Asymmetric Effects of Monetary Policy on Firms*

Ezgi Kurt†

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Abstract

This paper documents the first firm-level evidence on the asymmetric effects of monetary policy in the US. Focusing on firm-level data from 1980q3 to 2016q2, I find that monetary contractions triple the effects of monetary expansions on firms' employment, investment rate, and sales. Furthermore, I examine the role of alternative financial characteristics in propagating these asymmetric effects. My findings show a higher level of asymmetry for firms with a small size, low leverage, high liquidity, or a no-dividend paying status. These results provide evidence that financial characteristics play a role in propagating the asymmetric effects of monetary policy.

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†Assistant Professor, Bentley University, Department of Economics. Email: ekurt@bentley.edu

1. Introduction

The literature on monetary transmission has extensively documented the non-linear effects of monetary policy at the aggregate level. However, the sign dependent effects of monetary policy at the disaggregate level remain relatively underexplored. In this paper, I examine whether there is asymmetry in firms' response to sign dependent monetary innovations and whether financial characteristics play a role in propagating the asymmetric effects of monetary policy.

What causes asymmetry in monetary effectiveness? In recent years, the literature has proposed various mechanisms such as financial frictions and downward wage rigidity to model the asymmetric effects of monetary policy.[1] According to the financial frictions literature, a monetary tightening (e.g. an increase in interest rates) may result in weaker firm and bank balance sheets and lower expected future value of collateral assets, which in turn leads to more binding borrowing constraints on firms that are at the very margin.[2] The main idea is that during monetary contractions, credit constraints tend to bind, leading to larger effects on financially constrained firms. This type of amplification during contractions can be associated with banks engaging in credit rationing or incorporating higher risk premium into the financial contracts of high-risk firms to mitigate adverse selection and moral hazard problems.[3] In contrast, during monetary expansions, borrowing constraints tend to relax, weakening the amplification mechanism.

Studying the role of financial frictions in the context of monetary asymmetry requires (i) time-series identified, sign dependent monetary policy innovations and (ii) an indicator capturing the variation of financial constraints at the disaggregate level. To do this, I first follow Gertler and Karadi (2015), Cloyne et al. (2019), Gurkaynak et al. (2005), and Nakamura and Steinsson (2018a) and exploit high frequency surprises in interest rate futures contracts within a 30 minute window around policy announcement. Then, I use these monetary policy shocks to instrument the increases (or decreases) in the one-year government bond yields depending

[1] A non-exhaustive list of papers include Lin (2020), Barnichon et al. (2017), Kandil (1995), Gorodnichenko and Weber (2016), and Guerrieri and Iacoviello (2017).

[2] Gertler and Gilchrist (1994), Bernanke and Gertler (1989), Kiyotaki and Moore (1997), and Calomiris and Hubbard (1990) show that in an environment with capital market imperfections, borrowers' balance sheet conditions may play a significant role in access to credit.

[3] See the literature on credit channels and market imperfections: Gertler and Karadi (2015), Bordo et al. (2016), Bayoumi and Melander (2008), Aron et al. (2012), Jiménez et al. (2012) and Ciccarelli et al. (2015). Bernanke and Gertler (1990) and Calomiris and Hubbard (1990) study the reallocation of credit in downturns from low net worth to high net worth borrowers. In addition, Barnichon et al. (2017) argue that banks may change the overall pass-through of interest rate changes in an asymmetric way depending on the sign of the monetary policy intervention.

on the sign of movements in that particular quarter. I also use quarterly Compustat firm-level data from 1980q3 to 2016q2 that provides rich balance sheet information and allows me to test alternative financial proxies proposed in the literature.

This paper makes two contributions to the literature. First, the results of this paper present the first firm-level evidence, to the best of my knowledge, on the asymmetric effects of monetary policy in the US. By analyzing 36 years of micro-data, I show that monetary contractions triple the effects of monetary expansions on firms' employment, investment rate and sales. These results are robust to various checks such as (i) controlling for additional firm characteristics, (ii) having a more restrictive sample, (iii) using alternative monetary policy shocks, and (iv) sub-sample analysis across sectors.

Second, this paper tests the role of common financial constraint proxies used in the literature in the context of monetary asymmetry and provides evidence that financial frictions play a role in propagating the sign dependent effects of monetary policy. My findings suggest that characteristics such as having a small size, holding low leverage, holding high liquidity, or not paying dividends lead to larger asymmetric responses in firms' employment. I also find characteristics such as having small size, high liquidity or no-dividend paying status to also contribute to a larger asymmetry in firms' investment rate. However, the role of firms characteristics is more clearly observed in employment responses than investment ratio.

This paper contributes to the literature studying the asymmetric effects of monetary policy. Analyzing sign dependent money supply shocks in the US from 1951 to 1987, Cover (1992) documents that negative money supply shocks affect output and positive money supply shocks do not.[4] Using data from 1954q3 to 2002q4, Lo and Piger (2005) find a policy contraction to be more effective than a policy stimulus. Using aggregate data from 1989:8 to 2007:7, Angrist et al. (2018) show that monetary tightening has more pronounced effects than monetary expansions on inflation, industrial production, and unemployment in the US. Last, using inflation and output data from 1969:1-2002:4, Tenreyro and Thwaites (2016) show that monetary tightenings have a bigger impact on output—but not on inflation– than monetary expansions. A common feature of this literature is to focus on aggregate time-series data to study the sign dependent effects of monetary policy. In contrast, I focus on providing the first US firm-level evidence

[4] Similar to Cover (1992), de Long et al. (1988) and Thoma (1994) find that negative monetary policy shocks to have a greater effect on real GNP and industrial output, respectively. In contrast, Weise (1999), using data from 1960q2 to 1995q2, finds no evidence to support the differential effectiveness of positive and negative shocks. Note that most of the earlier studies work with money-based indicators of monetary policy rather than interest rate-based measures.

on the asymmetric effects of monetary policy, which, unlike earlier findings, allows for a rich analysis of transmission mechanisms in the context of monetary non-linearities. My empirical strategy allows for testing a variety of firm characteristics and can determine whether certain firm characteristics propagate the non-linear effects of monetary policy.

There is also a literature studying how the effectiveness of monetary policy depends on the state of the economy (Thoma, 1994; Weise, 1999; Garcia R. and Schaller H., 2002; Lo and Piger, 2005; Peersman and Smets, 2009).[5] Although this literature is mainly interested in sensitivity to the interest rate at different points in business cycles, some interesting studies explore the sign dependence *jointly* with size and business cycle-related effects. Among these, Ravn and Sola (2004) analyzes the *size* and direction of monetary policy shocks jointly and concludes that *small* contractionary monetary policy shocks have real effects on output.[6] In addition, Tenreyro and Thwaites (2016) explores the asymmetric effects of monetary policy depending on the state of the business cycle and documents that there is little difference between the distributions of shocks in booms and recessions (Tenreyro and Thwaites (2016), p. 59). Hence, the two sets of asymmetries in monetary effectiveness (sign dependence and regime dependence) co-exist.

This paper also contributes to the literature studying the heterogeneity of monetary policy on firm-level data. These papers provide evidence on how financial and non-financial factors like balance sheet conditions (Gertler and Gilchrist, 1994; Ottonello and Winberry, 2020; Kudlyak and Sánchez, 2017), dividend payments (Fazzari et al., 1988; Farre-Mensa and Ljungqvist, 2016), firm age-dividend (Cloyne et al., 2019), liquidity conditions (Jeenas, 2019; Fazzari et al., 1988; Kashyap et al., 1994; Gilchrist and Himmelberg, 1995) and collateral assets (Bahaj et al., 2020) play a role in the transmission of monetary policy. Although these studies investigate a wide variety of monetary policy transmission mechanisms, a common feature in them is to form a direct link between firm finance and the transmission of monetary policy. I contribute to the literature by exploring alternative financial proxies in the context of monetary asymmetries and examining how financial characteristics play a role when we allow for *non-linear* effects of monetary policy.

Taken together, this paper makes two contributions to the literature. First, the results of this

[5]For example, Garcia R. and Schaller H. (2002) finds asymmetry in the effects of monetary policy, with stronger effects during recessions than during expansions. Using data from 1969q1 to 2002q4, Tenreyro and Thwaites (2016) show that the effects of monetary policy are less powerful in recessions for durables expenditure and business investment.

[6]Note that Ravn and Sola (2004) finds asymmetric effects only on the estimates using the federal funds rate.

paper present the first micro-level empirical evidence, to the best of my knowledge, quantifying the sign dependent effectiveness of monetary policy in the US. Specifically, I find that monetary contractions are approximately three times as effective on firms' number of employees, investment rate and sales than monetary expansions. Second, with the use of micro-data, I'm able to test alternative financial proxies debated in the literature. My findings document that certain firm characteristics, such as being small, having low leverage, high liquidity, or no-dividend paying status, trigger a larger amount of variation in the sign dependent monetary policy effectiveness. In sum, the results of this paper provide a practical rule-of-thumb for the design of stabilization policy and contribute to our understanding of the scope of monetary policy when there are non-linearities.

The rest of the paper is organized as follows. Section (2) discusses firm-level data and monetary policy shocks. Section (3) presents the empirical strategy, main results, and robustness checks. Section (4) concludes.

2. Dataset

This section describes the datasets used in the paper. I first present the Compustat firm-level database, discuss the construction of the main variables, and present descriptive statistics. Next, I discuss the monetary policy shocks used in the paper, and illustrate their basic properties. A detailed description of sources, definitions, and the sample selection are provided in Appendix A.

2.1. Firm-Level Variables

This paper uses the quarterly Compustat North America database on the universe of publicly traded C-corporations, which offers high-quality information on balance sheet and income statement components of active and inactive publicly held companies. The total sample covers the period between 1980q3 and 2016q2 and consists of observations from 13,621 firms. I take 1980q3 as the starting date since the monetary policy shocks start then. The sample ends in 2016, which is the last available observation on the excess bond premium data from Gilchrist and Zakrajšek (2012). The main variables of interest are the number of employees (*emp*); investment ratio ($\frac{i_{j,t}}{k_{j,t-1}}$), defined as the capital expenditures of firm j in period t relative to the level of physical capital stock in the last period; sales (*saleq*); book value of total assets (*atq*); liquidity ratio; and leverage (total debt divided by the book value of total assets).[7]

Using Compustat data in this paper is advantageous for several reasons. First, Compustat is a long enough panel to study within-firm variation, allowing me to analyze 36 years of quarterly firm-level data where the average firm is observed for about 13 years. Second, Compustat has a rich cross-sectional dimension that allows me to test alternative hypotheses and conduct heterogeneity analysis. Finally, it is a high-frequency dataset that allows me to analyze monetary policy at a quarterly frequency. One limitation of using Compustat data is that despite the good coverage across different sized firms, the data may disproportionately feature large companies and therefore may underrepresent small firms. In addition, Compustat estimates represent only the behavior of publicly traded C-corporations.[8]

2.2. Summary Statistics

Table 1 presents the summary statistics of key variables of interest in the firm-level data for the period 1980q3–2016q2. The sample contains 687,513 firm-by-quarter observations from 13,621 firms. Since the sample consists of public firms, the average size (total real assets) is \$2.1 million, and average firm real sales is \$0.4 million over the sample. The investment ratio ($i_{j,t}/k_{j,t-1}$) is, on average, 8 percent with a standard deviation of 10.8. The median number of employees in the sample is 707, and the average number of employees is 7,300. The average leverage ratio is 31.4 percent, and the average liquidity rate is 17 percent. The right-skewed size distribution of firms motivates the use of log variables in regressions.

Next, I compare different firm characteristics across the size distribution, which allows me to assess the correlations across cross-sectional characteristics. Figure A.2 in Appendix A presents leverage, liquidity, investment ratio, and dividend profiles of firms across different size deciles.[9] The figure suggests that firms in the first decile of the employment distribution (e.g., very small firms) tend to hold the highest leverage level in the sample. However, comparing medium-small, medium, and large sizes reveals that leverage also tends to increase positively with size.

In terms of liquidity, small firms seem to hold the largest liquidity in their portfolios, with

[7]The liquidity ratio is calculated as the share of cash and short-term investments (*cheq*) to total assets. Total debt is calculated as the sum of debt in current liabilities (*dlcq*) and long-term debt (*dlttq*). I provide further details on sample selection and data construction in Appendix A.

[8]Since private firms often have harder financial constraints, the estimates incorporating financial proxies in Compustat should be taken as a lower bound.

[9]Size deciles are generated using real assets.

rates as high as 27 percent. However, their cash holdings decrease gradually from 27 to 6 percent as they grow. Similarly, small firms also seem to show higher investment levels than large firms. Finally, the dividend payouts increase only for firms in the highest deciles, e.g., very large firms. These correlations reveal underlying patterns in firm characteristics in the Compustat, and I will revisit them in Section 3.4 when I explore the role of alternative firm characteristics in the context of financial constraints.

2.3. Monetary Policy Shocks

A common challenge in identifying monetary policy surprises is the concern of endogeneity. Since interest rate movements can both react to prevailing economic conditions and influence them, it is challenging to isolate the causes and effects of monetary policy innovations.[10] To address this, I identify the exogenous movements in monetary policy by using the external instrument VAR approach of Gertler and Karadi (2015), developed by Stock and Watson (2012) and Mertens and Ravn (2013). Gertler and Karadi (2015) uses high-frequency surprises on interest rate futures around Federal Open Market Committee (FOMC) meetings as external instruments in VARs to identify the effects of monetary policy shocks.

Following the high frequency identification literature (Kuttner, 2001; Gurkaynak et al., 2005; Nakamura and Steinsson, 2018a), the main identifying assumption of Gertler and Karadi (2015) is that they measure the surprises in the futures rate within the 30-minute window of a FOMC meeting. The tight window deals with the endogeneity problem and helps identify monetary surprises that are due to purely exogenous policy shifts. Hence, any surprise movements in fed funds futures during this time period are contemporaneously exogenous to within-period movements in both economic and financial variables (Gertler and Karadi (2015), p. 46), leading to consistent estimates of monetary innovations.[11]

Similar to Gertler and Karadi (2015), I first estimate a monthly VAR using a one-year government bond rate, log industrial production, log consumer price index, Gilchrist and Zakrajšek (2012) excess bond premium, employment rate, and debt to GDP.[12] The reduced form of the

[10] See Nakamura and Steinsson (2018b) for a review of the literature on the causal estimation of monetary policy.

[11] As discussed in Gertler and Karadi (2015), within a period, policy shifts may not only affect financial variables but also be responding to them. By using daily data of surprise movements in fed funds future around a tight window, the high frequency identification (HFI) approach addresses the simultaneity issue.

[12] The VAR is estimated using 12 lags. Similar to Gertler and Karadi (2015), I use shocks to instrument changes in the one-year Treasury rate. This is advantageous as movements in the one-year rate not only incorporate surprises in the current funds rate but also shift in expectations about the future path of the funds rate through forward guidance.

proxy VAR is given by

$$\mathbf{Y_t} = \sum_{j=1}^{J} \mathbf{B_j} \mathbf{Y_{t-j}} + \mathbf{u_t} \tag{1}$$

where $u_t = \mathbf{S}\epsilon_t$ is the reduced-form shock and $\mathbf{S}$ is the structural impact matrix that maps latent structural shocks into reduced-form shocks. Data on fed funds futures are available from 1991, and the VAR data spans from 1979m6 to 2016m6. An advantage of the proxy VAR approach is that VAR can be estimated over a much longer time span than the instrument available (Cloyne et al., 2019, p. 14). Next, following Cloyne et al. (2019), I extract the latent monetary policy shocks from the implied residuals of their SVAR-IV by inverting the structural VAR impact matrix.[13] This yields a time series of monetary policy innovations from 1980m6 to 2016m6. I aggregate these innovations from monthly to quarterly frequency by summing. Figure A.1 plots the implied monetary policy structural shocks employed in the empirical section.

