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JEL Classification Numbers:	E24, E62, H20, J20, J64, J65.
Keywords:	Labor Market Transition; Job Retention Policies, Short-Time Work Scheme, Welfare Gains
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The Welfare Implications of Job Retention Schemes*

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1 Introduction

Job retention schemes–a form of active labor market policy–gained widespread attention with their implementation during the COVID-19 pandemic. These policies seek to mitigate the adverse labor market effects of negative macroeconomic shocks by providing government subsidies or other support to employers that are linked to the maintenance of their employment relationships with workers. By helping firms pay their workers and keep them employed, such measures allow firms to preserve the talent and experience of their workforce during difficult times and enable them to ramp up operations quickly once economic activity recovers, without having to go through the costly processes of hiring and training new workers.

Proponents argue that job retention schemes are a critical tool for preserving jobs and skills during downturns (ILO (2020), OECD (2020)). Opponents have raised concerns that such policies may hinder necessary labor market reallocation after negative shocks, thereby slowing down economic recovery (Boeri and Bruecker (2011); Cahuc and Carcillo (2011)). Recent syntheses of the short-time work (STW) literature conclude that, despite strong evidence on employment stabilization, the welfare and fiscal evaluation of retention schemes–especially when they interact with unemployment insurance and reallocation incentives–remain an open area for research (Cahuc (2024); Giupponi et al. (2022)). This paper aims to address this gap by providing new empirical, theoretical, and quantitative contributions on the economic effects of job retention schemes.

Empirically, we find that job retention schemes are associated with significantly lower job separation rates, particularly for low-wage workers, with the effect being more pronounced during recessions. Leveraging EU microdata spanning 2003-2018, we estimate a linear regression model conditioning on worker income and education. Our analysis yields four key findings.[1] First, workers who experience job loss and later regain employment face large earnings penalties, especially if they switch occupations. Second, separation rates are higher for low-wage workers and rise disproportionately during downturns. Third, separation rates are generally lower in countries with stronger job retention schemes. Fourth, this protective effect is especially large for low-wage workers during recessions.

Motivated by these facts, we develop a micro-founded search-and-matching model with endogenous occupational choice. Workers hold a risky productivity portfolio that combines general and occupation-specific human capital, and they face an aggregate productivity shock whose impact differs across occupations. Each period, employed and unemployed workers search for the occupation that maximizes expected utility, while firms post costly vacancies

[1] For the literature on the costs of job loss, see for example Davis and von Wachter (2011); Krolikowski (2017); Burdett et al. (2020); Huckfeldt (2022); Jarosch (2023). Unlike this literature, our focus is not on estimating earnings losses due to exogenous displacement but on documenting broader patterns of earnings dynamics.

to maximize expected profits. The government levies a proportional labour-income tax to finance unemployment insurance and a job-retention subsidy that covers part of firms' wage bills after an adverse shock. Wages are bargained only at match formation and remain rigid thereafter; thus, a negative shock that renders a match unprofitable triggers separation unless the subsidy offsets the loss.

The model delivers three central results. First, retention subsidies disproportionately protect low-income workers because their matches, being less profitable on average, are the first to incur negative profits when an adverse aggregate shock strikes; high-income matches, by contrast, typically remain profitable without support. Second, the marginal value of the subsidy rises with the depth of the recession, preserving a larger share of otherwise-unprofitable matches when the aggregate shock is severe. Third, although the retention policy scheme raises spending ex-ante, it can lower the government deficit ex-post. Saved matches continue to generate labor-tax revenue, and the subsidy needed to keep a worker employed is often smaller than the unemployment-insurance outlay that would follow separation.

To assess the welfare and fiscal consequences of job-retention schemes, we calibrate the model to the United Kingdom on the eve of the global financial crisis (GFC) and the subsequent euro-area sovereign-debt crisis; during this crisis, no retention scheme was in place. We proceed in two steps. First, we replicate the heterogeneous recession impact across occupations by shocking the model with an occupation-specific, asymmetric aggregate shock. We then run a counterfactual in which a COVID-style scheme is introduced, designed to reduce the increase in unemployment by one-half relative to the baseline without intervention.

The main quantitative results indicate that a job retention scheme calibrated to offset roughly half of the nearly 2 percentage point increase in the U.K. unemployment rate following the GFC would be both welfare-enhancing and cost-effective. First, retention transfers attenuate the initial rise in unemployment after the adverse shock. Second, they accelerate the return to the steady state by keeping more workers attached to existing matches, thereby reducing the aggregate costs of job search and re-matching. Third, the scheme limits inefficient occupational reallocation in the wake of the shock, mitigating the associated output and welfare losses. Overall, the policy raises welfare by 0.06 percent in consumption-equivalent terms relative to the no-retention counterfactual. Welfare gains are also heterogeneous: low-income workers benefit disproportionately from match preservation, with average welfare improvements nearly three times those of the median worker.

We assess robustness along three dimensions. Extending the crisis duration from one to two periods increases the welfare gains from the scheme: a one-period program yields a 0.07 percent consumption-equivalent gain, while a two period program approximately doubles the benefit to 0.14 percent. We also consider a permanent shock. In this case, retention policies mainly postpone match dissolution that would eventually occur under the new long-run conditions; nevertheless, the program remains welfare-improving, delivering gains of about 0.03 percent in consumption-equivalent terms. The key mechanism is that workers are better off adjusting through on-the-job search and reallocation than through unemployment, so the scheme reduces the time spent non-employed and the associated welfare costs. Finally, incorporating the fiscal and administrative costs of implementing the retention scheme does not overturn the results: the policy remains welfare-enhancing.

The rest of the paper is organized as follows. Section 2 discusses how our paper relates to the existing literature. Section 3 presents stylized facts and empirical associations regarding job retention schemes and labor market outcomes using cross-country microdata. Section 4 describes the analytical model of the labor market and economy. Section 5 derives some theoretical results of the model. Section 6 presents a calibration of the model and quantitative results for the case of the United Kingdom around the GFC. Section 7 concludes with a summary of our key findings and some closing remarks.

2 Literature Review

The empirical literature on job-retention schemes (or short-time work, STW) can be grouped into two strands.[2] The first strand uses cross-country macroeconomic evidence to document broad patterns in take-up and labor-market adjustment, but it faces well-known challenges in establishing causal effects (Abraham and Houseman, 2009; Audenrode, 1994; Hijzen and Venn, 2011; Hijzen and Martin, 2013). The second strand exploits within-country or administrative variation to identify better measured impacts, typically emphasizing firm-level heterogeneity and institutional features.

Within the cross-country strand, Lydon et al. (2019) make an important advance by exploiting the ECB Wage Dynamics Survey, a firm-level panel spanning 20 European economies. They show that STW take-up is highest among firms hit by negative demand shocks and is more prevalent where firing costs are high, firm-specific human capital is valuable, and downward nominal wage rigidity is strong. This evidence underscores wage stickiness as a key condition for retention policies to be beneficial. Building on this insight, we provide new worker-level cross-country evidence that relates scheme generosity to job-separation proba-

[2] Cahuc (2024) reviews the STW literature and highlights three open questions that motivate our approach. First, the interplay between STW and unemployment insurance (UI) remains unclear. Second, the employment and hours effects of STWâand consequently, behavioral responses to key scheme design features remain underexplored. Third, more evidence is needed on STW's influence on workforce reallocation. Our paper addresses the first and third gaps: empirically, we provide worker-level cross-country evidence on separations (a margin central to UI and welfare) and how it varies with scheme generosity; and theoretically, we develop a search-and-matching model with endogenous occupational choice, such that retention subsidies affect separations and reallocation incentives in a unified framework.

bilities during downturns, a margin that is central to welfare and distributional analysis.[3]

Country-specific studies using research designs aimed at causal identification generally find that retention schemes can mitigate employment losses, while also highlighting potential distortions. For Germany, Boeri and Bruecker (2011) instrument STW take-up during the GFC using firms' prior experience with the scheme and find that STW helped limit job destruction see also Cooper et al. (2017) for evidence on the employment and output effects of STW in Germany. Using macro data and lagged policy features as instruments, Cahuc and Carcillo (2011) find similar employment-stabilization effects but caution that STW may induce inefficient reductions in hours and adversely affect outsiders by protecting insiders. Using a combination of firm data and a structural framework, Balleer et al. (2016) likewise conclude that STW stabilizes employment more strongly in rigid labor markets than in flexible ones. More recently, Giupponi and Landais (2023) exploit administrative variation in eligibility across firms and document that supported firms reduce hours per worker (the intensive margin) while increasing employment (the extensive margin) relative to untreated firms. Using French administrative data, Cahuc et al. (2018) also find that STW saved jobs among firms experiencing large revenue declines during the GFC, with larger effects among highly leveraged firms. More recently, Cahuc et al. (2021) emphasize substantial heterogeneity in impacts, distinguishing genuinely saved jobs from windfall effects, underscoring the importance of targeting and scheme design. While this evidence is informative about firm heterogeneity and the intensive versus extensive margins, it is largely silent on worker heterogeneity and the distributional welfare consequences that are central to our analysis.

On the theory side, existing quantitative models show that retention subsidies can cushion employment but typically abstract from margins that are pivotal for welfare and distributional evaluation. For instance, Tilly and Niedermayer (2017) embed an STW subsidy in a life-cycle search model and find modest welfare gains concentrated among workers whose outside options are close to the bargained wage, but the framework does not feature occupation switching. Balleer et al. (2016) incorporate downward nominal wage rigidity and firing costs in a search-and-matching model and show that STW is substantially more effective in rigid labor markets however, they do not allow for heterogeneous recession impacts across occupations, nor for the costs of occupational reallocation. Dengler and Gehrke (2021) study STW in a DSGE framework with endogenous separations and a formal policy rule, highlighting its stabilization properties over the business cycle, again without an occupation-switching channel. Relatedly, Birinci et al. (2021) study the optimal mix of payroll subsidies and unemployment insurance during a pandemic in an environment with epidemiological dynamics,

[3]Our evidence uses worker-level microdata from the European Union Statistics on Income and Living Conditions (EU-SILC) for 12 EU/OECD countries from 2003 to 2018, merged with annual indicators of job-retention scheme generosity from the OECD Labor Market Policy Database. While the regressions are associational rather than causal, they establish stylized facts that motivate the model-based analysis.

and find that retention-type policies, although with a limited role, can be welfare-improving.

We contribute to this literature along three dimensions. First, using harmonized cross-country microdata, we document new worker-level evidence that more generous job-retention schemes are associated with lower separation probabilities during downturns, with particularly pronounced correlations for low-wage workers; these stylized facts discipline and motivate the model. Second, we develop a search-and-matching model with endogenous occupational choice that features costly occupational switching and downward nominal wage rigidity, allowing retention schemes to influence reallocation incentives that depend on institutional frictions. Third, calibrating the model to the pre-crisis United Kingdom, we quantify the distributional and fiscal implications of retention policy schemes, finding that welfare gains are concentrated among low-income workers, while saved matches reduce unemployment-insurance outlays and increase tax revenues. Thus, a well-designed scheme can be deficit-reducing despite the wage subsidy. Taken together, the framework provides a tractable benchmark for evaluating job-retention policies and for assessing when stabilization benefits dominate reallocation costs.

3 Stylized Facts

To motivate our quantitative model, we start by establishing a few stylized facts regarding the relationship between job retention schemes and job separation rates. We employ data from the European Union Statistics on Income and Living Conditions (EU-SILC). Our analysis begins by exploring the costs associated with job loss and occupational switches, leveraging the longitudinal dimension of the dataset. Specifically, we examine the consequences of job loss and the dynamics of occupational transitions within the EU-SILC data. Subsequently, we study the association between job retention schemes and job separation rates.

3.1 Data

The EU-SILC is a micro-level survey that tracks individuals for up to four years. We restrict our sample to individuals aged between 20 and 65 years. Table A.1 shows the list of sample countries along with the years covered and the number of observations. The number of observations in our sample is over 1.8 million individuals across 12 countries between 2003 and 2018 (Austria, Belgium, Denmark, Estonia, Finland, Italy, Netherlands, Portugal, Slovenia, Spain, Sweden, and United Kingdom). As discussed later, we focus on individuals who initially lose employment and later become reemployed.

There are advantages and disadvantages to using the EU-SILC data compared to individual countries' labor force surveys. One major disadvantage of the EU-SILC compared to individual countries' labor force surveys is that the EU-SILC panel data do not include industry information. Thus, we focus only on occupational switching. Occupational categories in the EU-SILC are one-digit ISCO-08 codes (nine occupation categories).[4] Moreover, relative to some national labor force surveys, the EU-SILC only has data from 2003 to 2018, suggesting a shorter-sample period and smaller sample size. However, our data includes the period and aftermath of the Global Financial Crisis.

The main advantage of the EU-SILC is the large number of European countries in the sample, which allows us to explore cross-country differences in the use of job retention schemes. This cross-country heterogeneity enables us to confirm the relationship between occupational switching and the use of job retention schemes that have been documented by previous studies in specific countries.

3.2 Cost of Job Loss and Occupational Switch

This section establishes a few stylized facts: (i) a job loss is costly for an individual worker, and (ii) it is even more costly for workers who switch occupations upon reemployment after an unemployment spell.

Table 1 column 1 shows the average earnings changes for workers who were reemployed after one year of unemployment (labeled as "EUE"). Their earnings have dropped, on average, by 41.6 log points. Column 2 "EUE" further compares workers who were reemployed in the same occupation ("Constant") and those who switched occupations ("Occ. Switchers"). Those who returned to the same occupations (stayers) lost earnings of 32.5 log points, while those who switched experienced an earnings loss of 54 log points (=-32.5-21.5). This additional earnings penalty arising from switching occupations is robust to the inclusion of country year fixed effects, year fixed effects, macroeconomic variables (i.e., output gap and log GDP per capita), and individual characteristics (gender, age, age-squared, high-skill dummy), as shown in column 3. On the other hand, those who continued to be employed (labeled as "EE") had an average earnings gain of 6.5 log points (column 4). In particular, those who remained employed and stayed in the same occupations experienced average gains of 6.1 log points, while those who switched occupations after on-the-job search obtained an additional 2.3 log points in earnings (column 5). This additional earnings gain arising from switching occupations on-the job is robust to including country year fixed effects, year fixed effects, macroeconomic variables (i.e., output gap and log GDP per capita), and individual characteristics (gender, age, age-squared, high-skill dummy), as shown in column 6. Thus,

[4] Occupations are categorized into: 1) managers, 2) professionals, 3) technicians and associate professionals, 4) clerical support workers, 5) service and sales workers, 6) skilled agricultural, forestry, and fishery workers, 7) craft and related trades workers, 8) plant and machine operators and assemblers, and 9) elementary occupations. With only one-digit ISCO-08 categories, our analysis captures only large occupational switches.

Table 1: Earnings Change of Occupational Change

Sample	EUE	EUE	EUE	EE	EE	EE
	(1)	(2)	(3)	(4)	(5)	(6)
Dep. Var. Δ ln(Earnings)						
Occ. Switching		-0.215***	-0.206***		0.0226***	0.0130**
		(0.0587)	(0.0534)		(0.00669)	(0.00577)
Constant	-0.416***	-0.325***	-1.066	0.0648***	0.0612***	1.953
	(0.0380)	(0.0442)	(7.872)	(0.00444)	(0.00419)	(1.355)
Country FE	No	No	Yes	No	No	Yes
Year FE	No	No	Yes	No	No	Yes
Macro Controls	No	No	Yes	No	No	Yes
Individual Char	No	No	Yes	No	No	Yes
Observations	2,126	2,126	2,109	172,801	172,801	171,808
R-squared	0	0.00938	0.0925	0	0.000309	0.0304
Adjusted R-squared	0	0.00891	0.0790	0	0.000303	0.0302

Notes: The standard errors are clustered at country and year level and are in parentheses, with significant levels being * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Columns (1), (2), and (3) correspond to the sample of "EUE" who became reemployed after an unemployment spell, and Columns (4), (5), and (6) contain the sample of "EE" who continued to be employed for two consecutive years without an unemployment spell. Macro controls include output gap and ln GDP per capita. Individual characteristics include age, age-squared, female dummy, marital status dummy. and high skill dummy (college and above degree).

these results suggest a significant distributional impact of job loss: while those who remain employed continue to experience annual earnings growth, those who become unemployed experience significant earnings losses even if they get reemployed. Moreover, results from Table 1 are consistent with the idea that on-the-job occupational switching is voluntary and thus is associated with additional earnings gains, while those who switch occupations upon reemployment after an unemployment spell do so involuntarily and at a high cost. These results are consistent with a sequential auction framework in the literature (e.g., Cahuc et al. (2006); Jarosch (2023); Postel-Vinay and Robin (2002a,b)).

