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Labor market effects of monetary policy across workers and firms☆

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ABSTRACT

This paper uses Austrian social security records to analyze the effects of ECB monetary policy on the labor market. Our focus is on the role of worker and firm wage components, defined by an Abowd et al. (1999) wage regression. We find that monetary tightening causes the largest employment losses for low-paid workers who are employed in high-paying firms before the tightening. Monetary tightening further causes a reallocation of workers to lower-paying firms. In particular low-paid workers who were originally employed by low-paying firms are prone to falling down the firm wage ladder.

1. Introduction

The distributional effects of monetary policy are both of direct concern for policymakers and important for the transmission of monetary policy.[1] In fact, a growing empirical literature studies the distributional effects of monetary policy across workers and firms.[2] However, understanding how the worker-level effects of monetary policy depend on both the worker type *and* the worker's firm type remains largely unexplored.

A key aspect of worker and firm heterogeneity is that they jointly determine the worker's wage. Wages depend on worker-specific components (e.g., worker productivity) and firm-specific components (e.g., firm profitability). Therefore, the distribution of workers across firms matters for earnings inequality (e.g., Bagger and Lentz, 2018; Song et al., 2018; Bonhomme et al., 2019a, 2022), productive efficiency (e.g., Hagedorn et al., 2017), and earnings losses (e.g., Gulyas and Pytka, 2019; Lachowska et al., 2020; Bertheau et al., 2023a). In addition, worker and firm type determine jointly whether a worker–firm match is sustained. Importantly, it is ex-ante unclear to what extent worker and firm-specific characteristics explain why some workers are more affected by monetary policy than others.

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[1] See, e.g., McKay et al. (2016), Kaplan et al. (2018), Auclert (2019), and Gornemann et al. (2021).

[2] See, e.g., Coibion et al. (2017), Holm et al. (2021), Broer et al. (2021), Andersen et al. (forthcoming), Amberg et al. (2022), Lenza and Slacalek (2022), and Moser et al. (2022) on the heterogeneous effects of monetary policy across workers and Gertler and Gilchrist (1994), Bahaj et al. (2019), Ottonello and Winberry (2020), Meier and Reinelt (2022), and Jungherr et al. (2022) on the heterogeneous effects across firms.

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In this paper, we empirically characterize the distributional effects of ECB monetary policy shocks across workers and firms using Austrian social security records. Using an (Abowd et al., 1999) wage regression, we estimate worker and firm (wage) fixed effects. From a worker's perspective, the firm fixed effect is arguably the most important aspect of firm heterogeneity, as it measures the firm wage premium relative to other firms. We refer to workers with a high worker fixed effect as high-paid workers, and to firms with a high firm fixed effect as high-paying firms, and analogously for low-paid workers and low-paying firms.

We document three novel results. First, we show that employment losses after monetary tightening are concentrated among low-paid workers in high-paying firms. Second, monetary tightening increases the rate at which workers reallocate across firms, in particular for low-paid workers. Third, the firms to which workers switch after monetary tightening tend to be lower-paying than their previous firms. Especially low-paid workers who were originally employed in low-paying firms reallocate to (even) lower-paying firms. All results apply symmetrically to expansionary monetary policy.

While our finding that low-paid workers are more affected by monetary policy is in line with the previous literature (quoted above), the novelty of our results is the role of the worker's original employer for the distributional effects of monetary policy. As low-paid workers at high-paying firms tend to become non-employed, low-paid workers at low-paying firms tend to reallocate to lower-paying firms. Although a large literature studies heterogeneous effects of monetary policy across workers *or* firms, jointly studying worker and firm heterogeneity has been largely ignored. An exception is Moser et al. (2022) which estimates the distributional effects of lower credit supply due to negative interest rates on employment and pay both within and between firms. Another closely related paper is Crane et al. (2022) which studies the effects of recessions across both worker and firm ranks. Compared to Coibion et al. (2017), we shed light on the black box of the earnings heterogeneity channel, by making use of rich administrative social security data.

Our analysis uses the universe of Austrian social security records, which includes a worker identifier, an establishment identifier, the start and end dates of employment and registered unemployment spells, the wage, and a few other worker characteristics. We use these records to construct a quarterly worker-level panel with 200 million observations between 1999 and 2019. We combine the worker panel with high-frequency identified ECB monetary policy shocks (Altavilla et al., 2019; Jarociński and Karadi, 2020). To characterize the distributional effects of monetary policy, we estimate worker-level panel local projections.

Our main findings show statistically and economically significant heterogeneity in the employment effects of monetary policy across workers and firms. Across all workers, the average employment probability is 0.3 percentage points (p.p.) lower one year after a one-standard deviation contractionary monetary policy shock, and the opposite for an expansionary shock. The average, however, masks large differences across workers. For workers with an above-median worker fixed effect, the employment probability falls by 0.24 p.p., while for workers with a below-median worker fixed effect the employment probability falls by 0.36 p.p. That is, low-paid workers are 50% more likely to become non-employed than high-paid workers. However, only examining the role of worker fixed effects misses large differences across firm fixed effects. Perhaps surprisingly, among the low-paid workers, those originally employed at high-paying firms are particularly likely to become non-employed. Their employment probability falls by 0.4 p.p. Conversely, the employment probability of low-paid workers at low-paying firms only falls by 0.23 p.p.

Monetary policy shocks not only affect the probability whether a worker is employed, but also induce reallocation of workers across firms. On average, a one standard deviation monetary policy shock increases the likelihood of changing employers by 0.2 p.p. Job switching is especially concentrated among low-paid workers. These workers are three times more likely than high-paid workers to change employers in response to a monetary policy shock. A natural question that arises is where workers reallocate to: Are workers moving to better paying or worse paying employers? We find that across all workers switching employers, the average wage premium of firms falls by 0.16% after a one-standard deviation contractionary monetary policy shock. In other words, workers reallocate to lower-paying firms. Interestingly, this reallocation response is fairly similar when comparing low-paid to high-paid workers, and when comparing workers at low-paying to those at high-paying firms. However, we do find large differences in the interaction of worker type and firm type. In particular, we find that low-paid workers originally employed by low-paying firms are disproportionately reallocating towards worse-paying firms. In contrast, low-paid workers originally employed by high-paying firms tend to reallocate to similar firm types.

Taken together, our results imply that contractionary monetary policy shocks especially hurt low-paid workers across multiple dimensions. They lower their employment probability, especially for those originally employed at high-paying firms. This finding is consistent with the poaching dynamics mechanism put forward by Moscarini and Postel-Vinay (2012, 2013), who show that employment growth at large firms, which tend to pay high wages, is more cyclically sensitive than at small firms. Large firms poach workers from small firms during economic expansions, which constrains the growth of small firms. During economic contractions, large firms shed workers and smaller, worse-paying firms have an opportunity to grow. This implication of poaching dynamics is additionally in line with our evidence that workers reallocate to worse-paying firms in response to contractionary monetary policy shocks. In addition, our findings might be also driven by labor supply mechanisms. Workers at high-paying firms may have accumulated more savings and entitlements to unemployment benefits than workers at low-paying firms. Thus, the former workers might invest more time searching for higher-paying firms, leading to longer non-employment durations. This explanation is also in line with our reallocation evidence that particularly low-paid workers at low-paying firms transition to worse-paying firms.

Our paper provides new empirical moments which can be useful for the further development of Heterogeneous Agent New Keynesian models. While our findings highlight the role of both worker and firm heterogeneity, existing models either feature only worker heterogeneity (e.g., Gornemann et al., 2021; Dolado et al., 2021; Bergman et al., 2022; Bhandari et al., 2021; Ravn and Sterk, 2020), or only firm heterogeneity (e.g., Ottonello and Winberry, 2020; Meier and Reinelt, 2022). Instead, a New Keynesian model with two-sided heterogeneity would allow studying the positive and normative implications of our evidence.

The paper is organized as follows: Section 2 describes the data. Section 3 provides evidence on the employment effects of monetary policy. Section 4 provides evidence on the reallocation effects of monetary policy. Section 5 provides a sensitivity analysis. Section 6 discusses the underlying mechanisms behind our findings and Section 7 concludes.

2. Data

In this section, we describe the data and key variables used in our analysis.

2.1. Austrian social security data

We use administrative data from the Austrian social security administration that cover the universe of administrative employment and unemployment records for all workers subject to social security from 1999 through 2019.[3] The data include a worker identifier, an establishment identifier, the first and last day of employment and unemployment spells, the worker's age, and the establishment's industry classifier. In the data, we observe only the establishment a worker is employed at, but not the firm. For simplicity, we will refer to establishments as firms in the remainder of the paper.[4] For every worker–firm match, we observe annual labor income. On average, we observe 2.7 million workers per year.

We construct a worker panel based on which we estimate worker-level responses to monetary policy shocks. In theory, we could construct a daily panel, since both social security data and monetary policy shocks are available at a daily frequency. Such a panel, however, would include 20 billion observations rendering the regression analysis extremely burdensome if not infeasible. Furthermore, given the presence of various labor market frictions and the typically sluggish response of macroeconomic aggregates to monetary policy shocks, we should not expect large employment responses at very short horizons. We therefore construct a quarterly worker panel. We focus on individuals with high labor force attachment by excluding workers below 26 and above 60 years old.[5]

Our sample only consists of employment spells subject to social security and registered unemployment spells.[6] There are several reasons why a worker may disappear from our sample. A worker may drop out of the labor force, move outside of Austria, or find employment not covered by social security such as self-employment. In our analysis, we have to take a stance on how to define the employment status of workers who disappear from our dataset. We decide to only consider the employment and non-employment trajectories of workers who are either employed or registered as unemployed. We think of this choice as conservative, as we may underestimate the employment responses if workers are pushed outside of the labor force in response to monetary policy shocks.[7] Our final panel has 226.8 million worker-quarter observations and Table 1 provides summary statistics. As we use the universe of all employment observations subject to social security, the descriptive statistics mirror the labor market structure of Austria.

2.2. Worker and firm fixed effects

Our goal in this paper is to empirically characterize the distributional effects of ECB monetary policy shocks across the joint distribution of worker and firm types. We estimate worker and firm types using the seminal (Abowd et al., 1999) wage regression (in short: AKM), which has become the workhorse model to separate workers' and firms' contribution to wage determination. In particular, we estimate worker and firm types through the fixed effects in the following annual wage regression

$$wage_{i,j,\tau} = \boldsymbol{F}_{j(i,\tau)} + \boldsymbol{W}_i + \beta X_{i,\tau} + \varepsilon_{i,j,\tau}, \tag{2.1}$$

where $wage_{i,j,\tau}$ is the log average daily wage of worker i, employed in firm j in year τ, $\boldsymbol{F}_{j(i,\tau)}$ is a firm fixed effect, $\boldsymbol{W}_i$ is a worker fixed effect, and $X_{i,\tau}$ is a cubic polynomial of worker age.[8] For each worker and year, we select the dominant employer according to total yearly income. Table 1 provides descriptive statistics of the worker and firm fixed effects. The AKM firm fixed effects together with the sorting component, i.e., the covariance between worker and firm fixed effects, together explain around a third of wage variation (Bonhomme et al., 2022). Most of the remaining wage variation is explained by the worker fixed effect. Thus, to comprehensively understand the wage inequality effects of monetary policy, it is important to understand how monetary policy shocks affect worker and firm types differentially, but also to understand how the sorting of workers across firms responds.

The firm fixed effect $\boldsymbol{F}_{j(i,\tau)}$ for firm j is assumed to be invariant over time and is identified through wage changes of workers moving across firms.[9] Theoretically, it is possible that the firm fixed effect is affected by monetary policy shocks. Although monetary policy shocks are at least an order of magnitude smaller in standard deviation than idiosyncratic shocks to firms, to avoid endogeneity concerns, our analysis will mostly use the firm and worker fixed effects estimated from a backward-looking 5-year rolling window. We denote the estimated worker and firm fixed effects for the rolling windows by

$$\boldsymbol{W}^{rolling}_{i,\tau} \qquad \text{and} \qquad \boldsymbol{F}^{rolling}_{j(i,\tau),\tau}. \tag{2.2}$$

3 All private sector jobs are subject to social security except self-employed individuals. The data also include many public sector jobs except civil servants ("Beamte"), see Zweimüller et al. (2009) for details.

4 While most establishments are owned by one-establishment firms, establishments at multi-establishment firms are well known to be larger on average and account for a sizeable share of aggregate employment. Our analysis does not distinguish between these types of firms as our data do not contain firm identifiers.

5 In this step we lose around 36.6 mln observations — the original dataset contained around 250.5 mln observations. Section 5 shows that our main results are robust when including all individuals in our sample.

6 Unemployment benefits are paid only for a specific amount of time. After running out of unemployment benefits, workers continue to receive benefits, although at a lower replacement rate, and are still observed as registered unemployed in our dataset.

7 Our results are robust to coding workers that drop from our sample as non-employed (see Section 5).

8 The average daily wage is the annual wage in year τ of worker i received from firm j divided by the number of days worked by worker i for firm j.

9 The related literature has pointed out that few workers moving in some firms creates a limited mobility bias in the variance of firm fixed effects. However, we do not study the variance of firm fixed effects but rather the point estimates, which are unbiased under limited mobility bias. Nevertheless, we will show that our results are very similar when using a clustering algorithm following Bonhomme et al. (2019b).

Table 1
Descriptive statistics.

	Mean	Min	P25	P75	Max	Obs
Worker characteristics						
Employment *(0/1)*	0.906	0	1	1	1	226,765,739
Age *(in years)*	41.7	26	34	49	60	226,765,739
Wage *(in 2010€)*	98.2	15.9	65.1	127.4	195.8	205,435,660
Labor market transitions						
EE *(0/1)*	0.029	0	0	0	1	197,468,968
EU *(0/1)*	0.026	0	0	0	1	197,468,968
UE *(0/1)*	0.248	0	0	0	1	18,791,085
Firm characteristics						
Firm age *(in years)*	21.5	0	9	33	100	205,435,660
Firm size *(employees)*	1060.8	1	16	545	35,383	205,435,660
Worker and firm fixed effects						
Worker fixed effect	0.035	−6.361	−0.190	0.276	3.025	205,239,643
Firm fixed effect	0.013	−5.147	−0.107	0.179	2.882	205,266,679
Monetary policy						
MP shock *(in bp)*	0.43	−21.26	−1.54	2.13	12.69	84

Note: This table provides descriptive statistics for our worker-level panel from 1991Q1 through 2019Q4. Workers are either employed (1) or unemployed (0). Wages are daily wages of employed workers. The labor market transitions are quarterly transitions from employment at one firm to another (EE), from employment to unemployment (EU) and vice versa (UE). The AKM fixed effects are expressed in log real wage units. MP shock describes our baseline shock series in basis points.

where the sample used to estimate $\boldsymbol{W}_{i,\tau}^{rolling}$ and $\boldsymbol{F}_{j(i,\tau),\tau}^{rolling}$ ranges from year $\tau - 4$ to τ. To be able to compare the rolling-window estimates over time, we compute the percentile rank of these fixed effects, which we denote by[10]

$$\widetilde{\boldsymbol{W}}_{i,\tau}^{rolling} = \text{percentile}\left(\boldsymbol{W}_{i,\tau}^{rolling}\right) \quad \text{and} \quad \widetilde{\boldsymbol{F}}_{j(i,\tau),\tau}^{rolling} = \text{percentile}\left(\boldsymbol{F}_{j(i,\tau),\tau}^{rolling}\right). \tag{2.3}$$

When studying the reallocation of workers across firms, we need a constant measure of firm fixed effects over time. Thus, in Section 4 we will use the firm fixed effects estimated in (2.1) over the entire sample.