3. Empirical Framework

This section provides the empirical framework that explores the asymmetric effects of monetary policy in the micro-data. I first study the responses of three sets of variables: the number of employees, investment rate, and real sales to sign dependent effects of monetary policy. I then provide robustness checks of the baseline results using a variety of different specifications and controls. Last, I explore whether certain firm characteristics propagate the sign dependent effects of monetary policy.

3.1. Micro Estimates on the Asymmetric Effects of Monetary Policy

I first estimate the asymmetric effects of monetary policy shocks in the spirit of Tenreyro and Thwaites (2016) using the following local projection instrumental variable (LP-IV) (Jordà et al., 2015) specification:

$$y_{j,t+h} - y_{j,t-1} = \alpha_j^h + \beta_h^+ \, max[0, \Delta R_t] + \beta_h^- \, min[0, \Delta R_t] + \Omega'(L) \, Z_{j,t-1} + \epsilon_{j,t+h}, \tag{2}$$

where horizon is h = 0, 1,..., H, α_j^h is firm-level fixed effects, and ΔR is the change in the one-year government bond yield instrumented with the monetary policy shocks following Gertler

[13] Using $u_t = \mathbf{S}\epsilon_t$, we can write $E(u_t u_t') = E(\mathbf{S}\epsilon_t \epsilon_t' \mathbf{S}')$, where $E(u_t u_t') \equiv \Sigma$. $\Sigma = E(\mathbf{SS}')$ requires $\mathbf{S}$ to be identified as the Cholesky factor of Σ. Since $u_t = \mathbf{S}\epsilon_t$, $\mathbf{S}^{-1} u_t = \epsilon_t$ would yield the latent shocks.

and Karadi (2015).

The monetary policy shocks instrument the increases (or decreases) in the one-year government bond yields depending on the sign of movements in that particular quarter in the one-year Treasury rate. That is, I pin down the increases and decreases in the one-year Treasury rate for each quarter and instrument them with the monetary innovations that occurred in these quarters. This approach applies the sign restriction *only* to the movements of the one-year Treasury rate, and not to the monetary policy instruments. The reason is that monetary policy shocks reflect deviations from pre-FOMC meeting expectations of financial markets; hence its sign is not informative about whether the monetary policy is contractionary or expansionary.[14] For this reason, I only use the sign restriction on the one-year Treasury rate and use the instrument that occurred *on* these dates.

There are three main dependent variables: number of employees,[15] real sales, and investment rate.[16] The dependent variable is defined as the cumulative difference to interpret the parameters as impulse responses. β_h^+ captures the effect of a 25 basis point increase in the interest rate across different horizons, and β_h^- captures the impact of a 25 basis point decrease in interest rate across different horizons. The estimation is done up to horizons of $H = 20$ quarters, and the lag structure on the control variable is 4 quarters.

Firm fixed effects, α_j^h, soak up permanent differences across firms and allows me to explore within-firm variation. $Z_{j,t-1}$ is the vector of control variables that include lags of real asset growth, lags of firm-level employment growth, and lags of log real GDP. Firm-level controls help control for differences in cross-sectional characteristics across firms, and the aggregate variables help capture the aggregate outlook of the economy.[17] All the control variables in $Z_{j,t-1}$ are measured at the end of the last year before the monetary shocks to ensure exogeneity with respect to the shock. Standard errors are two-way clustered by firm and quarter (calendar), where serial correlation adjustment is set to 4 quarters using Driscoll and Kraay (1998)'s methodology. This is a standard method to account for serial correlation at the firm level and through time.[18]

[14] I thank Professor Òscar Jordà for this valuable suggestion.

[15] Since employment is reported annually in Compustat, I linearly interpolate the within-year movements of the number of employees by firm.

[16] The investment ratio is defined as the share of capital expenditures ($capx$) to physical capital at the beginning of the period ($ppent$).

[17] This control is motivated by Tenreyro and Thwaites (2016), which argues that positive and negative monetary policy shocks may be correlated with the expansions and recessions in the economy.

[18] See Cloyne et al. (2019) and Bahaj et al. (2020).

To prevent the results from being driven by outliers, I trim the sample by 1 percent on both ends based on the investment ratio, employment growth and debt-to-equity ratio. I also trim top 1 percent of the debt-to-asset ratio.[19] Firms with lives less than 20 quarters are dropped as the impulse responses are estimated using at least five years of consecutive data. Lastly, since I test the implications of an aggregate shock on micro-data, the analysis does not suffer from reverse causality, which would imply that firm-level variables to affect aggregate shocks.

3.2. Baseline Results

This section presents the impulse responses of specification 2 on dependent variables employment, investment ratio, and sales, respectively. These results pin down the sign dependent effectiveness of monetary policy in the firm-level data and show that, on average, monetary contractions are three times as effective as monetary expansions.

Figure 1 plots the impulse response of number of employees for a monetary expansion (β_h^-) and monetary contraction (β_h^+), respectively. The shaded areas display 90 percent confidence intervals, and the policy rate is scaled such that the shock raises the one-year policy rate by 25 basis points on impact. The first column of Figure 1 (Figure 1a) shows that firms lower the number of employees gradually for about two years after a contractionary monetary policy shock. The peak effect is –1.5 percent and occurs about ten quarters after the shock. Overall, the effect is significant from quarter 4 to quarter 11. In contrast, Figure 1b shows that a monetary expansion increases employment by a maximum of 0.4 percent, with the effect only significant at quarter 5. On average, monetary contractions triple the effects of monetary expansions on firms' employment.

Next, monetary tightenings and expansions may not only alter firms' scale of production but also impact their investment rate. Figure 2 shows that the empirical model delivers a similar picture on firms' investment rates. Following a 25 basis point monetary contraction, the investment ratio has a –0.5 percentage point peak effect occurring 11 quarters after the shock. Investment responds by dropping after quarter three and becoming significant at quarter 11. The effect dies off about four years after the monetary shock. On the other hand, monetary expansions have much weaker effects that are not statistically significant across the horizon. Figure 2b shows that firms respond to a 25 basis point monetary expansion by increasing the investment ratio by

[19] See Appendix A for the sample selection procedure.

a maximum of 0.1 percentage points. Overall, Figure 2 suggests that the effects on firm-level investment rate are visibly smaller and less pronounced for monetary expansions as compared to the contractions.

Next, I present the effects of monetary expansions and contractions on firms' sales. Figure 3 shows that firms experience a decline in sales for about three years following a contractionary monetary policy shock. The peak effect is –3.8 percent, and it occurs about 13 quarters after the shock. The effect is significant from quarter six to quarter 14, and sales starts to recover about three years after the shock. In contrast, a monetary expansion increases sales by about 0.9 percent at maximum. In line with the earlier results, the impact on sales is smaller and less significant for monetary expansions than the contractions.

Last, I present a formal asymmetry test for the hypothesis that positive and negative monetary policy shocks have alternative effects on firm-level variables. I test the following hypothesis

$$H_0 : \beta^+ = \beta^-$$

$$H_1 : \beta^+ \neq \beta^-$$

using horizon 10 estimates as they are the half-life of the dynamic estimation window. The test results confirm that monetary contractions and expansions have significantly different effectiveness on firms' employment and sales at a 10 percent significance level. I also find that the asymmetric effects on investment are statistically insignificant.[20]

This section showed that firms' employment, investment, and sales respond substantially more to monetary contractions than monetary expansions. Overall, these dynamics line up with the earlier literature findings that analyze this type of non-linearity using aggregate data.[21] Both aggregate and micro-data estimates suggest that monetary tightenings have a larger impact on the economy than monetary expansions. Specifically, monetary contractions, on average, triple the effects of monetary expansions on firms' employment, investment rate and sales. In the next sections, I (i) confirm the robustness of these results across a range of specifications and (ii) disaggregate this average effect to see whether firms' financial characteristics propagate the observed non-linearity. This exercise will help disentangle the role of financial frictions within the asymmetric effects of monetary policy.

[20]The p-value of the asymmetry test on employment and sales is 0.06, and the p-value on investment results is 0.5.

[21]See Tenreyro and Thwaites (2016), Cover (1992), Angrist et al. (2018), among others.

3.3. Robustness

In this section, I show that the main results capturing the non-linearity of monetary policy on firm-level employment, investment, and sales are robust to a range of alternative specifications. In particular, I confirm that the main findings are robust to (i) controlling for additional firm characteristics, (ii) having a more restrictive sample, (iii) using alternative monetary policy shocks, and (iv) sub-sample analysis across sectors.

The main findings of this paper use control variables: lags of real asset growth, firm-level employment growth, and log real GDP. In the following specification, I extend the control set with firms' leverage rate, real sales growth, and log real assets since these variables can capture even more cross-sectional variation in the estimates. Figure 4 shows the results that mirror the baseline findings: adding new control variables to the specifications does not change the non-linearity results. I also add a specification where I control for the lags of the independent variable in addition to baseline controls. Figure 5 plots the impulse responses. The results are very similar to the baseline findings and are slightly more significant than the baseline.

Next, I trim the sample with a more restrictive criteria and re-test the baseline specification. In addition to the baseline trim (see Appendix A for details), I trim the sample based on firms' sales growth.[22] Figure 6 shows that the results look remarkably similar to the baseline impulse response functions. Both specifications support the main findings that monetary policy has substantial non-linear effects on firm-level employment, investment, and sales.

I also consider whether my estimates are driven by a particular sector in the sample. To do this, I focus on the two largest sectors in my sample: manufacturing and services. Manufacturing consists of 48 percent of the sample, and services consist of 18 percent. I also form a third group consisting of companies belonging to all remaining sectors.[23] The first and second rows of Figure 7 show the dynamic effects of a sign dependent monetary policy on firm-level employment for manufacturing and service firms, respectively. The last row shows the effects on the rest of the industries. In all three figures, the baseline results of asymmetry are visible across all major sectors.

Finally, I check the robustness of the main results using Romer and Romer (2004) monetary policy shocks. In the following specification, I use extended Romer shocks of Wieland

[22] In particular, I trim the top and bottom 1 percent of sales growth. All the trimming is done by year.

[23] The largest sectors in the final group consist of construction (7 percent), transportation and communications services (13 percent), and wholesale trade (11 percent).

and Yang (2020) to instrument sign-dependent changes in one year treasury rate. Figure 8 displays the baseline findings with new monetary policy shocks. The results corroborate the baseline findings that monetary contractions are generally more effective on firm employment than monetary expansions.

3.4. Heterogeneity Analysis

This section examines heterogeneity of the main findings and explores the role of financial frictions in the context of monetary asymmetries. Assessing the role of financial frictions requires identifying firms that are "financially constrained." Since financial constraints are not directly observable, the empirical macroeconomics literature has used indirect measures as proxies of financial constraints.[24] This section studies a group of these proxies and explores whether some of these observables predict a larger sensitivity to sign dependent effects of monetary policy.

Earlier contributions in Bernanke et al. (1996), Oliner and Rudebusch (1996) and Gertler and Gilchrist (1994) propose firm size as a proxy for access to credit markets. According to the financial accelerator literature, the effects of changes in the financial conditions of firms close to the margin would be much larger than the firms above the standard requirements, e.g., less constrained. Figures 9 and 10 show the dynamic responses of firm-level employment to monetary policy for large and small firms, respectively. The small versus large binning is done using the median real assets by year.

Comparing the full dynamic responses of Figures 9a and 10a suggests that small firms seem to reduce their employment capacity by about 2.2 percent three years after a monetary contraction. In contrast, large firms contract only by 1.4 percent. The effect is significant for both types of firms for about three years. These results partially corroborate the financial accelerator view: small firms show greater downturns after monetary contractions than large firms. On the other hand, the results comparing monetary expansions are less clear-cut. Both large (Figure 9b) and small firms (Figure 10b) respond to monetary expansions with comparable magnitudes. Overall, we can observe a larger asymmetry for small firms, that is mainly driven by heterogeneous responses to monetary contractions.

I also re-estimate the baseline specification on the investment ratio across different size bins. Figures 11 and 12 show the impulse responses of firms' investment ratio to monetary

[24] See Cloyne et al. (2019) for a discussion of these alternative proxies in the literature.

policy shocks across large and small firms, respectively. Similar to the employment results, I observe a larger asymmetry in small firms' responses to monetary policy, that is mainly driven by monetary contractions.[25] However, these findings do not have a sharp asymmetry as seen in employment results.

Following Fazzari et al. (1988), Farre-Mensa and Ljungqvist (2016), and Cloyne et al. (2019), I also test the role of firms' dividend status in the baseline specification. To test this, I separate the sample to firms that do not pay dividends (no-dividend payers) and those that do (positive dividend-payers). Figures 13 and 14 show the impulse responses of employment based on dividend groups, where the largest asymmetry is observed for firms that pay no dividends. Specifically, the dividend status seems to double the downturns of firms' employment following monetary contractions. The peak effect in employment in response to monetary expansions is also slightly higher for no dividend paying firms. Similar to employment, the investment results (Figures 15 and 16) also point to a similar type of asymmetry, although the impulse responses of the investment ratio based on dividend groups show less clear-cut asymmetry than the employment results.

Next, I consider whether heterogeneity in leverage can drive the asymmetry in the baseline results.[26] Figures 17 and 18 re-estimate the baseline results using leverage binning of firms. In this categorization, firms are separated into high versus low leverage groups using median cutoff by year. Figure 18a shows that the highest asymmetry is seen for low leverage firms that lower their employment by 2 percent three years following a contractionary monetary policy. In contrast, the response of high leverage firms to a monetary contraction is about a 1.1 percent cut in employment, which is much smaller than low leverage groups. For monetary expansions, low leverage firms (Figure 18b) also show a larger response than the high leverage firms (Figure 17b). These results show that the employment of low leverage firms shows a larger swing in *both* contractions and expansions than high leverage firms. I also analyze these results on the firm-level investment rate. Unlike the employment results, the investment responses do not reveal any significant heterogeneity in the asymmetric effect based on firms' leverage conditions

[25] Specifically, the peak effect on investment rate for small (large) firms is -0.57 (-0.48) following a monetary contraction.

[26] The evidence on leverage is mixed. On the one hand, Ottonello and Winberry (2020) shows that firms with high leverage are associated with high default risk, and they respond the least to monetary policy due to high marginal costs of external finance. On the other hand, high leverage can be a proxy for financial frictions which would have opposite predictions. For example, Ippolito et al. (2017) study the floating rate channel and find that firms that use more bank debt and do not hedge it display a stronger sensitivity of their stock price, cash holdings, sales, inventory, and fixed capital investment to monetary policy.

(Figure 19b–20b).

Finally, I test the liquidity conditions of firms in the context of monetary asymmetry following Kashyap et al. (1994) and Jeenas (2019).[27] This specification tests the role of firms' cash holdings on firm-level employment and investment, allowing for monetary non-linearities. Figures 21 and 22 re-estimate the baseline results on employment using liquidity binning of firms. The findings evidence that firms with high liquidity conditions reveal much larger asymmetric effects of monetary policy. These results are, once again, driven by the heterogeneous responses to monetary contractions. In line with this, Figures 23 and 24 also confirm that high liquidity firms show a slightly larger investment rate response to monetary contractions.

So far, four main factors – having a small size, holding low leverage, holding high liquidity, and not paying dividend – contribute to firm-level employment showing larger responses to the monetary contractions. For the monetary expansions, I only find leverage characteristics to contribute to a larger response in the number of employees. For investment, small size, having high liquidity, and not paying dividends also seem to contribute to firms responding more to monetary contractions. However, these results are not captured for the investment responses to the expansionary monetary innovations. Overall, these results suggest that much of the earlier evidence on heterogeneity aligns more with monetary contractions than expansions.

Next, I analyze simple correlations among these main firm-level observables to help see the stylized connections between these variables within the Compustat sample. According to Figure A.2, the findings on the heterogeneous effects in this paper are consistent with correlations across observables, as the figure shows that small firms tend to hold high liquidity and pay no dividends. For leverage, Figure A.2 also shows that small firms generally have less leverage except for the first decile of firms that seem to hold an outlier amount of debt in their portfolios. Overall, these correlations imply that the heterogeneity findings of this paper seem coherent with the underlying links between these variables.