3.3 Job Separation

To motivate our theoretical model later, we study (i) how job separation varies by wages and (ii) how such incidences change over the business cycle. Table 2 shows a negative correlation between job separation and wages from the previous period. That is, workers with lower wages have a higher probability of job separation (column 1). Lower wage earners not only have higher job separation rates, as indicated by the negative and significant coefficient on past wages, but they also experience an even higher job separation rate during recessions, as indicated by the negative and significant coefficient on the interaction term between past wages and recession dummies ("Recxln(Wage)") (column 3). These results hold true even after controlling for country fixed effects, year fixed effects, macroeconomic variables, and individual characteristics (columns 2 and 4).

3.4 Role of Retention Policies in Mitigating Job Separation

We now turn to the role of job retention policies on job separation.[5] Given that job retention policies are not purely exogenous to the economic environment, like job separation, the aim of this section is to provide suggestive rather than causal associations between the role of retention policies and job separations, and the motivation for our theory, which is the key contribution of this paper. We run the following regression with interaction terms between degrees of retention policies and recessions (economic shocks):

$$Separation_{ict} = \alpha_c + \beta_t + \gamma Rec_{ct} + \delta HighReten_c + \theta Rec_{ct} \times HighReten_c + \lambda X_{ict} + \epsilon_{it} \quad (1)$$

[5] To define a broad definition of job retention schemes, we include the following categories from the OECD Labor Market Policies database as job retention policies, with item numbers in parentheses: (i) benefits administration (12), (ii) workplace training (22), (iii) apprenticeship (24), (iv) employment incentives for maintenance (keeping jobs) (42), (v) partial unemployment benefits (82), and (vi) part-time unemployment benefits (83), where the values in parentheses indicate the respective spending item numbers.

Table 2: Job Separation: Recession and Low-Wage Workers

	(1)	(2)	(3)	(4)
Dep. Var. Job Separation				
ln(Wage)	-0.0253***	-0.0239***	-0.0242***	-0.0244***
	(0.00185)	(0.00168)	(0.00213)	(0.00191)
Rec			0.0311*	0.0163
			(0.0170)	(0.0106)
Recxln(Wage)			-0.0101*	-0.00796**
			(0.00546)	(0.00395)
Constant	0.0947***	0.0713	0.0927***	-0.0184
	(0.00584)	(0.341)	(0.00666)	(0.414)
Country FE	No	Yes	No	Yes
Year FE	No	Yes	No	Yes
Macro Controls	No	Yes	No	Yes
Individual Char.	No	Yes	No	Yes
Observations	188,365	187,097	157,271	156,157
R-squared	0.0164	0.0264	0.0179	0.0278
Adjusted R-squared	0.0164	0.0262	0.0179	0.0276

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Notes: Dependent variable is the dummy variable for whether the worker had a job in year t-1 and became unemployed in year t. ln(Wage) is the real hourly wages in year t-1 when the worker was employed. Rec is a recession dummy is defined following Harding and Pagan (2002). The standard errors are clustered at country and year level and are in parentheses, with significant levels being * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Macro controls include output gap and ln GDP per capita. Individual characteristics include age, age-squared, female dummy, marital status dummy. and high skill dummy (college and above degree).

where $Separation_{ict}$ is a dummy variable equal to 1 if the individual i in country c is separated from their job in the year t. α_c denotes the country fixed effects to account for cross-country differences in average separation rates, while β_t represents the time-fixed effects that account for any global factors affecting job separation rates over time. Rec_{ct} is a dummy variable equal to 1 if a country c is in recession in the year t, and 0 otherwise.[6] $HighReten_c$ is a dummy variable equal to 1 if the country's average retention policy is above the median, and 0 otherwise. Lastly, X_{ict} contains other individual and country level time-varying controls. Controls for individual characteristics include age, age-squared, gender, marital status, and high skill (i.e. college or higher education). Country level time-varying controls include (i) output gaps to capture the states of the economy.[7] (ii) the level of GDP per capita to account for differences in the level of development, (iii) policy variables, including unemployment insurance and reallocation policies, to account for differences in the degrees of policy environment across countries.[8] Output gaps and GDP per capita are based on the IMF World Economic Outlook database, while labor market policies are sourced from the OECD Labor Market Policies database. The coefficient of interest is θ, which captures the association between the degree of retention policies and job separation during recessions.

Table 3 shows the regression results from equation (1). Column 1 shows the regressions without country and year fixed effects. Column (2) adds country fixed effects. Column (3) includes both country fixed effects and year fixed effects. Column (4) adds country time-varying controls (output gaps and retention policies). Column (5) further adds individual controls. Except for column (1), a dummy variable, HighReten, is fully captured by the country fixed effects and is thus dropped from the regression. Note that column (1) indicates that, even during non-recessionary periods, countries with high job retention policies have lower job separation rates than those without such policies, potentially suggesting the presence of other labor market institutions and policies in these countries that would keep the average job separation rate low. At the same time, even when we have country-fixed effects (columns (2)-(5)), where we are observing the deviations of job separation probability from country-specific means, we still see that job separation is lower in a country with a high retention policy than in a country with a low retention policy during a recession. Specifically, based on column (5), the job separation probability is 1.2 percentage points lower in countries with job

[6] We follow the Harding and Pagan (2002) algorithm to define business cycle dating, which identifies local peaks and troughs that alternate. Since the data are annual, phases are set to have a minimum length of one year. This implies that recessions are defined as contiguous blocks of years with negative real GDP growth.

[7] Output gaps are defined in the IMF World Economic Outlook database for each country.

[8] Similarly to retention policies, reallocation policies are defined as the sum of the following variables from the OECD Labor Market Policies database (with variable numbers in parentheses): (i) placement administration (11), (ii) institutional training (21), (iii) integrated training (23), (iv) employment incentives for recruitment (hiring) (41), (v) direct job creation (60), (vi) start-up incentives (70), and (vii) early retirement.

Table 3: Job Separation and Retention Policy

	(1)	(2)	(3)	(4)	(5)
Dep. Var. Job Separation					
Rec	0.0200***	0.0158***	0.0108***	0.00610**	0.00570**
	(0.00757)	(0.00440)	(0.00386)	(0.00261)	(0.00258)
HighReten	-0.0129***				
	(0.00355)				
RecxHighReten	-0.0228***	-0.0214***	-0.0192***	-0.0122***	-0.0122***
	(0.00844)	(0.00546)	(0.00440)	(0.00325)	(0.00318)
Constant	0.0406***	0.0351***	0.0361***	1.281**	1.445***
	(0.00274)	(0.00139)	(0.00122)	(0.499)	(0.486)
Country FE	No	Yes	Yes	Yes	Yes
Year FE	No	No	Yes	Yes	Yes
Macro Controls	No	No	No	Yes	Yes
Policy Controls	No	No	No	Yes	Yes
Individual Char	No	No	No	No	Yes
Observations	188,700	188,700	188,700	180,315	178,809
R-squared	0.00374	0.00807	0.00926	0.0104	0.0184
Adjusted R-squared	0.00373	0.00800	0.00914	0.0102	0.0182

Notes: Dependent variable, job separation, is the dummy variable for whether the worker had a job in year t-1 and became unemployed in year t. ln(Wage) is the real hourly wages in year t-1 when the worker was employed. Rec is a recession dummy is defined following Harding and Pagan (2002). The standard errors are clustered at country and year level and are in parentheses, with significant levels being * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Macro controls include output gap and ln GDP per capita. Individual characteristics include age, age-squared, female dummy, marital status dummy. and high skill dummy (college and above degree).

retention policy spending above the median.

3.5 Differential Impacts of Retention Policies for Low-wage Workers

Given our previous result that low-wage workers have a higher chance of separating from jobs, we now extend our analysis to consider whether retention policies differentially benefit lower-wage workers compared to higher-wage workers during a recession. That is, do lower-wage workers in a country that emphasizes high-retention policy-spending have a lower chance of job separation during a recession than their counterparts? To this end, equation (1) is extended to allow for triple interactions of recession $\times$, retention policy $\times$, wages, and their respective double interactions.

Table 4 shows the results with the same set of controls for columns (1) through (5). The variable of interest is the triple interaction term among wages, recession, and high retention policy dummies–"ln(Wage)xRecxHighReten". Its coefficient is positive and becomes statistically significant once controls are introduced (columns (2) through (5)). This implies that *low-wage* earners in high-retention policy countries experience lower job separation during the recession than their counterparts across different sets of controls, with two workers being approximately equal. In other words, job retention policies have a mitigating effect on the job separation rate of low-wage workers during recessions in high retention policy countries.

To illustrate, consider two workers: a low-wage worker at the 25th percentile of hourly wages and a high-wage worker at the 75th percentile of hourly wages.[9] According to the coefficients from column (5) in Table 4, a low-wage worker has a 3 percentage point higher chance of losing their job in general compared to a high-wage worker (ln(Wage) during normal, non-recession times). During a recession, the low-wage worker's chance of losing their job increases by 2.1 percentage points in the absence of a retention policy (ln(Wage)xRec). However, if the low-wage worker lives in a country with a strong retention policy, this additional increase in the chance of losing their job during a recession relative to a high-wage worker will be fully mitigated by 2.4 percentage points (ln(Wage)xRecxHighReten)."

To sum up, this section establishes four stylized facts about job separations and job retention policies. First, the earnings loss for those who went through an unemployment spell is significant and is amplified for those who had to switch occupations.[10] Second, job separation rates for low-wage workers are higher than those of their counterparts and are particularly high during recessions. Third, job separation rates are overall higher during recessions but are mitigated in countries with strong job retention schemes. Fourth, this mitigating effect on

[9] The 25th percentile and 75th percentile of ln(wage) are 2.03 and 3.04, respectively.

[10] While it would be interesting to look at the impact of retention policies in mitigating earnings loss studied in Table 1, it is not possible due to the small sample size, particularly for those who get reemployed after one year of unemployment spell.

Table 4: Retention Policy x Separation x Hourly Wages

	(1)	(2)	(3)	(4)	(5)
Dep.Var: Job Separation					
Rec	0.0434*	0.0423**	0.0418***	0.0540***	0.0536***
	(0.0243)	(0.0186)	(0.0156)	(0.0149)	(0.0151)
HighReten	0.0113				
	(0.0126)				
ln(Wage)	-0.0259***	-0.0312***	-0.0307***	-0.0310***	-0.0301***
	(0.00280)	(0.00267)	(0.00264)	(0.00263)	(0.00258)
ln(Wage)xHighReten	-0.000931	0.00419	0.00327	0.00392	0.00460
	(0.00393)	(0.00400)	(0.00400)	(0.00408)	(0.00406)
ln(Wage)xRec	-0.0117	-0.0128*	-0.0149**	-0.0211***	-0.0209***
	(0.00837)	(0.00713)	(0.00615)	(0.00657)	(0.00663)
RecxHighReten	-0.0540*	-0.0563**	-0.0612***	-0.0697***	-0.0687***
	(0.0293)	(0.0247)	(0.0218)	(0.0213)	(0.0214)
ln(Wage)xRecxHighReten	0.0137	0.0152*	0.0184**	0.0245***	0.0240***
	(0.00983)	(0.00882)	(0.00793)	(0.00830)	(0.00835)
Constant	0.0927***	0.105***	0.106***	1.129*	1.188*
	(0.00830)	(0.00571)	(0.00546)	(0.676)	(0.679)
Country FE	No	Yes	Yes	Yes	Yes
Year FE	No	No	Yes	Yes	Yes
Macro Controls	No	No	No	Yes	Yes
Policy Controls	No	No	No	Yes	Yes
Individual Char	No	No	No	No	Yes
Observations	157,271	157,271	157,271	150,441	150,288
R-squared	0.0187	0.0237	0.0251	0.0274	0.0292
Adjusted R-squared	0.0187	0.0236	0.0250	0.0272	0.0290

Notes: Dependent variable, job separation, is the dummy variable for whether the worker had a job in year t-1 and became unemployed in year t. ln(Wage) is the real hourly wages in year t-1 when the worker was employed. Rec is a recession dummy is defined following Harding and Pagan (2002). The standard errors are clustered at country and year level and are in parentheses, with significant levels being * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. HighReten is a dummy for which the average retention policies are above the 50th percentile in the sample. Policy controls include unemployment insurance spending and reallocation policies spending as percent of GDP. Macro controls include output gap and ln GDP per capita. Individual characteristics include age, age-squared, female dummy, and high-skill dummy (college and plus education).

the job separation rate during recessions seems to be larger for low-wage workers in countries with high retention policies. Motivated by these stylized facts, the next section builds a search-and-matching model that incorporates the role of job retention policies with endogenous occupational choices.

4 Model

We develop a search and matching model with endogenous occupational choice, building on the frameworks established by Mortensen and Pissarides (1994) and Diamond (1982). In our model, workers have a risky productivity portfolio across occupations, composed of both general and occupation-specific human capital, in the spirit of Roy (1951). Workers face idiosyncratic risks that affect their occupation-specific human capital. This risk allows the model to replicate key aspects of labor market transitions, such as job to-job occupation switches and transitions out of unemployment. Workers also face an aggregate productivity shock that is asymmetric across occupations. Each period, employed and unemployed workers direct their search to the occupation that maximizes expected utility.

Firms post vacancies at a cost to maximize current profits. Wages are determined by static Nash bargaining at match formation and remain rigid thereafter. Government policy operates on two fronts. First, the government levies a proportional labor-income tax that finances unemployment insurance in the steady state, following Baily (1978). Second, the government can implement a job-retention scheme that subsidizes part of firms wage bills a la Blanchard and Tirole (2008) to preserve otherwise unprofitable matches when an adverse shock occurs. The job retention scheme is financed through lump-sum transfers. The government maintains an intertemporal balanced budget: a proportional labor-income tax finances steady-state unemployment insurance and, when activated, a job retention scheme that preserves a share of matches rendered unprofitable by the shock, financed via lump-sum transfers.

4.1 Workers

Workers live indefinitely and discount future periods. β is the discount rate. Agents are heterogeneous in their productivity portfolios across occupations, denoted as $k \in \mathcal{K}$. The productivity portfolio is divided into workers' general human capital, $h \equiv ||e||_2$, and occupation specific human capital, $\varepsilon \equiv e/||e||_2$. We assume that workers' general human capital is fixed, while occupation specific human capital is affected by an idiosyncratic shock. We denote the support for the human capital specific component as $\mathcal{E} \equiv \{\varepsilon \in \mathbb{R}_+^K : ||\varepsilon||_2 = 1\}$. Besides the idiosyncratic shock to workers' human capital, occupations can also be impacted by an occupation specific aggregate shock, $z^k \in \mathbf{R}_+^K$.

Each period is divided into two sub-periods. In the first half, all workers enter the labor market and choose in which occupation to search for a job. In the second half, employed workers work, unemployed workers receive their unemployment insurance, and everyone consumes. Agents are hand-to-mouth; consequently, they cannot save or borrow.

Unemployed workers. Unemployed agents receive unemployment insurance T_u in the second half of the period. The unemployment insurance is used solely for consumption. Unemployed agents enter the labor market from the pool of unemployed workers in the following period. An unemployed worker's value function in the second half of the period is characterized by

$$V^0(\varepsilon, h, z) = u(T_u) + \beta \mathbb{E}\left[W^0(\varepsilon', h, z')\right], \tag{2}$$

where $W^0(\varepsilon', h, z')$ represents the first half value function in the following period, and 0 indicates the unemployment state. The expectation is taken with respect to the future human capital specific shock ε' and the aggregate shock z'.

Employed workers. Employed agents working in occupation k receive wage compensation net of taxes $(1-\tau)w^k(\varepsilon, z)$ for the unit labor supplied in the second half of the period. Wages are set by a static Nash-bargaining process and are explained in detail in the next section. At the end of the period, with a probability $\delta \in [0, 1]$, agents are separated from their jobs and become unemployed. Agents who are not separated may also lose their jobs if profits become negative, depending on the aggregate occupation shock z', the workers' occupation specific human capital shock ε', and the amount of retention policies provided ω. We denote $s^k(\varepsilon', h, z') \in \{0, 1\}$ as a policy function that is equal to 1 when the match is preserved and zero otherwise. The employed worker's value function in the second half of the period is characterized by:

$$\begin{aligned} V^k(\varepsilon, h, z) = u((1-\tau)w^k(\varepsilon, h)) + \beta \mathbb{E}\Big[&\delta W^0(\varepsilon', h, z') \\ &+(1-\delta)\left(s^k(\varepsilon', h, z')W^k(\varepsilon', h, z') + (1 - s^k(\varepsilon', h, z'))W^0(\varepsilon', h, z')\right)\Big], \end{aligned} \tag{3}$$

where $W^k(\varepsilon', h, z')$ represents the value function of an agent employed in occupation k in the first half of the following period.