2.3. ECB monetary policy shocks

As ECB monetary policy shocks, we consider high-frequency changes in the Overnight Index Swap (OIS) rates around policy meetings of the ECB Governing Council. The OIS is a swap contract exchanging a fixed interest rate for the floating Euro Overnight Index Average (Eonia) on the European interbank market. We exclusively consider scheduled meetings, which mitigates the problem that monetary surprises may convey private central bank information about the state of the economy. The event window starts 10–20 min before the press release and ends 10–20 min after the press conference. Following Jarociński and Karadi (2020), we further use sign restrictions to separate information effects from conventional monetary policy shocks. The identifying restriction is that monetary policy shocks should move interest rates and stock prices in opposite directions, while central bank information moves them in the same direction.

Our baseline shock series is constructed from high-frequency changes in the 6-months ahead OIS rate provided by Altavilla et al. (2019).[11] While surprises in the 3-month rate become minuscule during the zero lower bound (ZLB) episode, we observe non-negligible surprises in the 6-month rate throughout our sample. We aggregate the daily shocks to quarterly frequency. Daily shocks are assigned fully to the current quarter if they occur on the first day of the quarter. If they occur within the quarter, they are partially assigned to the current and subsequent quarter (Gorodnichenko and Weber, 2016). The monetary policy shock series covers 1999Q1 through 2019Q4. Table 1 shows descriptive statistics and Fig. A.1 in the Appendix A shows the time series.

As a plausibility check and to provide a benchmark for our subsequent worker-level results, we estimate the responses of macroeconomic aggregates for the Austrian economy to the monetary policy shocks, see Fig. A.2 in Appendix A. We find that a one-standard deviation monetary policy shock lowers the employment rate of prime-age workers by up to 0.3 p.p. Similarly, we find that real GDP declines by up to 0.4% with the peak effects attained between one and two years after the shock. Note that the GDP response that we estimate for Austria is well within the range of estimates for the US output response to US monetary policy shocks, c.f. Table 1 in Ramey (2016).

[10] Using percentile rankings has another advantage: Since we will use these estimates as right-hand side variables in the estimation of the effects of monetary policy, measurement error in the right-hand side variables would lead to attenuation bias. Measurement error in the percentile rankings is plausibly more limited. We will revisit this in Section 5.

[11] Our results are robust to using the 3-months ahead OIS rate, see Section 5.

3. Employment probability

In this section, we estimate the effects of monetary policy shocks on the employment probability of workers. We find that low-paid workers who are employed in high-paying firms before the shock are most affected by monetary policy.

3.1. Average response

Before studying the distributional employment effects of monetary policy, we estimate the average employment effect across all workers. This provides a benchmark for the subsequent analysis. We estimate the following worker-level panel local projections on around 200 million worker-quarter observations of our baseline sample[12]:

$$e_{i,t+h} = \alpha_i^h + \beta^h \varepsilon_t^{\text{MP}} + \delta^h Z_{i,t-1} + v_{i,t+h}^h, \tag{3.1}$$

for $h = 0, \dots, 12$ quarters, where $e_{i,t+h}$ denotes a binary employment variable with

$$e_{i,t+h} = \begin{cases} 1 & \text{worker } i \text{ is employed in quarter } t+h, \\ 0 & \text{else.} \end{cases}$$

We include only workers in the regression that are employed in $t-1$, the quarter preceding the monetary policy shock. This facilitates the comparison with the subsequent analysis, in which we need to condition on employment in $t-1$ in order to study the responses by worker and firm types.[13] On the right-hand side, α_i^h denotes a worker fixed effect (not the AKM worker fixed effect), $\varepsilon_t^{\text{MP}}$ is the monetary policy shock, and $Z_{i,t-1}$ is a vector of control variables, notably a linear time trend and season fixed effects for the four quarters.[14] The coefficient of interest is β^h, which captures the change in the employment probability in response to a monetary policy shock.[15]

Fig. 1 shows the average response of the employment probability based on (3.1). The solid line shows the point estimates of β^h, normalized to correspond to a one-standard deviation monetary policy shock, and the shaded areas indicate 68% and 95% confidence bands based on standard errors that are two-way clustered by worker and quarter. We find that the employment probability significantly falls. The response gradually builds up and peaks at a 0.28 p.p. lower employment probability five quarters after the shock. For comparison, the unconditional employment probability, i.e., the sample average of $e_{i,t+h}$, for $h = 5$ is 94.98% (Fig. A.3). Hence, the probability of non-employment increases from an average of 5.02% to 5.30% in response to the monetary policy shock. We consider this a non-negligible change. The magnitude of the average worker-level response is broadly in line with the aggregate employment response in Fig. A.2.

While Fig. 1 shows the employment response of workers employed in the quarter before the monetary policy shock, we also examine the effect on workers who were unemployed before the shock. Fig. A.4 in the Appendix A shows that unemployed workers are significantly less likely to become employed after monetary policy shocks. In response to a one standard deviation shock, their employment probability falls by up to 0.76 p.p. In comparison, the average quarterly UE transition rate is 24.8% (see Table 1).

3.2. Heterogeneity across worker and firm fixed effects

We next present our empirical results on the distributional employment effects of monetary policy across worker and firm fixed effects. Multiple theories make predictions for these distributional effects. In this section (and the following), we first document our evidence. In Section 6, we discuss the theoretical mechanisms and argue that in particular poaching dynamics and labor supply can explain the evidence.

[12] The large number of observations together with the two-way clustering implies a very high computational demand of this regression, which makes it infeasible to run this regression on standard personal computers. We thank Baden-Württemberg High Performance Computing (bwHPC) for its support of our project.

[13] We study the response of workers that are non-employed in period $t-1$ at the end of this subsection.

[14] Given that we condition on workers that are employed in period $t-1$, including the lagged dependent variable $e_{i,t-1}$ in $Z_{i,t-1}$ would be redundant as it is already captured by the worker fixed effect.

[15] An alternative to the linear probability model would be a probit or logit model. Unfortunately, estimating a logit or probit model on our large dataset with high-dimensional fixed effects is not computationally feasible, even on the high-performance cluster we use. Using a 2.5% sub-sample, a logit regression yielded similar results.

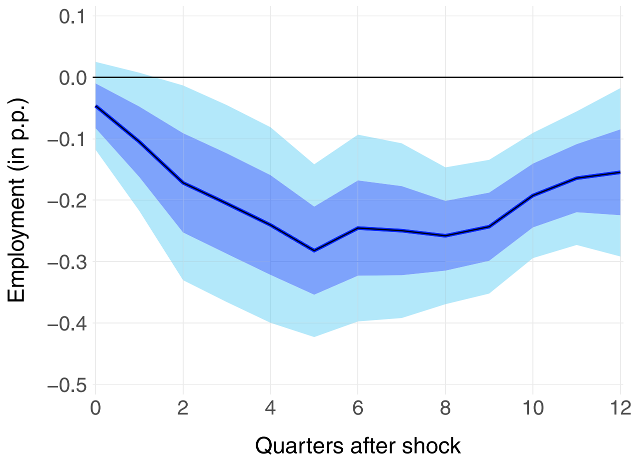

Fig. 1. Average employment response (β^h). Note: The solid line shows the estimated β^h coefficients in Eq. (3.1). The β^h coefficients are standardized to capture the employment probability response to a one standard deviation increase in $\varepsilon_t^{\mathrm{MP}}$. The inner and outer shaded areas respectively indicate 68% and 95% confidence bands two-way clustered by worker and quarter.

Formally, we estimate the following state-dependent worker-level panel local projections

$$\begin{aligned} e_{i,t+h} &\qquad (3.2)\\ = \quad & \alpha_i^h + \delta^h Z_{i,t-1} + v_{i,t+h}^h \\ & + \beta^h \ \varepsilon_t^{\mathrm{MP}} && (average\ effect)\\ & + \gamma^{W,h}\ \varepsilon_t^{\mathrm{MP}} \left(\widetilde{\boldsymbol{W}}_{i,\tau-1}^{rolling} - \overline{\widetilde{\boldsymbol{W}}_{i,\tau-1}^{rolling}} \right) && (worker\ heterogeneity)\\ & + \gamma^{F,h}\ \varepsilon_t^{\mathrm{MP}} \left(\widetilde{\boldsymbol{F}}_{j(i,t-1),\tau-1}^{rolling} - \overline{\widetilde{\boldsymbol{F}}_{j(i,t-1),\tau-1}^{rolling}} \right) && (firm\ heterogeneity)\\ & + \gamma^{WF,h}\ \varepsilon_t^{\mathrm{MP}} \left(\widetilde{\boldsymbol{W}}_{i,\tau-1}^{rolling} - \overline{\widetilde{\boldsymbol{W}}_{i,\tau-1}^{rolling}} \right) \left(\widetilde{\boldsymbol{F}}_{j(i,t-1),\tau-1}^{rolling} - \overline{\widetilde{\boldsymbol{F}}_{j(i,t-1),\tau-1}^{rolling}} \right), && (interaction) \end{aligned}$$

where β^h captures the employment response of a worker with an average worker fixed effect in the year preceding the monetary policy shock (i.e., for $\widetilde{\boldsymbol{W}}_{i,\tau-1}^{rolling} = \overline{\widetilde{\boldsymbol{W}}_{i,\tau-1}^{rolling}}$) and an average firm fixed effect for the firm which employed the worker in quarter $t-1$ (i.e., for $\widetilde{\boldsymbol{F}}_{j(i,t-1),\tau-1}^{rolling} = \overline{\widetilde{\boldsymbol{F}}_{j(i,t-1),\tau-1}^{rolling}}$).[16] The coefficient $\gamma^{W,h}$ captures the differential employment response of a higher worker fixed effect, $\gamma^{F,h}$ captures the differential employment response of a higher firm fixed effect, and $\gamma^{WF,h}$ captures the differential employment response of the interaction between a higher worker and a higher firm fixed effect.[17] While we study the heterogeneity in our baseline with a linear specification, we show in the Appendix A (see Fig. A.7) that our results are very similar if we use worker and firm groups instead.

Fig. 2 presents our main results from Eq. (3.2). Panel (a) shows that workers with higher worker fixed effect are significantly less likely to become non-employed after a monetary policy shock (conditional on an average firm fixed effect). The estimated differences are economically meaningful. Workers with a one standard deviation higher worker fixed effect are up to 0.07 p.p. less likely to become non-employed compared to the average employment probability response of up to 0.27 p.p. Turning to the role of firm fixed effects, panel (b) shows that workers employed in firms with a higher firm fixed effect are significantly more likely to become non-employed after a monetary policy shock (conditional on an average worker fixed effect). The magnitudes are similarly economically meaningful as for worker fixed effects. Eq. (3.2) also contains an interaction effect between the worker and firm fixed effects. Panel (c) shows that the coefficient on the interaction is significantly positive. This means that workers with combinations of high (or low) worker and firm fixed effects are less likely to become non-employed than workers with opposite combinations. Put differently, workers are more likely to become non-employed when their worker fixed effect is in the opposite half of the distribution as their firm fixed effect.

[16] Given period $t-1$ firm and worker fixed effects on the right-hand side of Eq. (3.2), our analysis only includes workers that are employed in $t-1$, the quarter preceding the monetary policy shock.

[17] The control vector $Z_{i,t-1}$ is specified as in Section 3.1 except that the seasonal fixed effects are interacted with quintile group dummies for worker and firm fixed effects, respectively. This allows us to control for some heterogeneity in the employment seasonality across workers and firms.

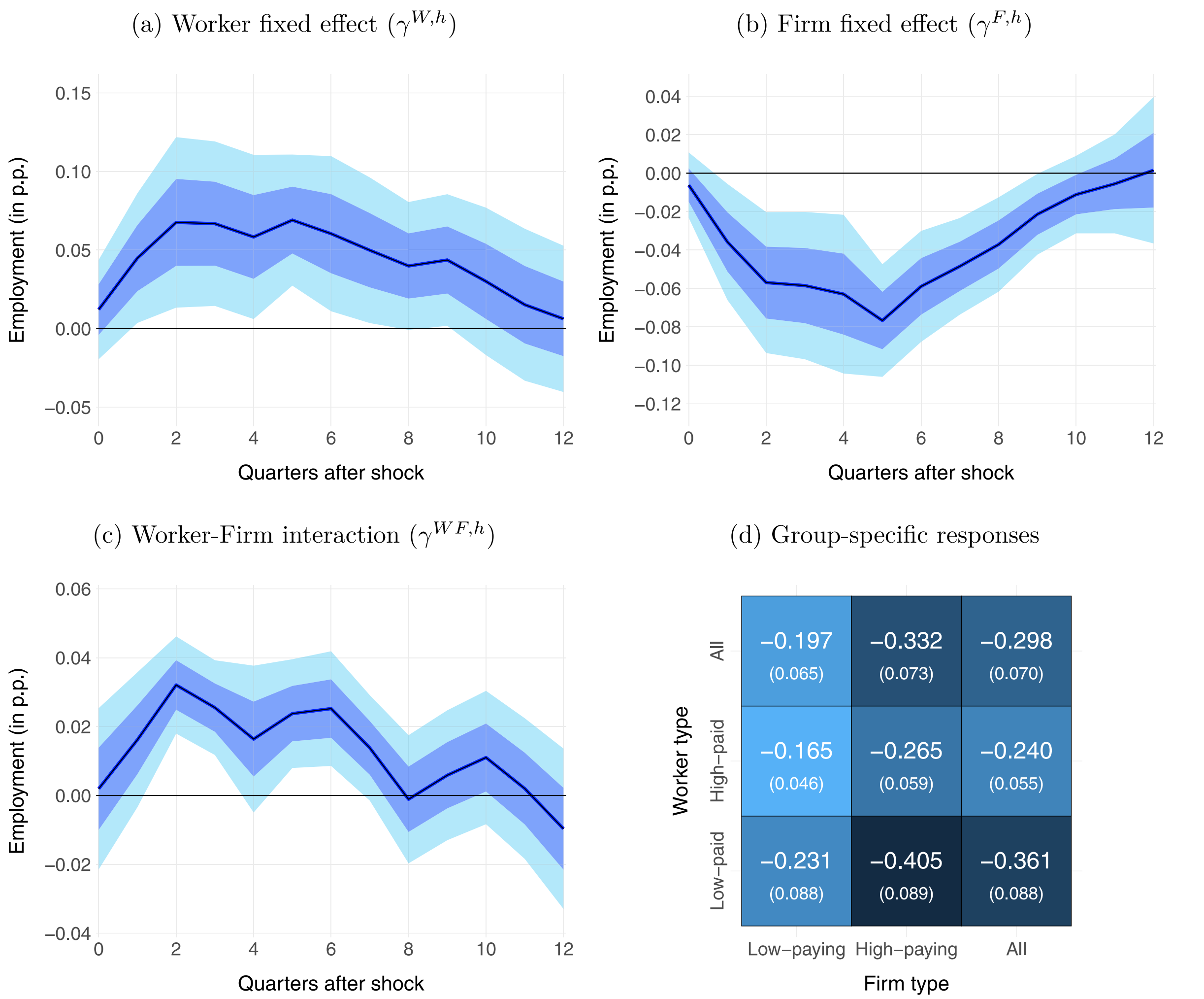

Fig. 2. Employment response across worker and firm fixed effects. Note: The solid lines in panels (a)–(c) show the estimated differential responses, the γ coefficients in Eq. (3.2). The γ coefficients are standardized to capture the employment probability response to a one standard deviation increase in ε_t^{MP} and for a one standard deviation above-average worker and firm fixed effect. The inner and outer shaded areas respectively indicate 68% and 95% confidence bands two-way clustered by worker and quarter. Panel (d) shows the total employment response of different worker groups estimated based on β^h, $\gamma^{W,h}$, $\gamma^{F,h}$, $\gamma^{WF,h}$ at $h = 5$ and the associated standard errors are in parentheses. For example, the employment response of high-paid workers in low-paying firms is estimated based on $\beta^h + (p^W_{75} - p^W_{50})\gamma^{W,h}/\sigma_W + (p^F_{25} - p^F_{50})\gamma^{F,h}/\sigma_F + (p^W_{75} - p^W_{50})(p^F_{25} - p^F_{50})\gamma^{WF,h}/(\sigma_W \sigma_F)$, where p^W_x and p^F_x denote the x-th percentiles of the distribution of worker and firm fixed effects, and σ_W and σ_F are the associated standard deviations.