As a next step, I analyze different cross-group bins to determine if some of these characteristics are of second order for monetary contractions and expansions. To do this, I analyze size and leverage dimensions jointly by splitting the sample based on small versus large and high versus low leverage firms. Note that these specifications divide the data into groups, hence

[27] Kashyap et al. (1994) show that firms with low liquid asset holdings contract their inventories more following a contractionary monetary policy. Jeenas (2019) shows that low cash holdings predict a stronger contraction of capital and argues that the firms with the least internal wealth are the ones with a high marginal productivity of capital and the most to gain from raising debt.

it has the advantage of not imposing any restrictions on the underlying distribution of data. Figure B.3 suggests small and low leverage firms respond most to monetary contractions and expansions and therefore show the highest asymmetry in the responses. Moreover, controlling for size, Figure B.3 still accounts for some marginal effect from having low leverage. Similarly, controlling for leverage, there is still an additional effect from the firm size indicator. Overall, both monetary contractions and expansions seem more effective on small-low leverage firms.

Next, Figure B.4 analyzes size and liquidity conditions jointly and both size and liquidity conditions are relevant characteristics to determine asymmetric effects of monetary policy. Controlling for liquidity, Figure B.4 also shows that firm size is still an important driver for amplifying the responses of low liquidity firms. Similarly, Figure B.5 analyzes leverage and liquidity conditions jointly and suggests that low leverage and high liquidity firms have the largest asymmetric response to monetary policy. Finally, Figure B.6 compares size and dividend conditions jointly and suggests that the dividend status is more important for amplifying the responses of large firms' than that of small firms.[28]

To summarize, this section provides three main results. First, the baseline findings on monetary asymmetry are present across alternative sub-samples and are robust to alternative estimation strategies, control sets, instruments and underlying assumptions. In all specifications, I show that even when the sample is conditioned on various observables, the average asymmetry results are present. Second, I trace alternative proxies on financial frictions and find a considerable degree of heterogeneity in firms' responses to sign dependent monetary innovations. In particular, I find that characteristics such as having a small size, holding low leverage, holding high liquidity and not paying dividends lead firms to show larger asymmetric effects on employment. I also find characteristics such as having a small size, holding high liquidity and not paying dividends lead firms to show larger asymmetric effects on investment rate. Finally, I also document that most of the amplification is seen more clearly in employment results than in the investment ratio results.

These findings corroborate the financial accelerator view that small firms may be subject to higher information frictions and risk premiums, resulting in a much larger deterioration in access to credit after a monetary contraction. Hence, as monetary tightening makes credit constraints bind, contractionary monetary policy may result in larger effects in this particular

[28]The corresponding results for investment rate can be seen in Figures B.8, B.9, and B.10.

group of firms, and propagate the asymmetric effects of monetary policy.

4. Conclusion

This paper documents how exogenous monetary policy shocks generate strong asymmetric effects using detailed firm-level data. Specifically, I study firm-level employment, investment, and sales responses to monetary policy changes, allowing the effects to vary based on the sign of monetary policy.

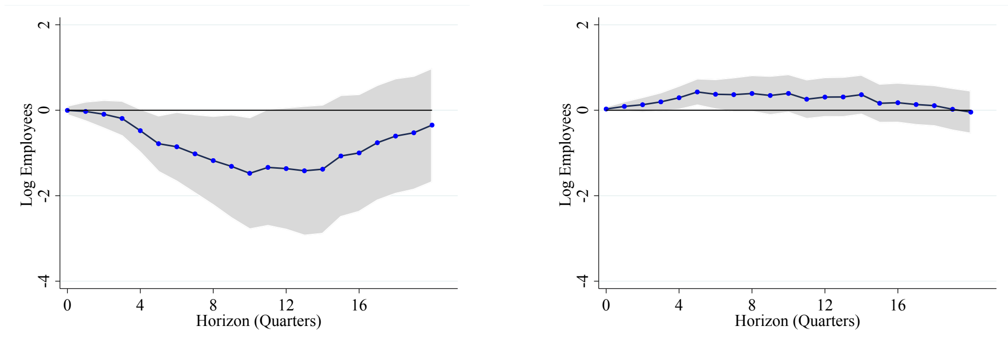
The main results of this paper are summarized as follows. First, monetary policy shocks generate fairly asymmetric effects on the firms depending on the direction of the monetary action. In particular, I show that monetary contractions triple the effects of monetary expansions on firms' employment, investment rate, and sales. These findings are robust to various checks such as controlling for additional firm characteristics, having a more restrictive sample, using alternative monetary policy shocks, and sub-sample analysis across sectors. Second, I study the role of alternative firm characteristics in the context of monetary asymmetries. My results show that firms that are small, hold low leverage or high liquidity, or do not pay dividends have larger asymmetry in their employment responses to monetary policy than other firm groups. Similarly, I find characteristics such as having a small size, holding high liquidity and not paying dividends lead firms to show larger asymmetric effects on investment rate. I also document that most of these amplifications are seen in monetary contractions than monetary expansions.

The results of this paper are particularly important for two reasons. First, this study is the first to evaluate the asymmetric effects of monetary policy within firm-level data in the US. This is quite different than the earlier approaches adopted in the monetary transmission literature that mainly uses aggregate data to test monetary non-linearities. Second, the results highlight the role of firm-level observables on monetary asymmetries, which may be an important input for future modeling efforts. Overall, these findings provide a practical rule of thumb for the design of stabilization policies and contribute to our understanding of the scope of monetary policy when non-linearities are present.

5. Figures

5.1. Main Results

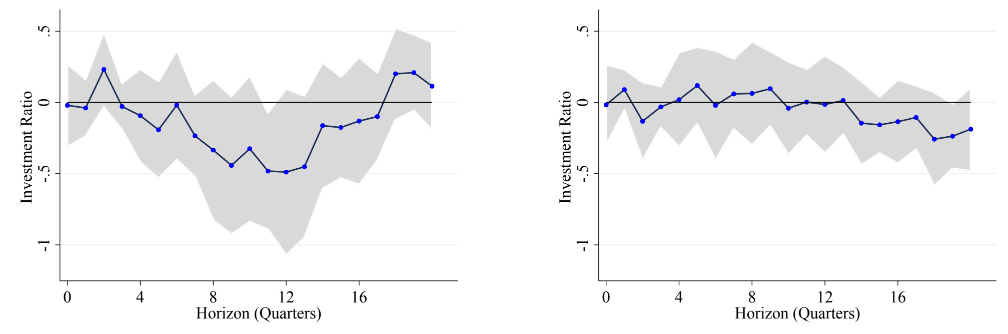
Figure 1: Asymmetric effects of monetary policy on log employees



(a) Monetary Contraction (β_h^+) (b) Monetary Expansion (β_h^-)

Note: The first (second) column shows the impulse response to a monetary policy shock that increases (decreases) the one-year Treasury rate by 25 basis points on impact. Control variables are real asset growth, log GDP, and growth in employees. The shaded areas show 90 percent confidence intervals.

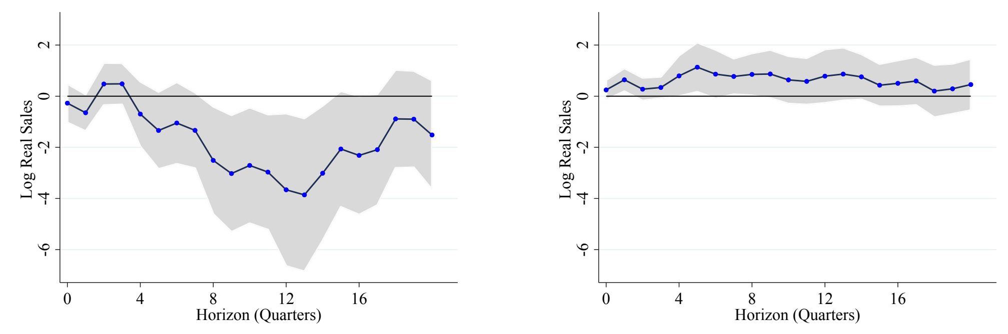
Figure 2: Asymmetric effects of monetary policy on investment ratio



(a) Monetary Contraction (β_h^+) (b) Monetary Expansion (β_h^-)

Note: The first (second) column shows the impulse response to a monetary policy shock that increases (decreases) the one-year Treasury rate by 25 basis points on impact. Control variables are real asset growth, log GDP, and growth in employees. The shaded areas show 90 percent confidence intervals.

Figure 3: Asymmetric effects of monetary policy on log real sales

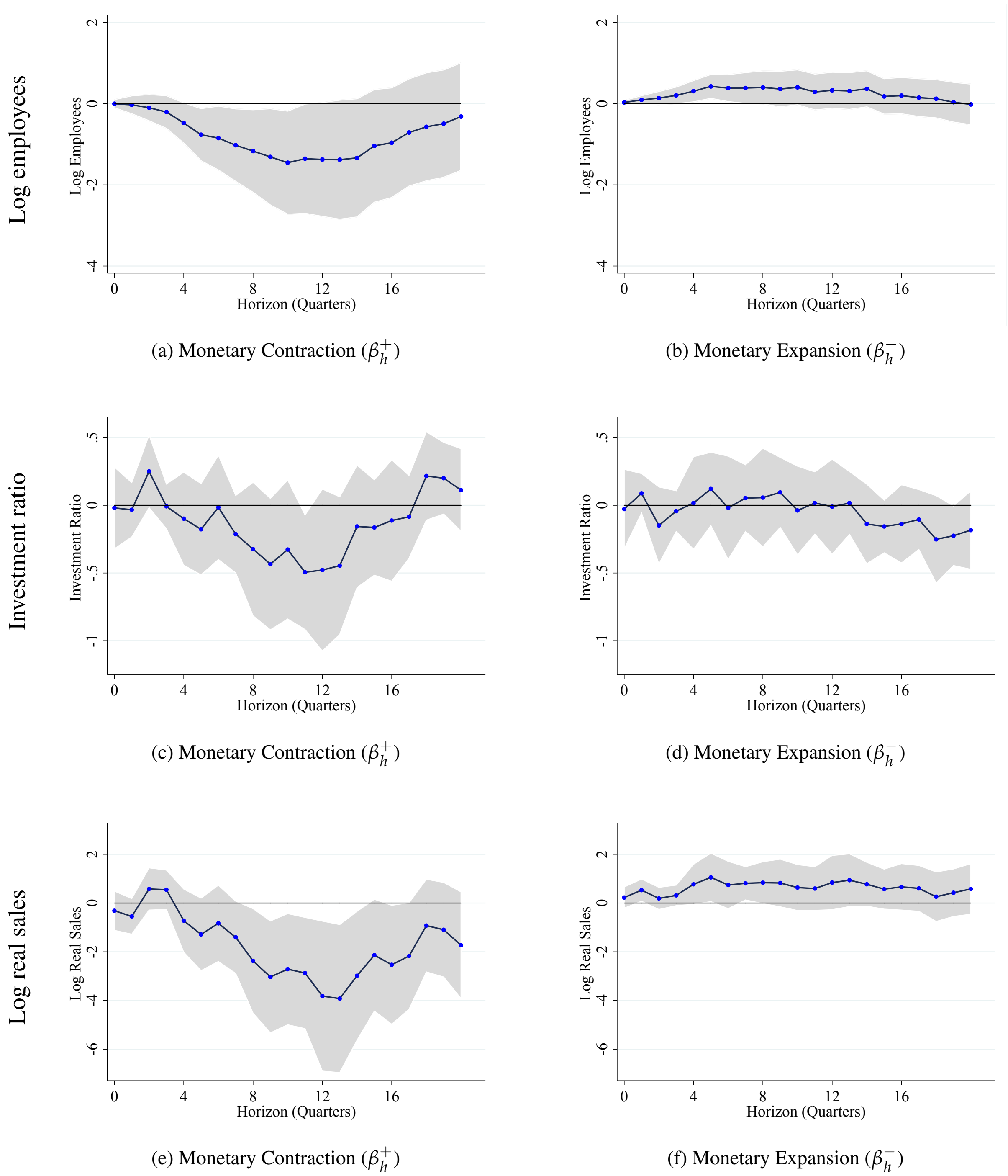


(a) Monetary Contraction (β_h^+) (b) Monetary Expansion (β_h^-)

Note: The first (second) column shows the impulse response to a monetary policy shock that increases (decreases) the one-year Treasury rate by 25 basis points on impact. Control variables are real asset growth, log GDP, and growth in employees. The shaded areas show 90 percent confidence intervals.

5.2. Robustness Figures

Figure 4: Impulse responses to expansionary and contractionary monetary policy



(a) Monetary Contraction (β_h^+)

(b) Monetary Expansion (β_h^-)

(c) Monetary Contraction (β_h^+)

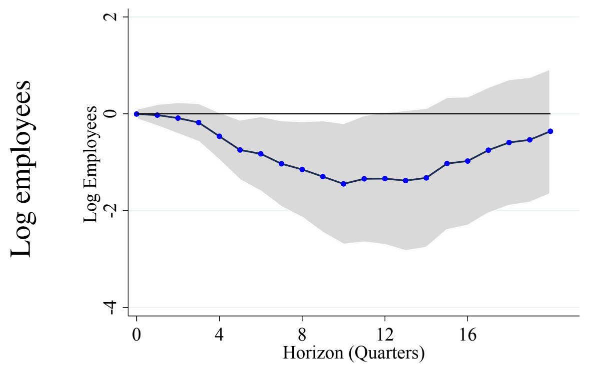
(d) Monetary Expansion (β_h^-)

(e) Monetary Contraction (β_h^+)

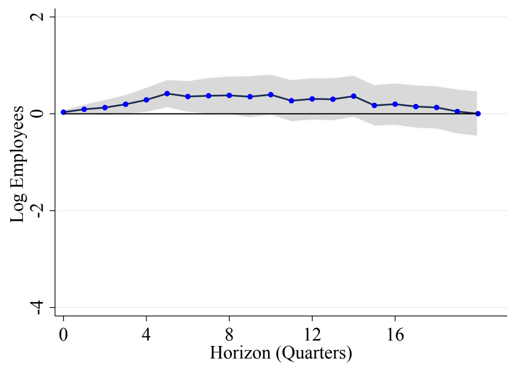
(f) Monetary Expansion (β_h^-)

Note: The first (second) column shows the impulse response to a monetary policy shock that increases (decreases) the one-year Treasury rate by 25 basis points on impact. Each row is estimated separately. Control variables are real asset growth, log GDP, growth in firm-level employees, firms' leverage rate, real sales growth, and log real asset. The shaded areas show 90 percent confidence intervals.