Labor market. In the first half of the period, all agents enter the labor market. They maximize lifetime utility by choosing the occupation in which they will search for a job, given their employment status $j \in \mathcal{K} \cup \{0\}$, general human capital h, occupation specific human capital ε, and aggregate state z. The labor market value function in the first half of the period is characterized by

$$W^j(\varepsilon, h, z) = \underset{k \in \mathcal{K}}{\text{Max}} \left\{ \left(1 - p\left(\theta^k\left(\varepsilon, h, z\right)\right)\right) V^j(\varepsilon, h, z) + p\left(\theta^k(\varepsilon, h, z)\right) V^k(\varepsilon, h, z) \right\}, \tag{4}$$

where $p\left(\theta^k(\varepsilon, h, z)\right)$ represents the probability of finding a job in occupation $k \in \mathcal{K}$. We denote the optimal occupation choice $\hat{k}^j(\varepsilon, h, z)$ as

$$\hat{k}^j(\varepsilon, h, z) = \underset{k \in \mathcal{K}}{\arg\text{Max}} \left\{ \left(1 - p\left(\theta^k\left(\varepsilon, h, z\right)\right)\right) V^j(\varepsilon, h, z) + p\left(\theta^k(\varepsilon, h, z)\right) V^k(\varepsilon, h, z) \right\}. \tag{5}$$

Figure 1 below describes the model dynamics.

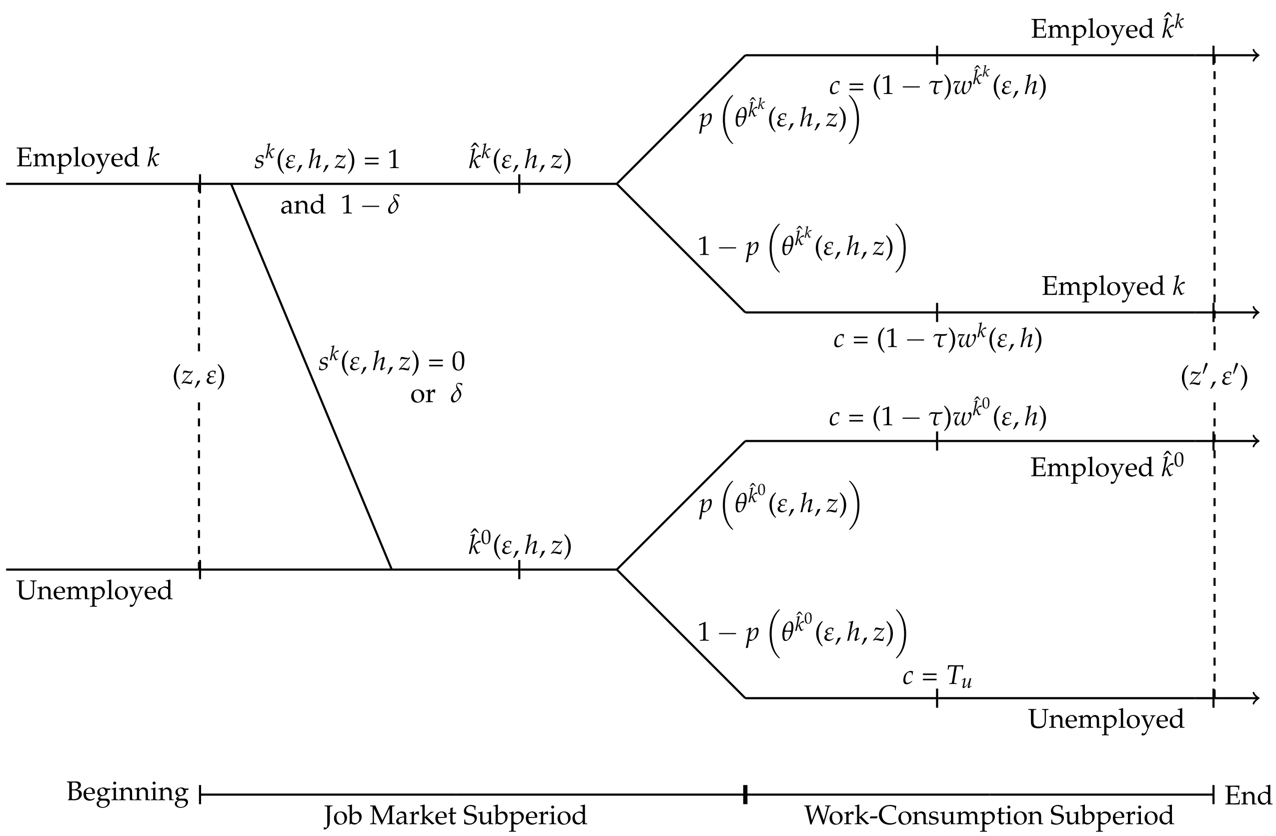


Figure 1: Timing

4.2 Firms

The firm's main objective is to maximize shareholders' dividends by posting vacancies and producing output.

Vacancy posting. To post a vacancy, a firm pays a fixed cost $\chi > 0$. If the match is successful, output is produced, and the firm receives a profit. If the match is unsuccessful, output is not produced. Hence, the firm's vacancy posting problem is characterized by

$$G^k(\varepsilon, h, z) = \underset{v \in \{0,1\}}{\text{Max}} \left\{ v \left(-\chi + q \left(\theta^k(\varepsilon, h, z) \right) J^k(\varepsilon, h, z) \right) + (1 - v)(0) \right\},$$

where v is an indicator function that is equal to 1 if a firm posts a vacancy and zero otherwise, $q\left(\theta^k(\varepsilon, h, z)\right)$ represents the probability of filling a vacancy, and $J^k(\varepsilon, h, z)$ is the expected value of a successful match. In equilibrium, the free-entry condition can be expressed as:

$$q \left(\theta^k(\varepsilon, h, z) \right) J^k(\varepsilon, h, z) \geq \chi, \tag{6}$$

where the constraint binds only when $q\left(\theta^k(\varepsilon, h, z)\right) > 0$. The free-entry condition also ensures that in equilibrium $G^k(\varepsilon, h, z) = 0$.

Matched firms. The firms' output is a function of the aggregate shock z^k, workers' productivity in occupation k ε^k, and workers' human capital h. The firm pays the worker a wage compensation $w^k(\varepsilon, h)$ negotiated through Nash bargaining in the period when the firm and the worker are matched. Matches are dissolved with an exogenous probability $\delta \in [0, 1]$. Matches can also be terminated if they stop being profitable, and retention policies are not sufficient to cover the loss $1 - \hat{s}^k(\varepsilon', h, z')$, or because the worker finds a new job in another occupation with a probability $p\left(\theta^{\hat{k}^k(\varepsilon', h, z')}(\varepsilon', h, z')\right)$. Finally, if the matched worker fails to find a new job via on-the-job search, then the firm and the worker continue to produce output. The value function of the matched firm is characterized by

$$\mathcal{J}^k(\varepsilon, h, z) = z^k \varepsilon^k h + r^k(\varepsilon, h, z) - w^k(\varepsilon, h) + \frac{1 - \delta}{1 + r} \mathbb{E} \left[\left(1 - p \left(\theta^{\hat{k}^k(\varepsilon', h, z')}(\varepsilon', h, z') \right) \right) \hat{s}^k(\varepsilon', h, z') J^k(\varepsilon', h, z') \right],$$

where $r^k(\varepsilon, h, z)$ represents the retention policy scheme. In equilibrium, the matched firm value function satisfies

$$J^k(\varepsilon, h, z) = \mathcal{J}^k(\varepsilon, h, z, r^k(\varepsilon, h, z), w^k(\varepsilon, h)). \tag{7}$$

where the equilibrium wages and retention schemes are characterized by $w^k(\varepsilon, h)$ and $r^k(\varepsilon, h, z)$, respectively.

Retention Policies We assume that the government provides perfectly targeted retention transfers $r^k(\varepsilon, h, z)$ to cover the wage bill of existing firms when an aggregate productivity shock causes firms to have negative profits. These transfers are perfectly targeted, and firms that receive them make zero profits after receiving the transfers. We assume that transfers are bounded by an upper limit T_r that restricts the amount of transfer that can be given to a firm, which can result in not all firms benefiting from the retention policy scheme. This upper limit may bind, leading some matches to be dissolved after a negative aggregate shock z. The retention transfer $r^k(\varepsilon, h, z)$ is characterized by

$$r^k(\varepsilon, h, z) = \begin{cases} w^k(\varepsilon, h) - z^k \varepsilon^k h & \text{if} \quad 0 < w^k(\varepsilon, h) - z^k \varepsilon^k h \leq T_r \\ 0 & \text{if} \quad e.o.c. \end{cases}$$

where $s^k(\varepsilon, h, z)$ indicates matches that are saved by the retention policy

$$s^k(\varepsilon, h, z) = \begin{cases} 1 & \text{if} \quad 0 < w^k(\varepsilon, h) - z^k \varepsilon^k h \leq T_r \\ 0 & \text{if} \quad e.o.c. \end{cases}.$$

For tractability, we abstract from adjustments on the intensive margin; in our model, hours per worker remain fixed, and the subsidy operates solely by preserving firm-worker matches.[11]

4.3 Wage bargaining

Matched agents and firms negotiate wages in a static Nash-bargaining framework. We assume a static Nash-bargaining approach to simplify the model estimation. Wages depend on the worker's occupation $k \in \mathcal{K}$, human capital h, occupation specific human capital ε, and average aggregate productivity $\bar{z}^k$.[12] Wages are negotiated only once and are kept fixed thereafter. We assume that agents bargain over their gross labor income, while firms bargain over their revenues free of retention transfers.[13] This leads to the following wage bargaining problem:

$$w^k(\varepsilon, h) = \arg \underset{w}{\text{Max}} \left\{ (w - T_u)^\gamma \left(\bar{z}^k \varepsilon^k h - w \right)^{1-\gamma} \right\},$$

[11]In many Short time work (STW) programs, the subsidy reimburses firms for hours not worked (e.g., Germany's Kurzarbeit), which causes both layoffs and hours to fall; see Hijzen and Venn (2011). Allowing hours to adjust would leave the extensive-margin mechanism intact but would spread the subsidy over a wider pool of workers.

[12]We assume that the wage depends on the average aggregate productivity instead of the current aggregate productivity to exemplify the stickiness in wages (Gertler et al. (2020)).

[13]These assumptions are made to simplify the modeling estimations, particularly the government budget constraint.

where $\gamma \in (0, 1)$ represents the agent's bargaining power. The solution to this problem sets equilibrium wages for each occupation k, human capital h, occupation specific human capital ε, and average aggregate shock $\bar{z}^k$ as

$$w^k(\varepsilon, h) = \gamma \bar{z}^k \varepsilon^k h + (1 - \gamma) T_u. \tag{8}$$

Because $\bar{z}^k$ is common to all matches in occupation k, the state space reduces to the triplet (k, h, ε); once the wage in (8) is negotiated, it remains fixed for the duration of the match.

4.4 Matching probabilities

The occupation matching technology is characterized by the function $M^k(s, v)$, where s represents the mass of agents searching for a job and v represents the mass of vacancies available. The market tightness is characterized by the ratio between vacancies posted by firms and agents searching for a job, $\theta \equiv \frac{v}{s}$. Markets are segmented. There is a market for every occupation k, human capital h, productivity deviations ε, and aggregate state z. Finally, the job finding and job filling probabilities, which are characterized respectively by $p(\cdot)$ and $q(\cdot)$, are

$$p\left(\theta^k(\varepsilon, h, z)\right) = M^k\left(1, \theta^k(\varepsilon, h, z)\right) \qquad \text{and} \qquad q\left(\theta^k(\varepsilon, h, z)\right) = M^k\left(\frac{1}{\theta^k(\varepsilon, h, z)}, 1\right).$$

We assume the following matching technologies represented by $M^k(s, v) = A^k M(s, v)$, where A^k represents the degree of matching efficiency in the market, and $M(s, v)$ represents a matching function that is homogeneous of degree one.

4.5 Population dynamics

The economy is populated by a distribution of agents with respect to their productivity portfolios across occupations. The population density corresponding to the productivity portfolio e is defined by $\mathcal{X}(e)$ where $\int_{e \in \mathbb{R}_+^k} \mathcal{X}(e) de = 1$. Let $\pi(\varepsilon)$ represent the probability density function of the deviation shock ε, so $\int_{\varepsilon \in \mathbb{R}_+^K} \pi(\varepsilon) d\varepsilon = 1$. We can define the population density for a given level of human capital h as $X(h) \equiv \int_{\varepsilon \in \mathbb{R}_+^K} \mathcal{X}(h\varepsilon) d\varepsilon$. Specifically, we can express the following relationship: $\mathcal{X}(h\varepsilon) = X(h)\pi(\varepsilon)$.

Define $x^j(h, z)$ as the share of the population in occupation/unemployment $j \in \mathcal{K} \cup \{0\}$, with human capital h, and aggregate state z. In addition, define $\hat{x}^j(h, z)$ as the share of the population in occupation/unemployment $j \in \mathcal{K} \cup \{0\}$, with human capital h, and aggregate state z in the following period. The aggregate shares must satisfy the following dynamics:

$$\hat{x}^0(h,z) = \underbrace{\sum_{j=1}^{K} \left(1 - \left[\int_{\varepsilon\in\mathcal{E}} \hat{s}^j(\varepsilon,h,z)\left(1 - p\left(\theta^{\hat{k}^0(\varepsilon,h,z)}(\varepsilon,h,z)\right)\right)\pi(\varepsilon)d\varepsilon\right](1-\delta)\right) x^j(h,z)}_{\text{Share of exogenous separation}} \quad (9)$$

$$+ \underbrace{\left(1 - \left[\int_{\varepsilon\in\mathcal{E}} p\left(\theta^{\hat{k}^0(\varepsilon,h,z)}(\varepsilon,h,z)\right)\pi(\varepsilon)d\varepsilon\right]\right) x^0(h,z)}_{\text{Share of unsuccessful matches}}$$

$$\hat{x}^k(h,z) = \underbrace{\left[\int_{\varepsilon\in\mathcal{E}} \left(1 - p\left(\theta^{\hat{k}^k(\varepsilon,h,z)}(\varepsilon,h,z)\right)\right)\hat{s}^k(\varepsilon,h,z)\pi(\varepsilon)d\varepsilon\right](1-\delta)x^k(h,z)}_{\text{Share of unsuccessful matches}} \quad (10)$$

$$+ \underbrace{\sum_{j=1}^{K}\left[\int_{\varepsilon\in\mathcal{E}} \mathcal{I}\left\{\hat{k}^j(\varepsilon,h,z)=k\right\} p\left(\theta^k(\varepsilon,h,z)\right)\hat{s}^j(\varepsilon,h,z)\pi(\varepsilon)d\varepsilon\right](1-\delta)x^j(h,z)}_{\text{Share of successful matches}}$$

$$+ \underbrace{\left[\int_{\varepsilon\in\mathcal{E}} \mathcal{I}\left\{\hat{k}^0(\varepsilon,h,z)=k\right\} p\left(\theta^k(\varepsilon,h,z)\right)\pi(\varepsilon)d\varepsilon\right] x^0(h,z)}_{\text{Share of unemployed matches}}$$

4.6 Government budget

The government collects labor income tax τ to finance its expenditures on unemployment insurance and retention policy transfers.

