The Impact of U.S. Monetary Policy on Foreign Firms*

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Abstract

This paper uses cross-country firm-level data to explore the impact of U.S. monetary policy shocks on firms' sales, investment, and employment. We estimate a significant impact of U.S. monetary policy on the average foreign firm, while controlling for other macroeconomic and financial variables like the VIX and exchange rate fluctuations that accompany U.S. monetary policy changes. We then estimate the role of international trade exposure and financial constraints in transmitting monetary policy shocks to firms, allowing for a better identification of the importance of external demand effects and the financial channel. We first exploit cross-country sector-level data on intermediate and final goods to show that greater global production linkages amplify the impact of U.S. monetary policy at the firm level. We then show that the impact varies along the firm-level distribution of proxies for firms' financial constraints (e.g., size and net worth), with the impact being significantly attenuated for less constrained firms.

Keywords: U.S. monetary policy spillovers; foreign firms; international production linkages; financial constraints

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1 Introduction

The impact of U.S. monetary policy on the real economy is a long-studied topic, and one that is of particular importance to understand today as the Fed and other central banks have entered a global tightening cycle. These policy actions are not taken in a vacuum, and some economists such as Obstfeld (2022) and Wei (2022) have argued that there is risk of central banks dampening aggregate demand excessively. Indeed, spillovers of U.S. monetary policy may impact foreign economies via several channels independently of domestic policy actions.

This paper merges firm, sectoral and macroeconomic data for a large cross-section of countries to quantify how international trade exposure and the financial channel of interest rate changes affect transmission of U.S. monetary policy shocks to foreign firm activity. We study these two channels given that the recent confluence of escalating protectionism, Covid-19, disrupted supply chains, Brexit, OFAC sanctions, corporate delistings, and geopolitical tensions has raised questions about whether the decades-long trend toward globalization in trade and financial markets, as well as the rise of "megafirms" (Autor, Dorn, Katz, Patterson and van Reenen, 2020), is reversing. Such "end-of-globalization" considerations are important for global welfare depending on the degree to which – and channels through which – shocks such as monetary policy tightenings are fundamentally transmitted. Focusing on the firm level is particularly salient given the role of "granular" firms in driving aggregate fluctuations (Gabaix, 2011). Firm heterogeneity further interacts with exposure to the world economy, particularly via international trade, to play a large role in aggregate international business cycle co-movement (di Giovanni, Levchenko and Mejean, 2014, 2018, 2023; Wei and Xie, 2020).

We begin by estimating the effect of U.S. monetary policy shocks on the change in the average foreign firm's investment-to-capital share, sales-to-capital share, and employment growth in a given country. Our methodology utilizes a panel regression model, which allows us to control for time-varying firm-level and macroeconomic variables, along with a rich set of non-time varying fixed effects. The main results imply that the tightening of U.S. monetary policy has a statistically significant contractionary effect on the change in a firm's investment and sales ratios. Employment growth also falls, but not sufficiently to detect a statistically significant effect. Results are also economically meaningful. For example, a one percentage point contraction in U.S. monetary policy translates to a fall in the investment ratio equivalent to sixty-five percent of the median change in the investment ratio over the sample period. We then explore how this spillover effect varies along multiple country dimensions. For example, we document significant differences between emerging market economies (EMEs) and advanced economies (Kalemli-Özcan, 2019). We also examine how financial account and trade openness at the aggregate levels affect the magnitude of U.S. monetary policy transmission to foreign firms.

We next turn to a more in-depth analysis of the impact of a firm's trade exposure, both in relation to the world economy as well as with respect to the United States specifically. If a change in U.S. monetary policy impacts both its output and that of other countries, we would expect changes in countries' demand to spill over internationally via demand for traded goods – both final and intermediate ones. We test for the importance of this "trade channel" of monetary policy transmission to foreign firms by extending our regression methodology. We construct four export-oriented measures of trade using cross-country sector-level data on intermediate and final goods trade as well as sectoral output sourced from the World Input-Output Database (WIOD) from Timmer, Dietzenbacher, Los, Stehrer and de Vries (2015). Specifically, we construct a country-sector's (i) total exports-to-output ratio, (ii) final goods exports-to-output ratio, (iii) intermediate goods exports-to-output ratio, and (iv) export-based weighted outdegree. The latter measure captures how important a sector is as a supplier of intermediates in the production of one unit of its country-sector export partners' output. We interact these variables with the monetary policy shock in the next set of regressions, focusing on the impact on firm-level investment. The approach allows us to identify how the variation in trade exposure impacts shock spillover to the average firm within a country-sector. Given that we exploit variation at the country×sector×year level, we are able to control for time-varying fixed effects at the country and/or sector level.

