workers (Figure A.2), $k = \{1, 3\}$, (iii) short unemployment spells (Figure A.3) and (iv) different definitions of liquid wealth (Figure A.4). Regarding the latter, we construct wealth measures following the definitions in Koehne and Kuhn (2015):

- L1 = "Total market value of stocks/bonds/mutual funds" + "Total amount of money assets like savings accounts of r/spouse"
- L2 = L1 + "Total market value of vehicles inc. autos r/spouse own"- "Total amount of money r/spouse owe on vehicles inc. autos"
- L3 = L2 + "Total amount of money in assets like IRAS or KEOUGH" + "Total amount of money in assets like CDS or loans"

Figure A.1: Labor Market Outcomes by Turbulence and Wealth: Additional Controls

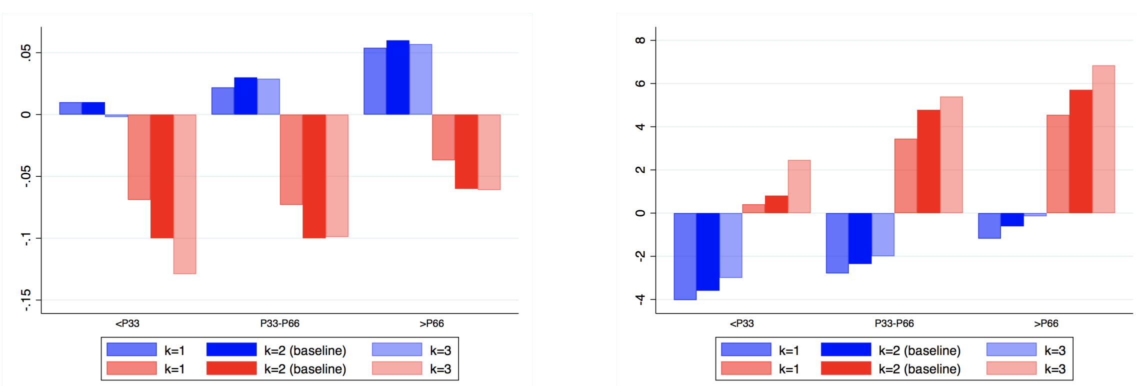
(A) Residual Wage Change　　(B) Residual Unemployment Duration



Notes: The left and the right panel plot, respectively, the average residual wage growth ($\hat{\varepsilon}^{\Delta w}$) and the average residual unemployment duration ($\hat{\varepsilon}^{\tau}$) for *turbulent* (red bars) and *tranquil* (blue bars) transitions at different parts of the liquid wealth distribution at the start of the unemployment spell. *unemp. benefit* and *spouse inc.* use, respectively, residuals from a specification that adds unemployment benefit eceived during the unemployment spell and spouce income as a control and *spouse inc.*. Sample includes all EUE' transitions observed over the period from 1979 to 2016 in NLSY79.

Figure A.2: Labor Market Outcomes by Turbulence and Wealth: Different thresholds

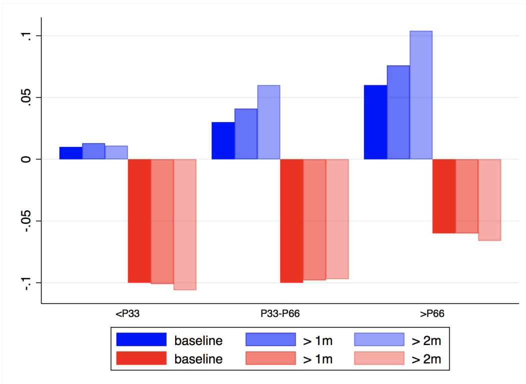
(A) Residual Wage Change　　(B) Residual Unemployment Duration



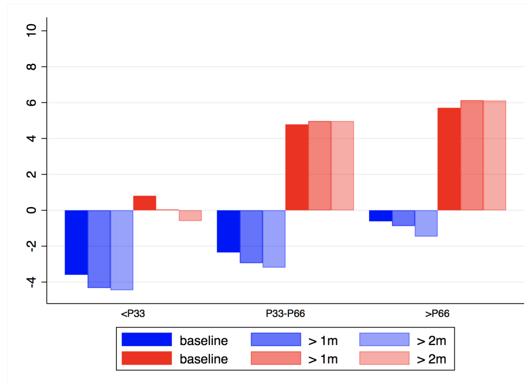
Notes: The left and the right panel plot, respectively, the average residual wage growth ($\hat{\varepsilon}^{\Delta w}$) and the average residual unemployment duration ($\hat{\varepsilon}^{\tau}$) for *turbulent* (red bars) and *tranquil* (blue bars) transitions at different parts of the liquid wealth distribution at the start of the unemployment spell. Turbulent workers are all workers that switch occupation upon reemployment with experience in the previous occupation larger than k years, while tranquil workers correspond to all transitions in which occupational tenure when entering unemployment was larger than k years and did not change occupation upon reemployment workers. Sample includes all EUE' transitions observed over the period from 1979 to 2016 in NLSY79.

Figure A.3: Labor Market Outcomes by Turbulence and Wealth: Short Unemployment Spells

(A) Residual Wage Change



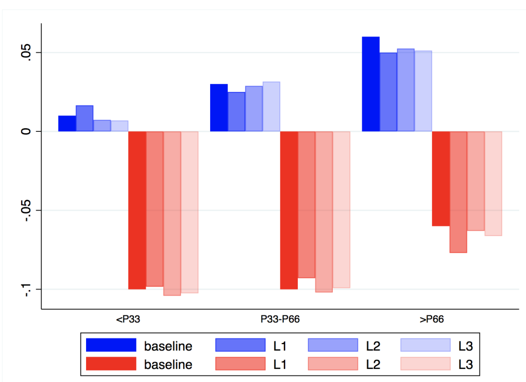
(B) Residual Unemployment Duration



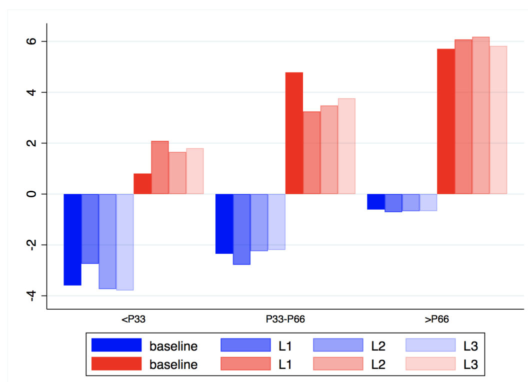
Notes: The left and the right panel plot, respectively, the average residual wage growth ($\hat{\varepsilon}^{\Delta w}$) and the average residual unemployment duration ($\hat{\varepsilon}^{\tau}$) for *turbulent* (red bars) and *tranquil* (blue bars) transitions at different parts of the liquid wealth distribution at the start of the unemployment spell. Sample includes all EUE' transitions observed over the period from 1979 to 2016 in NLSY79 or only those with with an unemployment spell higher than 1 and 2 months.