Unemployment Insurance. The total expenditure on unemployment insurance $\Phi_U(z)$ is given by

$$\Phi_U(z) = T_U\left(\sum_{j=1}^{K}\left[\int_{h\in\mathbb{R}_+}\left[\int_{\varepsilon\in\mathcal{E}}\left(1-(1-\delta)\hat{s}^j(\varepsilon,h,z)\right)\pi(\varepsilon)d\varepsilon\right]x^j(h,z)f(h)dh\right]\right. \quad (11)$$

$$\left. + \left[\int_{h\in\mathbb{R}_+}\left[\int_{\varepsilon\in\mathcal{E}}\left(1-p\left(\theta^{\hat{k}^0(\varepsilon,h,z)}(\varepsilon,h,z)\right)\right)\pi(\varepsilon)d\varepsilon\right]x^0(h,z)f(h)dh\right]\right).$$

Retention transfers. The total expenditure on retention transfers $\Phi_R^k(z)$ in occupation k is given by

$$\Phi_R^k(z) = \int_{h\in\mathbb{R}_+}\left[\int_{\varepsilon\in\mathcal{E}}\left(1-p\left(\theta^{\hat{k}^k(\varepsilon,h,z)}(\varepsilon,h,z)\right)\right)\hat{s}^k(\varepsilon,h,z)\hat{r}^k(\varepsilon,h,z)\pi(\varepsilon)d\varepsilon\right](1-\delta)x^k(h,z)f(h)dh. \quad (12)$$

Labor tax rate. The labor income tax is set such that the government budget constraint balances. Given the government expenditure on unemployment insurance (11) and retention policies (12), the labor income tax rate is given by

$$\tau(z) = \frac{\Phi_U(z) + \sum_{k=1}^{K} \Phi_R^k(z)}{\int_{h\in\mathbb{R}_+} \left[\int_{\varepsilon\in\mathcal{E}} \sum_{k=1}^{K} w^k(\varepsilon,h)d\varepsilon\right] \hat{x}^k(h,z)f(h)dh}. \tag{13}$$

4.7 Steady state equilibrium

Definition 1 (Stationary equilibrium) *A stationary recursive equilibrium is characterized by agents'value and policy functions* $\left\{V^k(\varepsilon,h,z), W^k(\varepsilon,h,z), \hat{k}^k(\varepsilon,h,z)\right\}$*, matched firms' value and policy functions* $\left\{G^k(\varepsilon,h,z), J^k(\varepsilon,h,z), r^k(\varepsilon,h,z), s(\varepsilon,h,z)\right\}$*, the labor market tightness schedule* $\left\{\theta^k(\varepsilon,h,z)\right\}$*, the wages schedule* $\left\{w^k(\varepsilon,h)\right\}$*, the labor tax rate schedule* $\{\tau(z)\}$*, and population density distributions* $\left\{\hat{x}^k(h,z)\right\}$ *such that*

1. *Given the labor market tightness* $\left\{\theta^k(\varepsilon,h,z)\right\}$*, the wages schedule* $\left\{w^k(\varepsilon,h)\right\}$*, and the tax schedule* $\{\tau(z)\}$*, the agents' policy functions* $\left\{V^k(\varepsilon,z), W^k(\varepsilon,z), \hat{k}^k(\varepsilon,z)\right\}$ *solve* (2), (3), *and* (5).
2. *Given the firms' policy functions* $\left\{G^k(\varepsilon,z), J^k(\varepsilon,h,z), r^k(\varepsilon,h,z), s(\varepsilon,h,z)\right\}$*, the labor market tightness schedule* $\left\{\theta^k(\varepsilon,z)\right\}$ *satisfies the free-entry condition* (6).
3. *Given the population density distributions* $\left\{\hat{x}^k(h,z)\right\}$ *and the wages schedule* $\left\{w^k(\varepsilon,z)\right\}$*, the labor income tax schedule* $\{\tau(z)\}$ *balances the government budget* (13).
4. *Given the occupation policy function* $\left\{\hat{k}^k(\varepsilon,h,z)\right\}$*, the population density distributions* $\left\{\hat{x}^k(h,z)\right\}$ *satisfy* (9) *and* (10).
5. *The distribution of workers across occupations* $j \in \mathcal{K} \cup \{0\}$ *is stationary:* $\hat{x}^j(h,z) = x^j(h,z)$

5 Theoretical analysis

This section distills three closed-form results that underpin our quantitative findings. Retention transfers (i) save more matches in deeper recessions, (ii) rescue disproportionately low-productivity matches, and (iii) yield larger gains in occupations that are hit harder by the shock. All proofs, algebra, and additional figures are relegated to Annex A.

We begin by imposing a set of simplifying assumptions that delivers a tractable, closed-form characterization of the policy's effects in partial equilibrium. In particular, we model the occupation-specific disturbance as an unanticipated multiplicative (proportional) shock to average match productivity in occupation k. Let $\bar{z}^k$ denote the pre-shock occupation-specific productivity parameter. Following the shock, effective productivity becomes

$$z^k = (1 - \phi^k)\,\bar{z}^k, \tag{14}$$

where ϕ^k indexes the *severity* of the occupation-level contraction. Hence, $\phi^k = 0$ corresponds to no disruption, while larger values of ϕ^k proportionally shift down the productivity of all matches in occupation k.

We restrict the support of ϕ^k to ensure that (i) post-shock productivity remains non-negative, and (ii) even the lowest-human-capital matches—given the lower bound $H_0 > 0$—remain in a parameter region where the retention decision is well-defined and interior. Formally, we assume

$$\phi^k \in \Big[0,\ (1-\gamma)\Big(1 - \frac{T_u}{\bar{z}^k H_0}\Big)\Big], \tag{15}$$

so that the shock cannot be so large that the post-shock surplus becomes mechanically negative for all matches in the occupation (or that the relevant policy thresholds collapse). This restriction is purely technical: it rules out degenerate cases in which retention is never privately or socially feasible, regardless of match quality, thereby preserving the closed-form structure used in this section.

Finally, we abstract from general-equilibrium feedback through vacancy posting and match creation. That is, we treat the distribution of matches and the inflow of new matches as fixed when the shock hits. This isolates the direct effect of an *unexpected activation or intensification of retention schemes* on the continuation and separation margins within existing matches while holding constant equilibrium tightness and creation incentives.

Assumption 1 *(i) Worker human capital is bounded below by* $H_0 > 0$. *(ii) Occupation-specific productivity is* $z^k = (1-\phi^k)\bar{z}^k$ *with shock* $\phi^k \in [0, (1-\gamma)(1 - T_u/(\bar{z}^k H_0))]$. *(iii) The density of matches over occupation-specific human capital* ε^k *is uniform.*

We can now rewrite firms' profits, $I^k(\varepsilon, h, z)$, as a function of the percentage deviation shock ϕ^k under static Nash-bargaining:

$$I^k(\varepsilon, h, z) \equiv z^k \varepsilon^k h - w^k(\varepsilon, h) = (1-\gamma)\left(\left(1 - \frac{\phi^k}{1-\gamma}\right)\bar{z}^k \varepsilon^k h - T_u\right).$$

The expression above shows that the firms'profits are increasing in workers' human capital h and workers' occupation-specific human capital ε^k, and are decreasing in the shock ϕ^k.

Firms' profit maximization implies a cut-off rule in ε^k given by

$$\bar{\varepsilon}^k\left(h,\phi^k\right) \equiv \left(\frac{1}{1-\frac{\phi^k}{1-\gamma}}\right)\frac{T_u}{\bar{z}^k h}, \tag{16}$$

such that firms' profits are zero at the cutoff. Matches with specific human capital ε^k below $\bar{\varepsilon}^k$ receive negative profits, while matches with specific human capital ε^k above $\bar{\varepsilon}^k$ receive positive profits. The profit function is displayed in Figure 2(a).

To build intuition, we start our comparative statistics by studying the implications of a recession in an economy with arbitrary human capital h and average aggregate productivity $\phi^k = 0$. We denote $\bar{\varepsilon}_0^k$ as the profit cut-off when $\phi^k = 0$. We assume a negative shock hits this economy, $\phi^k > 0$. This negative shock impacts firms' profits by changing the slope of the profit function, shifting the cut-off from $\bar{\varepsilon}_0^k$ to $\bar{\varepsilon}_1^k$, leading to matches between $\bar{\varepsilon}_0^k$ and $\bar{\varepsilon}_1^k$ that have negative profits. As a result, the matches between $\bar{\varepsilon}_0^k$ and $\bar{\varepsilon}_1^k$ are lost after the negative shock, as illustrated in Figure 2(a).

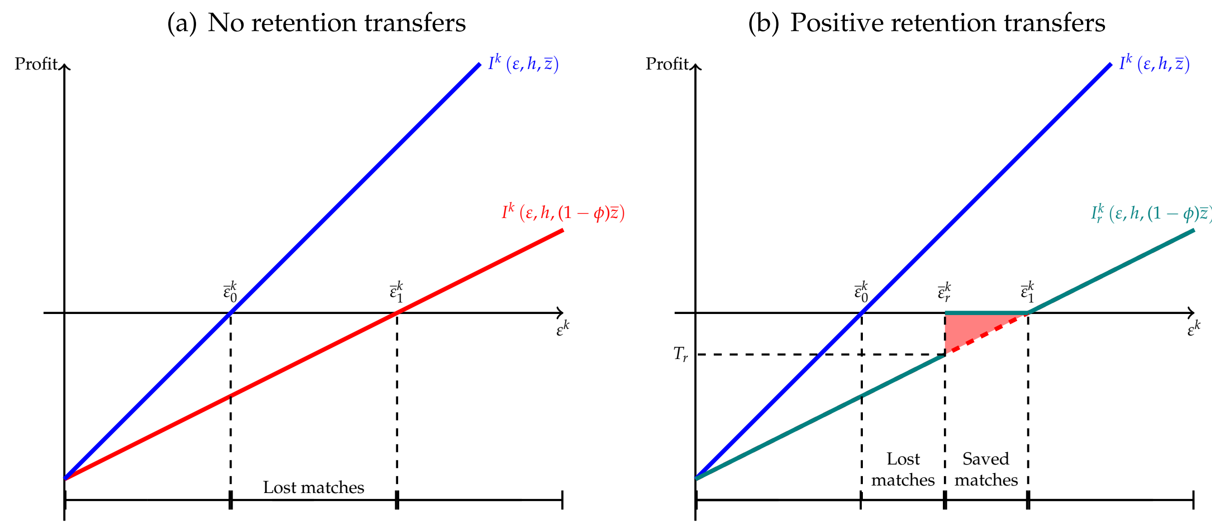


Figure 2: Retention policy transfers effectiveness diagram

Note: Panel 2(a) shows firms' profit and the impact of a negative shock $\phi^k > 0$. The area between $\bar{\varepsilon}_1^k$ and $\bar{\varepsilon}_0^k$ indicates the lost matches due to the negative aggregate shock. Panel 2(b) shows the same negative impact as in Panel 2(a) in an economy where retention policies are used. In this economy, the matches between $\bar{\varepsilon}_1^k$ and $\bar{\varepsilon}_r^k$ are lost, while the matches between $\bar{\varepsilon}_r^k$ and $\bar{\varepsilon}_0^k$ are saved because of the retention policy transfer. The shaded area represents the government's expenditure in retention transfers.

We now introduce the use of retention policies in this framework. Retention policies can reduce the impact of negative aggregate shocks by subsidizing firms' wages and preventing them from incurring negative profits. We assume that retention policies are targeted but bounded: firms receive enough transfers to cover their wage bill up to the upper limit $T_r > 0$.

When the government uses retention policies, firms' profits are given by

$$I_r^k(\varepsilon, h, z) = \begin{cases} z^k \varepsilon^k h - w^k(\varepsilon, h) & \text{if } z^k \varepsilon^k h - w^k(\varepsilon, h) \geq 0 \\ 0 & \text{if } z^k \varepsilon^k h - w^k(\varepsilon, h) < 0 \text{ and } z^k \varepsilon^k h - w^k(\varepsilon, h) + T_r \geq 0 \\ z^k \varepsilon^k h - w^k(\varepsilon, h) & \text{if } z^k \varepsilon^k h - w^k(\varepsilon, h) + T_r < 0. \end{cases}$$

When the government uses a retention policy, firms' profits become zero in the region where the retention policy transfer is enough to guaranty zero profit, and the required transfers are below the threshold $T_r > 0$. The use of a retention policy also alters the firms' cut-off in the region where retention policies are implemented. The new cut-off under retention policies $\bar{\varepsilon}_r^k$ is given by

$$\bar{\varepsilon}_r^k \left(h, \phi^k\right) \equiv \left(\frac{1}{1 - \frac{\phi^k}{1-\gamma}}\right) \frac{T_u - \frac{T_r}{1-\gamma}}{\bar{z}^k h}. \tag{17}$$

The use of retention policies reduces the cut-off $\bar{\varepsilon}_r^k$ relative to the cut-off when retention policies are absent $\bar{\varepsilon}_1^k$. In Figure 2(b), we illustrate how retention policies impact firms' profits after a negative shock. Only matches where the occupation-specific human capital is between $\bar{\varepsilon}_0^k$ and $\bar{\varepsilon}_r^k$ are lost due to the negative shock. Matches between $\bar{\varepsilon}_r^k$ and $\bar{\varepsilon}_1^k$ are saved by ensuring non-negative profits due to the retention policy transfers from the government. The measure of saved firms' matches can be expressed as the distance between $\bar{\varepsilon}_r^k$ and $\bar{\varepsilon}_1^k$, since we assume that the human-capital-specific productivity is uniformly distributed:

$$\bar{\varepsilon}_1^k(h, \phi^k) - \bar{\varepsilon}_r^k(h, \phi^k) = \frac{T_r}{((1-\gamma) - \phi^k)\bar{z}^k h}. \tag{18}$$

This measure is increasing in response to the negative shock ϕ^k, implying that for the same retention policy limit T_r, more matches will be saved as the recession deepens. This measure is also decreasing with respect to human capital h, implying that the retention policy saves matches with lower levels of human capital. We formalize these results in Lemma 1.

Lemma 1 (Effectiveness across productivity) *Under Assumption 1 and a fixed maximum retention policy transfer, a retention policy scheme saves more firms' matches, the deeper the recession within an occupation k and human capital h.*

Lemma 1 states that a retention policy scheme saves more matches from being dissolved when recessions are more severe. Figure 3 illustrates this mechanism. We start with an arbitrary recession $\phi_1^k > 0$ displayed in Panel 3(a). Under a deeper recession $\phi_2^k > \phi_1^k$, the firms' profit function $I^k_r(\varepsilon, h, z)$ becomes flatter, shifting thresholds $\bar{\varepsilon}^k_r$ and $\bar{\varepsilon}^k_1$ to the right, thus increasing the shaded area of saved matches. A similar graphic representation also shows that for a given occupation k, lower human capital levels flatten the profit function, leading retention policies to save more matches. In addition, Lemma 1 states that a retention policy scheme is more effective in safeguarding the matches of low productive firms within a specific human capital h and occupation k. The intuition behind this result relies on the fact that firms' profits are increasing in human capital h.

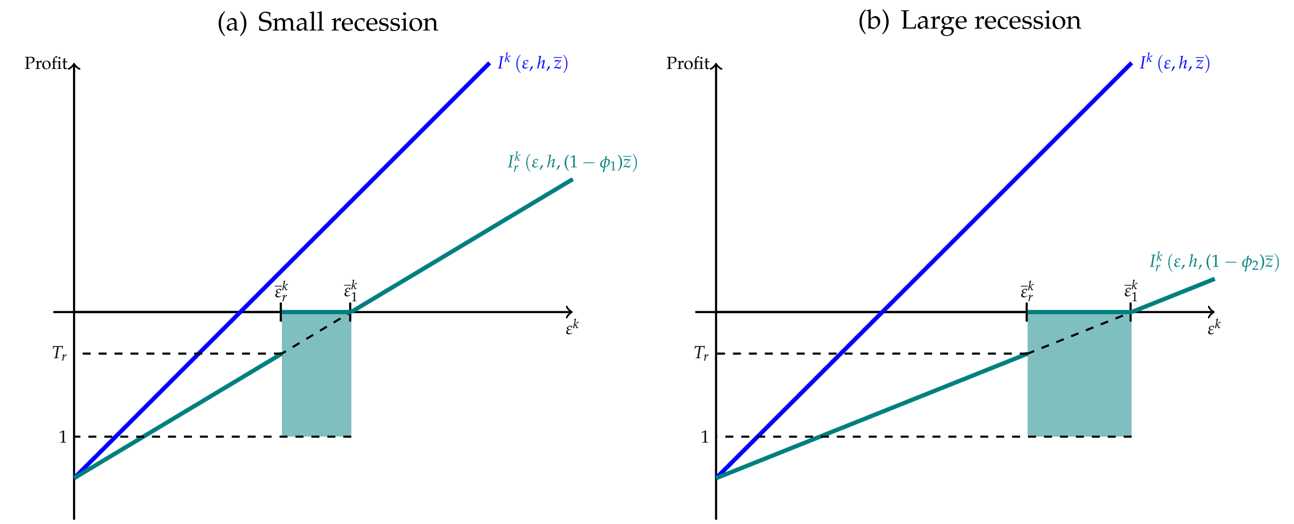


Figure 3: Retention policy transfers effectiveness under different recession degrees

Note: Both panels use a positive maximum retention policy transfer $T_r > 0$ and focus on a specific human capital h and occupation k. Panel 3(a) shows the impact on firms' profitability and the measure of saved matches under an arbitrary negative shock $\phi^k_1 > 0$. Panel 3(b) shows the same under a deeper negative shock $\phi^k_2 > \phi_1$. In both economies, the region between $\bar{\varepsilon}^k_r$ and $\bar{\varepsilon}^k_1$ depict the measure of saved matches. The shaded area represents the mass of saved matches due to the retention policy scheme.

We can also measure the government's expenditure-per-firm in retention policy transfers, which is the shaded triangular area displayed in Figure 2(b). This area represents the necessary transfers to ensure zero-profits for those firms that experience negative profits due to the aggregate shock and do not exceed the maximum retention policy transfer.

We conclude the analysis of the retention policy scheme by aggregating the effects studied in Lemma 1 across human capital h and occupations k in Proposition 1, leaving the formal proof to Annex A.

Proposition 1 (Retention transfers effectiveness) *Under Assumptions 1 and given a fixed maximum retention policy transfer $T_r > 0$, the following statements hold:*

i) A retention policy scheme saves more matches the deeper the recession, where a deeper recession is defined as a recession where $\phi^{k'}_1 > \phi^{k'}_2$ and $\phi^k_1 = \phi^k_2$ for all $k \neq k'$.

ii) If the human capital distribution is non-increasing, then a retention policy scheme saves more low-productive matches.

iii) If average productivity is the same across occupations ($\bar{z}^k = \bar{z}$), then a retention policy scheme saves more matches in occupations that are more severely impacted by the recession.