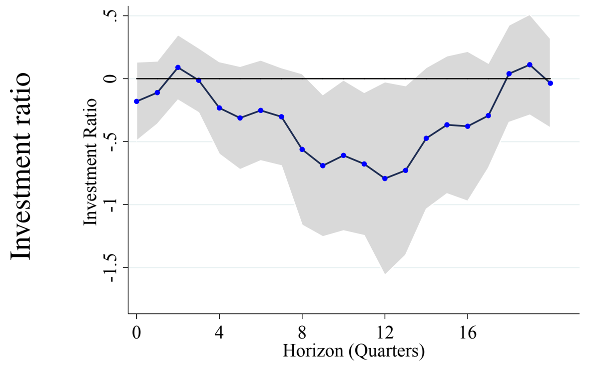
Figure 5: Impulse responses to expansionary and contractionary monetary policy



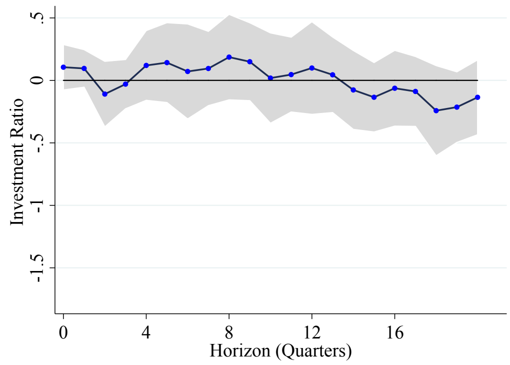
(a) Monetary Contraction (β_h^+)



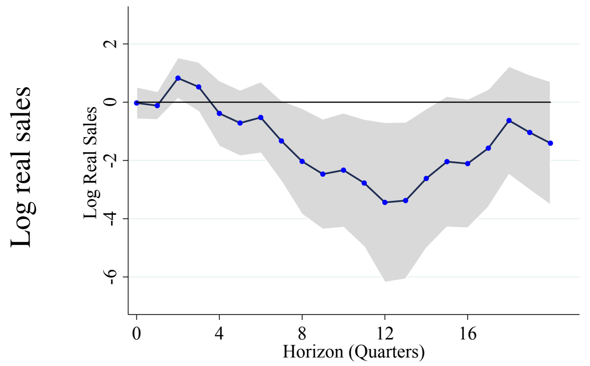
(b) Monetary Expansion (β_h^-)



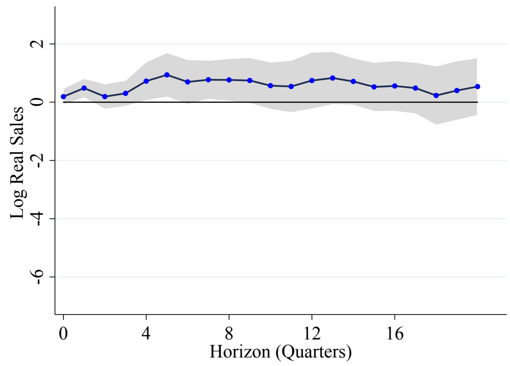
(c) Monetary Contraction (β_h^+)



(d) Monetary Expansion (β_h^-)



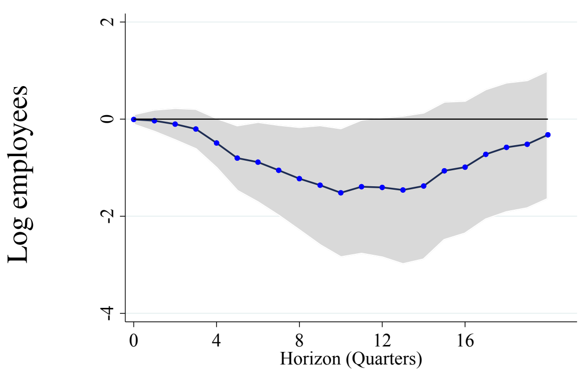
(e) Monetary Contraction (β_h^+)



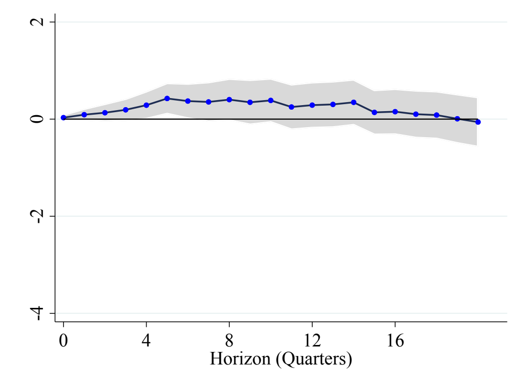
(f) Monetary Expansion (β_h^-)

Note: The first (second) column shows the impulse response to a monetary policy shock that increases (decreases) the one-year Treasury rate by 25 basis points on impact. Each row is estimated separately. Control variables are real asset growth, log GDP, growth in firm-level employees, and lags of dependent variable. The shaded areas show 90 percent confidence intervals.

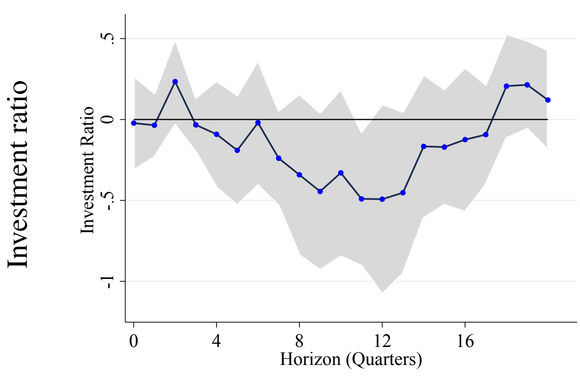
Figure 6: Impulse responses to expansionary and contractionary monetary policy



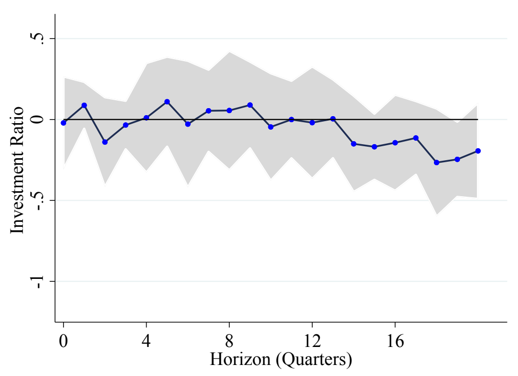
(a) Monetary Contraction (β_h^+)



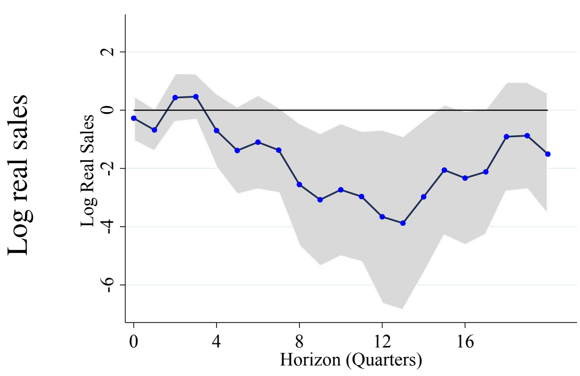
(b) Monetary Expansion (β_h^-)



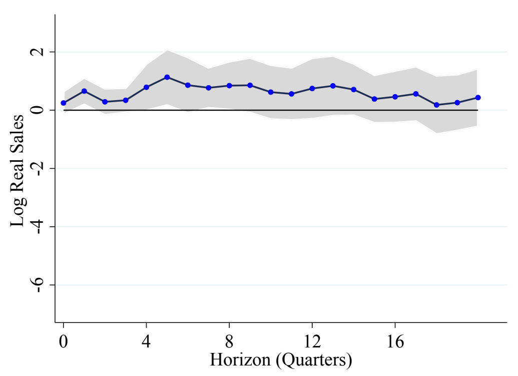
(c) Monetary Contraction (β_h^+)



(d) Monetary Expansion (β_h^-)



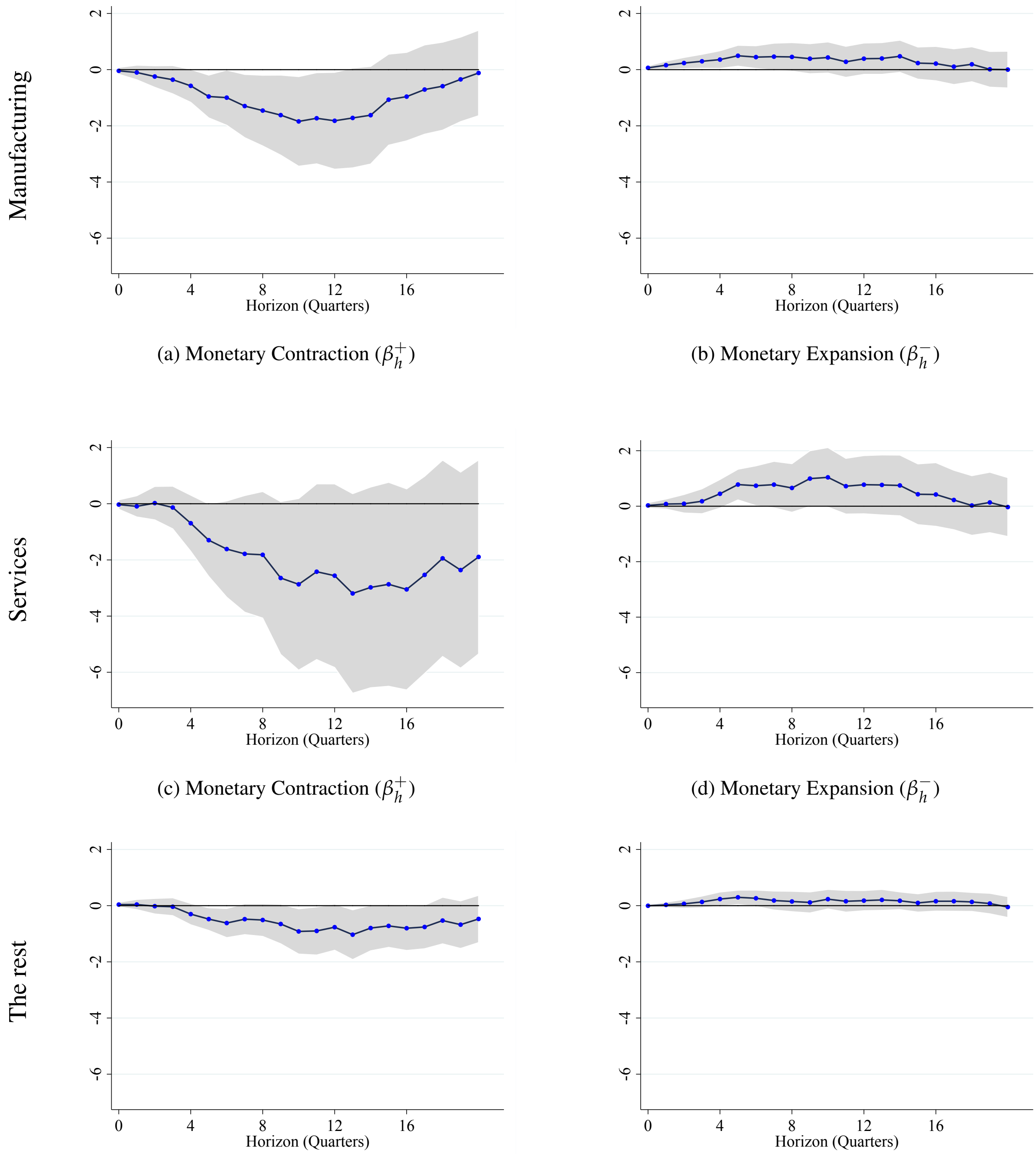
(e) Monetary Contraction (β_h^+)



(f) Monetary Expansion (β_h^-)

Note: The first (second) column shows the impulse response to a monetary policy shock that increases (decreases) the one-year Treasury rate by 25 basis points on impact. Each row is estimated separately. Control variables are real asset growth, log GDP and growth in firm-level employees. The shaded areas show 90 percent confidence intervals. The sample is further trimmed based on the top and bottom 1 percent of sales growth. The trimming is done by year.

Figure 7: Impulse responses to expansionary and contractionary monetary policy on employment



(a) Monetary Contraction (β_h^+)

(b) Monetary Expansion (β_h^-)

(c) Monetary Contraction (β_h^+)

(d) Monetary Expansion (β_h^-)

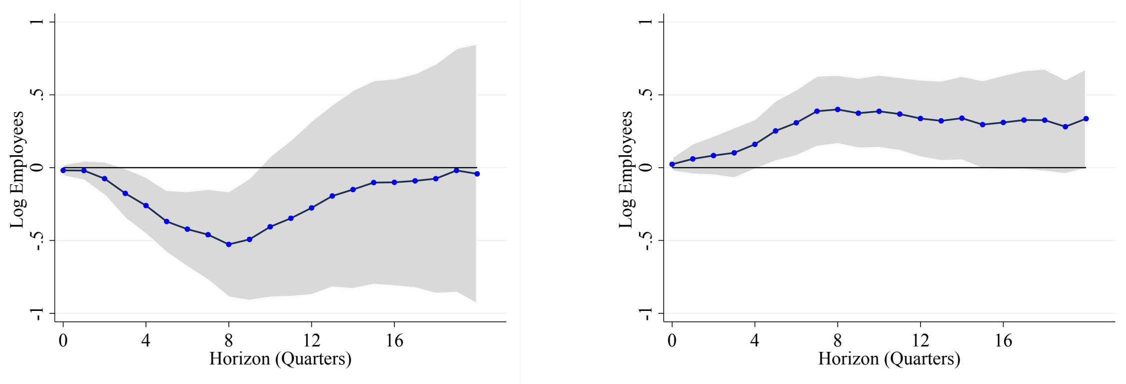
(e) Monetary Contraction (β_h^+)

(f) Monetary Expansion (β_h^-)

Note: The first (second) column shows the impulse response to a monetary policy shock that increases (decreases) the one-year Treasury rate by 25 basis points on impact. Each row is estimated separately for different sectors. Control variables are real asset growth, log GDP and growth in firm-level employees. The shaded areas show 90 percent confidence intervals.

Figure 8: Impulse responses to expansionary and contractionary monetary policy

Log employees



(a) Monetary Contraction (β_h^+)

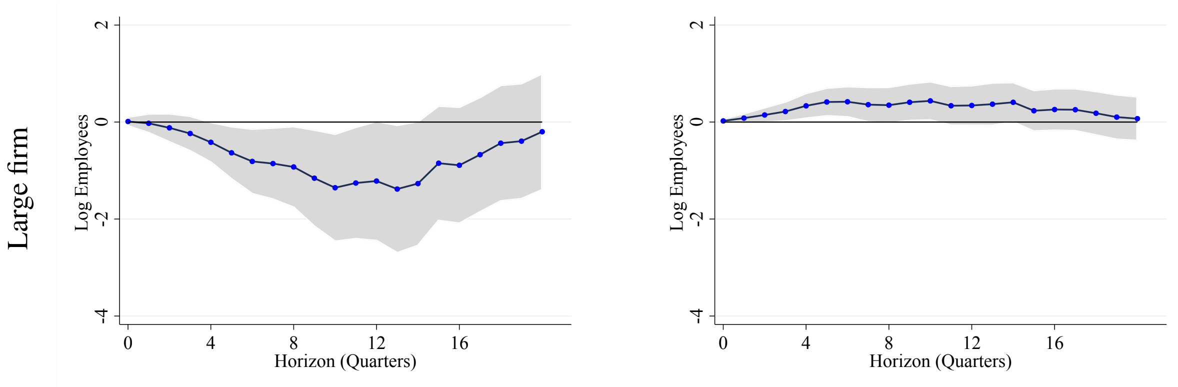
(b) Monetary Expansion (β_h^-)

Note: The first (second) column shows the impulse response to a monetary policy shock that increases (decrease) the one-year Treasury rate by 25 basis points on impact. Control variables are real asset growth, log GDP and growth in firm-level employees. The shaded areas show 90 percent confidence intervals. The specification uses extended Romer shocks following Romer and Romer (2004) and Wieland and Yang (2020). The sample period covers 1973q1-2016q4, as the quarterly firm-level data is sparse prior to 1973.