Figure A.4: Labor Market Outcomes by Turbulence and Wealth: Different Wealth Definitions

(A) Residual Wage Change



(B) Residual Unemployment Duration



Notes: The left and the right panel plot, respectively, the average residual wage growth ($\hat{\varepsilon}^{\Delta w}$) and the average residual unemployment duration ($\hat{\varepsilon}^{\tau}$) for *turbulent* (red bars) and *tranquil* (blue bars) transitions at different parts of the liquid wealth distribution. L1 = "Total market value of stocks/bonds/mutual funds" + "Total amount of money assets like savings accounts of r/spouse"; L2 = L1 + "Total market value of vehicles inc. autos r/spouse own"- "Total amount of money r/spouse owe on vehicles inc. autos"; L3 = L2 + "Total amount of money in assets like IRAS or KEOUGH" + "Total amount of money in assets like CDS or loans". Sample includes all EUE' transitions observed over the period from 1979 to 2016 in NLSY79.

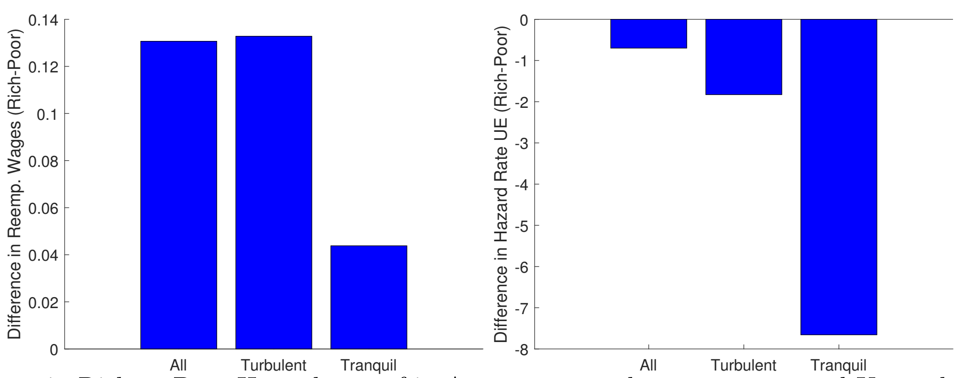
C Negative duration dependence

As pointed by Eeckhout and Sepahsalari (2019), canonical directed search models imply positive duration dependence of wages. This means that in those models higher wages are associated with lower probability of job finding and therefore higher unemployment duration. However, in the data we observe the opposite picture. Using NLSY data, we run a regression of reemployment wages on unemployment duration[19].

Eeckhout and Sepahsalari (2019) show that embedding risk aversion with precautionary savings and asset accumulation into directed search models results in negative duration dependence of wages.The cross-section effect in these models is similar to the canonical directed search models. However, dissaving during unemployment adds an over-time dimension to the problem since workers type (asset holding) changes over unemployment through dissaving (results in negative duration dependence). And, the net effect is in line with the latter one.

In the cross-section, rich unemployed workers who apply for riskier jobs have a lower hazard of leaving unemployment. However, over the duration of unemployment, workers who do not get a job today deplete their stock of wealth in order to smooth consumption and therefore next period they have less wealth and apply for less risky jobs which are lower paid. That increases the hazard of moving from unemployment to employment, UE_t/U_t. Overall the second effect (over time effect) dominates the cross-section one and implies a negative duration dependence of wages in line with what we observe in the data.

Figure A.5: Reemployment Wages and Hazard Rates (Cross-Section)



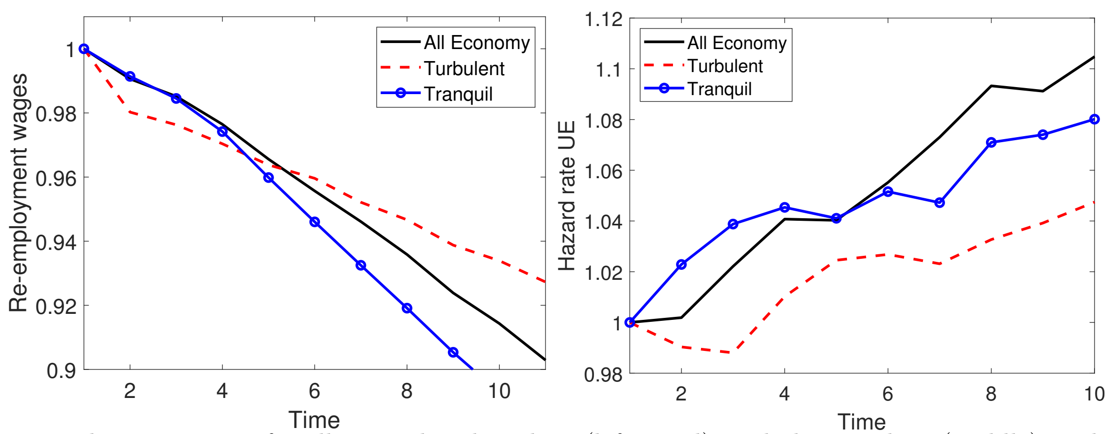
Notes: Difference in Rich vs Poor Hazard rate of in Average re-employment wages and Unemployment to Employment transitions for all unemployed workers (left panel), turbulent workers (middle), and tranquil workers (right). Data are taken from a model simulated cross-section of workers. Rich workers are defined as those with asset level equal to the 90th percentile of the asset distribution; poor workers are defined as those those with asset level equal to the 10th percentile of the asset distribution.