Proposition 1 captures our model's three main theoretical results. The first result compares two different recessions, differing only in their magnitude. We find that a retention policy scheme saves more matches when a recession impacts every occupation more severely. We obtain this result by aggregating the first part of Lemma 1 across human capital h and occupations k. Figure 4 illustrates this mechanism for one occupation. We start by graphing the thresholds $\bar{\varepsilon}_1^k$ and $\bar{\varepsilon}_r^k$ as a function of human capital h under an arbitrary recession $\phi_1^k > 0$. Panel 4(a) shows these curves. The shaded region represents the measure of matches saved by the retention policy transfers.

When a deeper recession is considered $\phi_2^k \geq \phi_1^k$, based on the first part of Lemma 1, we know that for every single unit of human capital h, the thresholds $\bar{\varepsilon}_1^k$ and $\bar{\varepsilon}_r^k$ shift upwards, increasing the measure of saved matches, as Panel 4(b) shows. Because every occupation experiences a deeper recession, we can assert that more matches survive under the same retention policy scheme.

The second result states that if the human capital distribution is non-increasing, then a retention policy scheme saves more low-productive matches. The assumption that the human capital distribution is non-increasing implies that the matches' mass is homogeneous or concentrated at low levels of human capital. Under this assumption and aggregating the second part of Lemma 1 across human capital h deliveries that the largest gains from the retention policy transfers are at the low levels of human capital because they receive more transfers and have a higher mass. Thus, a retention policy scheme saves more low-productive matches.

The last result compares occupations under an asymmetric recession. We find that a retention policy scheme saves more matches if the occupation experiences a deeper recession. The intuition behind this result is identical to the first one because occupations share the same average productivity among themselves. Figure 4 also illustrates the mechanism by comparing two different occupations under an asymmetric recession. Panel 4(a) represents the least affected occupation, and Panel 4(b) represents the most affected occupation during the recession. Following the previous line of thought, we can assert that occupations that experience deeper recessions benefit the most from a retention policy scheme. Lastly, we show that under some assumptions, a retention policy scheme reduces the government deficit.

Proposition 2 (Retention transfers efficiency) *Under Assumptions 1 and a recession $\phi > 0$, such that each occupation k contraction is below $(1-\gamma)\left(1 - \frac{T_u}{\bar{z}^k H_0}\right)$; a retention policy transfer scheme reduces the public deficit unequivocally if $T_r \leq 2T_u$.*

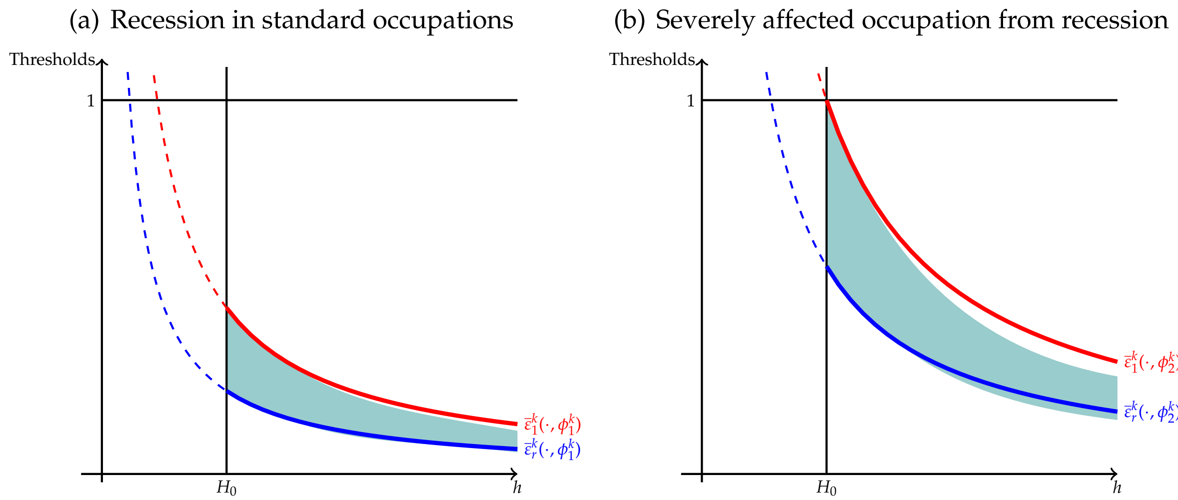


Figure 4: Retention policy transfers effectiveness across different levels of human capital

Note: Both panels use a positive maximum retention policy transfer $T_r > 0$. The human capital $H_0 > 0$ represent the lower bound of the density support. We show arbitrary productivity shocks ϕ_2^k and ϕ_1^k such that $\phi_1^k < \phi_2^k$. Panel 4(a) shows the low recession ϕ_1^k and Panel 4(b) shows the high recession ϕ_2^k. Both panels show the workers' occupation-specific thresholds as a function of human capital. The shaded area captures the measure of saved matches due to the retention policy scheme.

We leave the formal proof to Annex A.

6 Quantitative analysis

In this section, we calibrate the model in Section 4 to the U.K. economy around the Global Financial Crisis and the European debt crisis. The calibration targets a set of labor-market and fiscal moments in the data, reported in Table 6: the pre-GFC and GFC unemployment rates, the routine-employment share, the unemployment-benefits-to-GDP ratio, and the cross-sectional distribution and volatility of normalized labor income. We then use the calibrated model to conduct counterfactual policy experiments that quantify the aggregate and welfare effects of introducing a retention policy scheme.

6.1 Calibration

In the model, every period is one year. We narrow the variety of occupations to focus on only two main occupations: Routine (R) and Non-routine (N).[14] Hence, we fix $\mathcal{K} = \{R, N\}$.

[14] We follow Carrillo-Tudela et al. (2016) in defining routine and non-routine occupations. Using ISCO-08 at the 1-digit level, (i) managers, (ii) professionals, and (iii) technicians and associate professionals are defined as non-routine occupations (N), while the remaining occupations: (iv) clerical support workers, (v) service and sales workers,(vi) skilled agricultural, forestry, and fishery workers, (vii) craft and related trade workers, (viii) plant and machine operators and assemblers, and (ix) elementary occupations-are defined as routine occupations (R).

Aggregate state. We start by characterizing the model's evolution of the exogenous aggregate state. The aggregate state is a two-dimensional vector representing the aggregate productivity in the R and N occupations. For simplicity, we assume that aggregate productivity in both occupations is independent of each other and evolves according to an $AR(1)$ process as

$$\ln\left(z^{k\prime}\right) = (1-\rho^k)\ln\left(\bar{z}^k\right) + \rho\ln\left(z^k\right) + \sigma^k\varepsilon,$$

where $\varepsilon \sim \mathcal{N}(0,1)$, the shock persistency is $\rho^k \in (0,1)$, the steady state productivity level is $\bar{z}^k$, and the shock variance is occupation specific $\sigma^k > 0$. To obtain labor productivity, we use quarterly series of industry breakdowns of gross value added and total hours worked from 2000 to 2019 from Eurostat. Since labor productivity measures are only available by industry and not by occupation, we classify industries with more than half of workers belonging to a routine (non-routine) occupation as routine (non-routine) and aggregate up labor productivity for routine (non-routine) occupations.[15] We find that the persistency of shocks in the routine occupation lasts longer than in the non-routine occupation, $\rho^R = 0.42$ and $\rho^N = 0.37$. In addition, the shocks are more volatile in the routine occupation compared to the non-routine occupations, $\sigma^R = 0.015$ and $\sigma^N = 0.008$.

Agents preferences. We assume that agents have a CES utility function expressed in the following manner:

$$u(c) = \frac{c^{1-\alpha}}{1-\alpha},$$

where $\frac{1}{\alpha} > 0$ represents the intertemporal elasticity of substitution. We assume a standard and conservative value of $\alpha = 2$, which is a standard value in the literature.

Labor market. We assume a commonly used matching function proposed in Menzio and Shi (2010) because it yields well-defined job finding probabilities.

$$M(s,v) \equiv \frac{sv}{\left(s^\nu + v^\nu\right)^{1/\nu}},$$

[15]We classify (i) agriculture, forestry, and fishing (A), (ii) industry (except construction) (B), (iii) manufacturing (C), (iv) construction (F), and (v) wholesale and retail trade, transport, accommodation, and food service activities (G+H+I), and (vi) arts, entertainment, and recreation, other service activities, and activities of households and extra territorial organizations and bodies (R+S+T+U) as routine sectors, while all other sectors, (i) information and communication (J), (ii) financial and insurance activities (K), (iii) real estate activities (L), (iv) professional, scientific, and technical activities; administrative and support service activities (M+N), and (v) public administration, defense, education, human health, and social work activities (O+P+Q) are classified as non-routine sectors.

The matching elasticity parameter of the matching function is set to $\nu = 1.6$ as estimated in Schaal (2012). We set the bargaining power for agents to $\gamma = 0.70$, a level similar to Shimer (2005).

Agents productivity. We decompose the agents productivity portfolio $e \in \mathbb{R}_+^K$ into a human capital component $h = ||e||_2$ and an occupational advantage component $\varepsilon = e/||e||_2$. We assume that the human capital density is Beta distributed $h \sim B(\alpha_h^B, \beta_h^B)$. We calibrate this distribution to target the mean and the standard deviation of the labor income distribution in the data in the steady state. The labor income distribution data to be targeted is from the European Union Statistics on Income and Living Conditions (EU-SILC), with the sample restricted to the UK and the period from 2005 to 2016.[16] The empirical normalized labor income distribution has values of 0.11, 0.36, 0.82, 1.39, and 2.0 for the 10th, 25th, 50th, 75th, and 90th percentiles, with a standard deviation of 0.874. The resulting human capital distribution mean and standard deviation are 0.565 and 0.108, respectively. Exploiting the assumption of only two occupations, the occupational advantage component can be expressed as $\varepsilon = [\sqrt{0.5 + \tilde{\varepsilon}}, \sqrt{0.5 - \tilde{\varepsilon}}]$, where we assume $\tilde{\varepsilon} \sim \overline{N}(0, \sigma_\varepsilon; 0.5)$ is distributed under a Truncated Normal distribution. We calibrate the standard deviation to target the volatility.

Exogenous Parameter. We describe the exogenous parameters in Table 5. In addition, in the benchmark economy, we set the retention policy transfers equal to zero because these transfers were almost negligible in the U.K. prior to the global financial crisis.[17] We set the interest rate to 4 percent, corresponding to the annual long-run United Kingdom government bonds rate amidst the global financial crisis. The discount rate parameter is the inverse of the gross annual interest rate. We choose a conservative value for the risk aversion parameter widely used in the literature.

Endogenous Parameter. We calibrate the rest of the parameters to match key moments from the U.K. data during the global financial crisis. We normalize the routine steady-state productivity to be equal to 1, and we calibrate the non-routine steady-state productivity to match the

[16]We calculate the real annual earnings adjusted for inflation (constant 2015 Euro dollars).

[17]Based on OECD labor market policies data, we define retention policies as the spending on (i) benefits administration (12), (ii) workplace training (22), (iii) apprenticeship (24), (iv) employment incentives for maintenance (keeping jobs) (42), (v) partial unemployment benefits (82), and (vi) part-time unemployment benefits (83). Reallocation policies include (i) placement administration (11), (ii) institutional training (21), (iii) integrated training (23), (iv) employment incentives for recruitment (hiring) (41), (v) direct job creation (60), (vi) start-up incentives (70), and (vii) early retirement (90), where the numbers in parentheses show the corresponding item numbers in the database. For the UK, the retention policy ranged between 0.06 percent of GDP from 2004 to 2006.

Table 5: United Kingdom Key Parameter Values

Parameter	Value	Source
T_r	0.000	Baseline
$\overline{z}^R$	1.000	Normalization
r	0.010	Long-run UK government bonds rate
α	2.000	Conservative intertemporal elasticity of substitution
β	0.960	Gross interest rates inverse
γ	0.700	Shimer (2005)
ν	1.600	Schaal (2012)
ρ^R	0.422	Aggregate routine AR(1) process
σ^R	0.015	Aggregate routine AR(1) process
ρ^N	0.366	Aggregate non-routine AR(1) process
σ^N	0.008	Aggregate non-routine AR(1) process
$\overline{z}^N$	0.955	Routine employment share
T_u	0.155	Unemployment benefits transfers-GDP ratio
δ	0.010	Conservative exogenous separation rate
χ	0.001	Unemployment rate during GFC
α_h^B	7.255	Labor income mean distribution
β_h^B	4.855	Labor income dispersion distribution
σ_ε	0.355	Labor income volatility

employment in the routine occupation as a share of total employment.[18] The unemployment insurance transfer is calibrated to match the unemployment benefits-over-GDP ratio found in the data before the global financial crisis.[19] The separation rate, $\delta = 0.010$, matches the average unemployment rate prior to the global financial crisis, and the vacancy cost, $\chi = 0.085$, corresponds to the increase in the unemployment rate during the global financial crisis.

The calibrated model reproduces the key labor-market aggregates for the United Kingdom with considerable accuracy (Table 6). It matches the pre-crisis unemployment rate (5.1 percent in the data, 5.2 percent in the model), the crisis peak (7.2 versus 6.9 percent), and the routine-employment share (55.3 versus 54.7 percent). It also captures the small scale of unemployment-benefit spending relative to GDP. Earnings moments are less exact. Because labour income is generated by only two occupations and a Beta-distributed stock of general human capital, the simulated percentile profile is flatter than in EU-SILC, and the associated volatility (0.78) falls short of the empirical 0.87. Allowing for more within-occupation wage heterogeneity would close these gaps but would not alter our policy conclusions: the welfare effect of the retention subsidy hinges on (i) the relative earnings loss after separation, which

[18] In the UK between 2006 and 2015, the share of routine occupations is 55.3 percent based on EU-SILC data.

[19] We use the OECD Labor Market Policies database to obtain labor market policy spending as a percentage of GDP. Specifically, for the UK, the unemployment insurance spending as a percentage of GDP pre-GFC (2004-2006) is 0.17% of GDP.

the model captures, and (ii) employment dynamics, which are matched closely.

Table 6: United Kingdom data and model statistics targets

Parameter	Data	Model
Routine employment share	0.553	0.547
Unemployment benefits-GDP ratio	0.002	0.002
Unemployment rate before GFC	0.051	0.052
Unemployment rate during GFC	0.072	0.069
Labor income normalized percentiles	0.01/0.04/0.09/0.15/0.22	0.08/0.14/0.21/0.27/0.34
Volatility normalized labor income	0.874	0.779

6.2 Quantitative Results

In this section, we quantify the benefits of the retention policy scheme. We proceed in three steps. The first step involves an analysis of the benchmark economy in the absence of the retention policy schemes. Second, a retention policy scheme is introduced, allowing for comparative statistics between these two economies. A welfare analysis is performed to quantify the potential benefits of introducing a retention policy scheme. Lastly, a series of robustness checks are conducted regarding the length of the shock, the policy coverage, and the costs associated with implementation.

Under all scenarios, an asymmetric negative shock in the productivity of both occupations is considered. The shock replicates the U.K. experience amidst the global financial crisis and the European Debt Crisis when unemployment hit record-high levels in 2011. In this episode, routine occupations experienced a deeper contraction in employment than non-routine occupations, at 6.9 and 2.4 percentage points, respectively.[20] The shock lasts for one period, and after that, productivity in both occupations returns to their average levels. Lastly, we assume that the transition back to the steady state lasts for 10 periods overall.

The negative aggregate shock leads to an increase in government spending on unemployment insurance and a decline in the collection of labor income tax revenues. To keep the government inter-temporal budget constraint satisfied, we allow the government to issue public debt, which is financed with a non-distortionary fixed lump-sum tax imposed on all agents during each period of the transition. We keep the labor income tax rates fixed.[21]

[20] In Annex A, Figure 11 illustrates the dynamics of U.K. employment in routine and non-routine occupations from 2005 to 2016. The figure demonstrates that the 2008 financial crisis accelerated the pre-existing trend of declining routine jobs; However, this decline was significantly more pronounced during the crisis. Following the crisis, routine job employment rebounded, although it stabilized at levels lower than those observed prior to the crisis

[21] As in the baseline experiment, we fix the number of periods back to the steady state. The transition consists of 10 periods, representing 2 years and 6 months.

6.3 Baseline

This analysis commences with an examination of the effects of a negative aggregate shock on unemployment within the baseline economy. Specifically, a negative productivity shock diminishes firms productivity. Consequently, for a subset of firms, continued production becomes economically unfeasible since wages are fixed and firms are not allowed to borrow. This leads to the dissolution of unprofitable firm-worker matches, thereby resulting in increased unemployment.

After the shock, the unemployment rate increased by 1.6 percentage points, as illustrated in Figure 5(a). Unemployment is driven by a decline in the share of workers in routine occupations, which were hit harder by the shock. The share of workers in routine occupations fell by almost two percentage points. Employment in non-routine occupations increased by less than one percentage point because some unemployed and employed workers were able to find jobs in non-routine occupations. This result is driven by agentsâ expectations about the persistence of the shock. Workers with high levels of human capital in routine and non-routine occupations move to non-routine occupations because of the asymmetric nature of the shock.