5.3. Heterogeneous Effects

$$y_{j,t+h} - y_{j,t-1} = \alpha_j^h + \beta_h^+ \; max[0, \Delta R_t] + \beta_h^- \; min[0, \Delta R_t] + \Omega'(L) \; Z_{j,t-1} + \epsilon_{\,j,t+h}$$

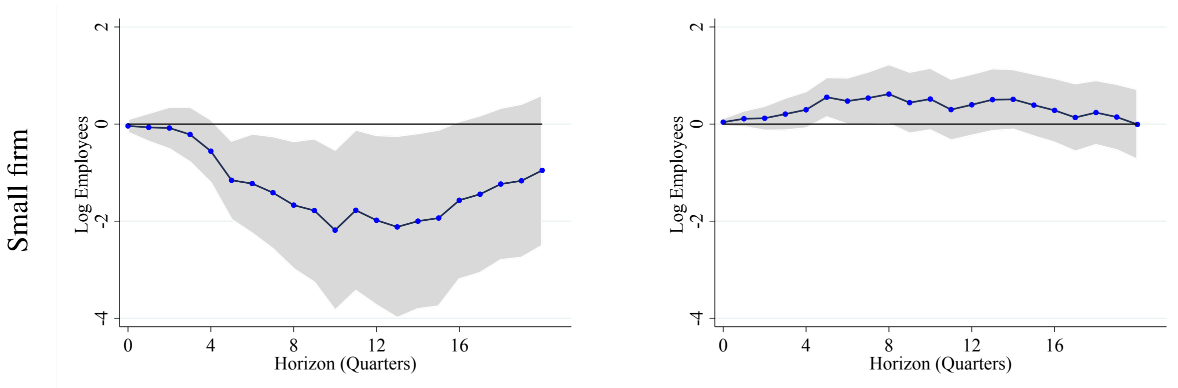
Figure 9: Asymmetric effects of monetary policy on log employees



(a) Monetary Contraction (β_h^+)

(b) Monetary Expansion (β_h^-)

Figure 10: Asymmetric effects of monetary policy on log employees



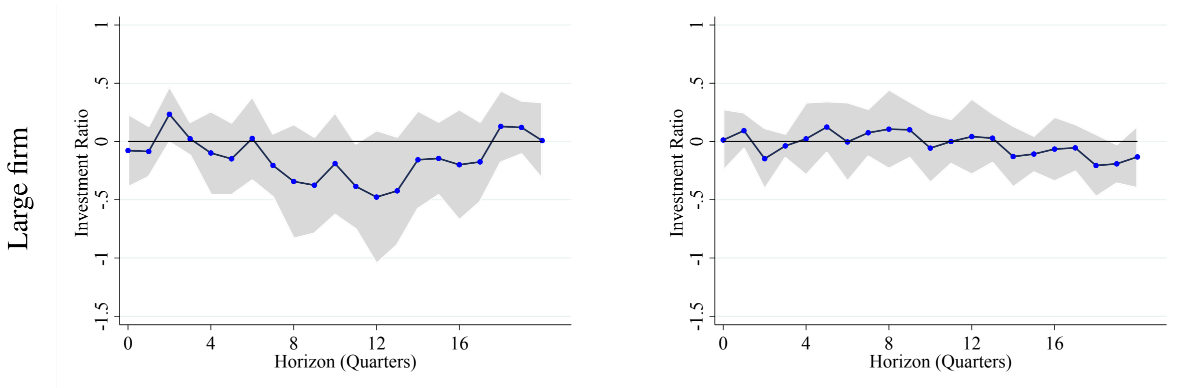
(a) Monetary Contraction (β_h^+)

(b) Monetary Expansion (β_h^-)

Note: The first (second) column shows the impulse response to a monetary policy shock that increases (decreases) the one-year Treasury rate by 25 basis points on impact. Control variables are real asset growth, log GDP, and growth in employees. The shaded areas show 90 percent confidence intervals.

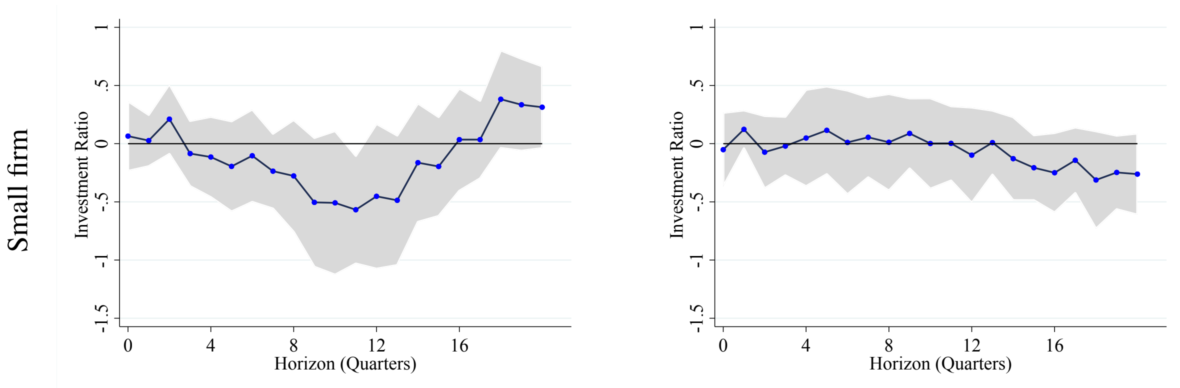
$$\frac{i_{j,t+h}}{k_{j,t+h-1}} - \frac{i_{j,t-1}}{k_{j,t-2}} = \alpha_j^h + \beta_h^+ \, max[0, \Delta R_t] + \beta_h^- \, min[0, \Delta R_t] + \Omega'(L) \, Z_{j,t-1} + \epsilon_{j,t+h}$$

Figure 11: Asymmetric effects of monetary policy on investment ratio



(a) Monetary Contraction (β_h^+) (b) Monetary Expansion (β_h^-)

Figure 12: Asymmetric effects of monetary policy on investment ratio

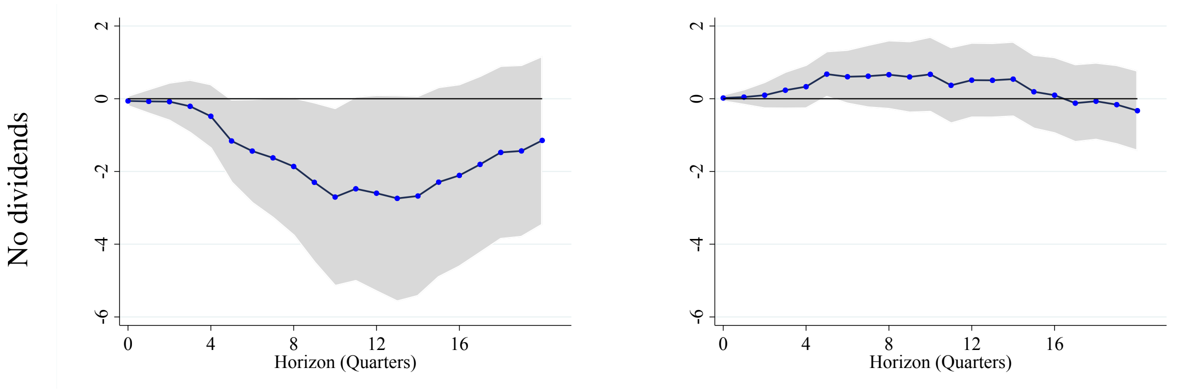


(a) Monetary Contraction (β_h^+) (b) Monetary Expansion (β_h^-)

Note: The first (second) column shows the impulse response to a monetary policy shock that increases (decreases) the one-year Treasury rate by 25 basis points on impact. Control variables are real asset growth, log GDP, and growth in employees. The shaded areas show 90 percent confidence intervals.

$$y_{j,t+h} - y_{j,t-1} = \alpha_j^h + \beta_h^+ \, max[0, \Delta R_t] + \beta_h^- \, min[0, \Delta R_t] + \Omega'(L) \, Z_{j,t-1} + \epsilon_{j,t+h}$$

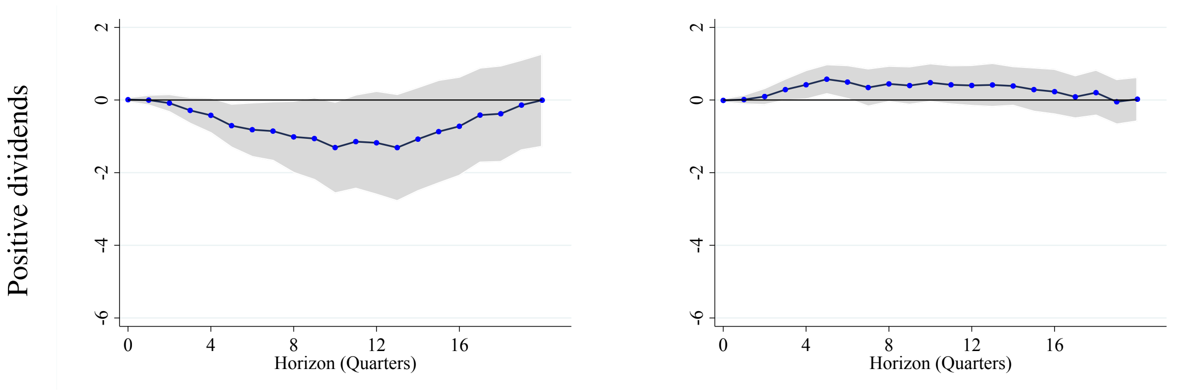
Figure 13: Asymmetric effects of monetary policy on log employees



(a) Monetary Contraction (β_h^+)

(b) Monetary Expansion (β_h^-)

Figure 14: Asymmetric effects of monetary policy on log employees



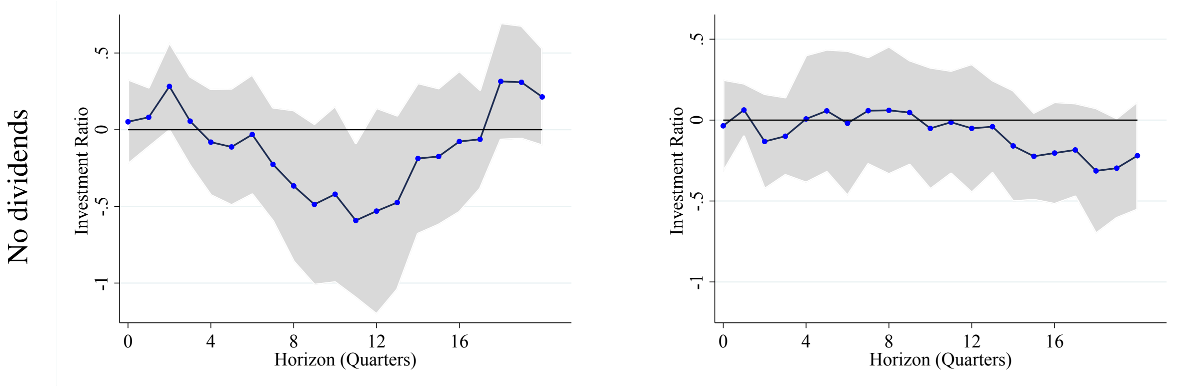
(a) Monetary Contraction (β_h^+)

(b) Monetary Expansion (β_h^-)

Note: The first (second) column shows the impulse response to a monetary policy shock that increases (decreases) the one-year Treasury rate by 25 basis points on impact. Control variables are real asset growth, log GDP, and growth in employees. The shaded areas show 90 percent confidence intervals.

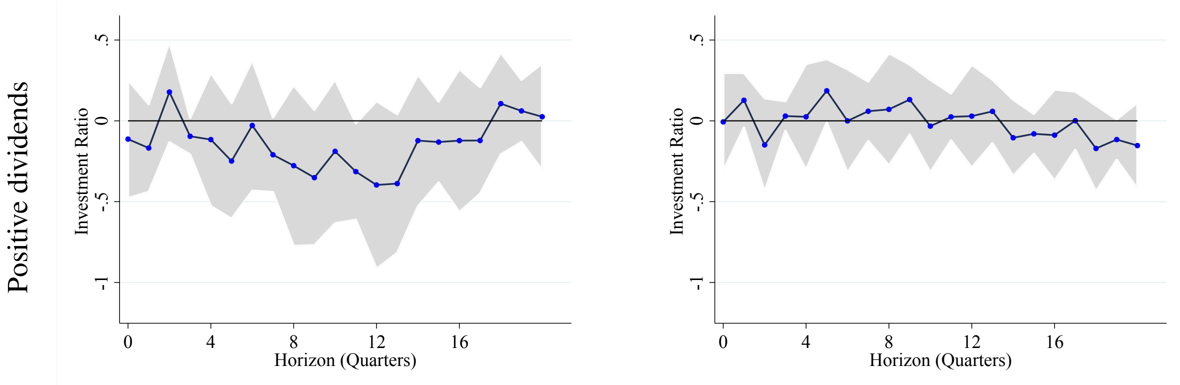
$$\frac{i_{j,t+h}}{k_{j,t+h-1}} - \frac{i_{j,t-1}}{k_{j,t-2}} = \alpha_j^h + \beta_h^+ \, max[0, \Delta R_t] + \beta_h^- \, min[0, \Delta R_t] + \Omega'(L) \, Z_{j,t-1} + \epsilon_{j,t+h}$$

Figure 15: Asymmetric effects of monetary policy on investment ratio



(a) Monetary Contraction (β_h^+) (b) Monetary Expansion (β_h^-)

Figure 16: Asymmetric effects of monetary policy on investment ratio

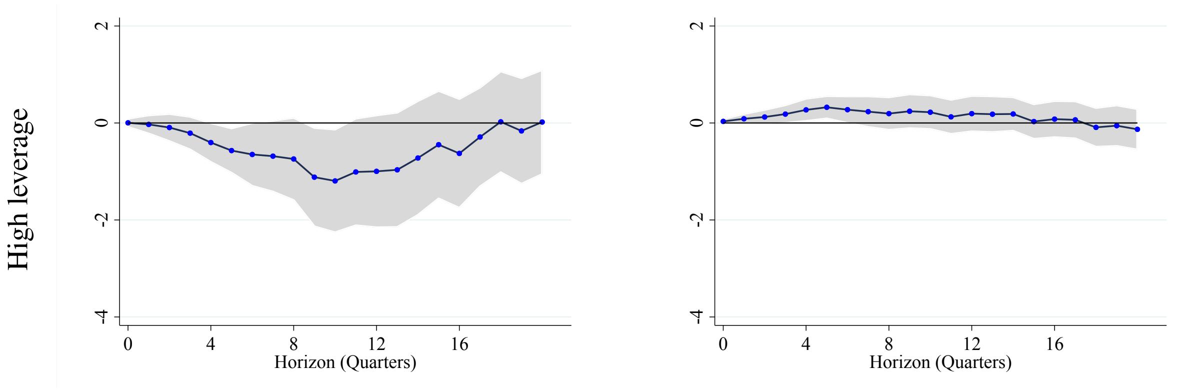


(a) Monetary Contraction (β_h^+) (b) Monetary Expansion (β_h^-)

Note: The first (second) column show the impulse response to a monetary policy shock that increases (decreases) the one-year Treasury rate by 25 basis points on impact. Control variables are real asset growth, log GDP, and growth in employees. The shaded areas show 90 percent confidence intervals.

$$y_{j,t+h} - y_{j,t-1} = \alpha_j^h + \beta_h^+ \, max[0, \Delta R_t] + \beta_h^- \, min[0, \Delta R_t] + \Omega'(L)\, Z_{j,t-1} + \epsilon_{j,t+h} \tag{3}$$

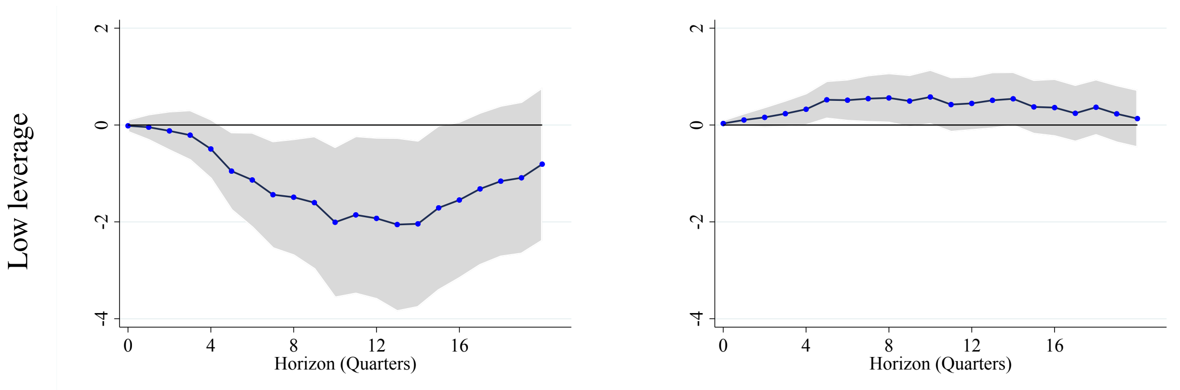
Figure 17: Asymmetric effects of monetary policy on log employees



(a) Monetary Contraction (β_h^+)

(b) Monetary Expansion (β_h^-)

Figure 18: Asymmetric effects of monetary policy on log employees



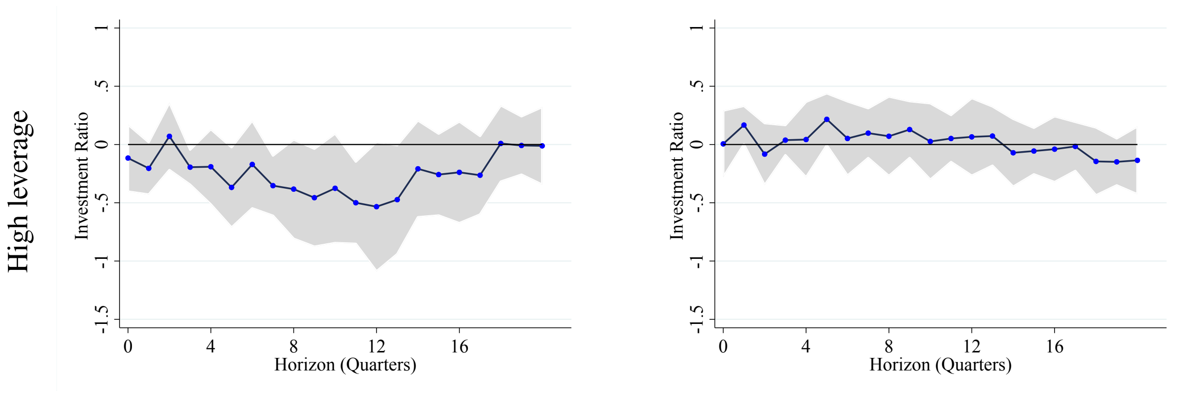
(a) Monetary Contraction (β_h^+)

(b) Monetary Expansion (β_h^-)

Note: The first (second) column shows the impulse response to a monetary policy shock that increases (decreases) the one-year Treasury rate by 25 basis points on impact. Control variables are real asset growth, log GDP, and growth in employees. The shaded areas show 90 percent confidence intervals.