We document that total export exposure plays a significant role in the transmission of U.S. monetary policy shocks to firm investment. Movement along the distribution of country-sector export openness from low (bottom decile) to high (top decile) amplifies the impact of the shock by forty percent relative to the impact on the average firm. Interestingly, when decomposing the total export-to-output ratio, we find that it is intermediate goods and services trade that drives the overall export exposure findings, both for trade with the whole world and bilaterally with the United States. Finally, the estimated coefficient on the weighted outdegree measure is also economically and statistically significant, indicating that it is not just the importance of overall intermediate exports in driving the transmission of U.S. monetary policy shocks to foreign firms, but also the amplification of demand shocks via global production linkages. Our results regarding this external demand channel via international trade and production linkages is in line with recent findings in the literature using more aggregated data, such as Bräuning and Sheremirov (2021) and di Giovanni and Hale (2022).

To provide evidence on the role of differential financial constraints, we run panel regressions interacting proxies of financial constraints (size or net worth) with the U.S. monetary policy shock. This allows us to exploit time-varying firm-level variation in the interaction variable to identify this mechanism, and thereby include an exhaustive set of time-varying fixed effects at the country×sector×year level along with non-time varying firm fixed effects. Our results show that foreign firms with greater financial constraints are less able to attenuate the impact of monetary policy shocks on their investment. The finding that more financially constrained firms respond more to monetary policy aligns with the empirical literature on U.S. firm responses to U.S. monetary policy shocks and with predictions of classic financial frictions theories (Bernanke and Gertler, 1989; Bernanke et al., 1999).[1] The magnitude of this effect is significant. For example, moving over the interquartile range of the firm-net worth distribution implies that less financially constrained firms are able to attenuate the impact of U.S. monetary policy shocks by roughly one-quarter of the impact on the mean firm.

Our final set of heterogeneity regressions combines the trade exposure measures with the financial constraint proxies in order to estimate the joint impact of these channels. These regressions yield interesting results. First, the magnitude and significance of the trade and financial interaction coefficients do not change dramatically when included together. Second, our quantification exercises imply that the dampening effect of looser financial constraints of larger firms dominates the amplification effect of greater trade exposure. While the trade measures are constructed at the country-sector level, it is worth noting that large firms tend to dominate the export market (Melitz, 2003; Freund and Pierola, 2015). Therefore, our overall findings suggest that these "granular" foreign firms are impacted to a lesser extent, on net, by U.S. monetary policy shocks, considering the channels identified in our regressions,

These results have important implications for policymakers in both industrial and EME countries. In the context of the current global policy cycle, our baseline results imply that even when conditioning on domestic monetary policy actions, U.S. monetary policy changes may have a nontrivial impact on foreign economies' firms and thus their countries' aggregate activity. Furthermore, our point estimates imply that foreign firms react more to U.S. monetary policy shocks in EMEs than industrial countries, indicating that EME policymakers have a harder job in insulating their economies from U.S. monetary policy actions. Turning to the channels driving the firm-level responses, we might further expect that countries more exposed to world trade, particularly to intermediate goods and global-value-chain trade, may be impacted more by U.S. monetary policy. In as much as large firms are involved in such trade, this impact may be attenuated by their greater resilience to potential financial spillovers given less binding financial constraints. However, if firms in EMEs are relatively more dependent on foreign financing, even large well-capitalized EME firms may suffer more than their counterparts in industrial countries.

[1] There are several differences between the setup our paper and that of the related literature, which has to date looked only at heterogeneity in the responses of U.S. firms' outcomes to U.S. monetary policy shocks. These differences include the outcome variables, monetary policy shock series, proxies for financial constraints, and regression specifications. Ottonello and Winberry (2020) report results showing that firms with *low* default risk and *low* leverage are *more* responsive to monetary policy. As Ottonello and Winberry (2020) discuss in detail in an Appendix, they interpret differences between their results and the more standard findings of Jeenas (2019), for example, as a difference between within-firm effects and across-firms effects, and do not consider them to be in conflict.