6.4 Retention Policies

We now turn to the application of retention policies. The policy under consideration aims to retain half of the otherwise lost matches after the negative aggregate shock. This objective is achieved by setting the maximum retention transfer. The retention policy subsidizes the wages of workers in matches that become unprofitable. As a result, firms become indifferent between firing workers and not firing them. As shown in Figure 5(a), the policy mitigates the impact of the aggregate shock on unemployment, which rises by 0.8 percentage points when the retention policy is in place (instead of 1.6 percentage points under the baseline). In addition, the decline in unemployment reduces the reallocation across occupations relative to the baseline. Employment in routine occupations falls by 1.5 percentage points instead of 2 percentage points in the baseline, and employment in non-routine occupations rises by 0.8 percentage points instead of 0.5 percentage points in the baseline.

In summary, the retention policy scheme changes employment dynamics in three ways. First, the retention policy reduces the spike in the unemployment rate. Second, the transition back to the steady state speeds up because fewer workers end up unemployed. Third, the retention policy transfer reduces the change in occupation switches from routine to non-routine occupations. All three of these factors are key in reducing the economic cost of the recession.

We continue our analysis by studying the fiscal costs associated with the retention policy scheme. Three key drivers of the fiscal costs are: i) the costs associated with unemployment

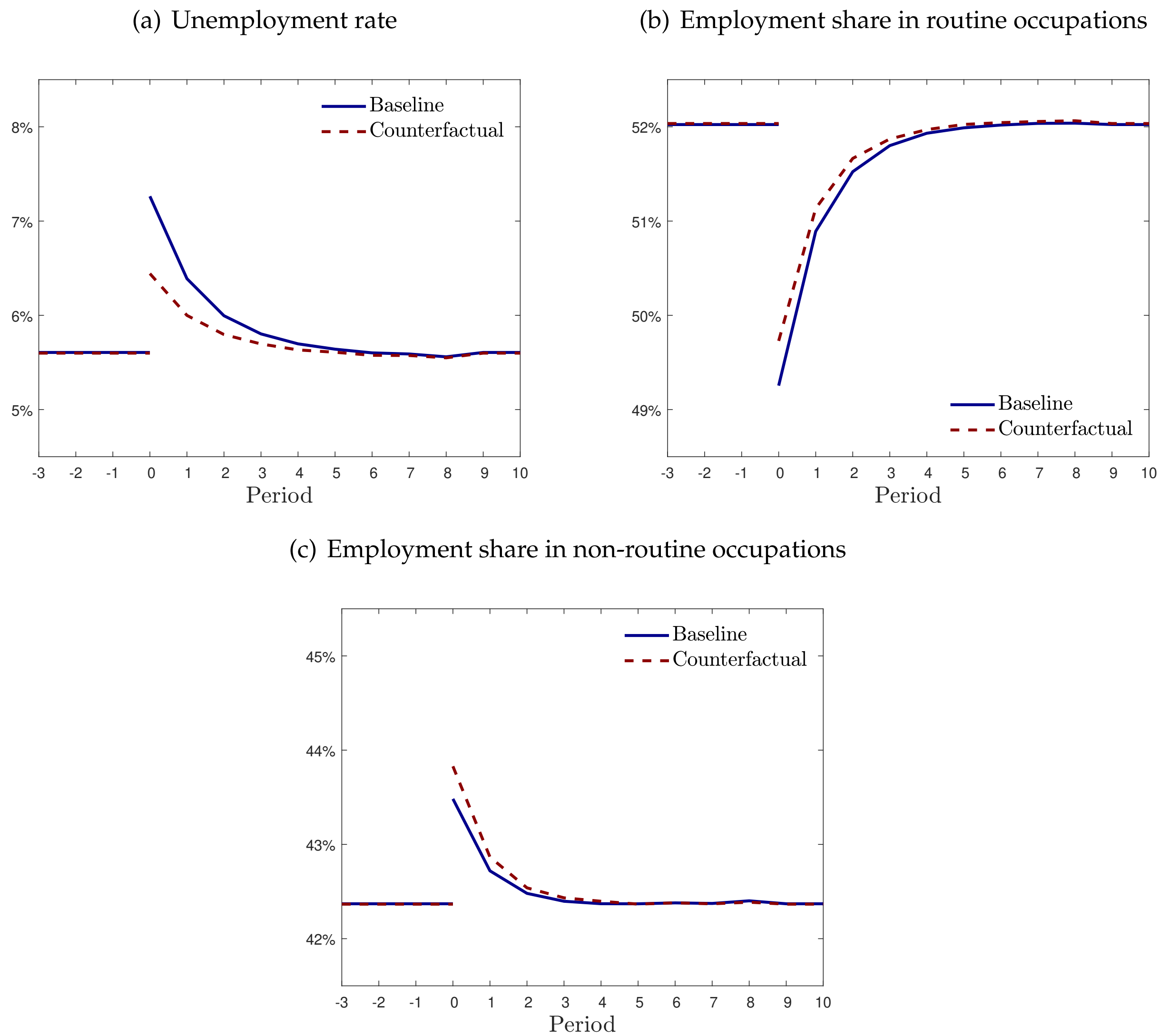


Figure 5: Population shares transitions after a negative shock

Note: The x-axis represents the periods of the model. We assume the negative productive shock happens in period 0 and take ten periods to return to the steady state. Periods before the shock is the stationary equilibrium. The y-axis represents the population share in unemployment or employed in routine and non-routine occupations. The solid blue line represents the baseline model, and the red dashed line represents the model with retention policy transfers.

benefits; ii) labor tax revenues; and iii) the transfers provided by the retention policy scheme. We plot the fiscal deficits under the retention policy scheme relative to the baseline in Figure 6. Panel 6(a) shows the relative fiscal deficit measured as a percentage of GDP. Panel 6(b) shows the relative government spending on unemployment insurance as a percentage of GDP. and 6(d) shows the government relative spending on retention policy transfers as a percentage of GDP.

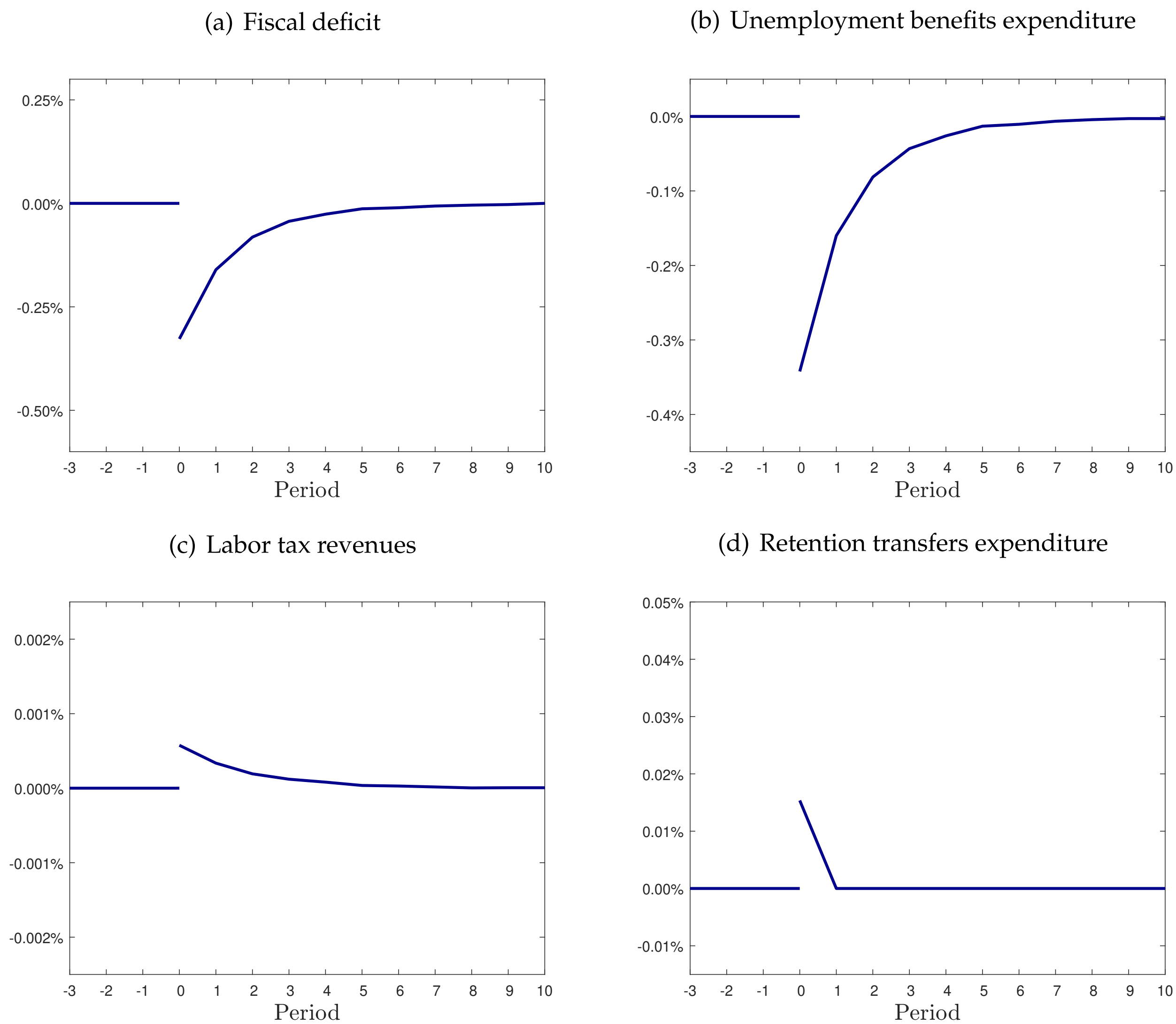


Figure 6: Government fiscal budget decomposition and transition relative to the baseline

Note: The x-axis represents the periods of the model. We assume the negative productive shock happens in period 0 and take ten periods to return to the steady state. Periods before the shock represent the stationary equilibrium. The y-axis represents the expenditures and revenues of the fiscal budget as a percentage of GDP in the model with retention policy scheme relative to the baseline model.

The implementation of a retention policy scheme reduces the number of unemployed workers, leading to a decline in government expenditure on unemployment benefits; the unemployment insurance spending decreases from 2.7% of GDP in the baseline economy to 2.4% in the economy with retention policy schemes, resulting in a decrease of 0.3% in government spending in the model with the retention scheme. In addition, the higher employment levels in the economy with the retention policy scheme mean that government revenue from labor income tax is also larger than in the economy without it. However, the policy comes with a small fiscal cost of almost 0.02% of GDP compared to the 0.3% savings in unemployment insurance.

In the baseline model, the fiscal deficit is 0.6 percentage points during the period of the shock, and it takes about seven periods for the baseline model to return to a balanced budget.[22] Under the retention policy scheme, the fiscal deficit is 0.3 percentage points during the period of the shock, half of the baseline impact despite the retention policy cost, and it takes five periods to return to a balanced budget. In other words, having a retention policy scheme halves the fiscal deficit during the shock period and reduces the time it takes for the government to return to a balanced budget.

6.5 Welfare Analysis

We conclude our analysis by studying the welfare implications of the retention policy scheme. We divide agents by human capital deciles, which map approximately to their income decline. Figure 7 illustrates the heterogeneous effects of retention policy transfers across routine and non-routine occupations and the welfare gains estimated using the consumption equivalent. Panel 7(a) shows the distribution of retention policy payments across the deciles of human capital and routine and non-routine occupations.

The retention policy transfers benefit the lowest human capital workers the most. Specifically, the three lowest human capital deciles accrue about 50% of all retention transfers. In addition, the routine occupation, which was the hardest hit, accrues 61% of all the transfers. The intuition behind this result comes from the fact that matches with lower human capital workers are less profitable than matches with higher human capital workers, making them more vulnerable to experiencing negative profits after a negative aggregate shock. Matches with high levels of human capital workers are less susceptible to the crisis because the match revenues are high enough to withstand the shock.

Implementing a retention policy scheme yields positive welfare gains of about a 0.06% increase in permanent consumption-equivalent. These gains are not equally distributed across the human capital distribution. Panel 7(b) shows the welfare gains of the policy for every human capital decile. The lower deciles benefit the most from the retention policy transfers because they were the most vulnerable to the shock in the first place, and they accrue most

[22] See Appendix Figure 12 for the full time paths with and without the retention policy scheme.

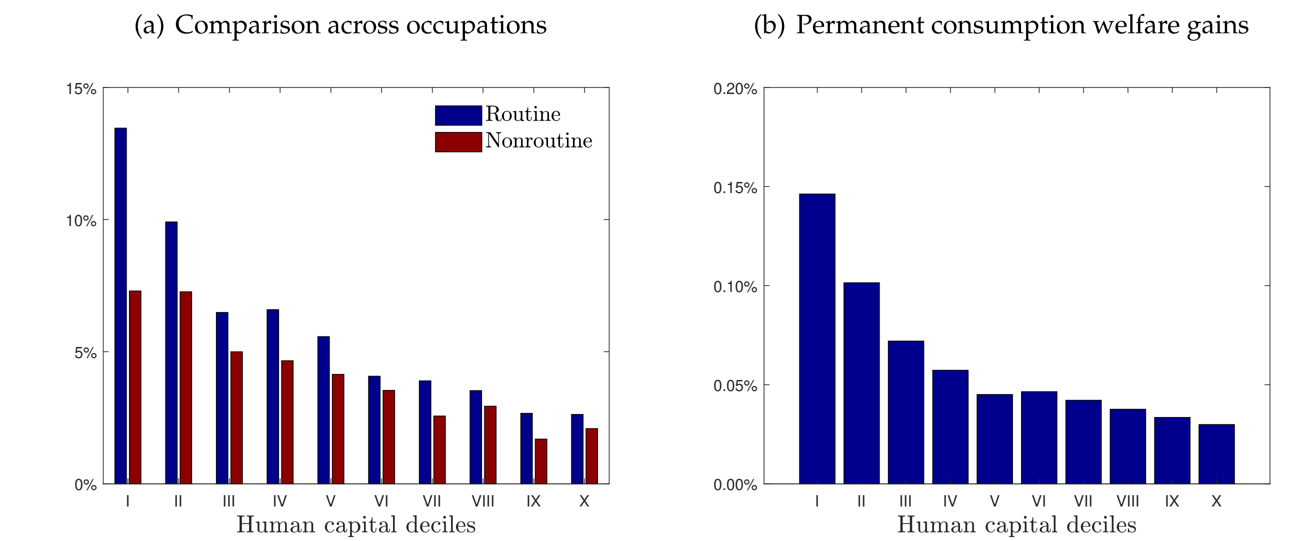


Figure 7: Retention policy transfers concentration across human capital

Note: The x-axis represents the deciles of human capital in ascending order. Panel 7(a) shows the concentration of the retention policy transfers across the deciles of human capital and occupations. The blue bars represent the retention occupation share and the red bars represent the non-routine occupation share. Panel 7(b) shows the welfare gains of implementing a retention policy scheme. The welfare gains represent the permanent percentage increase in consumption from the baseline welfare that matches an equivalent welfare with a retention policy scheme.

of the transfers; their welfare increases by almost 0.15%. In contrast, higher human capital workers benefit less from the retention policy scheme because they are less vulnerable to the negative aggregate shock. In the end, all workers are better off with the retention policy scheme because the government fiscal deficit is lower, and consequently, workers face lower transfer payments. Next, we analyze how the welfare analysis is affected by the length of the retention policy scheme.

6.5.1 Longer Transitory Shocks

We now extend the baseline quantitative experiment by allowing the aggregate productivity shock to last for two periods instead of one. This exercise assesses whether the macro-labor effects and welfare implications of the retention policy remain robust when the shock is more persistent but still temporary. The design of the shock mirrors the baseline calibration; the negative productivity shock affects both routine and non-routine occupations in periods 0 and 1 before returning to its steady state over the following nine additional periods. By lengthening the duration of the shock, we can examine how the persistence of labor-market disruptions alters the unemployment response, the short-run fiscal balance, and the aggregate welfare gains associated with the job-retention scheme. We consider three scenarios that differ only in the implementation of retention transfers while keeping all structural features unchanged: no retention policy, a policy implemented only in the first shock period, and a policy implemented in both shock periods. Figure 8 shows these results.

Figure 8(a) presents the unemployment dynamics when the aggregate shock lasts for two periods. In the absence of retention transfers, unemployment rises from 7.3 percent in period 0 to 8.2 percent in period 1, reflecting that the persistence of the shock continues to hinder surviving matches and contributes to additional job separations. Implementing retention transfers only in the first period reduces the initial increase in unemployment to 6.4 percent; however, once the policy is removed while conditions remain adverse, unemployment rises again in period 1 to 7.7 percent, undoing most of the gains achieved in the impacted period. In contrast, maintaining the retention transfers scheme throughout both shock periods stabilizes employment in both periods, limiting the increase in unemployment to 6.3 and 6.8 percent in periods 0 and 1, respectively, and preventing a second deterioration in labor market outcomes. These results indicate that the effectiveness of the retention policy becomes even stronger when the negative shock is more persistent: as long as the shock remains transitory, covering the full duration of the shock is essential to avoid further job losses and to secure a faster recovery.