The left panel in Figure A.5 shows the difference in average reemployment wages between rich and poor workers in the economy and between turbulent and tranquil workers. For all groups and at cross section, rich unemployed workers apply for better paying jobs and therefore

[19] In this regression we only use as control the wage in the past employment spell.

they have relatively higher reemployment wages. However, as it is shown in the right panel of Figure A.5, rich workers have a lower hazard of moving from unemployment to employment and therefore longer unemployment duration. Interestingly, the difference between reemployment wages is lowest among turbulent workers. Low levels of experiences as well as generous unemployment insurance increase the tendency of both poor and rich turbulent workers to apply for higher wages; however, higher wages for rich turbulent workers is associated with substantially lower hazard rate of finding a job. Tranquil workers are however more sensitive to their wealth in terms of the wage they apply for. Rich tranquil workers apply for considerably higher wages though the associated probability of job finding with those wages are only slightly less than poor tranquil workers.

Figure A.6: Re-employment wages and Hazard Rates (Across-Time)

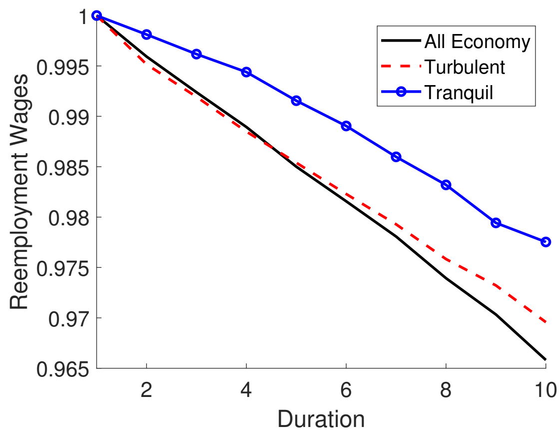


Notes: Re-employment wages for all unemployed workers (left panel), turbulent workers (middle), and tranquil workers (right). Data are taken from a model simulated panel of workers, who are given initially the same level of assets. For different time periods, mean re-employment wages are computed. We normalize outcomes by the time 0, which is the time they fall into unemployment.

To capture the over the time effect, we simulate a homogenous panel of workers who start their unemployment at the same time and with the same amount of assets. Unemployed workers who cannot get a job today, deplete their wealth in order to smooth their consumption and therefore they tend to apply for less risky and lower paying jobs. Therefore, longer unemployment duration is associated with lower reemployment wages implying negative duration dependence of wages over time (see left panel in Figure A.6). The hazard rate of moving from unemployment to employment increases considerably faster for tranquil workers compared to turbulent workers over the duration of unemployment. This is because of higher experience of these workers which increase the opportunity cost of unemployment for them. Therefore, the longer their unemployment duration becomes, they accept more aggressive wage cuts to increase the likelihood of finding a job (see right panel of Figure A.6).

Interestingly, although overall we observe negative duration dependence across all workers, this is strongest among tranquil workers. This is depicted in Figure A.7 . At cross-section,

Figure A.7: Re-employment Wages vs. Unemployment Duration



tranquil workers wages differentials between poor and rich is considerably higher than turbulent workers though the opposite is true when it comes to the hazard of moving from unemployment to employment. This highlights the sensitivity of high experienced tranquil workers to finding a job faster and that is why over the duration of unemployment they go for lower wages to leave unemployment faster. This is opposite to the turbulent workers who have a lower outside option and enjoying higher benefits during unemployment.

With the calibrated model at hand, we now study quantitatively the impact of increased turbulence risk and unemployment insurance for labor market dynamics and welfare.

D Effects of increasing turbulence risk

In this section, we analyze the effects of increasing turbulence risk—a larger exposure to the risk of losing occupation specific experience following a layoff—on key macroeconomic outcomes, both in the cross-section and at the aggregate level. The comparative statics consist of contrasting outcomes across steady states indexed by different levels of turbulence risk $\gamma^d \in [0, 1]$, while maintaining all other parameters at the baseline calibration outlined in Table 3. We discover that higher turbulence risk increases the unemployment rate, average unemployment duration, and average assets; in contrast, it reduces average wages. In the cross-section, we find that higher turbulence increases unemployment duration and reemployment wages following EUE' transitions.

D.1 Effects of turbulence risk on individual policies

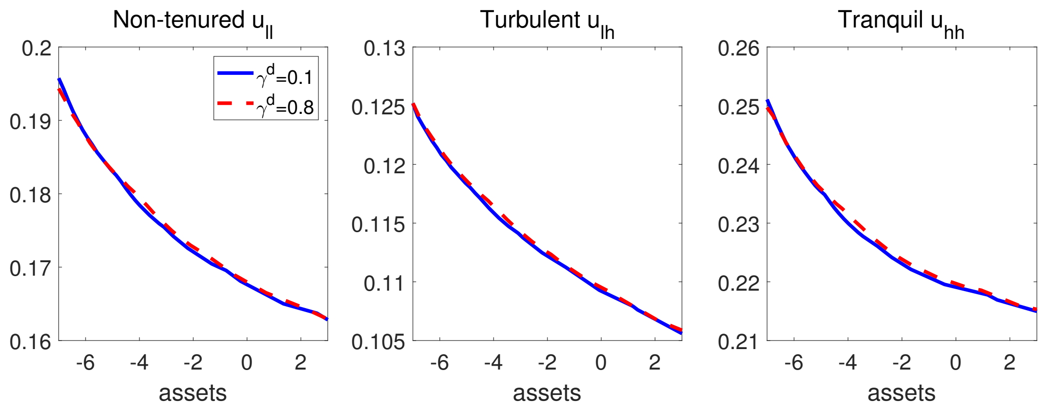
Turbulence risk decreases precautionary search. First we discuss the effect of higher turbulent risk on individual job search behavior. Figure A.8 illustrates unemployed workers' optimal job finding probability by worker type (i, j) and asset holdings for low turbulence risk ($\gamma^d = 0.1$, solid line) and high turbulence risk ($\gamma^d = 0.8$, dashed line). High turbulence risk shifts down the search policy towards riskier submarkets with lower finding rates and higher wages; this effect holds uniformly at all asset levels.