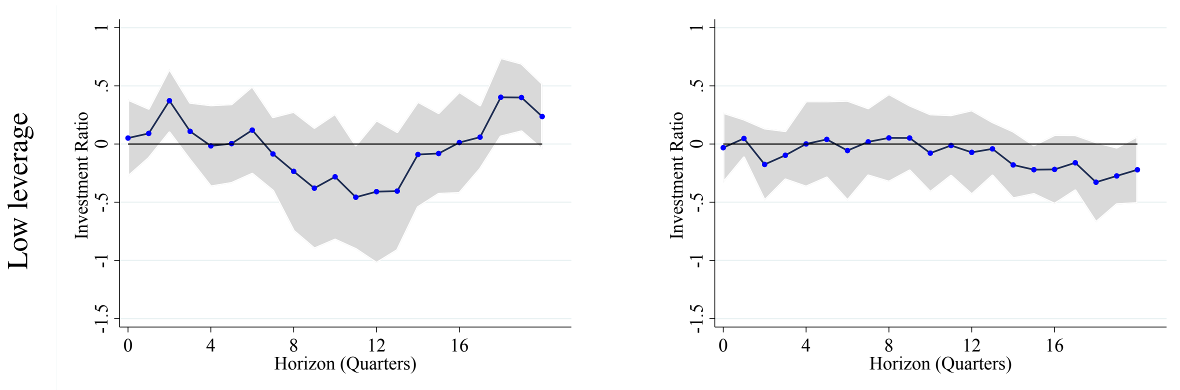
$$\frac{i_{j,t+h}}{k_{j,t+h-1}} - \frac{i_{j,t-1}}{k_{j,t-2}} = \alpha_j^h + \beta_h^+ \, max[0, \Delta R_t] + \beta_h^- \, min[0, \Delta R_t] + \Omega'(L)\, Z_{j,t-1} + \epsilon_{\,j,t+h}$$

Figure 19: Asymmetric effects of monetary policy on investment ratio



(a) Monetary Contraction (β_h^+) (b) Monetary Expansion (β_h^-)

Figure 20: Asymmetric effects of monetary policy on investment ratio

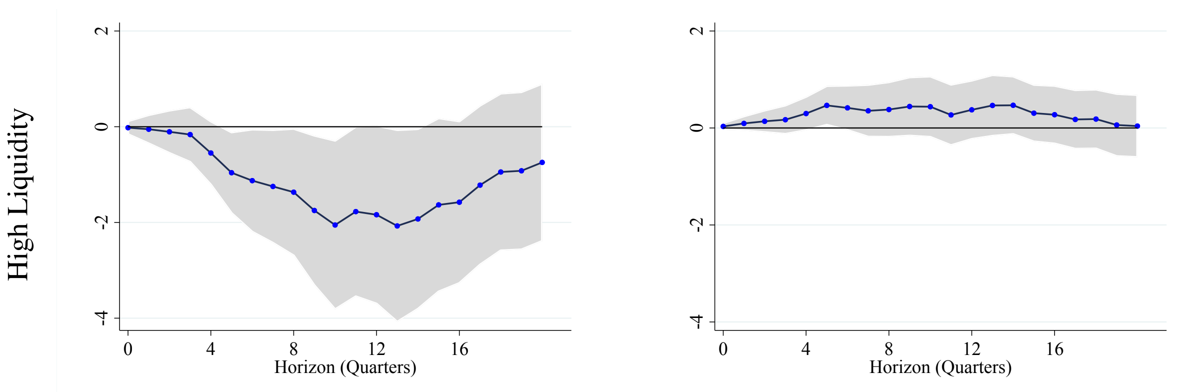


(a) Monetary Contraction (β_h^+) (b) Monetary Expansion (β_h^-)

Note: The first (second) column shows the impulse response to a monetary policy shock that increases (decreases) the one-year Treasury rate by 25 basis points on impact. Control variables are real asset growth, log GDP, and growth in employees. The shaded areas show 90 percent confidence intervals.

$$y_{j,t+h} - y_{j,t-1} = \alpha_j^h + \beta_h^+ \, max[0, \Delta R_t] + \beta_h^- \, min[0, \Delta R_t] + \Omega'(L) \, Z_{j,t-1} + \epsilon_{\, j,t+h}$$

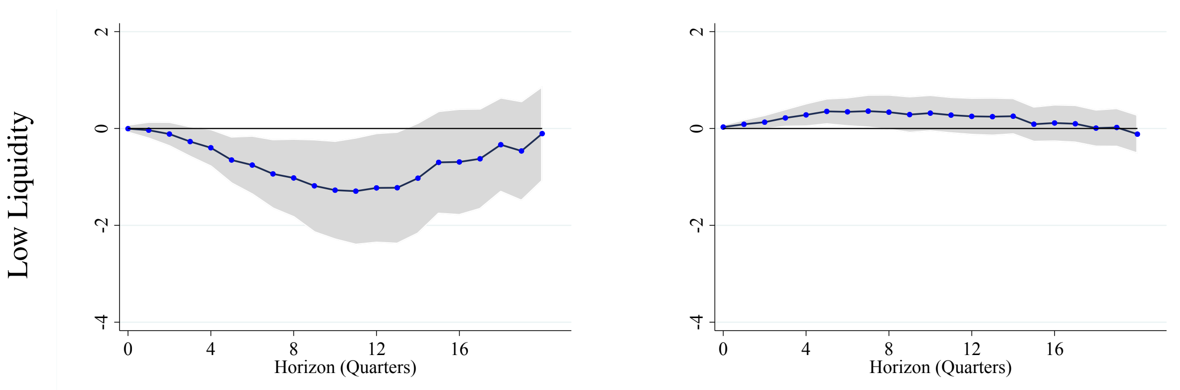
Figure 21: Asymmetric effects of monetary policy on log employees



(a) Monetary Contraction (β_h^+)

(b) Monetary Expansion (β_h^-)

Figure 22: Asymmetric effects of monetary policy on log employees



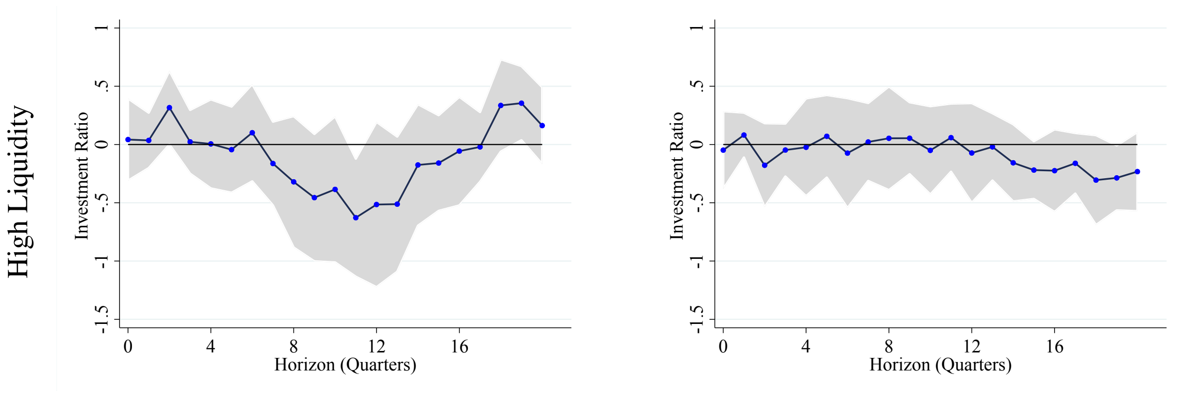
(a) Monetary Contraction (β_h^+)

(b) Monetary Expansion (β_h^-)

Note: The first (second) column shows the impulse response to a monetary policy shock that increases (decreases) the one-year Treasury rate by 25 basis points on impact. Control variables are real asset growth, log GDP and growth in employees. The shaded areas show 90 percent confidence intervals.

$$\frac{i_{j,t+h}}{k_{j,t+h-1}} - \frac{i_{j,t-1}}{k_{j,t-2}} = \alpha_j^h + \beta_h^+ \, max[0, \Delta R_t] + \beta_h^- \, min[0, \Delta R_t] + \Omega'(L) \, Z_{j,t-1} + \epsilon_{j,t+h}$$

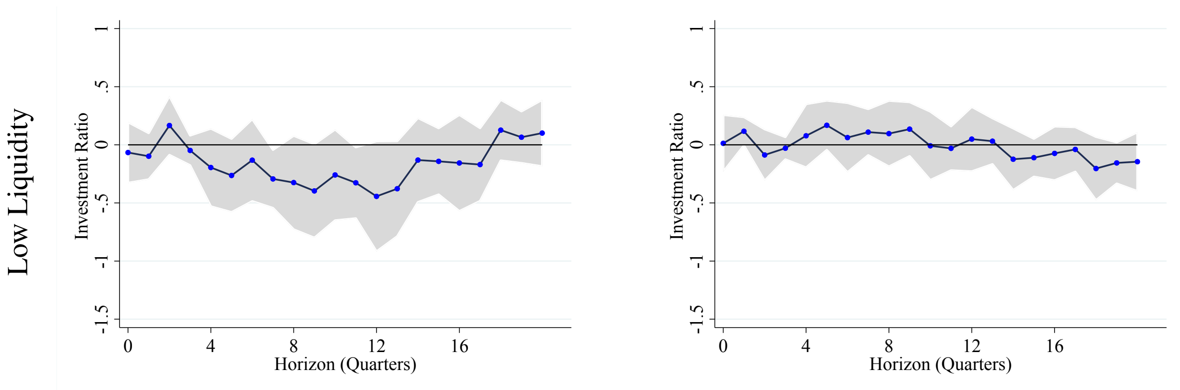
Figure 23: Asymmetric effects of monetary policy on investment ratio



(a) Monetary Contraction (β_h^+)

(b) Monetary Expansion (β_h^-)

Figure 24: Asymmetric effects of monetary policy on investment ratio



(a) Monetary Contraction (β_h^+)

(b) Monetary Expansion (β_h^-)

Note: The first (second) column shows the impulse response to a monetary policy shock that increases (decreases) the one-year Treasury rate by 25 basis points on impact. Control variables are real asset growth, log GDP, and growth in employees. The shaded areas show 90 percent confidence intervals.

6. Tables

Table 1: Descriptive Statistics

	Employees	Investment Rate	Sales	Assets	Debt to Assets	Liquidity Rate
Obs #	603,434	586,881	686,351	687,513	683,461	687,225
Bottom 5%	0.0	0.0	0.0	2.0	0.0	0.2
Median	0.7	4.5	35.2	134.3	22.5	6.9
Average	7.3	7.8	436.2	2111.3	31.4	17.0
Top 5%	30.7	26.3	1703.7	8346.6	78.3	71.0
Std dev	34.9	10.7	2282.2	12315.6	69.0	22.8

Note: The table reports descriptive statistics on main variables used in the paper. See Appendix A for data descriptions.

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ONLINE APPENDIX

A. Data appendix

Firm level variables I use quarterly Compustat firm-level from 1980q3 to 2016q2. Compustat provides high-quality information on balance sheet and income statement components of publicly traded C corporations in North America. Detailed variable definitions of Compustat can be accessed through Wharton Research Data Services for the United States.

Table A.1 provides the variable names and respective codes in Compustat. Leverage is the ratio of short and long-term debt to total assets. Liquidity ratio is the ratio of cash and short-term investments (*cheq*) to total assets. Dividend variable is used as an indicator on whether the firm has paid cash dividends in the previous year. *aqcq* represents the cash outflow or funds used to acquisition of a company. Employment data is pulled from yearly data and linearly interpolated across quarters within the year. All nominal variables in level are deflated using the aggregate GVA deflator.

Table A.1: Variable Definitions

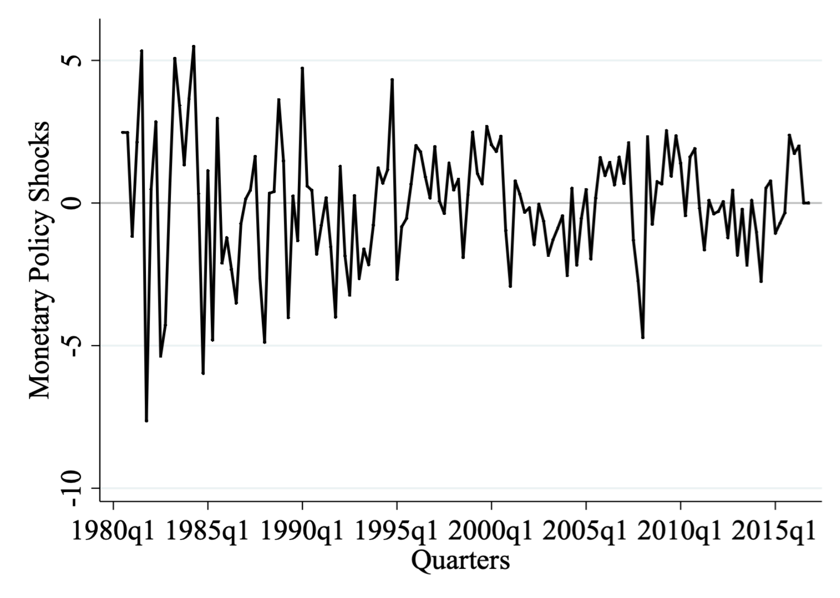
Variable	Compustat variable
Leverage	$(dlcq + dlttq) * 100/atq$
Liquidity ratio	$cheq * 100/atq$
Employees	emp
Investment ratio	$capxq/L.ppentq$
Total Assets (Book value)	atq
Debt-to-Equity ratio	$(dlcq + dlttq) * 100/ceqq$
Sales	$saleq$
Dividend	dvq
Acquisitions	$aqcq/atq$

Sample Restrictions I drop firms in finance, insurance, real estate and public administration sectors. Following Ottonello and Winberry (2020), I also exclude firms with acquisitions accounting for more than 5 percent of total assets. I drop firms which are in the panel for less than 5 years. The baseline trimming excludes firms with top and bottom 1 percent of the investment ratio, debt-to-equity ratio and employment growth. I also trim the top 1 percent of leverage ratio. Trimming is done by year. I also drop observations with negative debt to asset ratio, liquidity ratio, investment rate and sales.