Panel 8(b) shows the change in the government deficit relative to the economy without retention transfers. When retention transfers are implemented only in the first period, the deficit declines by 0.31 percent of GDP in period 0, reflecting the initial stabilization of employment. However, because the policy is removed while the adverse conditions continue into the second period, the deficit improvement is noticeably weakened, with the deficit reduction falling to only 0.19 percent in period 1. In contrast, under full implementation of the retention scheme across both periods of the shock, the fiscal position improves substantially and persistently. The deficit drops by 0.36 percent in period 0 and continues to deepen to a 0.53 percent reduction in period 1, illustrating that preventing job separations throughout the full duration of the negative shock eases the fiscal burden further. As the economy begins to recover, the fiscal deviation gradually narrows, consistent with the normalization of employment during the transition to steady state. Overall, these results underscore that a fully implemented retention policy not only stabilizes labor market conditions more effectively but also provides greater fiscal space during negative shocks by reducing the government's crisis-related spending needs.

Panel 8(c) displays the welfare gains from retention support, measured as permanent consumption-equivalent changes relative to the economy without the policy. When retention transfers are implemented only in the first period, the average welfare gain amounts to approximately 0.07 percent. Providing support throughout both shock periods doubles that improvement to roughly 0.14 percent. This difference is consistent across all deciles of human capital: in every segment of the distribution, covering the full duration of the shock nearly doubles the lifetime welfare benefits relative to providing support only in the first period. It is also noteworthy that partial implementation becomes slightly more beneficial when the downturn is more persistent. When the shock lasts for only one period and the policy is applied once, the average welfare gain is around 0.06 percent, whereas extending the shock to two periods while still implementing the policy in only the first period raises this gain to 0.07 percent. Although this improvement is modest, it indicates that the stabilization of labor market conditions, which carries over from the first to the second period, still delivers additional lifetime welfare benefits, even when the policy is not fully synchronized with the duration of the shock. Overall, these welfare results confirm that retention schemes continue to improve households' lifetime prospects when the shock is temporary and that extending the support to each period of the downturn materially strengthens those gains.

6.5.2 Permanent Shock Comparison

We now continue the extension of the baseline quantitative experiment by allowing the productivity shocks across occupations to be permanent. This exercise assesses whether the macro-labor effects and welfare implications of the retention policy remain meaningful when the economy does not return to its pre-shock productivity level. The design of the shock mirrors the baseline calibration in magnitude. We impose a permanent decline in productivity of 2.4 percentage points, and we apply it symmetrically to both occupations. This magnitude matches the productivity fall imposed on the non-routine sector under the transitory shock calibration. By adopting a homogeneous shock rather than an asymmetric one, we isolate the role of shock persistence. We then contrast the economy without retention transfers to a counterfactual that implements retention transfers for one period, as in the baseline experiment. This comparison allows us to examine how a one-period retention program affects the unemployment response, the short run fiscal balance, and the aggregate welfare gains associated with the job retention scheme. Figure 9 shows these results.

Figure 9(a) presents the unemployment dynamics when the aggregate productivity shock is permanent. In the absence of retention transfers, unemployment adjusts almost immediately to its new steady state level of 6 percent, reflecting that the shock permanently lowers match profitability and leaves little scope for a gradual recovery in labor market conditions. Implementing retention transfers for one period, matching the baseline experiment, reduces unemployment by temporarily preventing separations that would otherwise occur at the onset of the shock. However, because the productivity decline is permanent, many of the matches preserved in the impacted period are not optimal in the long run. As the temporary support is withdrawn and the economy continues to operate under permanently weaker fundamentals, unemployment increases more rapidly during the transition and converges to the same steady state level of 6 percent. These dynamics indicate that, under a permanent shock,

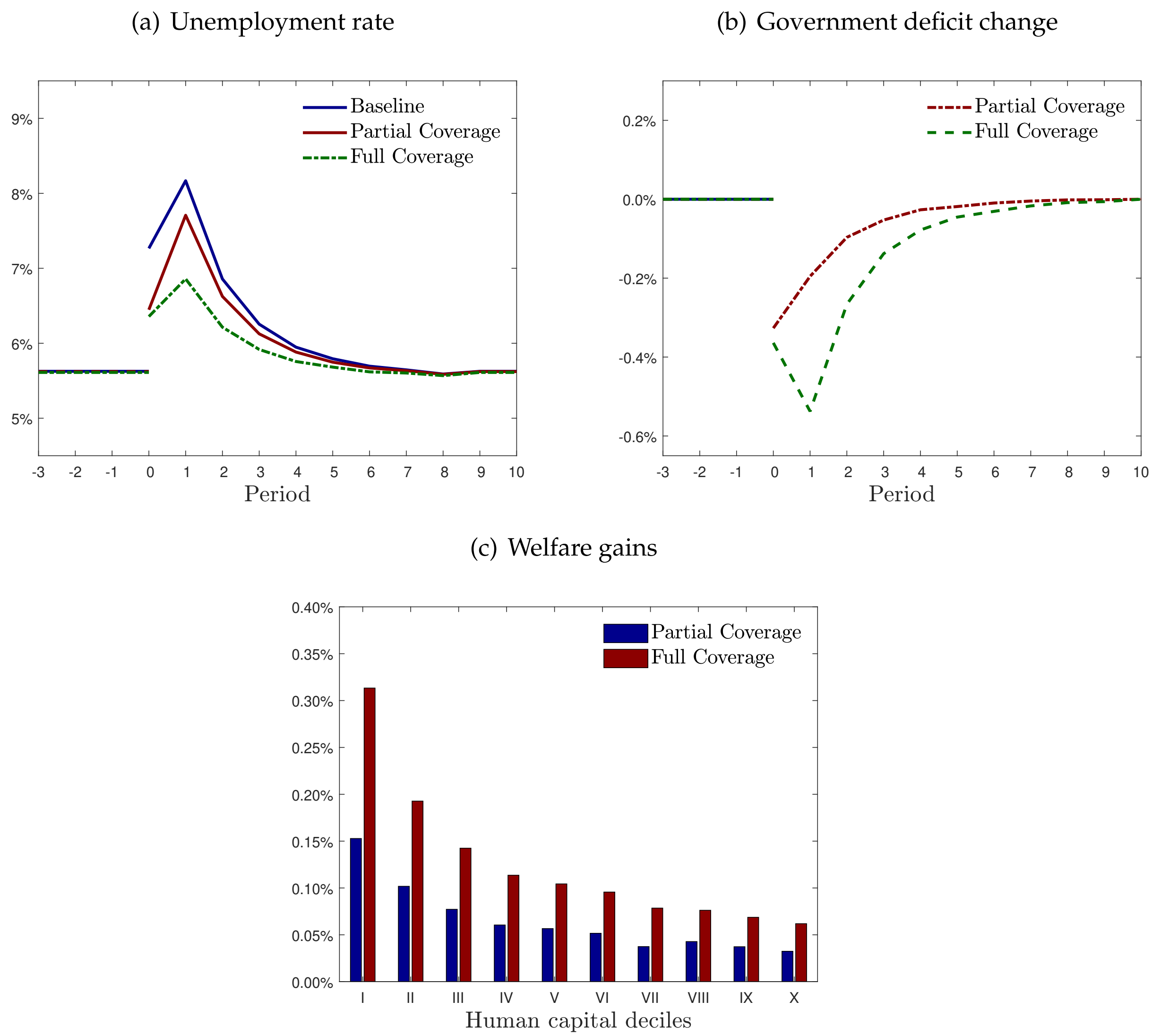


Figure 8: Two period shock and changes to extending the retention policy

Note: The figure plots the dynamics of the economy under a two-period negative aggregate productivity shock. The shock occurs in periods 0 and 1, then returns immediately to its steady-state level thereafter. The horizontal axis represents the periods in the transition path, where negative numbers indicate periods in the stationary equilibrium before the shock. The baseline economy corresponds to the case without retention transfers (solid blue line in Figure 8(a) and baseline reference in 8(b) and 8(c)). The dashed red line represents the retention policy implemented only in the first shock period (Partial Coverage), and the dashed-dotted green line represents the retention policy implemented in both shock periods (Full Covereage). Panel (a) presents the unemployment rate. Panel (b) shows the change in the government fiscal deficit as a percent of GDP relative to the benchmark without retention transfers. Panel (c) displays the permanent consumption-equivalent welfare gains across human capital deciles. All scenarios are computed under the same calibration used in the baseline experiment.

a one period job retention policy primarily delays separations rather than preventing them, and it saves matches that will eventually be destroyed as the labor market reoptimizes to the new steady state.

Panel 9(b) shows the change in the government deficit relative to the economy without retention transfers. Under the permanent shock, implementing retention transfers for one period delivers only a modest fiscal improvement, on the order of one fifth of a percentage point of GDP. The limited deficit response reflects that, while the program initially safeguards employment, many of the matches that are preserved are not sufficiently profitable under permanently weaker productivity. As a result, the policy mainly postpones separations rather than generating a sustained expansion in taxable labor income or a durable reduction in crisis related spending. Overall, these dynamics indicate that, when the disturbance is permanent, the retention program provides only limited fiscal space because it temporarily subsidizes job matches that are not viable in the long-run.

Panel 9(c) displays the welfare gains from the retention policy program, measured as permanent consumption equivalent changes relative to the economy without the policy. Under the permanent shock, the average welfare gain is positive but modest, at around 0.03%. The key mechanism is not the long-run preservation of job matches, since many of the subsidized matches are not viable once productivity remains permanently lower. Instead, the gains are delivered by the temporary nature of the retention program itself. By keeping workers attached to employment, the policy allows households to adjust through on the job search rather than through unemployment, which reduces the welfare costs associated with joblessness by supporting workers bargaining power as they search on the job. While these gains are smaller than those in the transitory shock exercises, they remain informative about the strength of retention policy schemes. A central concern in the policy debate is that retention programs may simply subsidize matches that are ultimately doomed to disappear when shocks are permanent. This result shows that short-run retention support can still raise welfare because it provides workers with the time and stability to transition into the new post-shock labor market.

6.5.3 Retention Policy Costs Sensitivity

An important assumption from the previous analysis is that the policy is efficient and does not carry any implementation costs. In this section, we add a bureaucratic cost for every unit transferred in the retention policy scheme. We interpret the bureaucratic costs as financial transfer fees, search costs associated with requesting private information, managerial salaries for processing the requests, or inefficiencies in implementing the policy. We assume a deliberately high bureaucratic cost amounting to 1% (full) and 0.5% (half) of GDP during the crisis period. The calibration implies that for every 1£ spent on retention transfers, the government

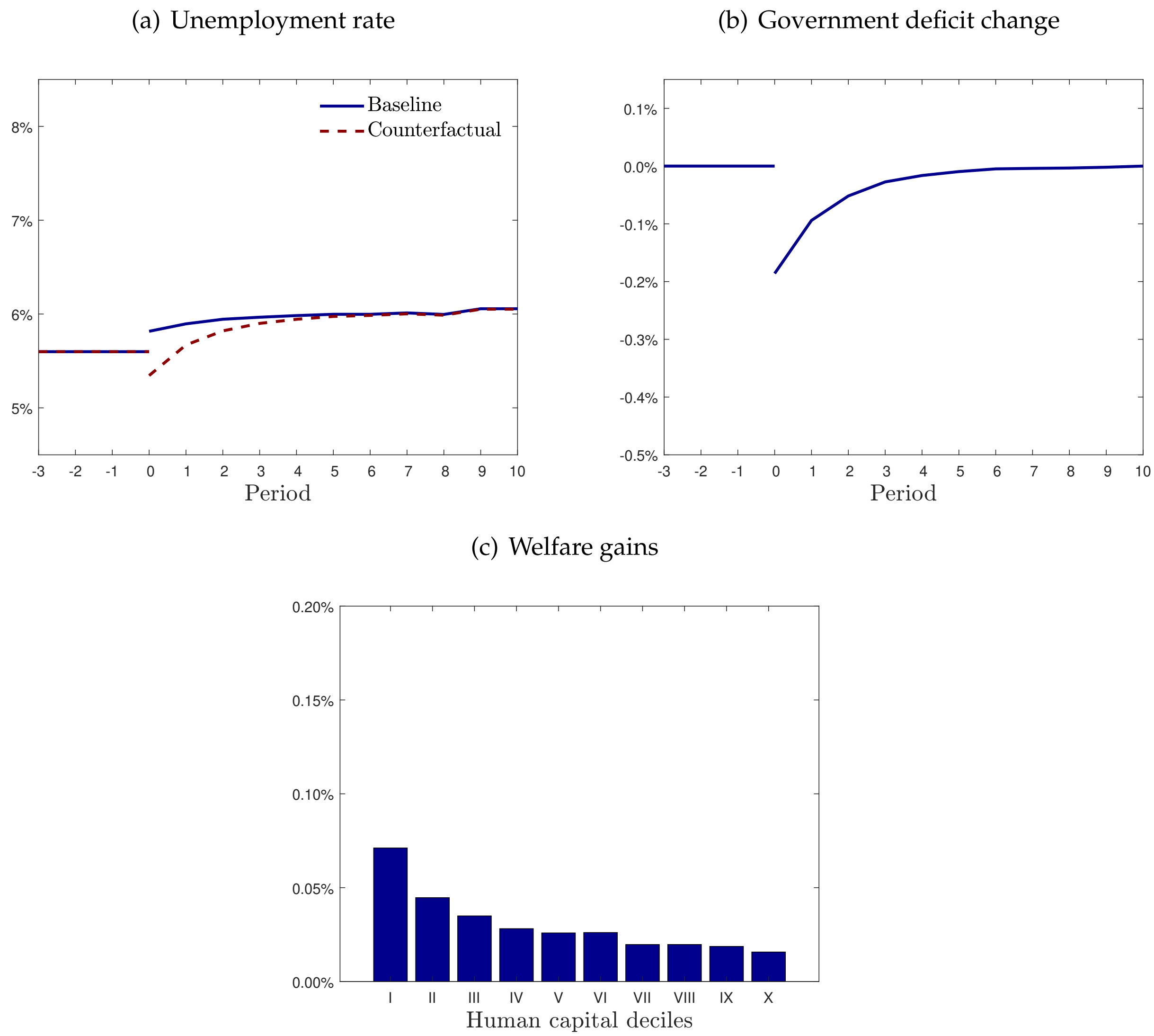


Figure 9: Permanent shock and changes to extending the retention policy

Note: The figure plots the dynamics of the economy under a permanent negative aggregate productivity shock. The horizontal axis represents the periods in the transition path, where negative numbers indicate periods in the starting stationary equilibrium before the permanent shock. The baseline economy corresponds to the case without retention transfers (solid blue line in Panel 9(a) and baseline reference in 9(b) and 9(c)). The dashed red line represents the retention policy implemented only in the first period. Panel (a) presents the unemployment rate. Panel (b) shows the change in the government fiscal deficit as a percent of GDP relative to the benchmark without retention transfers. Panel (c) displays the permanent consumption-equivalent welfare gains across human capital deciles. All scenarios are computed under the same calibration used in the baseline experiment.

spends 31£ or 63£ on bureaucratic costs, respectively. This cost is extremely high considering that in the baseline scenario, the policy only costs 0.02% of GDP. This bureaucratic cost is financed via non-distortionary lump-sum transfers that are adjusted so that the government intertemporal budget constraint is satisfied.

Figure 10 shows the sensitivity analysis regarding the bureaucratic costs. Specifically, Panel 10(a) displays the government fiscal deficit under three different scenarios: (i) No Cost - efficient retention policy implementation, (ii) Half Cost - when the bureaucratic costs amount to 0.5 percent of GDP and (iii) Full Cost - when the bureaucratic cost is 1 percent of GDP. Panel 10(b) displays the retention cost transfer under the same scenarios, and Panel 10(c) shows the welfare gains calculated as consumption-equivalent for each decile of the human capital distribution under the three scenarios.

Increasing the bureaucratic cost by a full or half percent of GDP similarly increases the government deficit after the shock, as shown in Panel 10(a). Compared to the baseline, half a percent of GDP has almost the same fiscal cost as in the baseline period, exceeding it by 2 percentage points.