Why does higher turbulence risk makes job search riskier? Higher turbulence risk reduces the attractiveness of employment relative to unemployment, as the potential returns to experience are more likely to get lost. In order to compensate for these potential loses, workers direct their search towards slacker submarkets: they hope for the arrival of a high wage offer, even if it means staying longer in the unemployment state.[20] Workers understand that, in a more turbulent environment, securing a high wage is a priority, as it will allow them to save while employed and secure a healthy financial position to insure against the increased risk of turbulence. Overall, the presence of higher turbulence risk makes job search riskier, increasing expected unemployment duration and expected wages at the individual level.

Turbulence risk increases precautionary savings. Second, we discuss the effect of higher turbulence risk on savings. Figure A.9 plots the saving policies of employed workers by experience and asset level, for a low and a high level of turbulence risk $\gamma^d \in \{0.1, 0.8\}$. Higher turbulence risk increases the savings of the employed workers as a way to build up insurance against the prospects of a turbulent layoff. The increase in savings is considerably larger for

[20]This is clearly seen in equation (28), which shows how the optimal submarket choice is increasing with the difference between the value of employment and the value of unemployed, i.e. $E - U$. By reducing the expected gains $E - U$, workers optimally search in submarkets with low tightness θ.

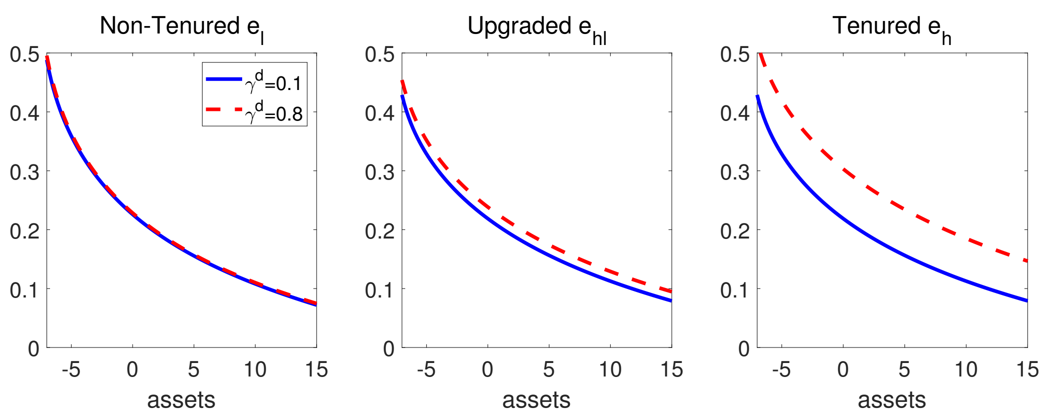
Figure A.8: Job search policies for high and low turbulence risk γ^d



Notes: Job finding rates are monotonically decreasing in turbulence risk. The figure plots the finding rates by worker type and asset holdings, for low ($\gamma^d = 0.1$, solid line) and high ($\gamma^d = 0.8$, dashed line) turbulence risks.

the experienced workers e_h, as these workers face the highest stakes in a more turbulent environment.[21]

Figure A.9: Savings policies for high and low turbulence risk



Notes: Savings of employed workers $a' - a$ are increasing in turbulence risk, evaluated at the average wage. This figure plots the savings policy by experience and asset holdings, for low and high levels of turbulence risk $\gamma^d \in \{0.1, 0.9\}$.

Note that the increase in savings follows naturally from our assumption of CRRA preferences with a risk aversion parameter larger than unity ($\sigma = 2$ in our baseline calibration). These preferences exhibit a strong prudent behavior, which implies that the saving rate increases with any risk, and in particular, with turbulence risk.[22]

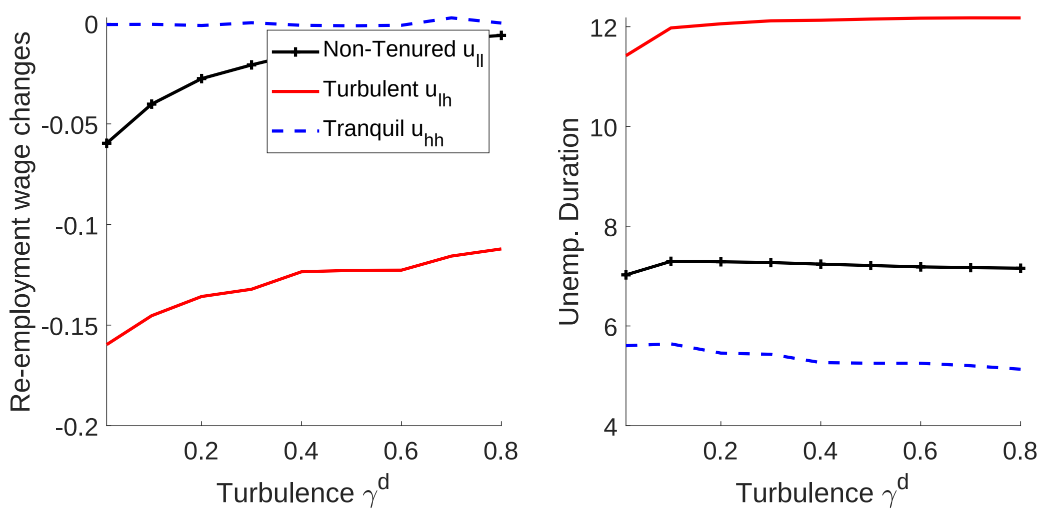
[21] Higher turbulence risk reduces the borrowing of the unemployed workers, but this effect is quantitatively small as their consumption smoothing motive is very strong and borrow as much as possible given the constraint.

[22] This is not true in general for all preferences with a third positive derivative, i.e., convex marginal utility. In the case of log preference, for instance, the income and substitution effect that arise from higher risk perfectly offset each other, and as a consequence, the saving rate is a constant fraction of cash at hand (income plus past savings), regardless of the level of risk.

D.2 Turbulence effects on reemployment wages and unemployment duration

Now we focus on the effects of turbulence risk on reemployment wages and unemployment duration in the cross-section. Figure A.10 plots the response of reemployment wage changes (in %) and unemployment duration (in months) to turbulence risk, for the EUE' transitions of three groups. For all transitions, both outcomes increase with turbulence risk. This is a tell-tale sign of the riskier job search behavior that targets slacker submarkets.