Macro Time Series Data The one-year risk free is the 1-Year Treasury Constant Maturity Rate (Monthly, Not Seasonally Adjusted) from FRED series GS1. The excess bond premium is complied by Gilchrist and Zakrajšek (2012), EBP_OA, available at author's website.[29] Employment rate is available at FRED as the seasonally adjusted employment rate of all persons aged 15:64 in the United States (LREM64TTUSM156S). CPI is the seasonally adjusted consumer prices index computed for total items in the United States by FRED (CPALTT01USM661S). Debt to GDP is from provided by macro trends, available here. PPI is the producer prices index computed for total items in the United States by FRED (PPIACO). The GVA (gross value added) deflator series (B358RG3Q086SBEA) is Price Index (Business : Nonfarm) from FRED.

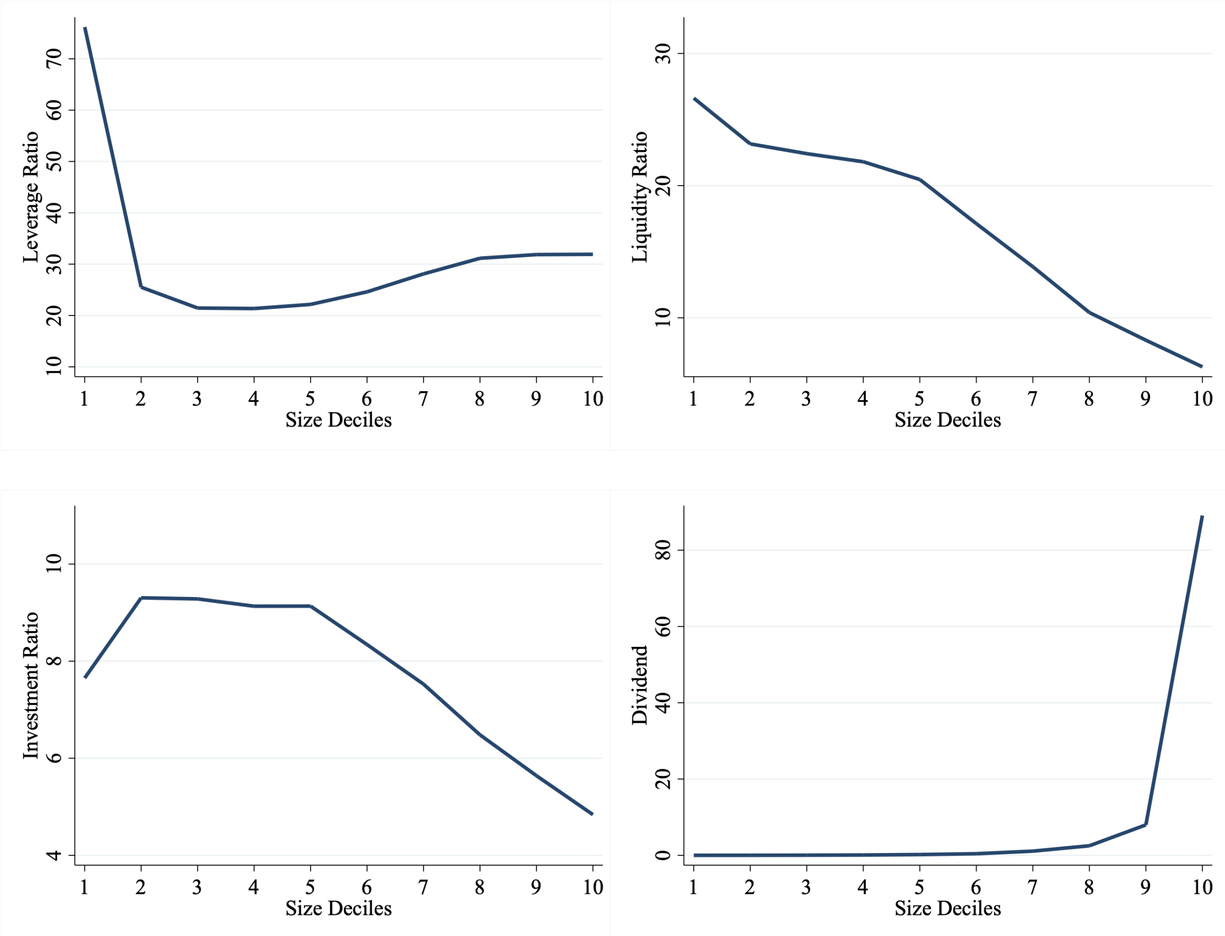
[29]The data was accessed in February 2021.

Figure A.1: Time-series of monetary policy shocks (1980q3-2016q2)



Note: The figure plots implied monetary policy shocks derived from Gertler and Karadi (2015)'s structural VAR impact matrix. See the text in section 2 for details.

Figure A.2: Characteristics of alternative firm size deciles



Note: Size deciles are generated using real assets. The figure uses data from 1980q3 to 2016q2, and is generated after the trims. See Appendix A for data construction and trimming.

B. Further Heterogeneity Results

Figure B.3: Asymmetric effects of monetary policy on log employees for size leverage groups

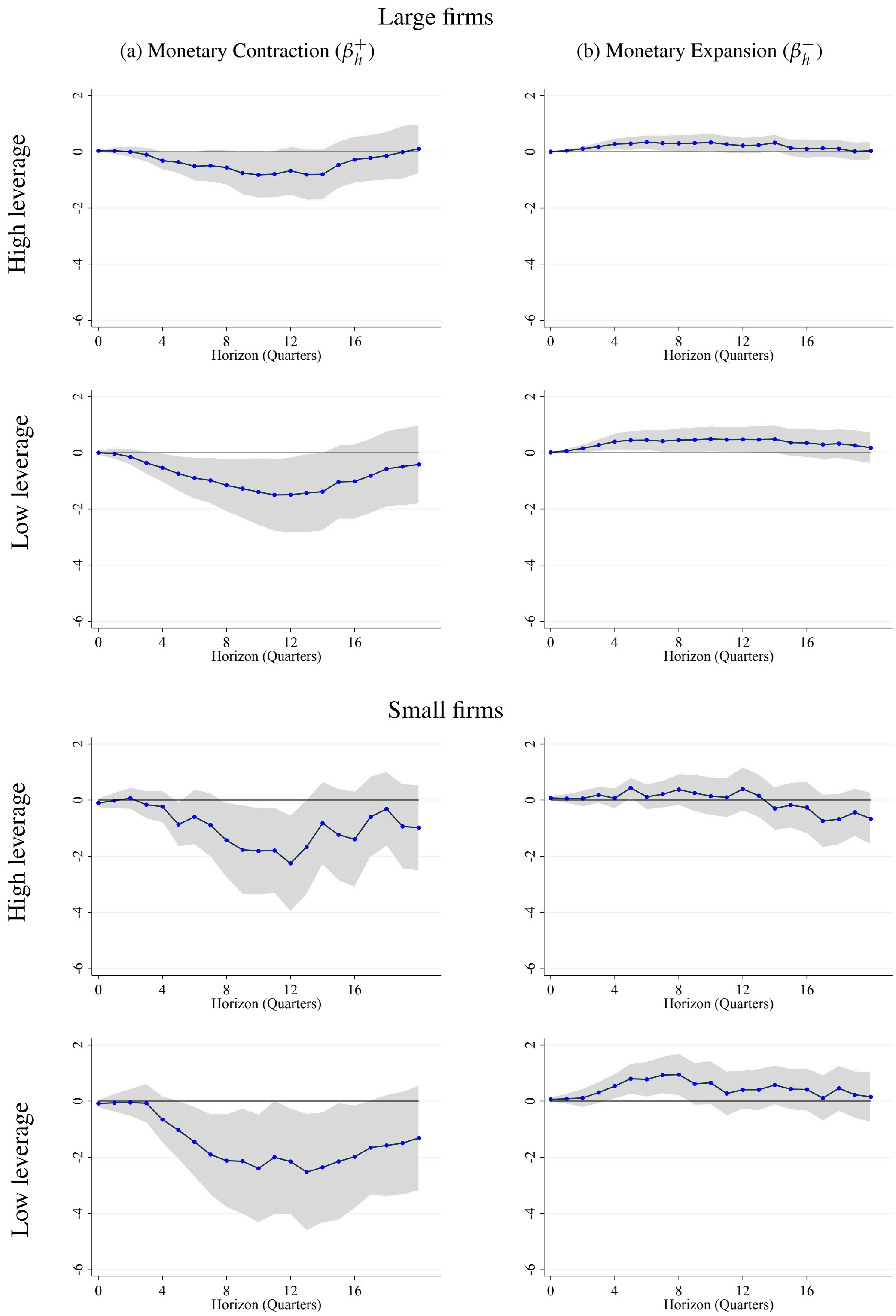


Figure B.4: Asymmetric effects of monetary policy on log employees for size liquidity groups

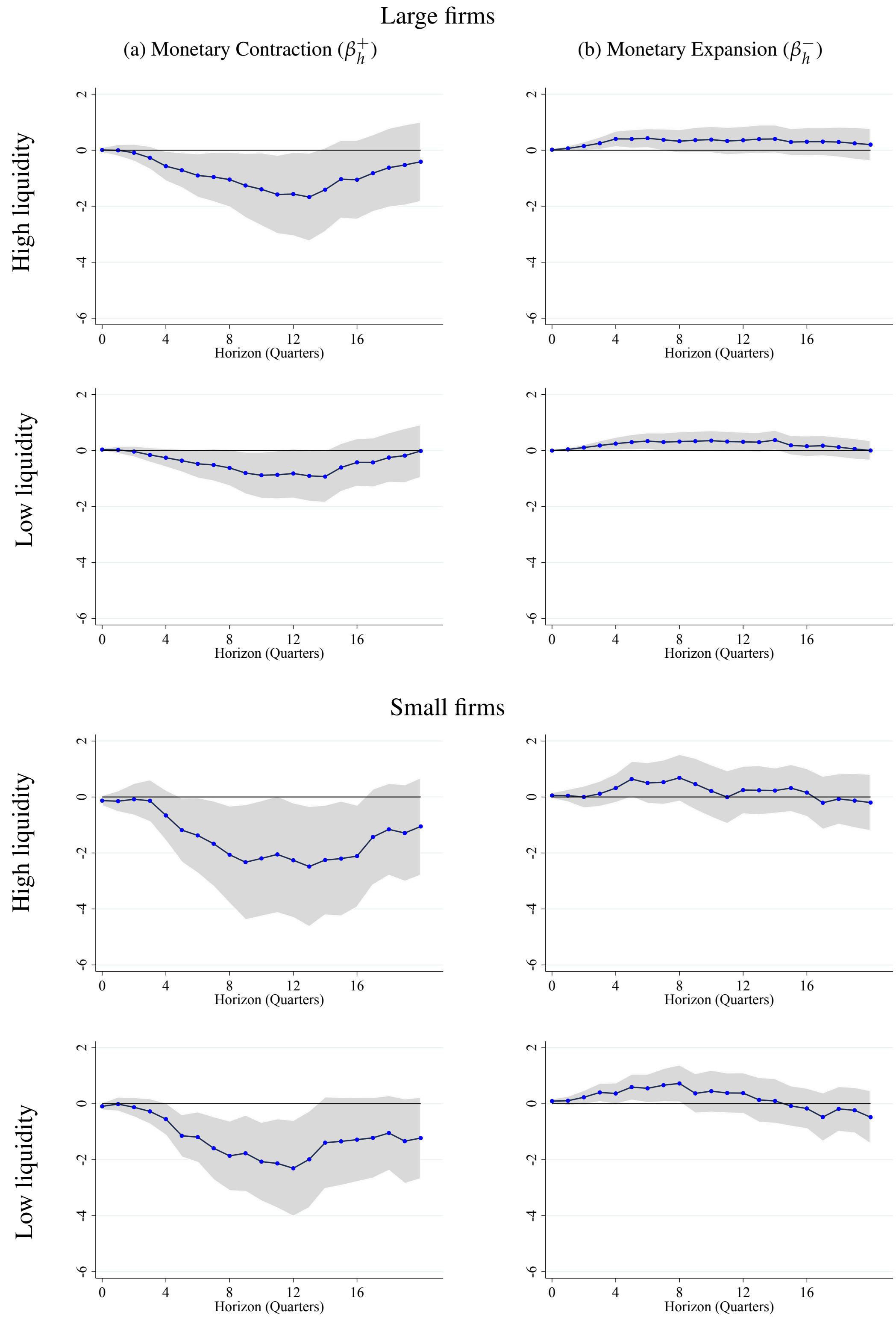


Figure B.5: Asymmetric effects of monetary policy on log employees for leverage liquidity groups

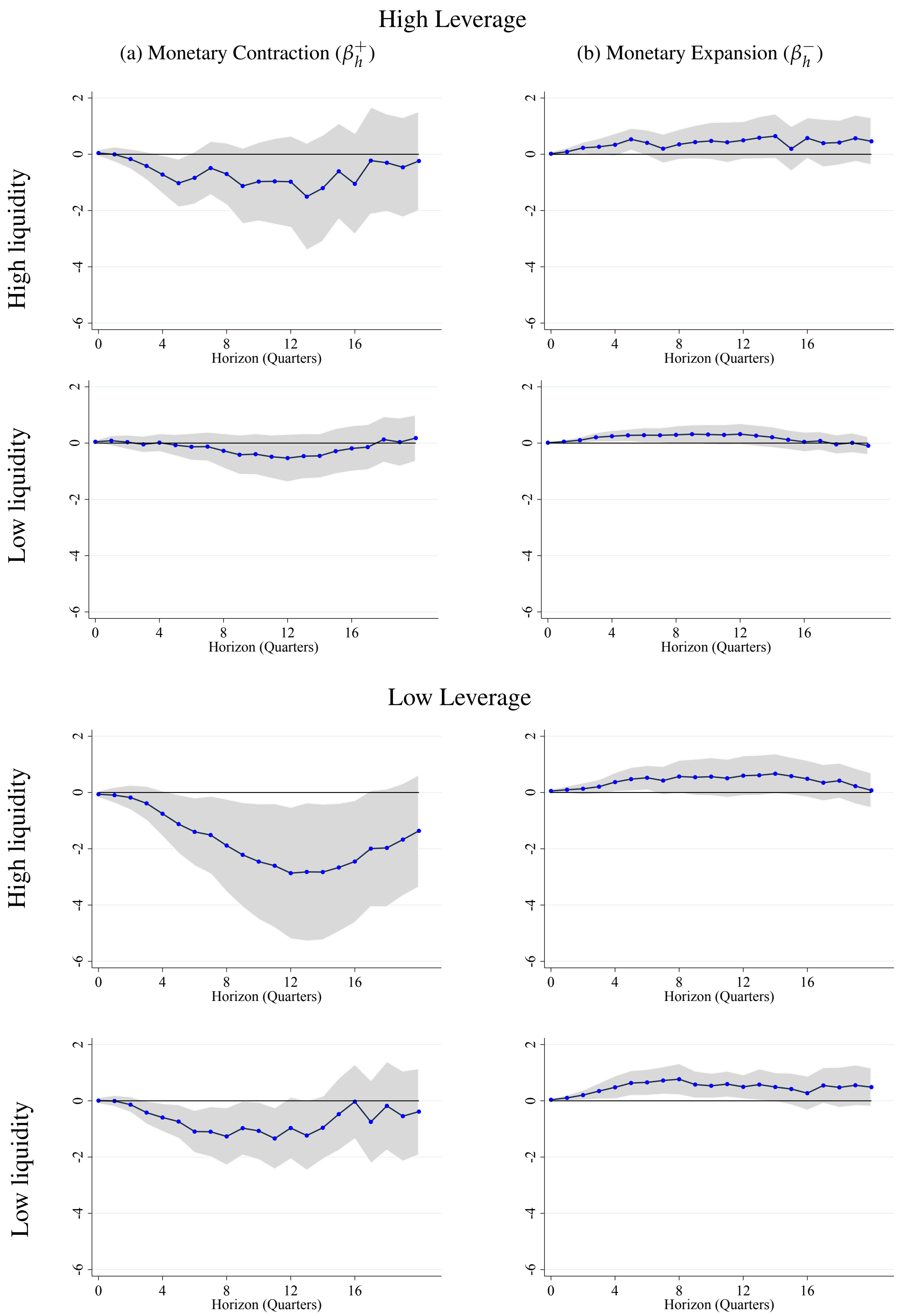


Figure B.6: Asymmetric effects of monetary policy on log employees for dividend size groups