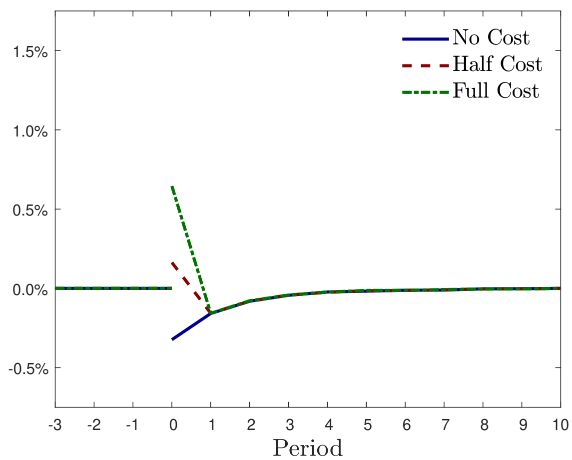
Turning to the welfare impact of the policy, the main impact of the bureaucratic cost is that it increases the lump-sum transfers imposed on all workers in the economy. Adding the bureaucratic costs associated with the retention policy scheme reduces all agent's welfare gains since this cost is not associated with any improvement in the policy. As a result, a higher fiscal deficit implies a higher lump-sum tax and, thus, lower consumption and welfare for every single agent. Moreover, when the bureaucratic cost is substantial, amounting to a 1 percent addition to GDP, the retention policy is no longer a Pareto improvement. Workers with higher levels of human capital experience welfare losses because they do not benefit directly from the policy since their matches are profitable even with the negative aggregate shock, and the substantial bureaucratic cost offsets the potential savings of a retention policy

7 Conclusion

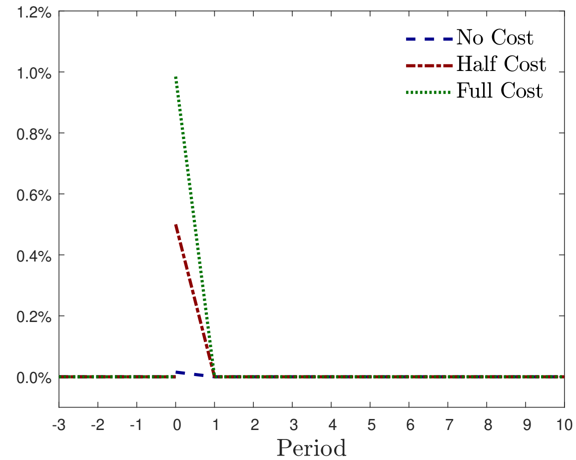
This paper quantifies the welfare implications of job-retention schemes, which were deployed widely during the COVID-19 recession. Using worker-level cross-country evidence, we document that more generous retention schemes are associated with lower job-separation probabilities during downturns, with particularly pronounced effects among low-wage workers. To interpret these patterns and evaluate policy design, we develop a search-and-matching model with endogenous occupational choice, costly occupational switching, and downward nominal wage rigidity, and calibrate it to the United Kingdom over the Global Financial Crisis and the European sovereign debt crisis.

The quantitative results indicate that a retention scheme calibrated to offset roughly half

(a) Fiscal deficit



(b) Retention transfer costs



(c) Welfare gains

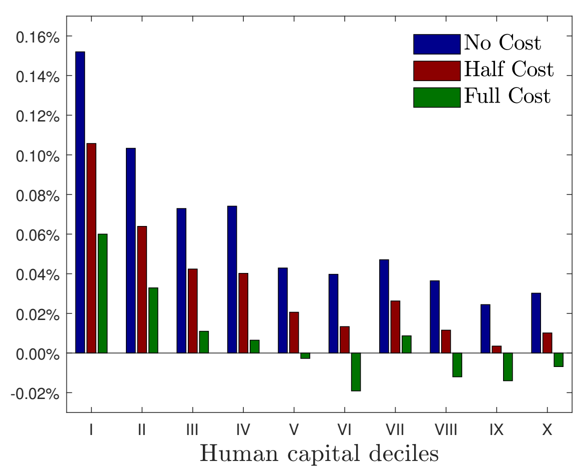


Figure 10: Retention policy scheme: bureaucratic cost sensitivity

Note: The green solid line(bar) represents the transition with full bureaucratic cost, the red dashed line(bar) represents transition with half the bureaucratic cost, and the blue dotted line(bar) represents the transition with no bureaucratic costs. In Panel 10(a) and Panel 10(b) the x-axis represents the periods of the model. In Panel 10(c) the x-axis displays the human capital deciles in ascending order. The negative productive shock occurs in period 0 and take ten periods to return to the steady state. Periods before the shock are the stationary equilibrium. The y-axis displays the government expenditures as a percentage of GDP in the model. Panel 10(c) shows the welfare gains of implementing a retention policy scheme. The welfare gains are estimated using consumption equivalents.

of the observed rise in unemployment would have meaningfully dampened labor-market deterioration. In the model, the economic recovery is faster because fewer workers enter unemployment and incur search and re-matching costs. Welfare rises by 0.06 percent in consumption-equivalent terms, with gains concentrated among low-income workers who benefit most from match preservation and the avoidance of costly reallocation. The policy is also fiscally cost-effective: by reducing unemployment-insurance outlays and preserving the tax base, the scheme can lower the fiscal deficit despite the wage subsidy.

Robustness exercises reinforce these conclusions. Welfare gains increase in longer downturns, and the policy remains welfare-improving even when the adverse shock is permanent, in which case retention primarily facilitates adjustment through on-the-job search rather than through unemployment. Overall, the findings support the view that job-retention policies can be an effective stabilization tool during downturns, particularly in environments where wage rigidities and reallocation frictions make separations especially costly.

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A Annex

A.1 Country List in the Sample

Table A.1 shows the list of countries in our sample with the corresponding number of observations and years observed.

Table A.1: Country List

	Country Name	Country Code	Year	Avg Annual Obs	Total Obs
1	Austria	AT	2004-2018	7,168	107,516
2	Belgium	BE	2004-2018	7,151	107,270
3	Denmark	DK	2003-2018	5,096	81,542
4	Estonia	EE	2005-2018	6,157	86,201
5	Finland	FI	2004-2018	11,239	168,589
6	Italy	IT	2004-2018	23,942	359,132
7	Netherlands	NL	2005-2018	12,414	173,791
8	Portugal	PT	2004-2017	6,859	96,020
9	Slovenia	SI	2005-2018	15,203	212,847
10	Spain	ES	2004-2018	17,346	260,189
11	Sweden	SE	2004-2018	7,331	109,969
12	United Kingdom	UK	2005-2016	9,733	116,795
	Total			129,639	1,879,861

A.2 Mathematical Proofs

A.2.1 Proof of Lemma 1

Proof Firs, by using Assumption 1 we can acknowledge that

$$\frac{\partial \Delta^k}{\partial \phi^k} = \frac{\Delta^k\left(\phi^k, h; T_r\right)}{(1-\gamma)-\phi^k} > 0.$$

Using Assumption 1 and the previous expression, we conclude that the measure of job matches saved increases the deeper the recession.

Moreover, by using Assumption 1 we can also acknowledge that

$$\frac{\partial \Delta^k}{\partial h} = -\frac{\Delta^k\left(\phi^k, h; T_r\right)}{h} < 0$$

Using Assumption 1 and the previous expression, we conclude that the measure of job matches saved decrease as the human capital increases.

A.2.2 Proof of Proposition 1

Proof We proceed by proving the three statements individually

i) Consider two different recessions ϕ_2 and ϕ_1 such that $\phi_2^k \geq \phi_1^k > 0$, $\phi_2^{k'} = \phi_1^{k'}$ for all $k \neq k'$ and $\phi_2^k, \phi_1^k \leq (1-\gamma)\left(1 - \frac{T_u}{\bar{z}^k H_0}\right)$ for every occupation k. Using Lemma 1 and exploiting Assumption **??**, for any arbitrary human capital $h \geq H_0$ and occupation k the following inequality holds

$$f(h)\left(\bar{\varepsilon}_1^k\left(h,\phi_2^k\right) - \bar{\varepsilon}_r^k\left(h,\phi_2^k\right)\right) > f(h)\left(\bar{\varepsilon}_1^k\left(h,\phi_1^k\right) - \bar{\varepsilon}_r^k\left(h,\phi_1^k\right)\right),$$

because $\varepsilon^k(h,\cdot)$ is increasing in ϕ^k. Aggregating across human capital h and occupations k, the following inequality holds

$$\sum_{k=1}^{K}\int_{H_0}^{\infty}\left(\bar{\varepsilon}_1^k\left(h,\phi_2^k\right) - \bar{\varepsilon}_r^k\left(h,\phi_2^k\right)\right)dF(h) > \sum_{k=1}^{K}\int_{H_0}^{\infty}\left(\bar{\varepsilon}_1^k\left(h,\phi_1^k\right) - \bar{\varepsilon}_r^k\left(h,\phi_1^k\right)\right)dF(h).$$

This concludes that under a deeper recession a retention policy scheme saves more matches.

ii) Consider a recession $\phi > 0$ such that $\phi^k \leq (1-\gamma)\left(1 - \frac{T_u}{\bar{z}^k H_0}\right)$ for every occupation. Using Lemma 1 and exploiting Assumption **??**, for any occupation k the following expression holds

$$f(h)\left(\bar{\varepsilon}_1^k\left(h,\phi^k\right) - \bar{\varepsilon}_r^k\left(h,\phi^k\right)\right) = f(h)\frac{T_r}{((1-\gamma)-\phi^k)\bar{z}h}.$$

Note that the expression above is decreasing because $f(\cdot)$ is positive in its domain and non-increasing by hypothesis and because $\frac{T_r}{((1-\gamma)-\phi^k)\bar{z}h}$ is also positive and decreasing. Aggregating across all occupations, we arrive at the following strictly decreasing function

$$\mathcal{H}(H) \equiv \sum_{k=1}^{K}\int_{H_0}^{H}\left(\bar{\varepsilon}_1^k\left(h,\phi^k\right) - \bar{\varepsilon}_r^k\left(h,\phi^k\right)\right)dF(h),$$

which implies that more jobs are saved in matches with a lower level of human-capital.

iii) Let $\bar{z}$ be the average productivity and consider an asymmetric recession $\phi > 0$, such that without loss of generality, $\phi^1 \leq \phi^2 \leq \phi^3 \leq \ldots \leq \phi^K \leq (1-\gamma)\left(1 - \frac{T_u}{\bar{z}H_0}\right)$. Pick an an arbitrary occupation k and exploiting Assumption **??**, we can express the distance between thresholds $\bar{\varepsilon}_1^k$ and $\bar{\varepsilon}_r^k$ as

$$\bar{\varepsilon}_1^k\left(h,\phi^k\right) - \bar{\varepsilon}_r^k\left(h,\phi^k\right) = \frac{T_r}{((1-\gamma)-\phi^k)\bar{z}h}.$$

Let occupation k and occupation k' be such that $k < k'$. By assumption $\phi^k < \phi^{k'}$ and aggregating across human capital h, the following inequality holds

$$\int_{H_0}^{\infty} \frac{T_r}{((1-\gamma)-\phi^k)\bar{z}h} dF(h) < \int_{H_0}^{\infty} \frac{T_r}{((1-\gamma)-\phi^{k'})\bar{z}h} dF(h).$$

This concludes that a retention policy scheme saves more firms' matches in occupations affected the most under an asymmetric recession.

∎

A.2.3 Proof of Proposition 2

Proof The savings of a retention policy scheme for an occupation k and a human capital h can be expressed as

$$\int_{\bar{\varepsilon}_r^k}^{\bar{\varepsilon}_1^k} \left(T_u + I^k(\varepsilon, h, (1-\phi)z)\right) d\varepsilon = \frac{\left(\frac{T_r}{2} - T_u\right) T_r}{((1-\gamma)-\phi^k)\bar{z}^k h} \geq 0,$$

because $T_r \leq 2T_u$. Aggregating across human capital h and occupations k we find that

$$\frac{T_r}{2}(T_r - 2T_u) \sum_{k=1}^{K} \frac{1}{(1-\gamma)-\phi^k} \left(\int_{H_0}^{\infty} \frac{1}{h} dF(h)\right) \geq 0.$$

This concludes that a retention policy scheme saves more low-productive firms' matches. ∎

A.3 Employment by Occupation

Figure 11 plots the employment share of routine and non-routine occupations in the U.K.

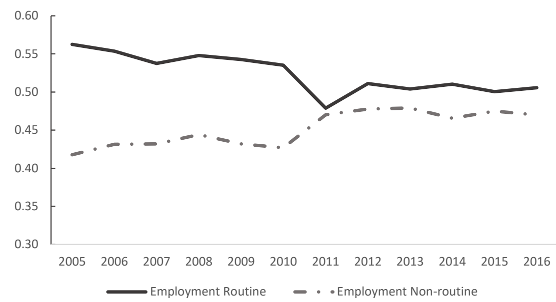

Figure 11: UK Employment by Occupation

Source: Office of National Statistics (ONS)
Note: The figure plots the employment in routine and non-routine occupation in the UK.

A.4 Baseline versus Counterfactual Analysis for Government Series

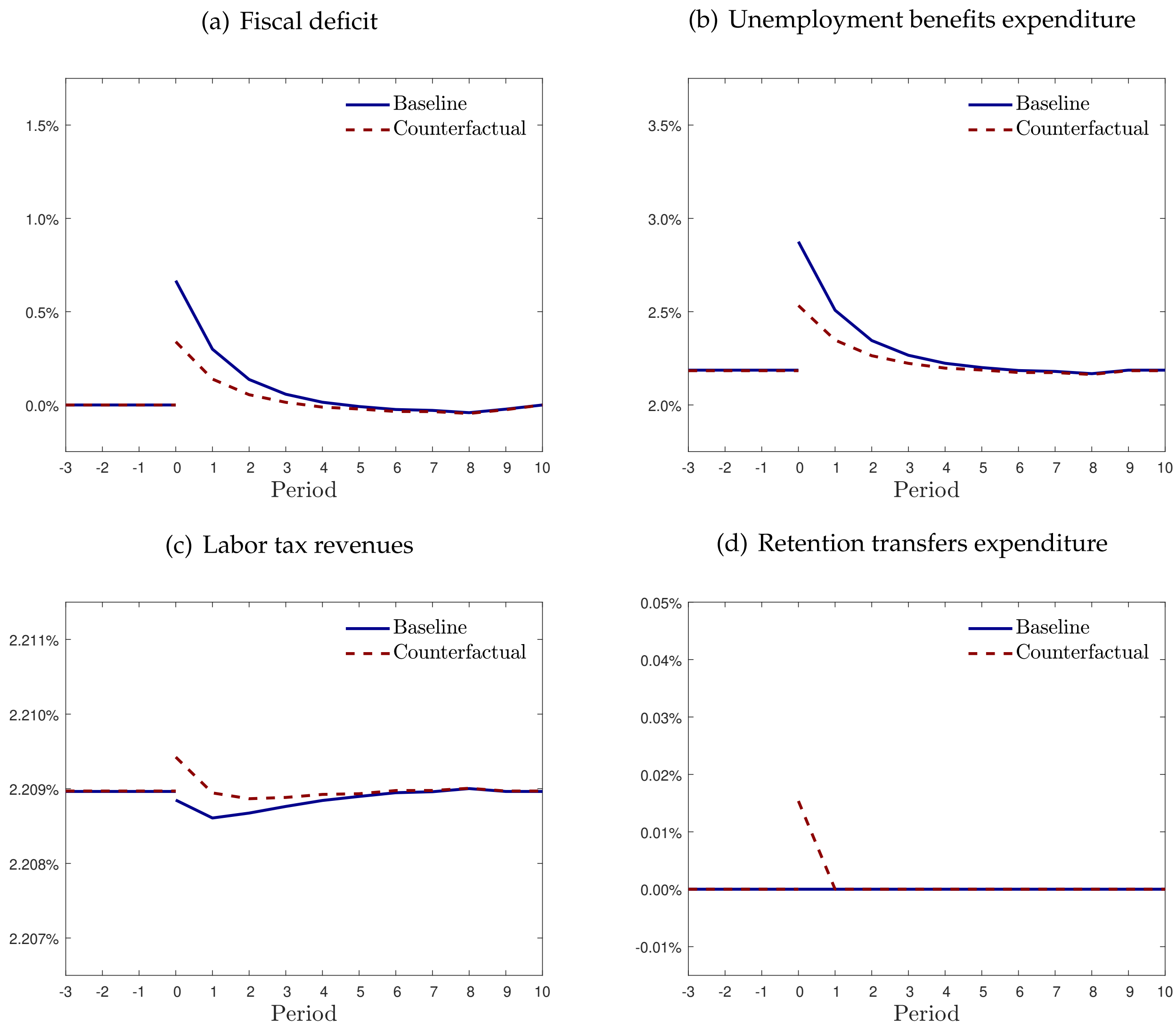

Figure 12: Government budget decomposition and transition baseline versus counterfactual

Note: The x-axis represents the periods of the model. The solid blue line represent the baseline series without retention policy scheme and the red dashed line the counterfactual with rentention policy scheme. We assume the negative productive shock happens in period 0 and take ten periods to return to the steady state. Periods before the shock represent the stationary equilibrium. The y-axis represents the expenditures and revenues of the fiscal budget as a percentage of GDP in the model with retention policy scheme relative to the baseline model.