Panel (d) of Fig. 2 presents the group-specific total employment responses, based on combining the average (β^h) and the differential ($\gamma^{W,h}, \gamma^{F,h}, \gamma^{WF,h}$) responses based on Eq. (3.2). We define low and high-paid workers as workers with a worker fixed effect at the 25th and 75th percentile, respectively. Analogously, we define low and high-paying firms as firm fixed effect at the 25th and 75th percentile across all workers, respectively. The table in panel (d) shows the employment response of different combinations of low and high-paid workers and low and high-paying firms at horizon $h = 5$, when the average employment response peaks. We find that the employment responses differ similarly across firm and worker types (see the "All" column and row, respectively). While a monetary policy shock lowers the employment probability by 0.20 p.p. for workers at low-paying firms, it plummets by 0.33 p.p. at high-paying firms. In comparison, the drop is 0.24 p.p. for high-paid workers and 0.36 p.p. for low-paid workers across all firms. What stands out from the table is that low-paid workers at high-paying firms are most affected by monetary policy shocks. The employment probability for them drops by 0.41 p.p. The least affected group is high-paid workers from low-paying firms, for which the employment probability drops by 0.17 p.p. This implies that the most affected group of workers in the table has a 2.4 times larger response than the least affected group. In fact, the difference between these groups is statistically significant at the 1% level (Table A.1). In addition, the majority of pairs of group-specific estimates are significantly different from each other. For comparison, the unconditional employment probabilities, i.e., the sample average of $e_{i,t+h}$ for the different combinations of worker and firm types, for $h = 5$ range from 93.0% to 97.3% (Fig. A.3).

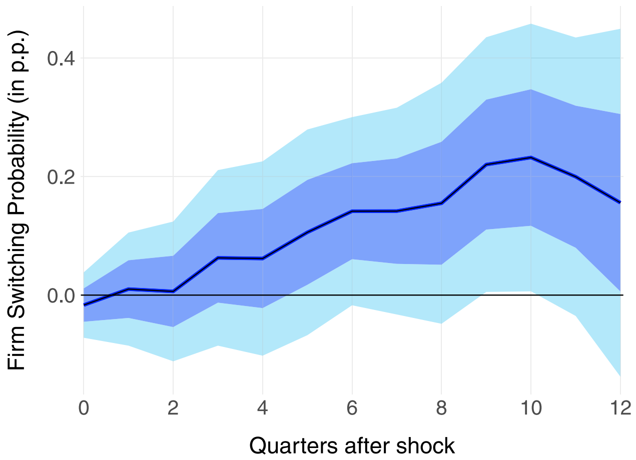

Fig. 3. Average response of firm switching probability. Note: The solid line shows the estimated β^h coefficients in Eq. (3.1) when using (4.1) as left-hand side. The β^h coefficients are standardized to capture the firm switching probability response to a one standard deviation increase in $\varepsilon_t^{\mathrm{MP}}$. The inner and outer shaded areas respectively indicate 68% and 95% confidence bands two-way clustered by worker and quarter.

While this section focuses on the employment (extensive) margin of the labor response to monetary policy, alternative channels of labor adjustment are hours worked and wages. Two important caveats of our data are that we do no observe hours worked and that we observe the labor earnings only at an annual frequency. We propose to study male employment as an imperfect mean to study a sub-population for which the hours margin is less important.[18] Fig. A.5(a) shows the average employment response of male workers to monetary policy shocks. The response is similar in shape and only somewhat larger in magnitude compared to the total population in Fig. 1. If the hours margin is more important for female workers' response, then the evidence suggests the hours margin is of limited quantitative relevance. Of course, this is a speculative conclusion and ultimately studying the hours margin requires data on hours worked. To study the response of wages, we compute labor earnings per days worked. A disclaimer is that our data only measures wages at yearly frequency. Fig. A.5(b) shows male workers' wage response to the monetary policy shock. Note that the underlying sample is restricted to workers that were continuously employed by the same firm during the 12 quarters after the shock. We find no statistically significant negative effect in the first three years after the monetary policy shock. This suggests that the wage margin is also of limited quantitative relevance, in particular when compared to the employment margin. This is in line with the evidence in Bertheau et al. (2023b), which shows that firms are reluctant to cut wages and resort to layoffs instead.

4. Reallocation of workers across firms

In this section, we estimate the effects of monetary policy shocks on the reallocation of workers across firms. We find that workers are more likely to switch firms and they tend to switch to worse-paying firms. In particular, low-paid workers employed by low-paying firms before the shock are most likely to switch to worse-paying firms.

4.1. Firm switching probability

To estimate the average effects of monetary policy shock on the probability that a worker switches between firms, we use Eq. (3.1) but replace the left-hand side with a dummy variable that indicates whether a worker switches firms

$$e_{i,t+h}^{switch} = \begin{cases} 1 & \text{if a worker is employed in } t+h \text{ by a different firm than in } t-1, \\ 0 & \text{else.} \end{cases} \tag{4.1}$$

For $h = 0$, the sample average of $e_{i,t+h}^{switch}$ is the quarterly firm switching probability, the EE transition rate, which is 2.8% (see Table 1).

The estimated average response of the firm switching probability to a one standard deviation monetary policy shock is shown in Fig. 3. The switching probability increases by up to 0.2 p.p. after the shock, which is a sizeable increase over the average switching probability. However, the response is only mildly significant, in particular when compared to the response of the employment probability in Fig. 1.

We again turn to the question of which workers are more prone to change employers. In particular, we use (3.2) but replace again the left-hand side with the dummy variable indicating a change in employer from Eq. (4.1). Fig. 4 provides our findings. Most remarkable is the role of the worker fixed effect. Low-paid workers are significantly more likely to switch firms. A one standard

[18] In Austria, less than 10% of male workers have a part-time employment, while the same figure is about 50% for female workers.

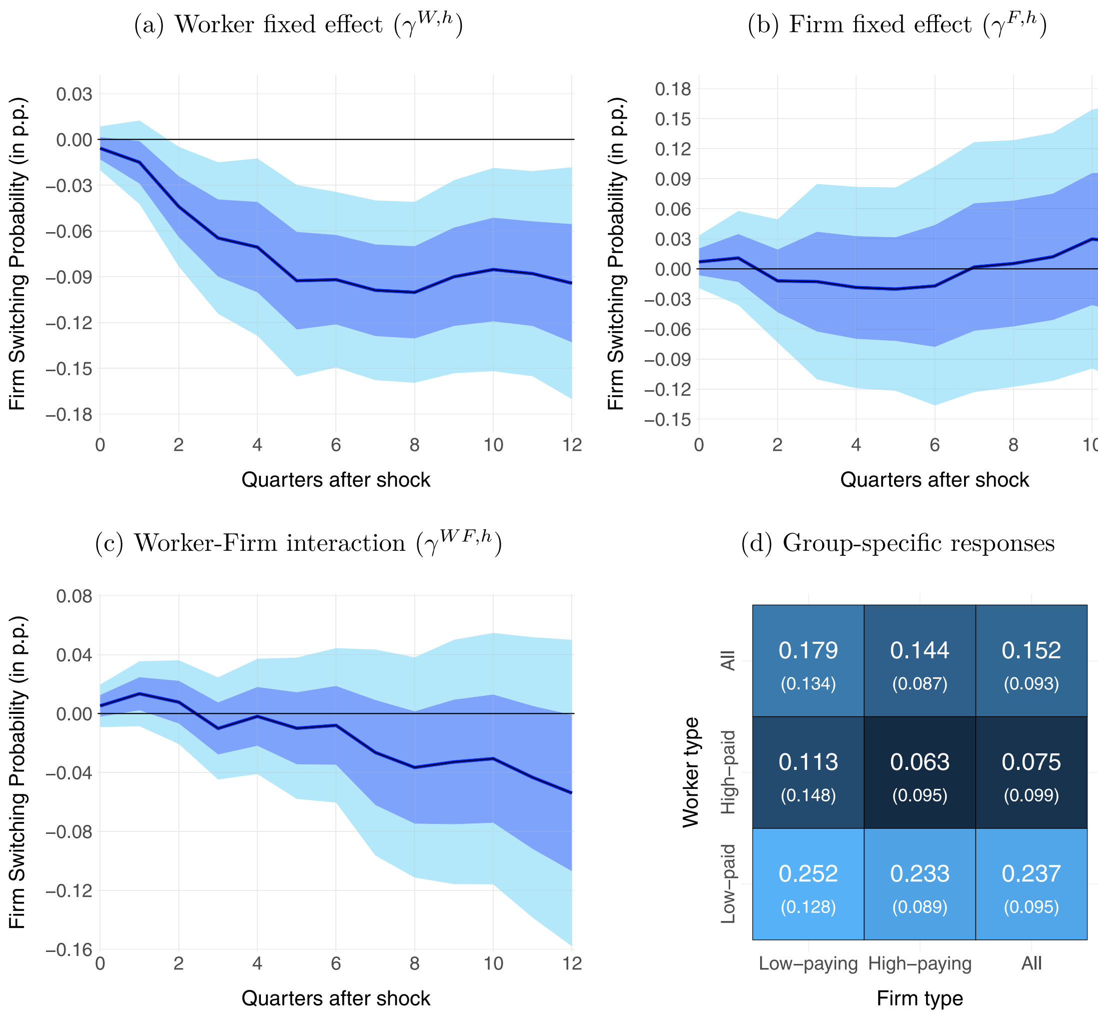

Fig. 4. Firm switching response across worker and firm fixed effects. Note: The solid lines in panels (a)–(c) show the differential responses estimated by the γ coefficients in Eq. (3.2) when replacing the left-hand side by (4.1). The γ coefficients are standardized to capture the firm switching probability response to a one standard deviation increase in $\varepsilon_t^{\mathrm{MP}}$ given a one standard deviation above-average worker and firm fixed effect. The inner and outer shaded areas respectively indicate 68% and 95% confidence bands two-way clustered by worker and quarter. Panel (d) shows the total firm switching response of different worker groups estimated based on β^h, $\gamma^{W,h}$, $\gamma^{F,h}$, $\gamma^{WF,h}$ at $h = 5$ and the associated standard errors are in parentheses. For example, the firm switching response of high-paid workers in low-paying firms is estimated based on $\beta^h + (p_{75}^W - p_{50}^W)\gamma^{W,h}/\sigma_W + (p_{25}^F - p_{50}^F)\gamma^{F,h}/\sigma_F + (p_{75}^W - p_{50}^W)(p_{25}^F - p_{50}^F)\gamma^{WF,h}/(\sigma_W\sigma_F)$, where p_x^W and p_x^F denote the x-th percentiles of the distribution of worker and firm fixed effects, and σ_W and σ_F are the associated standard deviations.

deviation lower worker fixed effect lowers the firm switching probability by up to 0.10 p.p. In contrast, we do not find significant differences across firm fixed effects or along the interaction of worker and firm fixed effects.

4.2. Firm wages

The previous section showed that monetary policy induces workers to switch employers, with the effect concentrated among low-paid workers. This naturally leads to the question of where these workers move to, in particular, whether they find better- or worse-paying employers compared to before. Thus, we first ask whether monetary policy on average leads to a reallocation of workers towards lower or higher firm fixed effects. To estimate the average effect of monetary policy shocks on the change in the firm fixed effects of workers that switch firms, we use (3.1) but replace the left-hand side by

$$\boldsymbol{F}_{j(i,t+h)} - \boldsymbol{F}_{j(i,t-1)}, \tag{4.2}$$

which is the change in the worker-associated firm fixed effect between the original employer in $t-1$ and the employer in $t+h$. Recall that in Section 3, we classified workers and firms using the backward-looking fixed effects in order to avoid the endogeneity of fixed effects with respect to the monetary policy shocks. In contrast, (4.2) features the firm fixed effect estimates over the entire

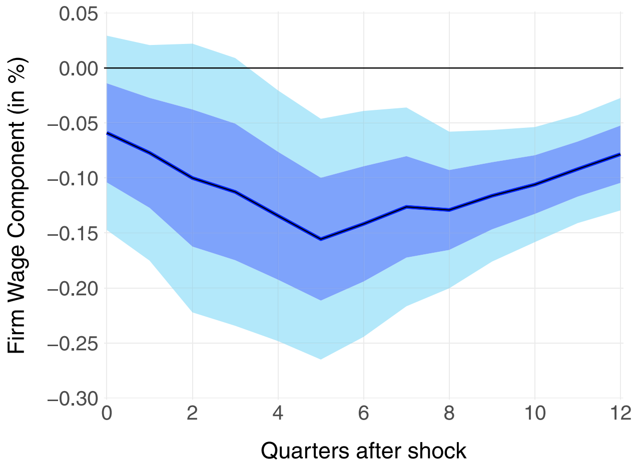

Fig. 5. Average response of firm fixed effect. Note: The solid line shows the estimated β^h coefficients in Eq. (3.1) when using (4.2) as left-hand side and restricting the sample to workers who switch firms. The β^h coefficients are standardized to capture the change in firm fixed effect to a one standard deviation increase in $\varepsilon_t^{\text{MP}}$. The inner and outer shaded areas respectively indicate 68% and 95% confidence bands two-way clustered by worker and quarter.

sample, because we cannot otherwise compare firm fixed effects over time. We estimate the regression on changes in the firm fixed effect on the subset of workers switching firms between period $t-1$ and $t+h$.