Figure A.10: Reemployment wage growth and unemployment duration for different turbulence risk γ^d



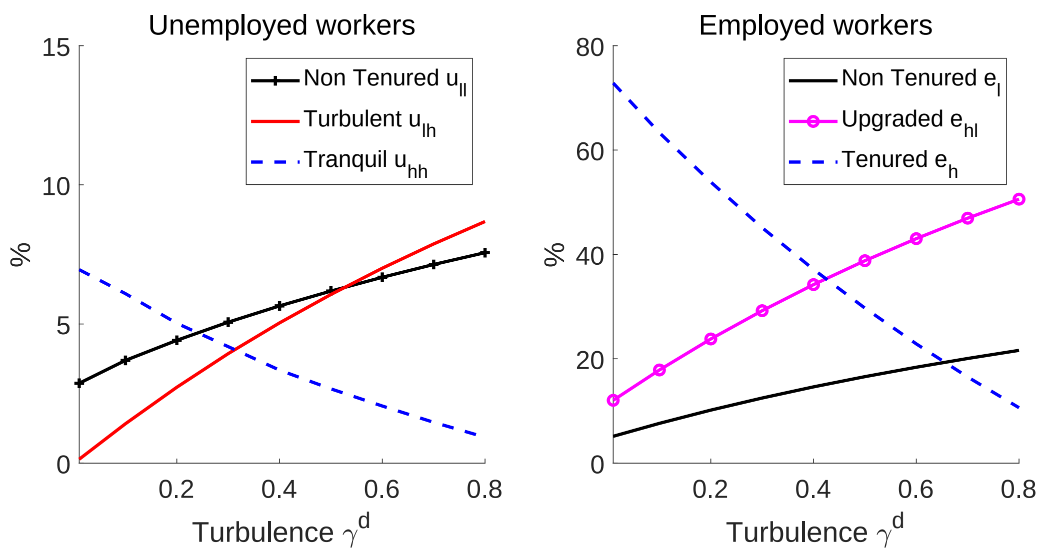
Notes: Cross-sectional reemployment outcomes. For varying levels of turbulence risk $\gamma^d \in [0, 1]$, the left panel plots reemployment wage growth (%); and the right panel plots unemployment duration.

D.3 Effects of turbulence risk on distributions

We have shown how turbulence risk affects individual policies: unemployed workers search for riskier jobs and employed workers increase their savings. Now we turn the focus to the distributional effects generated by turbulence risk on worker types and asset holdings. Shifts in these distributions have a large and direct impact on macroeconomic outcomes, since individual choices are aggregated at each steady state under different distributions.

Turbulence risk and worker-type distribution. Higher turbulence risk shifts workers from experienced into inexperienced. For various levels of turbulence risk, Figure A.11 plots the ergodic distribution of unemployed workers (left panel) and employed workers (right panel) by worker type, aggregated across wages and assets. In the absence of turbulence risk ($\gamma^d = 0$), all EUE' transitions of experienced workers are tranquil and there are no turbulent unemployed workers u_{lh}. Consequently, there is a large proportion of experienced workers in the economy as all workers get upgraded eventually. At the other end of the spectrum, as turbulence risk reaches its maximum level ($\gamma^d \to 1$), all laid-off workers lose their experience and the steady state distribution features a negligible proportion of experienced workers.

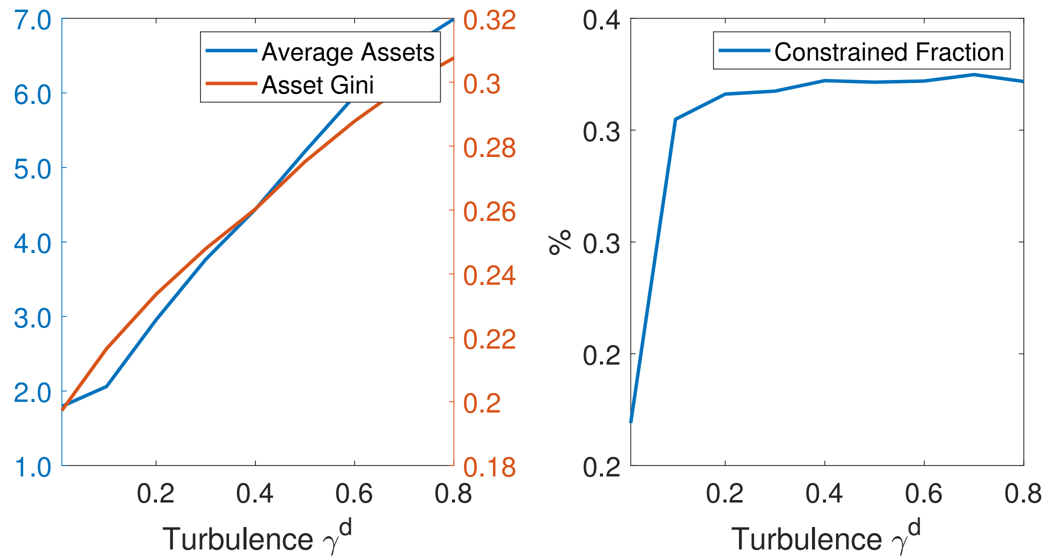
Figure A.11: Worker-type distributions for different turbulence risk γ^d



Notes: Turbulence risk and worker-type distribution. This figure plots the worker masses by labour status and type (i, j) for varying levels of turbulence risk $\gamma^d \in [0, 1]$.

Turbulence risk and asset distribution. The association between turbulence risk and the asset distribution is not obvious, as there are two forces driving assets in opposite directions. On the one hand, the exposure to higher risk engages the employed workers in larger precautionary savings; this pushes assets up (see left panel of Figure A.12). On the other hand, because of longer unemployment duration there is a larger fraction of unemployed workers who are more likely to have negative assets and hit the borrowing constraint; this pushes assets down (see right panel of Figure A.12). Precisely, as turbulence risk increases, the fraction of workers that hit the borrowing constraint rises from 0.8% to 1%. Overall, our quantitative results suggest that the first force dominates: more turbulent environments are accompanied by higher average wealth. Moreover, the asymmetry between the saving decision of employed workers, who increase their savings in response to higher risk, and unemployed workers, who increase their borrowing instead, increases wealth inequality, as measured by the increase in the Gini coefficient.[23]

Figure A.12: Asset accumulation for different turbulence risk γ^d



Notes: Turbulence risk and asset distribution. The left panel plots average assets and asset Gini coefficient; the right panel plots the fraction of constrained agents and negative asset holders, for varying levels of turbulence risk $\gamma^d \in [0, 1]$.