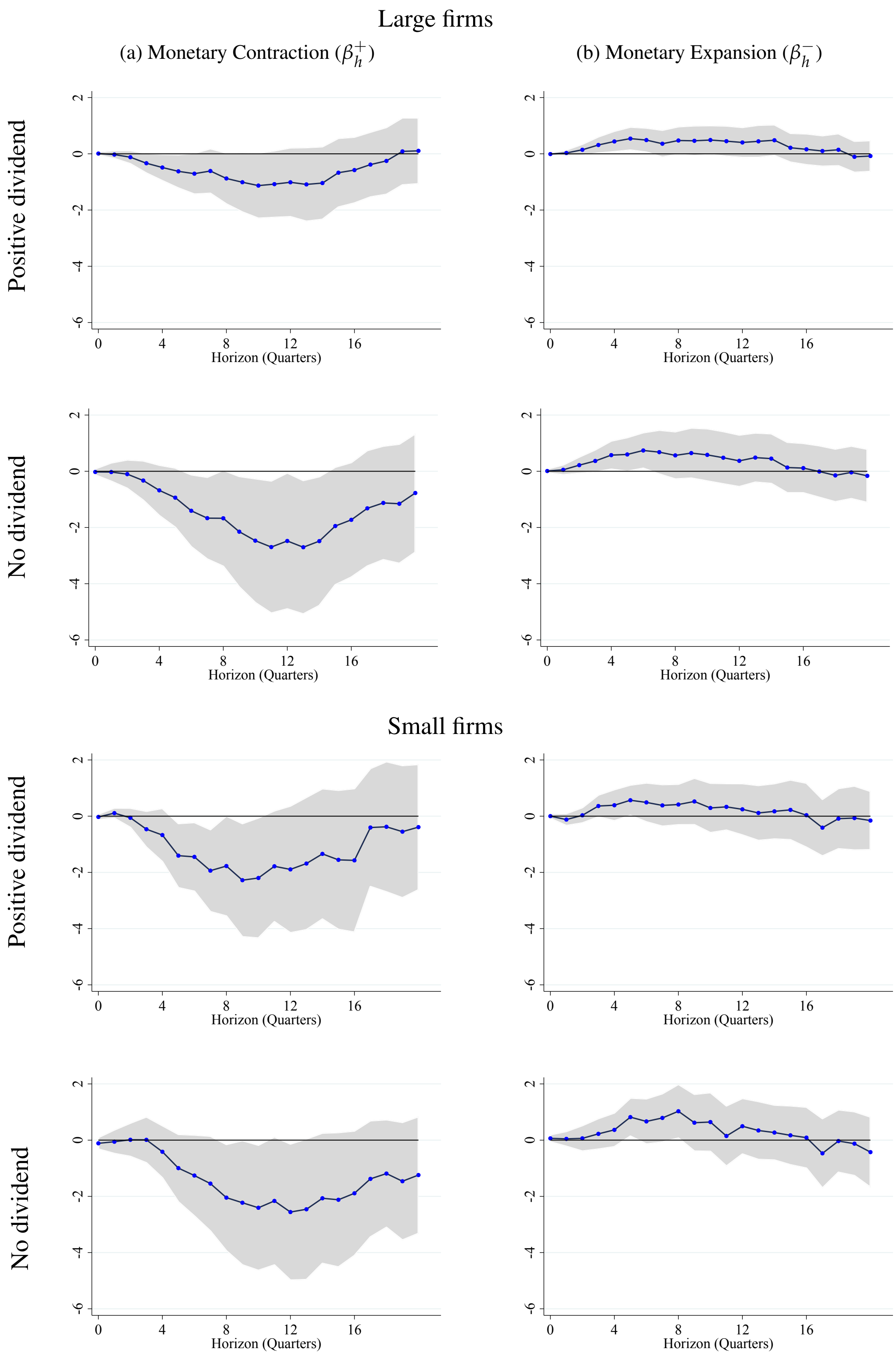


Figure B.7: Asymmetric effects of monetary policy on investment ratio for size leverage groups

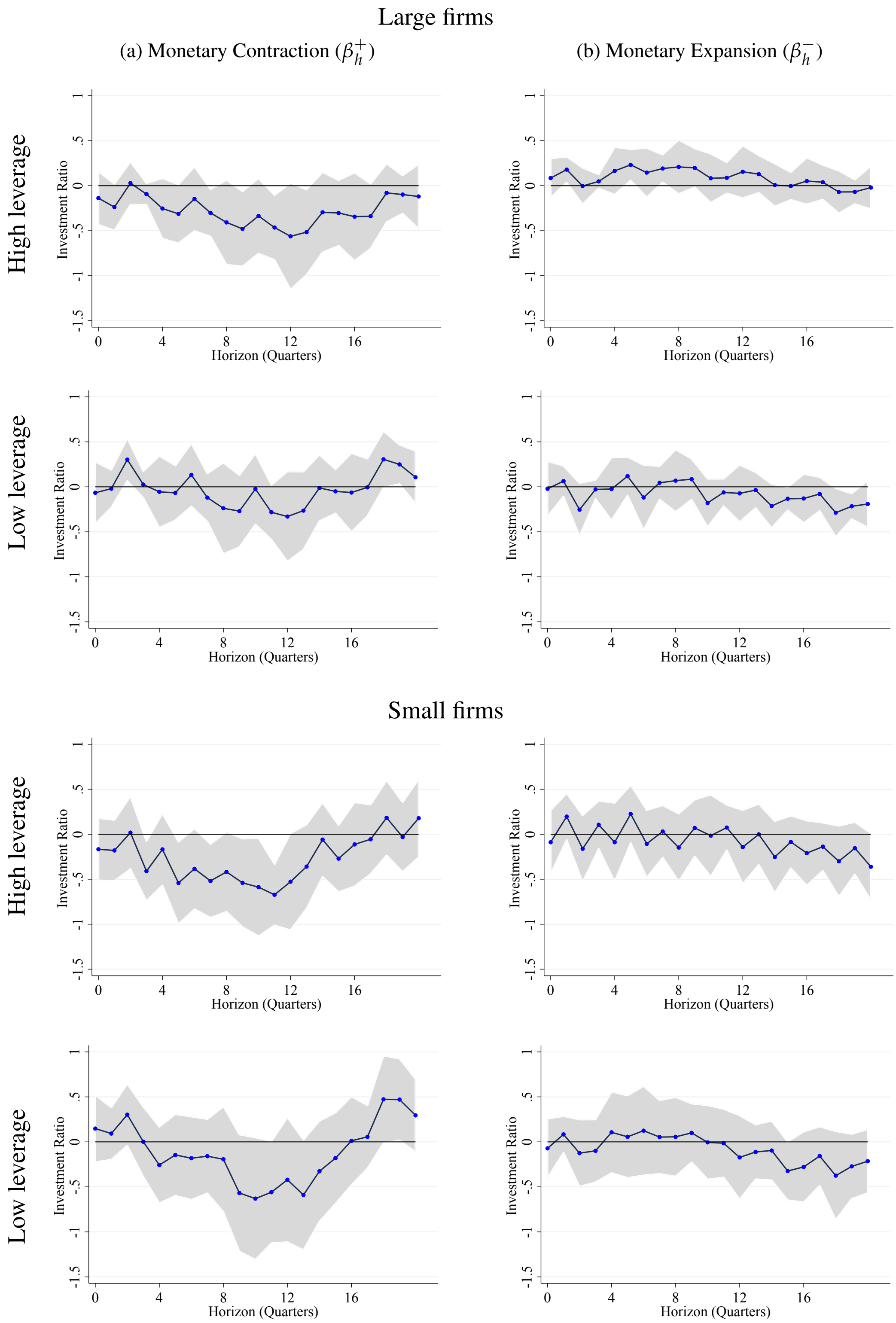


Figure B.8: Asymmetric effects of monetary policy on investment ratio for size liquidity groups.

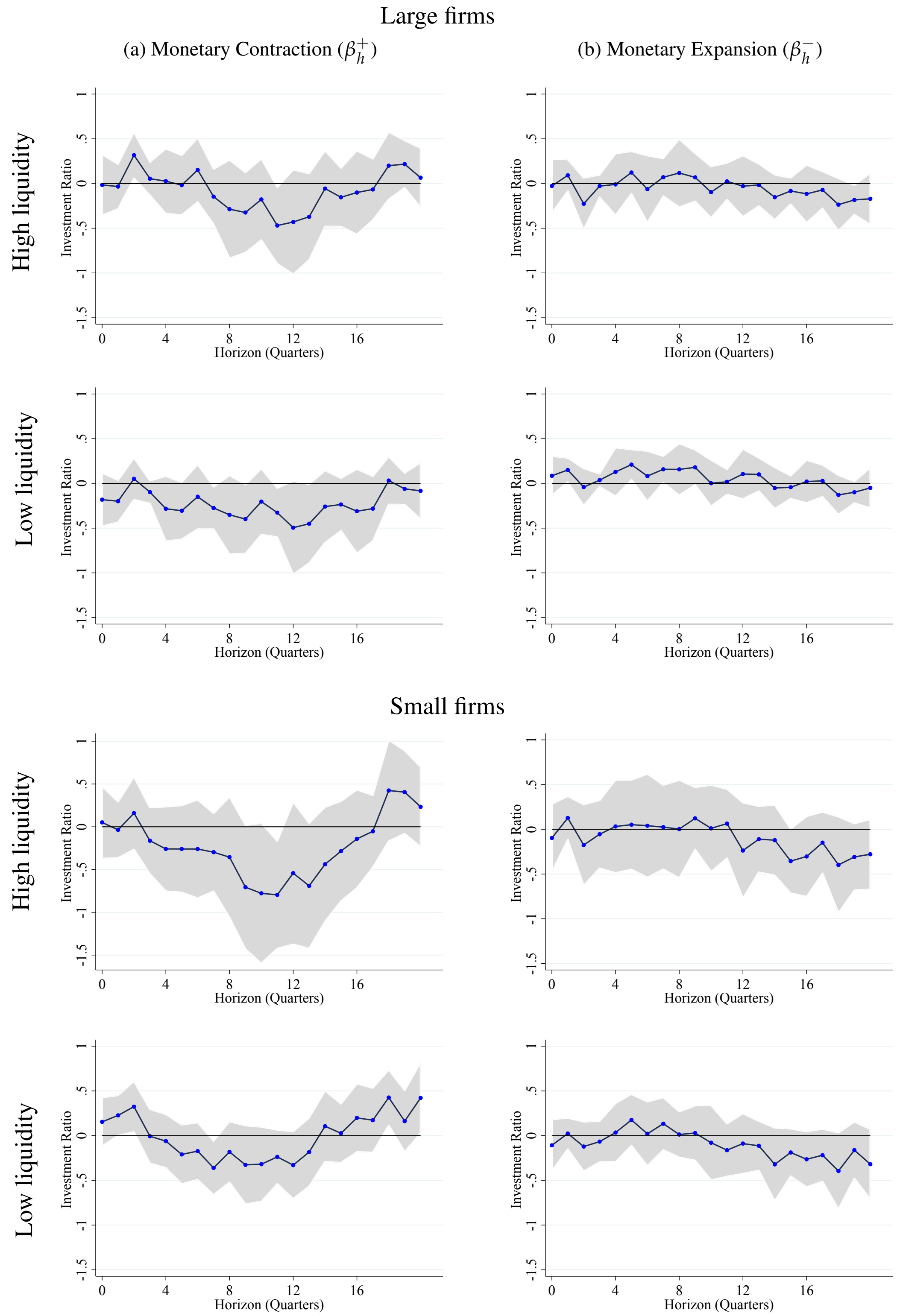


Figure B.9: Asymmetric effects of monetary policy on investment ratio for leverage liquidity groups.

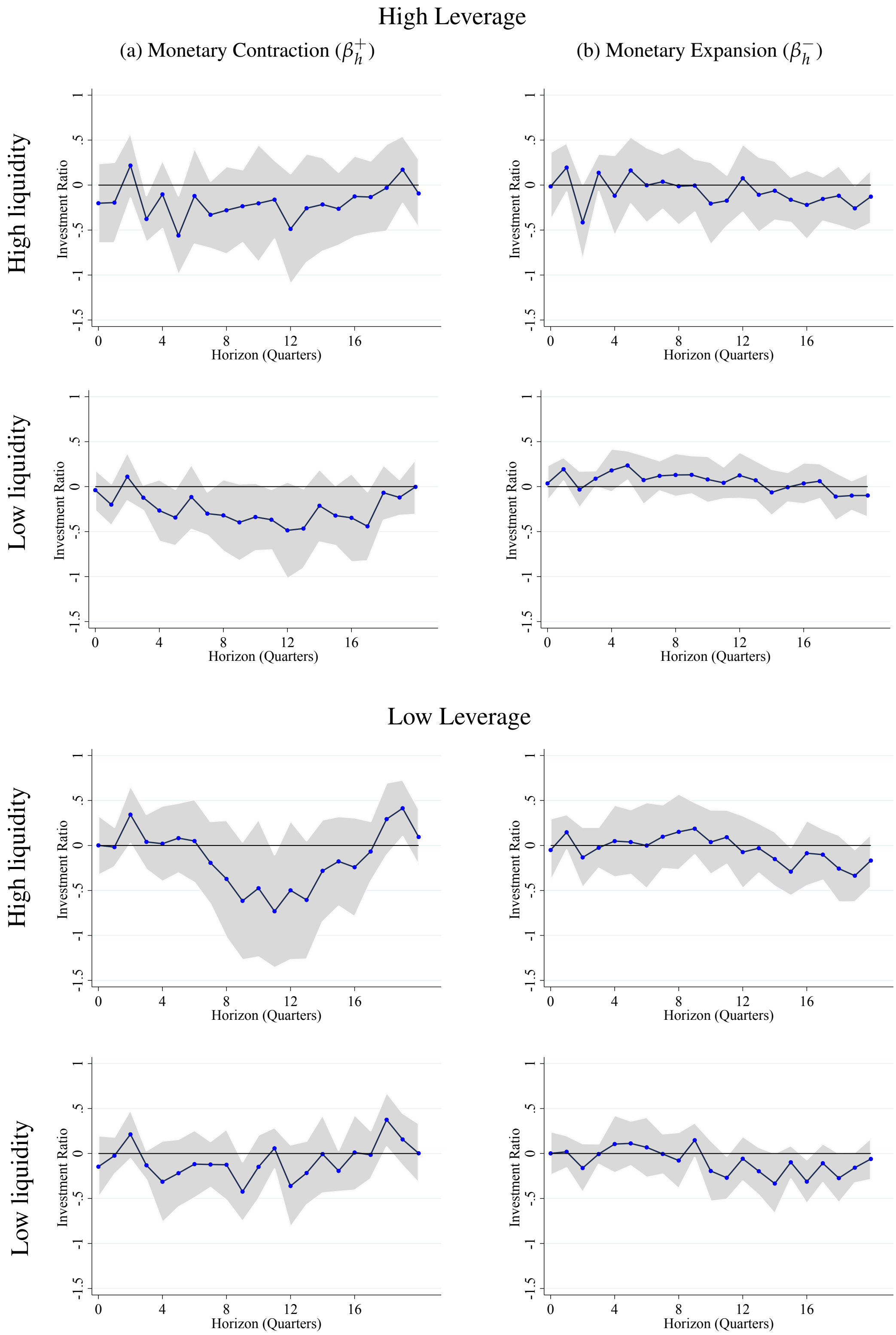


Figure B.10: Asymmetric effects of monetary policy on investment ratio for dividend size groups.