Fig. 5 shows that the average response of the firm fixed effect is significantly negative. After a one standard deviation monetary policy shock, the average change in the firm wage premium of workers who switch firms falls by up to 0.16%. These effects are sizeable, as compared to the unconditional average drop in the firm fixed effect of 1.6% for switching workers.

We next study the heterogeneity of the change in firm fixed effects across workers and firms. In particular, we use (3.2) but replace again the left-hand side with (4.2). Fig. 6 provides our findings. Panel (a) shows that the differential responses of changes in the firm fixed effect associated with a higher worker fixed effect are indistinguishable from zero when the original firm fixed effect equals the sample average. Similarly, panel (b) shows that the differential responses of changes in the firm fixed effect associated with a higher firm fixed effect are insignificant when the worker fixed effect equals the sample average. Interestingly, panel (c) shows that there is a strong interaction between the worker fixed effect and the initial firm fixed effect. Taking the average and all differential estimates together, panel (d) shows that low-paid workers employed at low-paying firms before the shock are losing the most from reallocation after monetary policy shocks.

Overall, our results show that monetary policy shocks tend to reallocate workers toward worse-paying firms. This effect is particularly pronounced for low-paid workers originally employed by low-paying firms.

Finally, we separately study the firm wage response of workers with job-to-job (EE) transitions and workers with an intermittent spell of unemployment (EUE). While the former may predominantly be quits, the latter transitions are likely dominated by layoffs. We may therefore expect the latter group to reallocate to worse firms than the former group. Fig. A.6(a) shows that EUE transitions indeed tend to reallocate to worse-paying firms than EE transitions. The same pattern emerges for the group-specific responses across worker and firm fixed effects, see panels (b) and (c) of the same figure.

5. Sensitivity analysis

In this section, we examine the sensitivity of our empirical findings with respect to an alternative regression specification, alternative monetary policy shocks, control variables, sample, and data treatment.

Dummies for worker and firm fixed effects groups. Our findings on the role of worker and firm fixed effects in Figs. 2, 4, and 6 are estimated based on the local projection model in (3.2), which features linear interactions between monetary policy shocks and worker and firm fixed effects. We examine the sensitivity of our findings to an alternative semi-parametric regression model, in which we replace the linear interactions by dummies signifying whether worker and firm fixed effects are above the average. Formally, we estimate

$$
\begin{aligned}
e_{i,t+h} =& \alpha_i^h + \beta^h \varepsilon_t^{\text{MP}} \\
&+ \gamma^{W,h} \varepsilon_t^{\text{MP}} \times \mathbb{1}\left\{ \widetilde{\boldsymbol{W}}_{i,\tau-1}^{rolling} > \overline{\widetilde{\boldsymbol{W}}_{i,\tau-1}^{rolling}} \right\} \\
&+ \gamma^{F,h} \varepsilon_t^{\text{MP}} \times \mathbb{1}\left\{ \widetilde{\boldsymbol{F}}_{j(i,t-1),\tau-1}^{rolling} > \overline{\widetilde{\boldsymbol{F}}_{j(i,t-1),\tau-1}^{rolling}} \right\} \\
&+ \gamma^{WF,h} \varepsilon_t^{\text{MP}} \times \mathbb{1}\left\{ \widetilde{\boldsymbol{W}}_{i,\tau-1}^{rolling} > \overline{\widetilde{\boldsymbol{W}}_{i,\tau-1}^{rolling}} \right\} \times \mathbb{1}\left\{ \widetilde{\boldsymbol{F}}_{j(i,t-1),\tau-1}^{rolling} > \overline{\widetilde{\boldsymbol{F}}_{j(i,t-1),\tau-1}^{rolling}} \right\} + \delta^h Z_{i,t-1} + v_{i,t+h}^h,
\end{aligned}
\tag{5.1}
$$

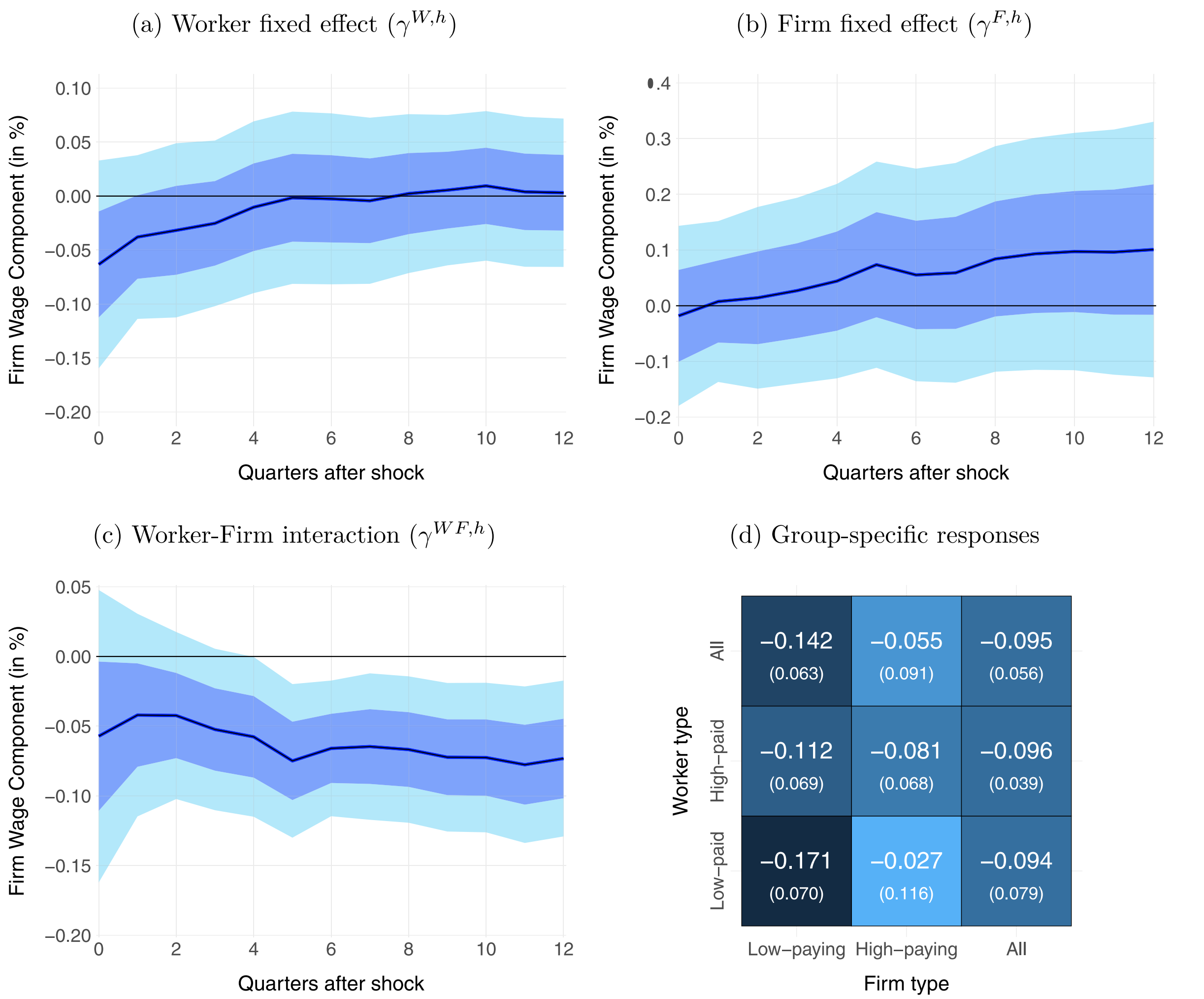

Fig. 6. Firm fixed effect response across worker and (original) firm fixed effects. Note: The solid lines in panels (a)–(c) show the differential responses estimated by the γ coefficients in Eq. (3.2) when replacing the left-hand side by (4.2) and restricting the sample to workers who switch firms. The γ coefficients are standardized to capture the change in firm fixed effects in response to a one standard deviation increase in ϵ_t^{MP} and for a one standard deviation above-average worker and firm fixed effect. The inner and outer shaded areas respectively indicate 68% and 95% confidence bands two-way clustered by worker and quarter. Panel (d) shows the total response of firm fixed effects of different worker groups estimated based on β^h, $\gamma^{W,h}$, $\gamma^{F,h}$, $\gamma^{WF,h}$ at $h = 5$ and the associated standard errors are in parentheses. For example, the firm fixed effect response of high-paid workers in low-paying firms is estimated based on $\beta^h + (p_{75}^W - p_{50}^W)\gamma^{W,h}/\sigma_W + (p_{25}^F - p_{50}^F)\gamma^{F,h}/\sigma_F + (p_{75}^W - p_{50}^W)(p_{25}^F - p_{50}^F)\gamma^{WF,h}/(\sigma_W\sigma_F)$, where p_x^W and p_x^F denote the x-th percentiles of the distribution of worker and firm fixed effects, and σ_W and σ_F are the associated standard deviations.

where $\mathbb{1}\{\cdot\}$ is a binary dummy and $Z_{i,t-1}$ is defined as in Section 3.

Panel (a) of Fig. A.7 in the Appendix A shows the group-specific employment responses estimated from (5.1). Our findings change little compared to using linear interactions (see panel (d) in Fig. 2). The estimated magnitudes are comparable and similarly significant. Importantly, the group with the highest non-employment exposure to monetary policy remains low-paid workers employed at high-paying firms before the shock.

Panel (b) of Fig. A.7 in the Appendix A shows the group-specific firm switching responses estimated from (5.1). Similarly to our findings using linear interactions (see panel (d) in Fig. 4), we find that low-paid workers are more likely to switch to another firm. Moreover, non-linear specification highlights that low-paid workers employed before the shock at high-paying firms are the group with the highest firm switching exposure to monetary policy.

Panel (c) of Fig. A.7 shows the non-linear estimates of firm fixed effect responses for workers switching firms after the shock. To be precise, we estimate (5.1) when replacing the left-hand side by the change in the firm fixed effect in (4.2). The differences between groups become more significant, but our findings are overall robust to using the linear interactions, compared with panel (d) in Fig. 6. In particular, the group with the highest exposure to monetary policy remains low-paid workers employed at low-paying firms before the shock.

Monetary policy shocks. Our baseline monetary policy shocks are based on the sign-restricted changes in the 6-month OIS rates. We examine the robustness of our results when using instead the changes in the 6-month OIS rates around policy announcements without applying sign restrictions. Fig. A.8 shows that our estimated employment responses have similar point estimates, but are mostly insignificant. This suggests that the raw surprises are strongly contaminated by information effects (Jarociński and Karadi, 2020). We further consider the sign-restricted 3-month OIS rate surprises. Fig. A.9 shows that we obtain very similar effects to the baseline, both in terms of magnitude and significance.

Control variables. We examine the sensitivity of our baseline specification to controlling for a set of standard macroeconomic variables. In particular, we enrich $Z_{i,t-1}$ to include a lagged monetary policy shock and changes in log GDP, log CPI, and the unemployment rate. Fig. A.10 shows that this does not change our findings much.

Pre-ZLB sample. Every paper using high-frequency identified monetary policy shocks faces the potential problem of the Zero Lower Bound (ZLB). Our baseline results use the longest possible sample including the ZLB. Importantly, because our monetary policy shocks are based on 6-month interest rates, we observe many shocks even during the ZLB episode (see Fig. A.1). Nevertheless, because monetary transmission may have changed we revisit our results in a pre-ZLB sample, ending in 2012Q2 just before the deposit facility rate reached zero. Fig. A.11 in the Appendix A shows that the employment responses are robust to using the pre-ZLB sample.

Missing worker observations. Our baseline data treatment only considers workers who are registered as employed or unemployed. Some workers leave our sample for some quarters before returning. Potential reasons are that they stopped receiving unemployment benefits, they left the country, or they became self-employed. We revisit our results when assuming that missing observations between two appearances of a worker in the sample are non-employment spells. Fig. A.12 shows that this change amplifies the average employment response to −0.4 p.p. and increases heterogeneity in worker fixed effects. In contrast, firm fixed effects become less important.

Robustness of AKM specification. The fixed effect estimates from the AKM regression for firms with few worker movements might be very imprecisely estimated, which is coined limited mobility bias. Although we are using only the point estimates from the AKM regression, which are unbiased under limited mobility bias, the imprecision of the estimates might be a concern by itself. In addition, it might lead to attenuation bias in our estimates. To address this, we use the method of Bonhomme et al. (2019a) and cluster firms in 10 groups in a first step, and then estimate the firm and worker effects using the 10 firm clusters instead of individual firms. In theory, this reduces the limited mobility bias, especially for small firms, where few worker movements across firms are observed. Fig. A.13 shows the results. The shape of the responses is nearly identical and the point estimates are very similar. In addition, Fig. A.14 shows that our baseline AKM results are robust to controlling for a 3rd order polynomial tenure effect.[19]

6. Discussion of mechanisms

In this section, we discuss the underlying economic mechanisms behind the central empirical findings in this paper.

The first finding in our paper is that low-paid workers experience larger employment losses after monetary tightening than high-paid workers. Qualitatively, this finding may not be very surprising. In standard search and matching models, low-paid workers create a smaller match surplus than high-paid workers. As a result, they are more likely to lose employment after monetary tightening. In addition, collective bargaining, which is a pervasive feature of the Austrian labor market, may be more binding for low-paid workers and thus explain why they are more likely to lose employment during an economic contraction. Yet another potential explanation is a trickle-down whereby high-paid workers are more likely to remain employed because they accept jobs of low-paid workers, which in turn raises the employment losses among low-paid workers (Barnichon and Zylberberg, 2019).

The second finding is that workers at high-paying firms are more likely to lose employment after monetary tightening than workers at low-paying firms. This finding may appear surprising at first, because the Hopenhayn (1992) model of firm dynamics predicts that low-productivity firms are more likely to exit.[20] However, our finding appears much less surprising against the backdrop of Moscarini and Postel-Vinay (2012), who document that employment growth at large firms, which tend to pay high wages, is more cyclically sensitive than at small firms. Our finding can be seen as a special case of their evidence when focusing on cyclical fluctuations due to monetary policy shocks. Moscarini and Postel-Vinay (2013) show that the finding in Moscarini and Postel-Vinay (2012), and by extension, our finding, can be rationalized by poaching dynamics. Large firms poach workers from small firms during economic expansions, which constrains the growth of small firms. During economic contractions, large firms shed workers and small firms have an opportunity to grow. This implication of poaching dynamics is additionally in line with our evidence that workers reallocate to worse-paying firms.