D.4 Effect of turbulence risk on aggregate labour market outcomes

Combining the individual policies and distributions at each steady state, we now study the equilibrium consequences of increased turbulence risk on labour market outcomes, in particular, in reemployment wages and unemployment duration in the cross-section.

Turbulence increases the unemployment rate and unemployment duration. The left panel in Figure A.13 shows that, as turbulence risk increases, the unemployment rate increases from 6.7% to 9.4%, while the average unemployment duration increases from 5.15 to 5.45 months. Thus our model generates a positive turbulence-unemployment relationship as in the classic papers of Ljungqvist and Sargent (1998, 2007, 2008) with exogenous separations and Baley, Ljungqvist and Sargent (2021) with endogenous separations.[24]

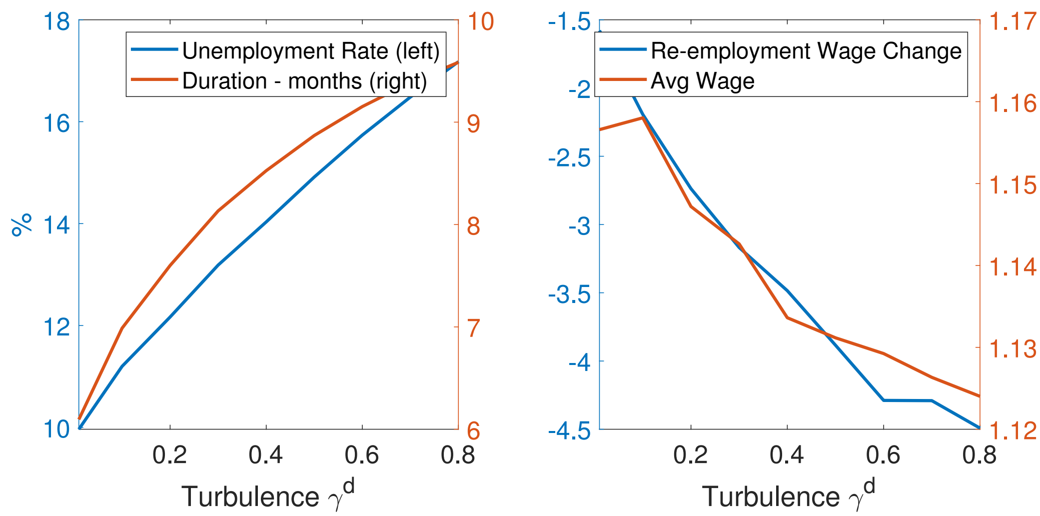
In those papers, a key ingredient to generate higher unemployment rate and duration is a generous welfare state. In a laissez-faire equilibrium (with $\phi = 0$), there is zero or very

[23] Other measures of wealth inequality (not reported), such as the cross-sectional dispersion of asset holdings, also increase with turbulence risk.

[24] den Haan, Haefke and Ramey (2005) find a negative relationship between unemployment and turbulence in a model with endogenous separations where turbulence risk also affects the employed workers. However, Baley, Ljungqvist and Sargent (2021) show that, once their parameterization is adjusted to fit historical observations on unemployment and layoff costs, a robust positive relationship between turbulence and unemployment reemerges.

small relationship between turbulence risk and unemployment; in contrast, in the presence of a generous welfare state, turbulent workers are reluctant to accept jobs as they have high unemployment insurance linked to their past wages. Interestingly, in our framework, the positive turbulence-unemployment relationship arises *even in the absence of a generous welfare state.*[25] In our setup, precautionary savings and precautionary search alter job search behavior resulting in higher unemployment rate and duration. Therefore, our findings show that the positive turbulence-unemployment relationship is robust to the inclusion of asset accumulation with imperfect financial markets and a directed search protocol in the labor market.

Figure A.13: Labour markets for different turbulence risk γ^d



Notes: Aggregate labour market outcomes. For varying levels of turbulence risk $\gamma^d \in [0, 1]$, the left panel plots average unemployment rate (%) and unemployment duration (months); and the right panel plots average wages and average reemployment wages.

Turbulence decreases average wages. The right panel in Figure A.13 shows that average wages decrease with higher turbulence risk. This negative association between wages and turbulence is not straightforward, as there are opposing forces at play. First, as discussed in sections D.2 and D.3, the job search policy of all workers becomes riskier, prompting workers to target high reemployment wages in markets with low hiring rates. Larger risk taking by the unemployed is compounded by their higher initial wealth upon unemployment, product of their precautionary savings while employed. These two forces push wages up. Second, the distributional channel kicks in: With high turbulence risk, there is a larger fraction of inexperienced workers who apply to low paying jobs given their productivity level. While individually reemployment wages grow (or fall less), on average, the change in the distribution

[25] The standard calibration of the turbulence literature assumes a replacement rate of $\phi = 0.7$ or above, whereas we set a value of $\phi = 0.25$ in our baseline calibration (the positive turbulence-unemployment relationship remains unaltered even at a replacement rate of $\phi = 0.1$). Moreover, the literature additionally includes generous layoff costs, which are absent in our framework.

increases the masses of turbulent and non-tenured unemployed who have lower wages. This compositional effect generates the lower average wages documented in Figure A.13. All in all, it is the distributional channel that dominates and wages are decreasing with turbulence.