An alternative explanation of our second finding is based on labor supply. Workers at high-paying firms may have accumulated more savings and entitlements to unemployment benefits than workers at low-paying firms. Thus, the former workers may decide to spend more time searching for a good job, i.e., at a high-paying firm, resulting in a larger non-employment probability in the meantime. The labor supply explanation is also in line with our reallocation evidence that particularly low-paid workers at low-paying firms transition to worse-paying firms. Yet another explanation relates to Ottonello and Winberry (2020) who show that

[19] The linear term is omitted, as it is co-linear with the worker, firm, and year fixed effects.

[20] Lochner and Schulz (2024) shows that firm productivity and the AKM firm fixed effect are strongly positively correlated, see Figure 2D in their paper.

firms with low default risk are more responsive to monetary policy because they have a flatter marginal cost curve. If high-paying firms have low default risk, this may explain our finding.

Our third finding pertains to the interaction effect between worker and firm type. Low-paid workers at high-paying firms are especially likely to lose employment after monetary tightening, more than predicted by adding up the average effects of being low-paid and of being employed at a high-paying firm. This is exactly the prediction of a sorting model with complementarity between firm productivity and worker productivity, see Lise and Robin (2017). In such a setup, complementarity implies that low-type workers employed at high-type firms are mismatched. Thus, they are the most vulnerable to aggregate shocks and their separation rates will increase more with an aggregate shock such as a monetary policy shock.

In addition, more productive firms may employ more sophisticated capital for which skilled labor is a more critical input. If high-paid (high-skilled) workers are more difficult to substitute in high-paying (more productive) firms, these firms will over-proportionally fire low-paid workers in response to tighter monetary policy.[21] A further explanation relates to the poaching dynamics discussed above. It may be particularly easy for well-paying firms to re-hire low-paid workers during the recovery.

Finally, a key empirical finding describes the reallocation of workers across firms. As discussed above, poaching dynamics can rationalize why workers reallocate to worse-paying firms after monetary tightening. In addition, labor supply effects can explain why in particular low-paid workers at low-paying firms reallocate down the wage-job ladder. While poaching dynamics and labor supply may explain our evidence, this does not rule out an important role for labor market institutions. For example, the extent to which collective bargaining agreements are binding constraints on wages differs across firms; so do the strength of unions and monopsony power across firms (Bachmann et al., 2023).

7. Conclusion

In this paper, we empirically characterize the distributional effects of ECB monetary policy shocks across workers and firms using Austrian social security records. We focus on the heterogeneity across worker and firm types identified by a (Abowd et al., 1999) regression, which is the workhorse model to estimate the worker and firm components of wages.

We document three novel results. First, we document which type of workers and firms face the highest decline in employment in response to a contractionary monetary policy shock. Individuals who are low-paid and employed at high-paying firms face the strongest employment declines. Second, monetary tightening increases the rate at which workers reallocate across firms, in particular for low-paid workers. Third, we document that monetary policy shocks lead to a reallocation of workers to worse-paying firms, with low-paid workers from low-paying firms especially prone to falling off the firm wage ladder. While all low-paid workers are especially exposed to contractionary monetary policy shocks, we document large differences across low-paid workers depending on the type of firm they are employed at before the shock.

Our results have implications for inequality, allocative efficiency, and transmission of monetary policy. For inequality, we show that the collapse of a job ladder is driven by the poorest workers. At the bottom of the income distribution, income is driven by labor earnings and its extensive margin (e.g., Amberg et al., 2022). Hence, the lower employment probabilities and the reallocation down a firm wage ladder for the low-paid worker increase income inequality after a monetary shock. For allocative efficiency, if worker fixed effects correspond to workers' skills and productivity, and if the firm fixed effects correspond to firms' productivity, reallocation towards lower-paying firms could contribute to a drop in aggregate productivity, as is well-documented in the literature (e.g., Jordà et al., 2020; Meier and Reinelt, 2022; Baqaee et al., 2022).

For the transmission of monetary policy, our results suggest that studying monetary models with two-sided heterogeneity is important. Moreover, our results suggest that a key moment is how the marginal propensity to consume is distributed across both worker and firm types. Promising topics for future research are to better understand the economic mechanisms leading to our findings, and their implications for macroeconomic stabilization policies.

Appendix A

A.1. Monetary policy shocks

[21] The capital-skill complementarity explanation is an extension of the mechanism in Dolado et al. (2021) to an environment with heterogeneous firms differing in their capital-skill complementarity. In fact, Dolado et al. (2021) show that high-skilled workers are more affected by monetary policy shocks, which may appear to contradict our first finding that low-paid workers are more responsive. One reason for the difference in findings is that we control for the firm-specific wage component, which, as we find, moves in the opposite direction as the worker-specific wage component. Another reason may be that Dolado et al. (2021) define high-skilled as having at least some experience in college, whereas we focus on AKM wage fixed effects. Theoretically, other channels may trump the effect of the capital-skill complementarity channel on the employment response of high-paid workers. Relatedly, we find similar responses of employment probabilities in the (non-public) service sector as in the industrial sector. With capital intensity lower in the former, this suggests a limited role for the capital-skill complementarity channel in our sample (see Fig. A.15 in the Appendix A).

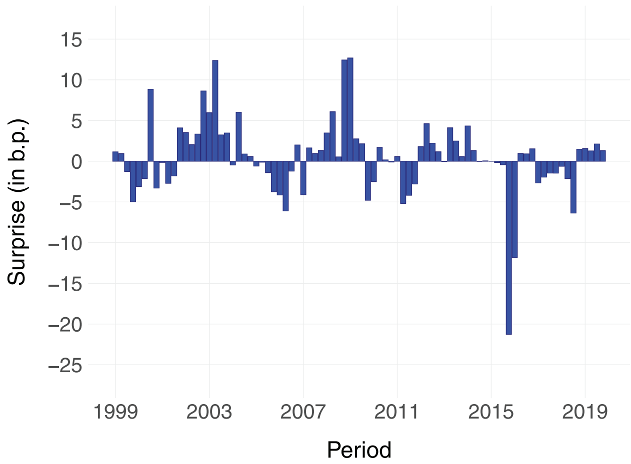

Fig. A.1. Monetary policy shocks series. Note: The monetary policy shock series is based on the changes in the 6-month OIS rates around ECB policy announcements from Altavilla et al. (2019) after applying sign restrictions as in Jarociński and Karadi (2020).

A.2. Additional results

Table A.1
Testing the difference between group-specific employment responses.

Hypothesis	t statistic
(low-paid workers) = (high-paid workers)	3.245
(workers at low-paying firms) = (Workers at high-paying firms)	5.128
(low-paid workers at low-paying firms) = (low-paid workers at high-paying firms)	5.395
(low-paid workers at low-paying firms) = (high-paid workers at low-paying firms)	1.461
(low-paid workers at low-paying firms) = (high-paid workers at high-paying firms)	0.737
(low-paid workers at high-paying firms) = (high-paid workers at low-paying firms)	4.979
(low-paid workers at high-paying firms) = (high-paid workers at high-paying firms)	3.828
(high-paid workers at low-paying firms) = (high-paid workers at high-paying firms)	3.847

Note: This table provides t statistics (in absolute values) for various tests of equality between the entries of Fig. 2(d).

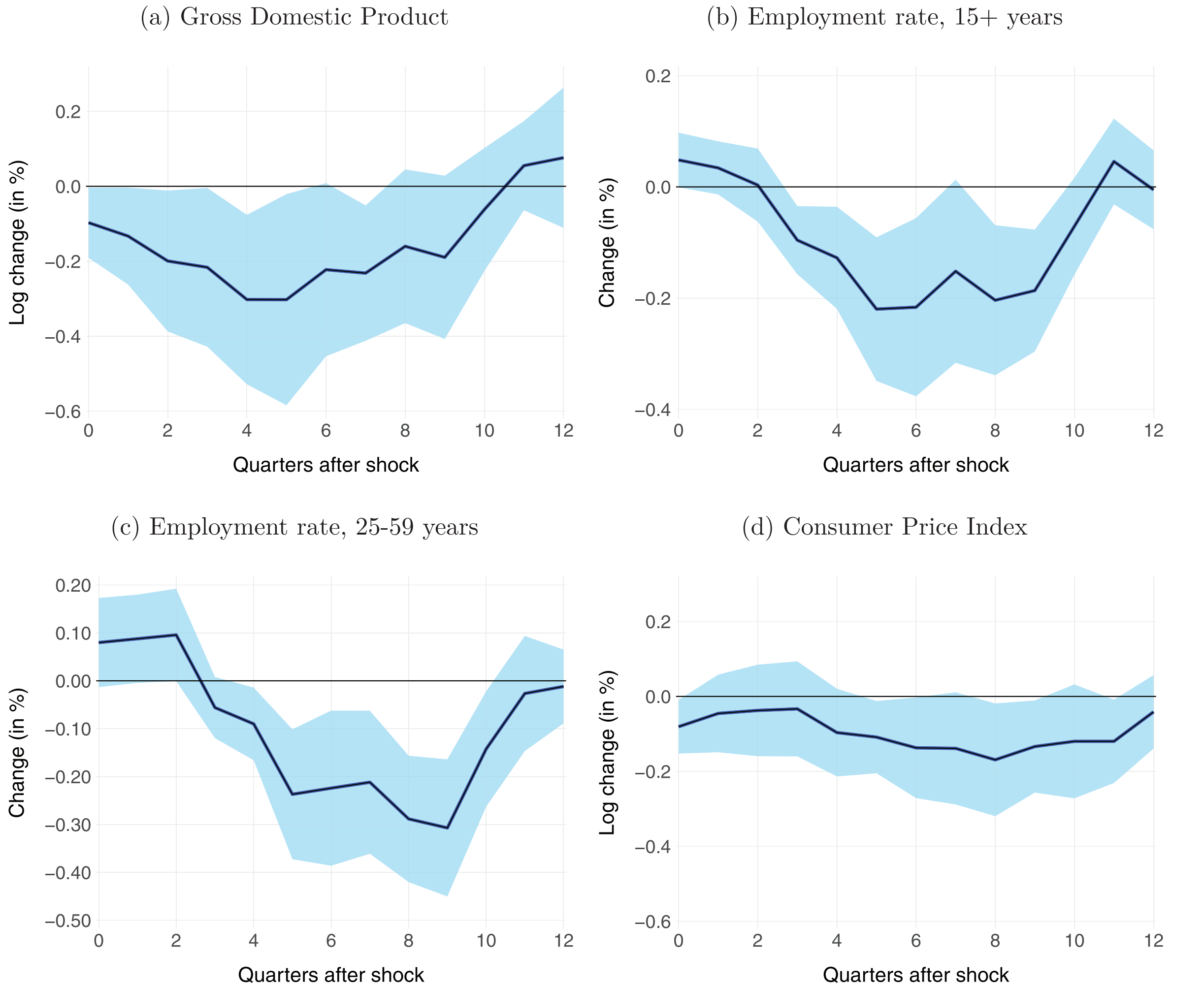

Fig. A.2. Macroeconomic responses to monetary policy shocks. Note: The solid lines show the estimated β^h coefficient in the local projection $y_{t+h} = \alpha + \beta^h\ \epsilon_t^{\mathrm{MP}} + \delta^h\ Z_{t-1} + \upsilon_{t+h}$, where Z_{t-1} contains a linear time trend, one lag of the shock ϵ_t^{MP} and four lags of the employment rate for persons of age 15+, GDP growth, and CPI growth. The left hand side y_{t+h} is $\Delta^h \log GDP_{t+h}$ in panel (a), ER_{t+h} in panels (b)–(c), and $\Delta^h \log CPI_{t+h}$ in panel (d). The β^h coefficients are standardized to capture the response to a one standard deviation increase in ϵ_t^{MP}. The inner and outer shaded areas respectively indicate 68% and 95% Newey–West confidence bands.

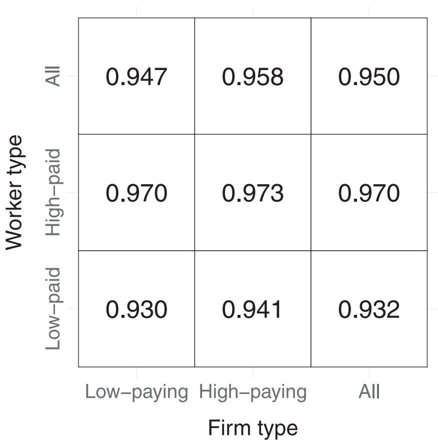

Fig. A.3. Group-specific unconditional employment probabilities. Note: The figure shows the average employment probabilities, that is the sample average of $e_{i,t+h}$, at $h = 5$, conditional on workers that are employed in $t-1$, for different groups of worker and firm types.

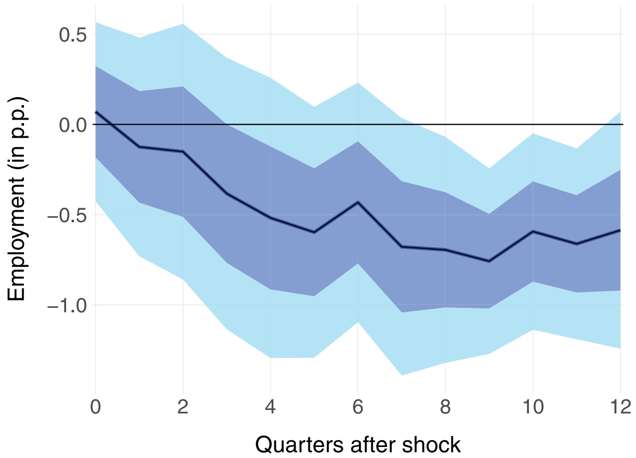

Fig. A.4. Employment probability of initially unemployed workers. Note: The solid line shows the estimated β^h coefficients in Eq. (3.1) for workers that are unemployed in $t-1$. The β^h coefficients are standardized to capture the employment probability response to a one standard deviation increase in ϵ_t^{MP}. The inner and outer shaded areas respectively indicate 68% and 95% confidence bands two-way clustered by worker and quarter.

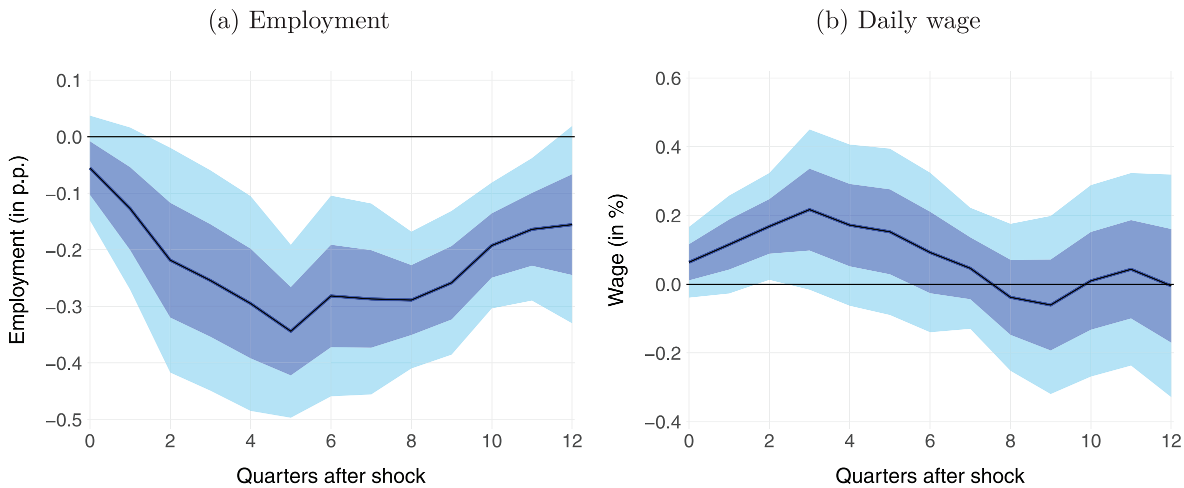

Fig. A.5. Wage and employment response of male workers. Note: Panel (a) shows the average employment response, analogous to Fig. 1, but restricting the sample to male workers. Panel (b) shows the average wage response of male workers, restricting the sample to males continuously working between $t-1$ and $t+12$ and not changing their employer. The wage response is estimated based on Eq. (3.1) when replacing $e_{i,t+h}$ by the difference between the log wage in quarter $t+h$ and the log wage in quarter $t-1$. The coefficients are standardized to capture the response to a one standard deviation increase in ϵ_t^{MP}. The inner and outer shaded areas respectively indicate 68% and 95% confidence bands two-way clustered by worker and quarter.

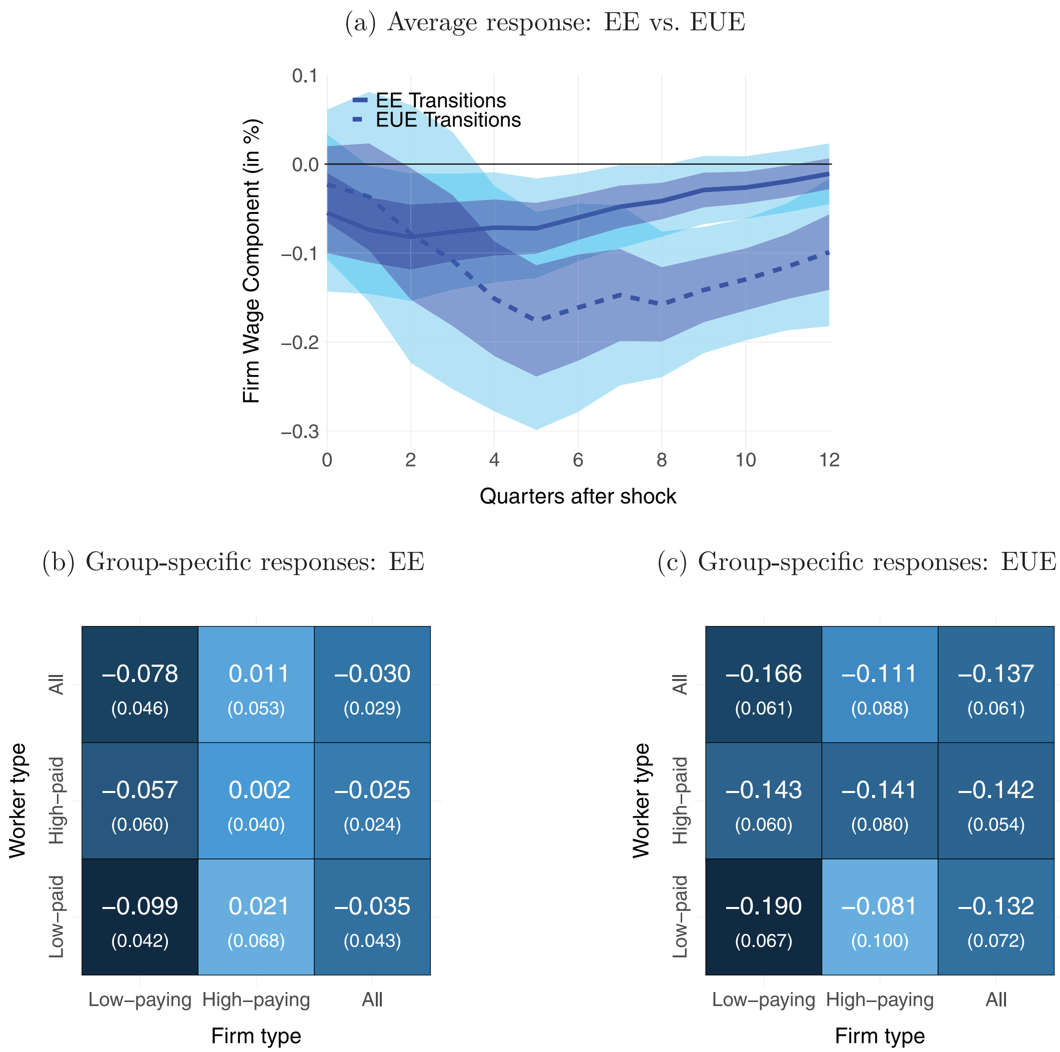

Fig. A.6. Response of firm fixed effect: EE vs. EUE transitions. Note: Panel (a) shows the estimated β^h coefficients in Eq. (3.1) when using (4.2) as left-hand side and restricting the sample to workers who switch firms, and conditioning on the type of job-to-job transition, i.e. $e^{switch|EE}_{i,t+h}$ or $e^{switch|EUE}_{i,t+h}$. The former equals one if a worker is employed in $t+h$ by a different firm than in $t-1$ and is unemployed for less than 30 days in between $t-1$ and $t+h$, and zero else. The latter equals one if a worker is employed in $t+h$ by a different firm than in $t-1$ and is unemployed for at least 30 days in between $t-1$ and $t+h$, and zero else. The β^h coefficients are standardized to capture the firm switching probability response to a one standard deviation increase in ϵ^{MP}_t. The inner and outer shaded areas respectively indicate 68% and 95% confidence bands two-way clustered by worker and quarter. Panels (b) and (c) are constructed analogously to Fig. 6(d) but defining switches by $e^{switch|EE}_{i,t+h}$ or $e^{switch|EUE}_{i,t+h}$.

A.3. Sensitivity analysis

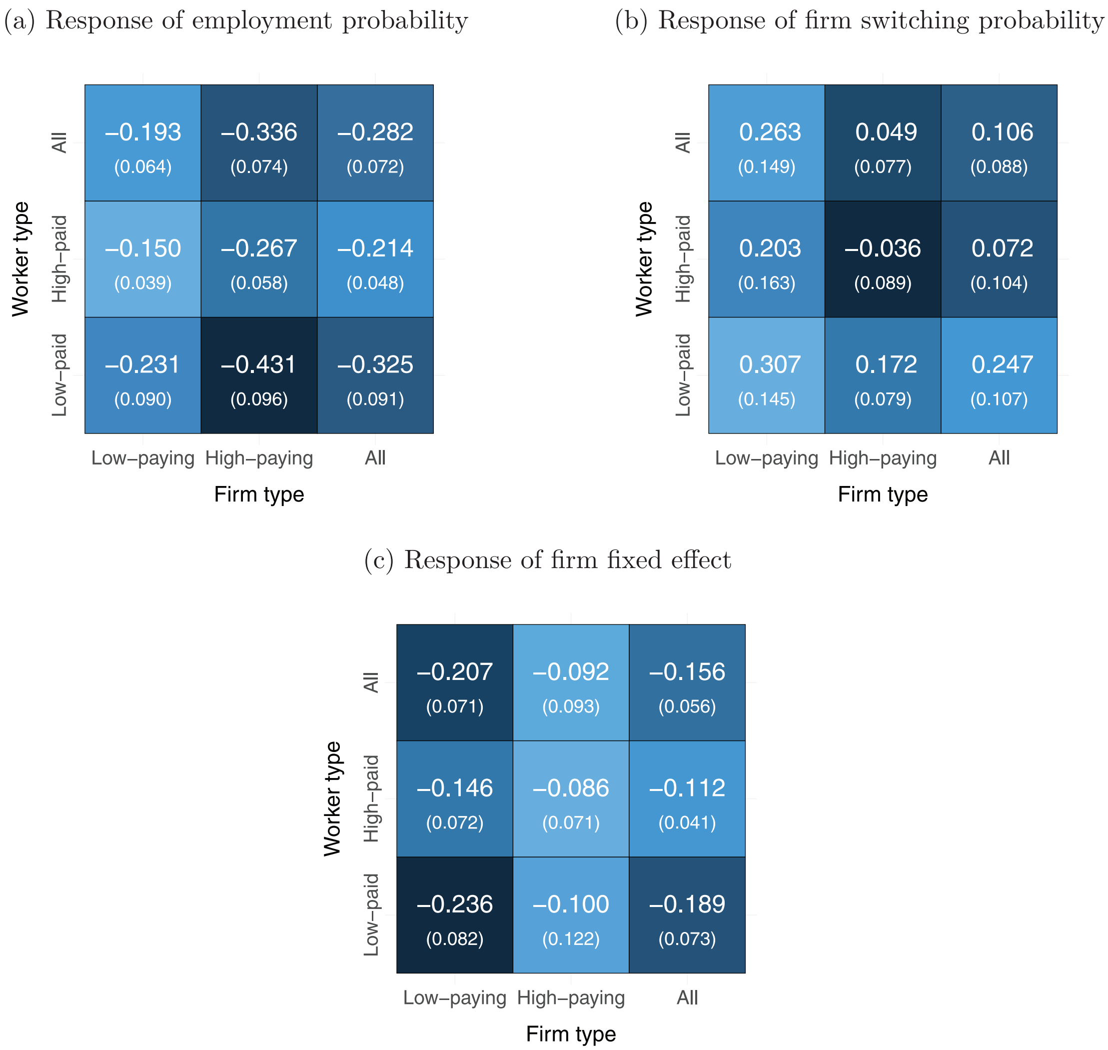

Fig. A.7. Group-specific responses using the non-linear specification. Note: Panel (a) shows the employment responses to a one standard deviation monetary policy shock of different worker groups estimated based on (5.1) at $h = 5$ with the associated standard errors are in parentheses. In panels (b) and (c), the left hand side of (5.1) is replaced by (4.1) and (4.2), respectively.

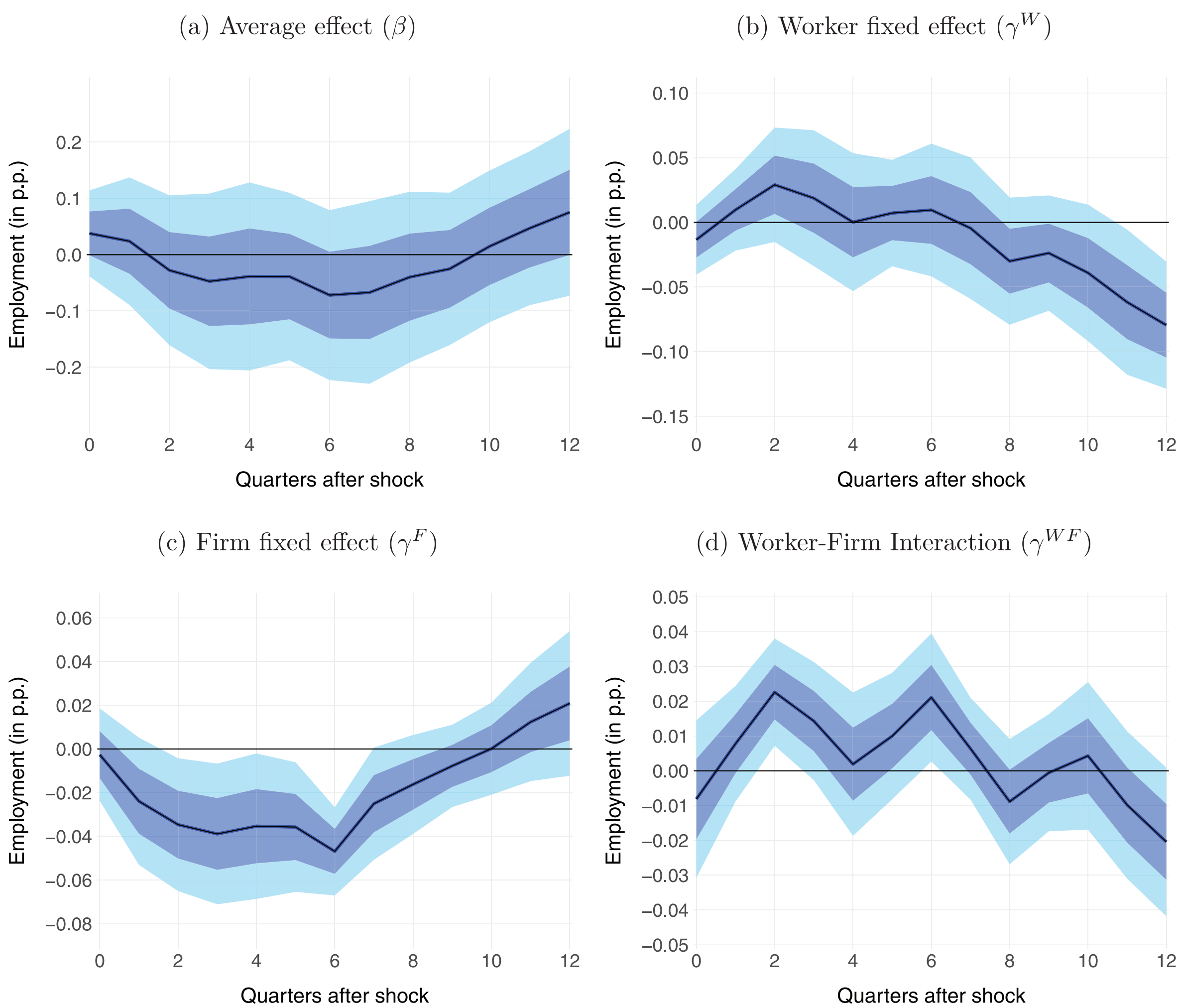

Fig. A.8. Employment response using surprises in 6-month OIS rate. Note: The solid line in Panel (a) shows coefficients β^h in Eq. (3.1) when ε_t are surprises in the 6-month OIS rate. The solid lines in panels (b)–(d) show the estimated γ coefficients in Eq. (3.2) when ε_t are surprises in the 6-month OIS rate. The coefficients are standardized to correspond to a one standard deviation increase in $\varepsilon_t^{\mathrm{MP}}$ and a one standard deviation increase in firm and worker fixed effects. The inner and outer shaded areas respectively indicate 68% and 95% confidence bands two-way clustered by worker and quarter.