E Role of unemployment insurance

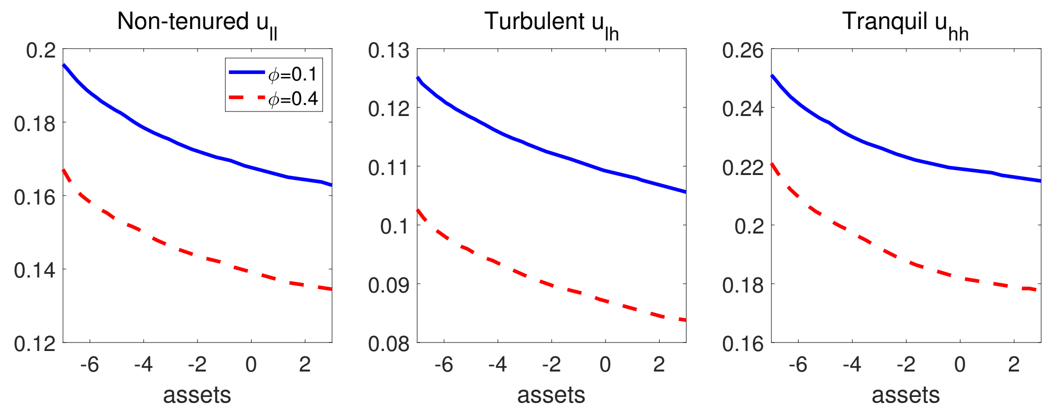
In this section, we consider the role of the unemployment insurance (UI) in shaping aggregate and cross-sectional macroeconomic outcomes. The motivation for this analysis is two-fold. First, we wish to relate our analysis to the turbulence literature that put forward the idea that the interaction of a generous welfare state with turbulence risk is the culprit behind the observed differences in labour market outcomes between Europe and the US during the 1980s and 1990s (Ljungqvist and Sargent, 1998, 2007, 2008). Second, since the Great Recession, many governments around the world dramatically increased the generosity of their UI programs. Our analysis sheds light on the consequences of an increase in UI in the presence of turbulence risk and the availability of insurance tools to the workers, i.e., precautionary search and savings.

We conduct comparative statics that contrast outcomes across steady states with varying generosity of the UI scheme, which is indexed by the replacement rates ϕ, while maintaining all other parameters at the baseline calibration outlined in Table 3. As in the previous section, we first show how the generosity of UI affects individual search and saving policies: We find that a more generous UI scheme decreases the precautionary search–as it happens with higher turbulence risk—but it decreases precautionary savings—in contrast to higher turbulence risk. Then, we show the distributional effects of UI on worker types and asset holdings. Overall, we discover that more generous UI increases the unemployment rate, unemployment duration and average wages; in contrast, it reduces average assets and wealth inequality. In the cross-section, we find that higher UI increases unemployment duration for all EUE' transitions, but reemployment wages are increasing in ϕ for turbulent transitions, while they are decreasing for tranquil transitions.

E.1 Effects of UI on individual policies

UI decreases precautionary search. Figure A.14 plots the job finding rates across worker types and asset levels for a low replacement rate ($\phi = 0.1$, solid line) and a high replacement rate ($\phi = 0.3$, dashed line). Job finding rates are monotonically decreasing (unemployment duration increasing) in ϕ. In other words, a higher replacement rate ϕ dampens the precautionary search motive. The reason is that higher UI reduces the income loss upon unemployment; this implies that unemployed workers have relatively lower marginal utility of consumption (relative to an environment with a low replacement rate) and their willingness to search for riskier jobs is higher.

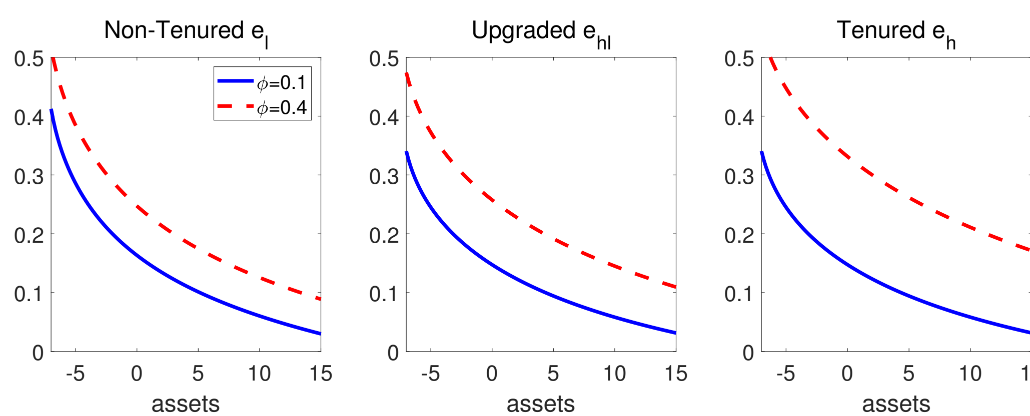
Figure A.14: Job search policies for low and high replacement rate ϕ



Notes: Job-finding rates are decreasing in UI generosity. The figure plots the job finding rate by worker type (i, j), for low and high levels of replacement rate $\phi \in \{0.1, 0.3\}$.

UI decreases precautionary savings. Now we discuss the effect of higher turbulence risk on asset accumulation. A generous benefit system provides higher insurance for workers in the event of losing their job and receiving a turbulence shock. This substantially reduces the need for self-insurance. Indeed, Figure A.15 shows that the saving policy of employed workers shifts down for all experience and asset levels when raising the replacement rate.

Figure A.15: Savings policies for low and high replacement rate ϕ

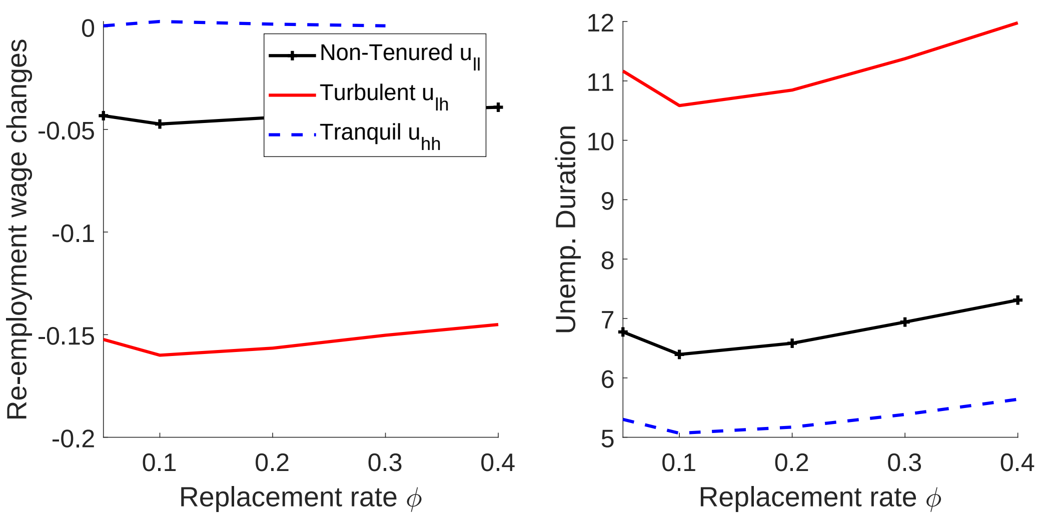


Notes: Savings are decreasing in UI generosity. The figure plots the saving policy by experience and asset holdings, for low and high levels of replacement rate $\phi \in \{0.1, 0.4\}$.