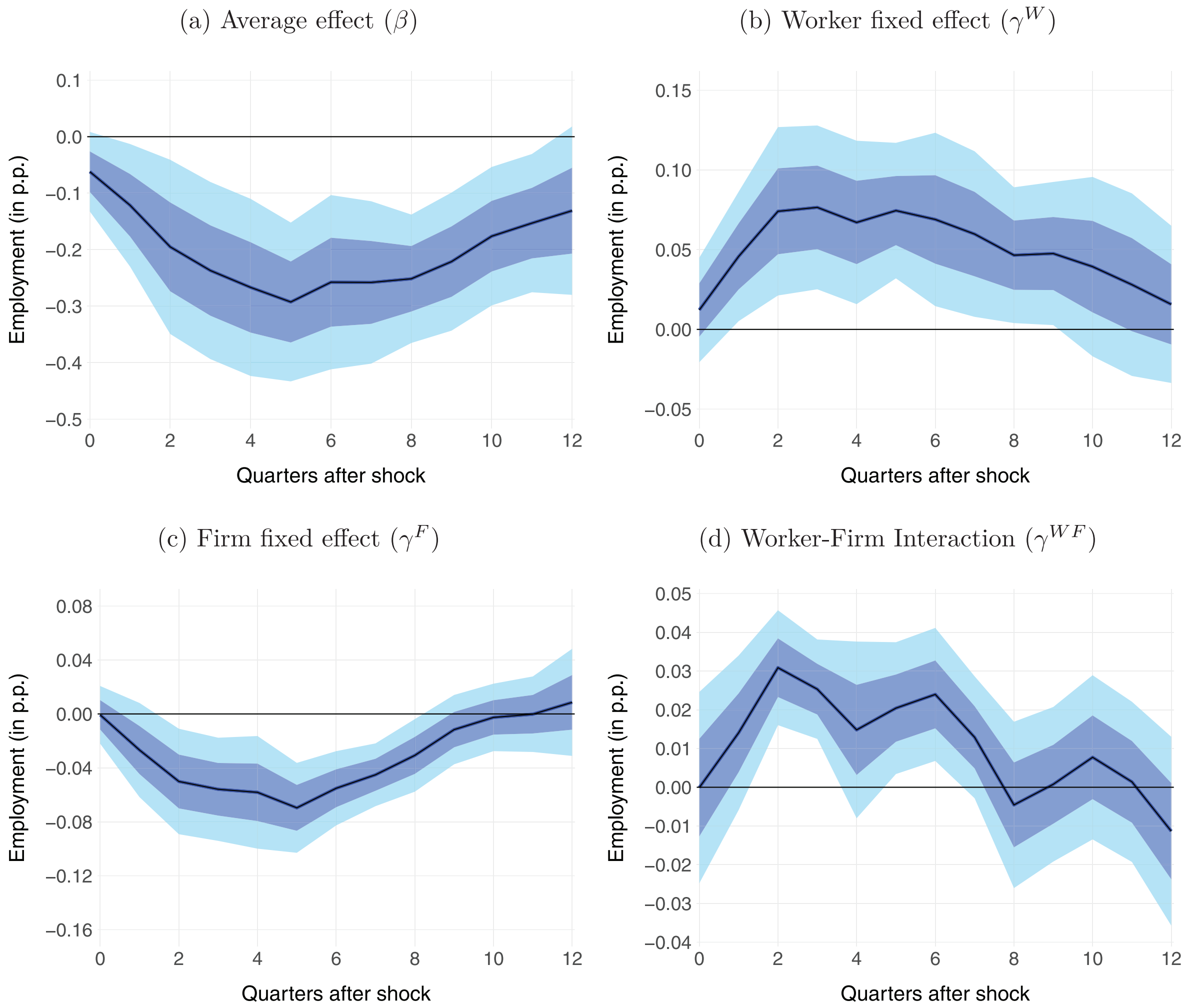

Fig. A.9. Employment response using sign-restricted surprises in 3-month OIS rates. Note: The solid line in Panel (a) shows coefficients β^h in Eq. (3.1) when ε_t are sign-restricted surprises in the 3-month OIS rate. The solid lines in panels (b)–(d) show the estimated γ coefficients in Eq. (3.2) when ε_t are sign-restricted surprises in the 3-month OIS rate. The coefficients are standardized to correspond to a one standard deviation increase in $\varepsilon_t^{\text{MP}}$ and a one standard deviation increase in firm and worker fixed effects. The inner and outer shaded areas respectively indicate 68% and 95% confidence bands two-way clustered by worker and quarter.

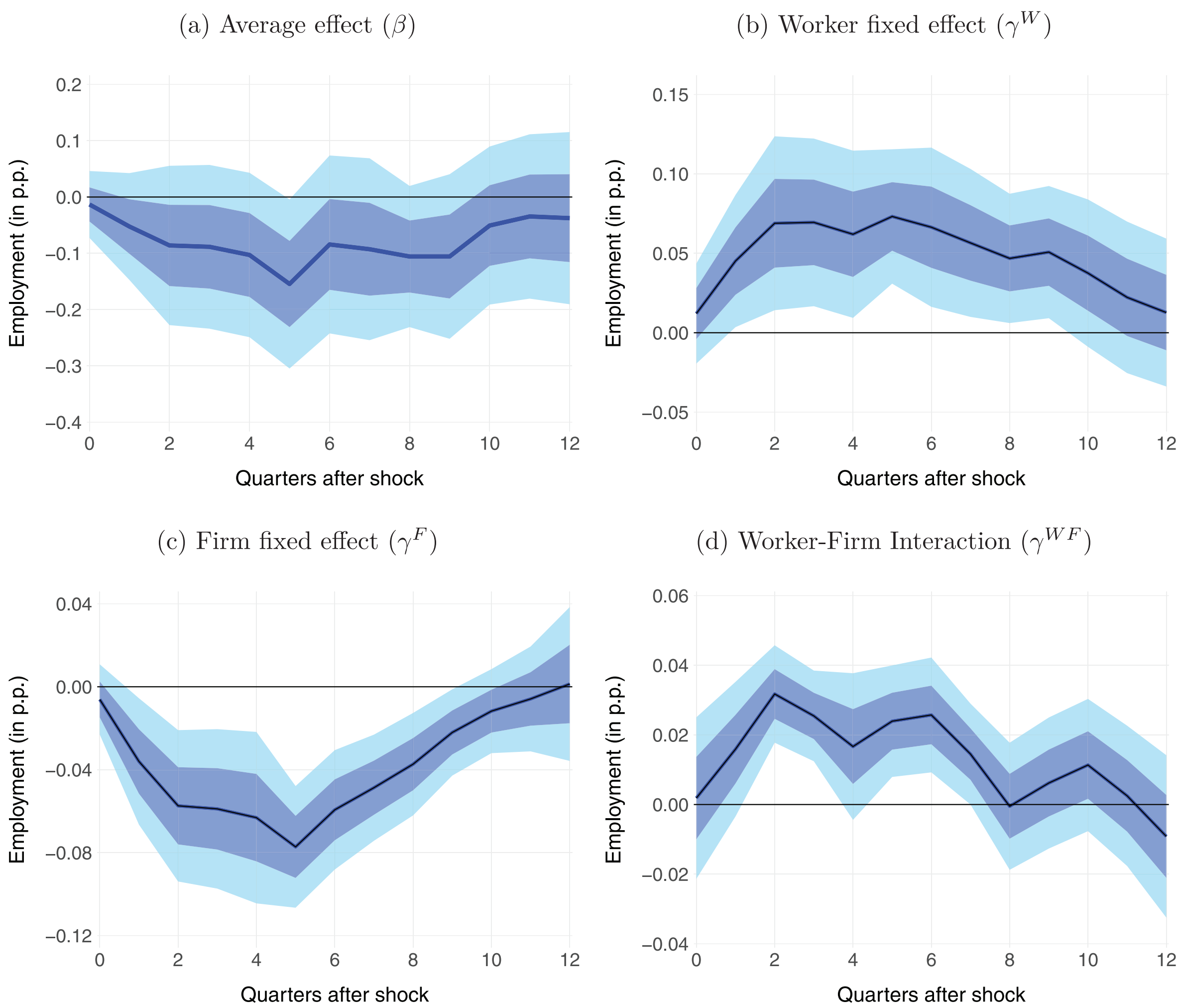

Fig. A.10. Robustness: Macro controls. Note: The solid line in Panel (a) shows coefficients β^h in Eq. (3.1) when we add to $Z_{i,t-1}$ lagged monetary policy shock, GDP, unemployment rate and inflation. The solid lines in panels (b)–(d) show the estimated γ coefficients in Eq. (3.2) when we add to $Z_{i,t-1}$ lagged monetary policy shock, GDP, unemployment rate and inflation. The coefficients are standardized to correspond to a one standard deviation increase in $\varepsilon_t^{\mathrm{MP}}$ and a one standard deviation increase in firm and worker fixed effects. The inner and outer shaded areas respectively indicate 68% and 95% confidence bands two-way clustered by worker and quarter.

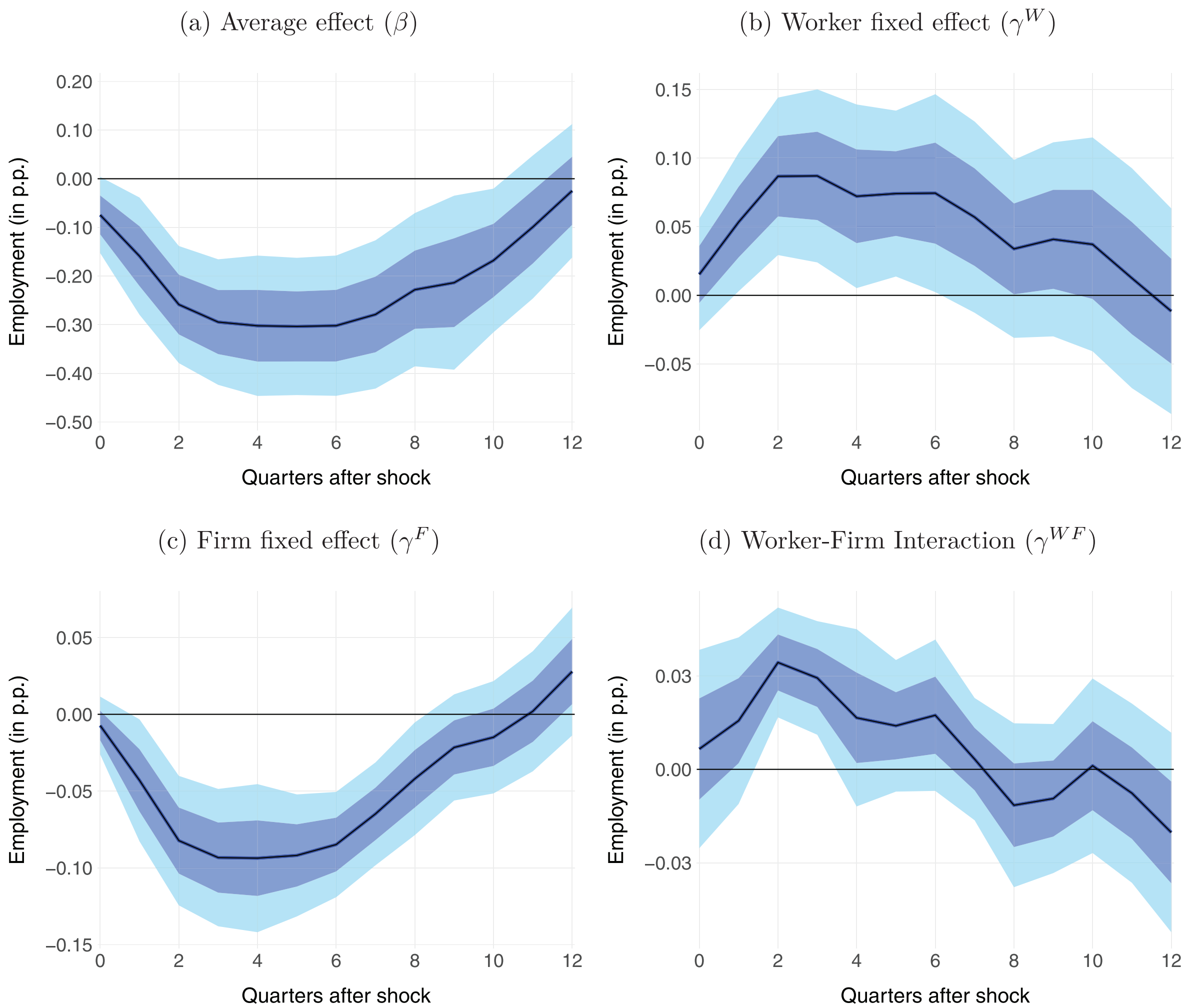

Fig. A.11. Employment response for the pre-ZLB period. Note: The solid line in Panel (a) shows coefficients β^h in Eq. (3.1) for observations until 2012Q2. The solid lines in panels (b)–(d) show the estimated γ coefficients in Eq. (3.2) for observations until 2012Q2. The coefficients are standardized to correspond to a one standard deviation increase in ε_t^{MP} and a one standard deviation increase in firm and worker fixed effects. The inner and outer shaded areas respectively indicate 68% and 95% confidence bands two-way clustered by worker and quarter.

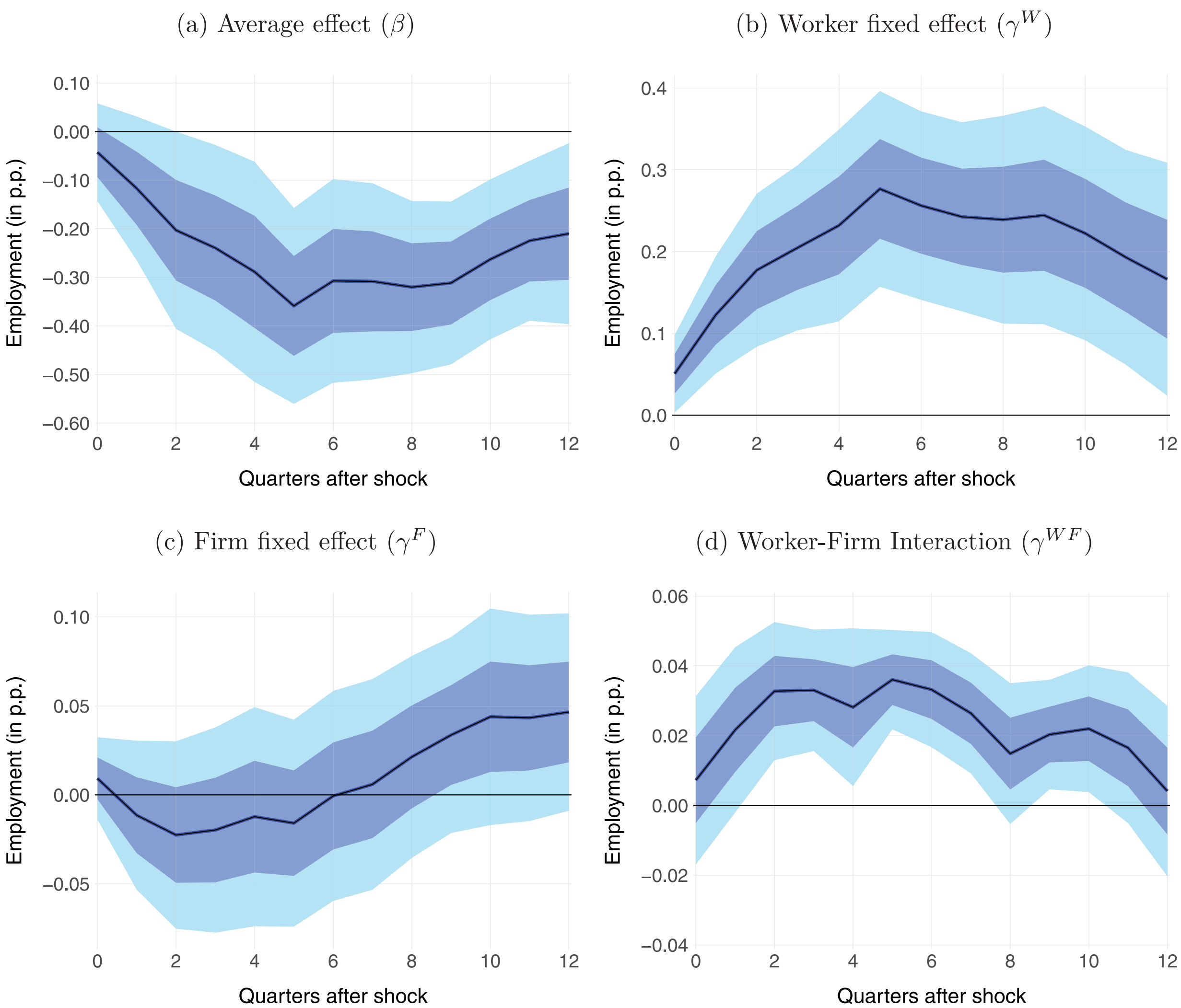

Fig. A.12. Employment response when filling missing observations. Note: The solid line in Panel (a) shows coefficients β^h in Eq. (3.1) when we fill missing observations as non-employed. The solid lines in panels (b)–(d) show the estimated γ coefficients in Eq. (3.2) when we fill missing observations as non-employed. The coefficients are standardized to correspond to a one standard deviation increase in $\varepsilon_t^{\mathrm{MP}}$ and a one standard deviation increase in firm and worker fixed effects. The inner and outer shaded areas respectively indicate 68% and 95% confidence bands two-way clustered by worker and quarter.

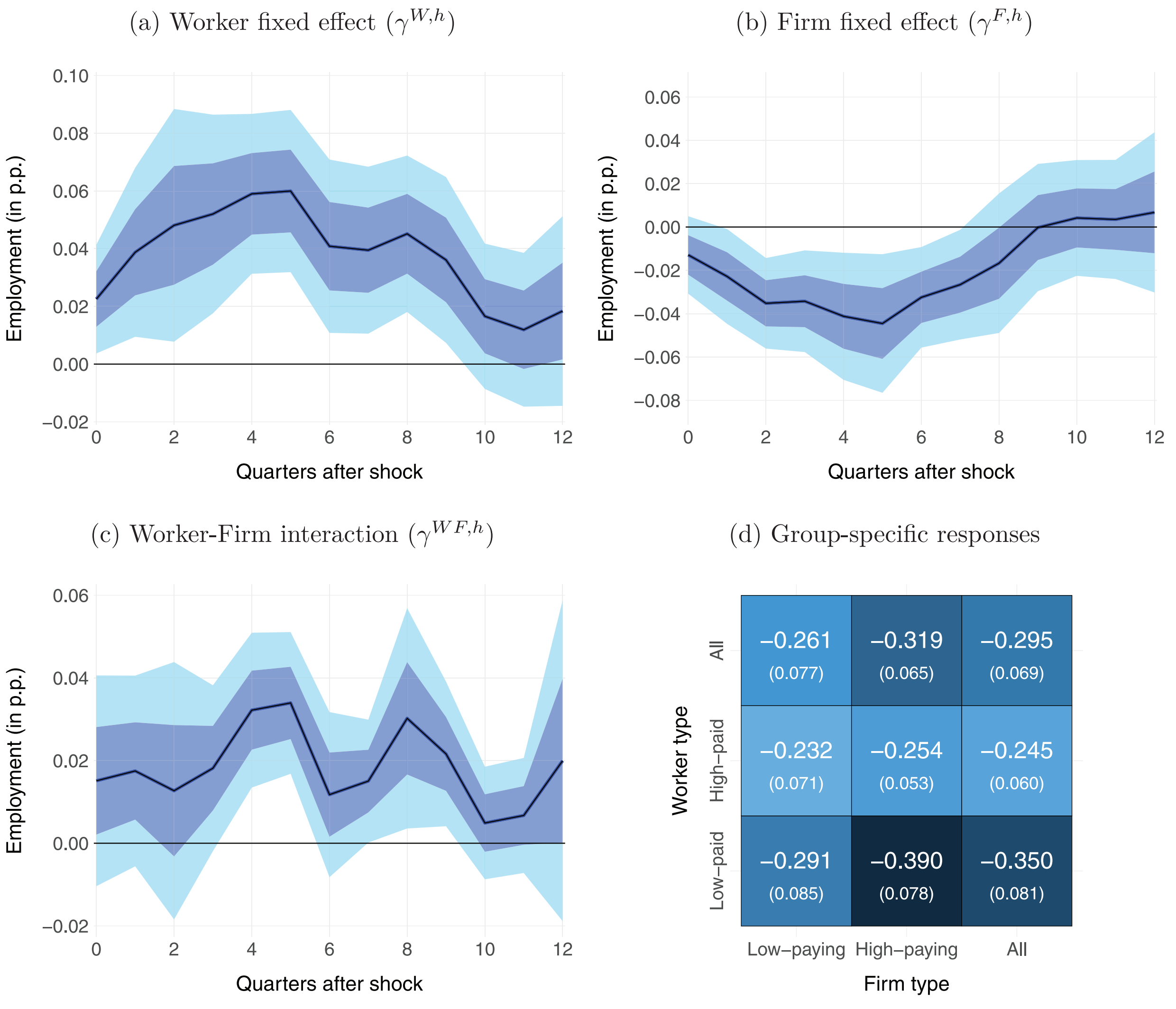

Fig. A.13. Employment response across worker and firm fixed effects when applying the clustering algorithm of Bonhomme et al. (2019a). Note: The panels are constructed analogously to Fig. 2 when estimating worker and firm fixed effects for 10 groups of firms.

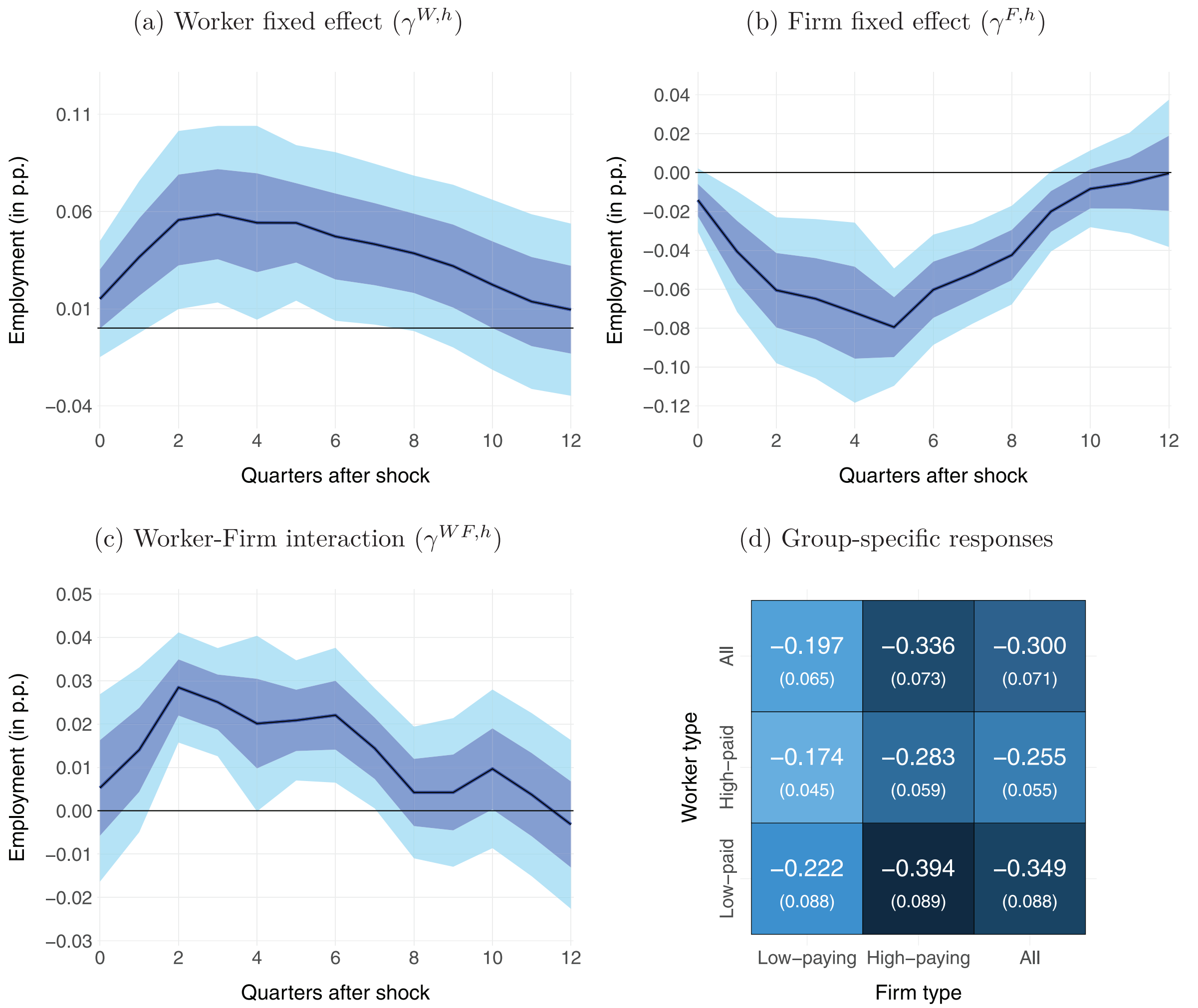

Fig. A.14. Employment response across worker and firm fixed effects when controlling for tenure in the AKM estimation. Note: The panels are constructed analogously to Fig. 2 when estimating worker and firm fixed effects using the AKM approach and controlling for a 3rd order polynomial of worker tenure.

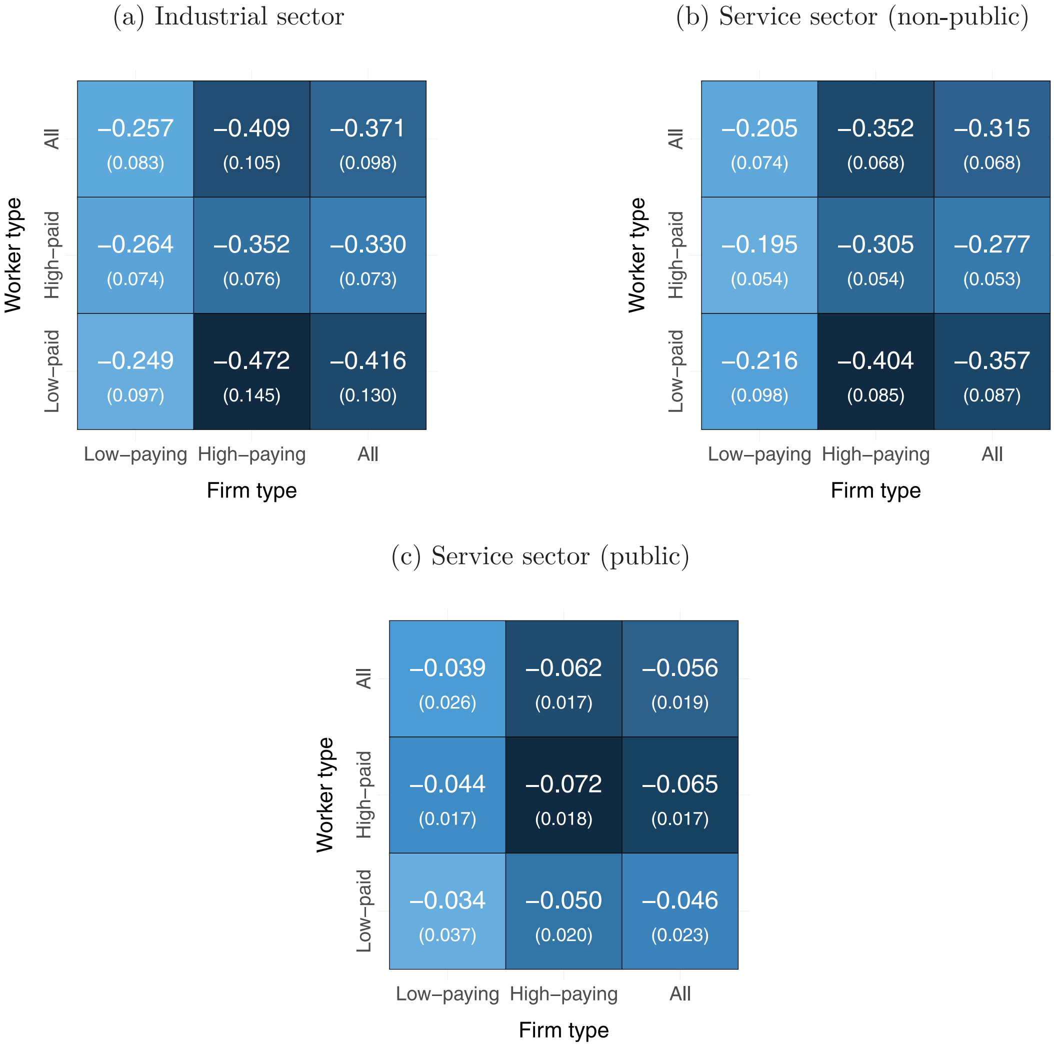

Fig. A.15. Employment response across sectors. Note: Panels (a)–(c) show the total employment response of different worker groups estimated based on β^h, $\gamma^{W,h}$, $\gamma^{F,h}$, $\gamma^{WF,h}$ at $h = 5$ and the associated standard errors are in parentheses. For example, the employment response of high-paid workers in low-paying firms is estimated based on $\beta^h + (p^W_{75} - p^W_{50})\gamma^{W,h}/\sigma_W + (p^F_{25} - p^F_{50})\gamma^{F,h}/\sigma_F + (p^W_{75} - p^W_{50})(p^F_{25} - p^F_{50})\gamma^{WF,h}/(\sigma_W\sigma_F)$, where p^W_x and p^F_x denote the x-th percentiles of the distribution of worker and firm fixed effects, and σ_W and σ_F are the associated standard deviations.

Appendix B. Supplementary data

Supplementary material related to this article can be found online at https://doi.org/10.1016/j.euroecorev.2024.104756.

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