E.2 UI effects on reemployment wages and unemployment duration

Now, we focus on the effects of UI on reemployment wages and unemployment duration in the cross-section. Figure A.16 plots the response of reemployment wage changes (in %) and unemployment duration (in months) to UI, for the three types of EUE' transitions. For all transitions, unemployment duration increases with UI, reflecting the riskier job search behavior that targets slacker submarkets. Interestingly, while workers are targeting high reemployment wages, reemployment wage *changes* are only positive for the turbulent unemployed u_{lh} (wages do now grow for the non-tenured workers u_{ll} and decline for the tranquil workers u_{hh}). The reason is that workers accumulate lower savings while employed, so the distribution of asset holdings inside each group shifts to the left, decreasing the reemployment wage relative to an alternative steady-state with lower UI. This force is strongest for the tranquil workers: the insurance brought by UI is most effective for them, thus they are the ones that reduce their savings (self-insurance) the most.

Figure A.16: Worker-type distributions for different turbulence risk γ^d

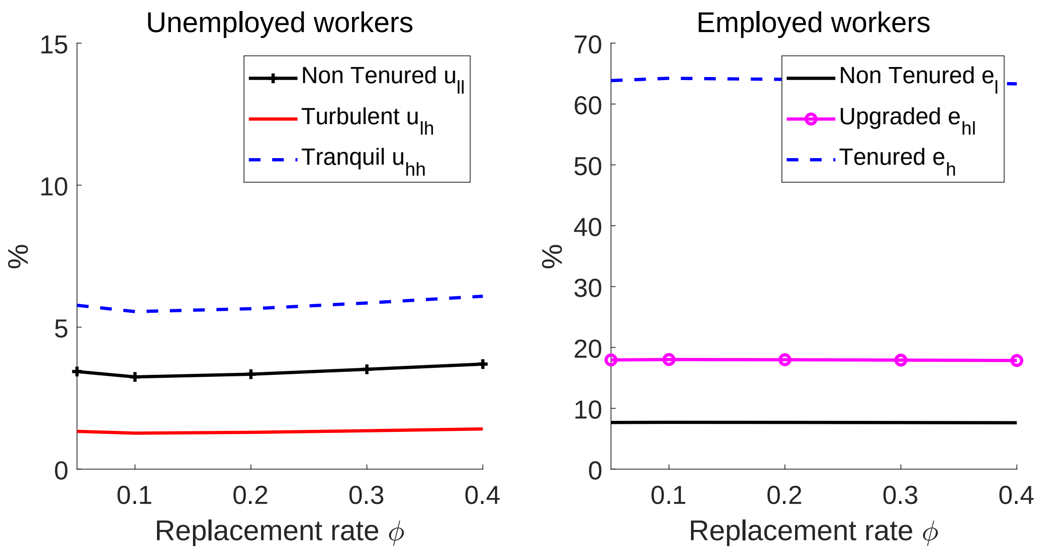


E.3 Effects of UI on distributions

We have shown how UI affects individual policies: unemployed workers search for riskier jobs and employed workers decrease their savings. Now we turn the focus to the distributional effects. For this, we compute the steady state equilibrium distributions across worker types and asset holdings for different values of the replacement rate $\phi \in [0.1, 0.4]$.

UI and worker-type distribution. For various levels of UI, Figure A.17 plots the ergodic distribution of unemployed workers (left panel) and employed workers (right panel) by worker type, aggregated across wages and assets. A more generous UI system increases the total mass of unemployed workers relative to employed workers; this is because UI alters workers' job search policy.

Figure A.17: Worker distributions for different replacement rates ϕ



Notes: Turbulence risk and worker-type distribution. This figure plots the worker masses by labour status and type (i, j) for varying levels of turbulence risk $\gamma^d \in [0, 1]$.

UI and asset distribution. The association between UI and the asset distribution is straightforward, in contrast to the more nuanced relationship that arises with turbulence risk. All workers reduce their savings and average assets decrease (see left panel of Figure A.18). As workers' need for self-insurance decreases, they move towards negative assets: the fraction of workers that hit the borrowing constraint rises from 1% to 6.5%, and the average fraction of workers with negative assets rises from 5% to 65% (see right panel of Figure A.18). Despite the fact that all workers reduce their savings, wealth inequality increases, as measured by the Gini coefficient.

E.4 Effect of UI on aggregate labour market outcomes

Combining the individual policies and distributions at each steady state, we now study the equilibrium consequences of UI on labour market outcomes, in particular, in reemployment wages and unemployment duration in the cross-section.

Figure A.18: Asset accumulation for different replacement rates ϕ

Notes: UI and asset distribution. The left panel plots average assets and the asset Gini coefficient; the right panel plots the fraction of constrained agents and negative asset holders, for varying levels of replacement rate $\phi \in [0.1, 0.4]$.

UI increases the unemployment rate and unemployment duration. The left panel in Figure A.19 shows that, as the replacement rate ϕ increases, the unemployment rate increases from 8% to 10.8%, while the average unemployment duration increases from 5.7 to 7.7 months. The positive relationship between unemployment rate and the generosity of the UI system is consistent with various models of the labour market. For instance, Ljungqvist and Sargent (2007) shows that unemployment increases with the replacement rate in a model with costly (random) search, as well as in a model with random matching. In these frameworks, the value of employment (or the joint value of a job relationship) is depressed relative to the value of unemployment and the outside options of firms, and thus unemployment increases.

UI increases average wages. The right panel in Figure A.19 shows that average wages increase with the generosity of the UI system. This positive association between wages and turbulence is not straightforward, as in the analysis with turbulence risk, because again there are opposing forces at play. On the one hand, workers' search policy is riskier, targeting high wages in markets with low hiring rates; this pushes wages up. On the other hand, the all agents have less assets. However, while there is reduction in savings, this is compensated by higher benefits, and therefore workers cash-at-hand upon unemployment remains largely unchanged.Taking all these effect jointly, the first effect dominates and wages are increasing with the generosity of the UI.

Figure A.19: Labour markets for different replacement rates ϕ