Related Literature

The empirical literature on cross-border spillovers of monetary policy shocks is voluminous. Most of this research, including early papers on the Global Financial Cycle, relied on aggregate data. Pioneering research on the GFC includes Rey (2013), Rey (2016), Kalemli-Özcan (2019), Han and Wei (2018), and Miranda-Agrippino and Rey (2020). Early work on spillovers from U.S. monetary policy shocks includes Eichenbaum and Evans (1995), Rogers (1999), Kim and Roubini (2000), Faust and Rogers (2003), and Faust, Rogers, Swanson and Wright (2003), who focused on foreign interest rates and exchange rates in VARs. Rogers, Scotti and Wright (2014) examine the effects of unconventional monetary policy by the Fed, BOE, ECB, and BOJ on cross-border bond yields and stock prices, as well as exchange rates.[2] Bräuning and Sheremirov (2021) document that trade plays a key role in explaining cross-country heterogeneity in the effects of U.S. monetary shocks on aggregate output, interest rates, and trade flows in a large panel of countries. Degasperi, Hong and Ricco (2021) find that a U.S. monetary policy tightening has large contractionary effects on both advanced and emerging economies, with financial channels dominating over demand and exchange rate channels in the transmission to real variables.

On the micro side, Bräuning and Ivashina (2020) examine the role of U.S. monetary policy in affecting credit conditions of EME firms. They show that the spillover is stronger in higher-yielding and more financially open markets and for firms with a higher reliance on foreign bank credit. Morais, Peydró, Roldán-Peña and Ruiz-Ortega (2019) analyze the universe of corporate loans in Mexico, matched with firm and bank balance-sheet data, to identify the spillover effects of advanced economy monetary policy shocks. They find that a tightening of foreign monetary policy increases the supply of credit from foreign banks to Mexican firms, and that this occurs via their respective (country's) banks. Di Giovanni and Hale (2022) examine spillovers of U.S. monetary policy shocks to sectoral stock returns. They derive a model in which firms in all countries are affected by a monetary shock by an amount that is proportional to a firm's global production linkages, and find that the global production network plays a key role in transmitting U.S. monetary policy shocks to cross-border stock returns, even when conditioning on financial channel variables.

In addition to our paper being related to the large literature on international spillovers of U.S. monetary policy, it is closely related to Claessens, Tong and Wei (2012) and Dao, Minoiu and Ostry (2021). Although neither of these papers examines U.S. monetary policy, Claessens et al. (2012)

[2] See also Georgiadis (2016), who finds that the magnitude of U.S. monetary policy spillovers depends on a host of receiving country characteristics, including trade and financial integration, exchange rate regime, and participation in global value chains; Dedola, Rivolta and Stracca (2017), who find that a surprise U.S. monetary policy tightening leads to a dollar appreciation, decline in foreign industrial production, real GDP, and inflation, and a rise in unemployment in a panel of advanced and emerging economies; and Kearns, Schrimpf and Xia (2019), who measure monetary policy shocks for seven advanced economy central banks and spillovers to 47 advanced and emerging market economies, and find no evidence that spillovers are related to real linkages such as trade flows, but some importance for exchange rate regimes, with the key country characteristic being financial openness.

examine how the global financial crisis affected firms' profits, sales, and investment, the focus of our paper. They find that the crisis had a bigger negative effect on firms with greater sensitivity to business cycle and trade developments, particularly in countries more open to trade. Dao et al. (2021) examine the relationship between real exchange rate fluctuations and firm-level investment and growth. They show that real depreciations boost profits, investment, and asset growth of tradable sector firms that have higher labor shares and are relatively more financially constrained, interpreting this finding as evidence for an "internal financing channel."[3]

Our paper is also related to work on trade and transport costs in international trade and macro (Obstfeld and Rogoff, 2000; Anderson and van Wincoop, 2004). The literature indicates that trade costs vary significantly across time, countries, and sectors. Our investigation of the linkages from U.S. monetary policy shocks to cross-border firms' activity exploits this variation in the data and uncovers a key role for trade networks, consistent with Bräuning and Sheremirov (2021) and di Giovanni and Hale (2022).

Finally, our paper is related to the literature on the investment channel of monetary policy transmission in closed economies. This literature emphasizes the importance of firm heterogeneity for the transmission of monetary policy, with much attention paid to "balance sheet effects." The balance sheet channel broadly refers to feedback effects between the health of borrowers' balance sheets, as measured for example by net worth, and investment (or output, asset prices, etc.). In this framework, financially constrained firms borrow in order to undertake productive long-term projects. The cash flows associated with these projects are vulnerable to aggregate shocks that may generate fluctuations in net worth, which could in turn trigger liquidations of capital and affect investment, the price of capital, and aggregate output. Monetary policy shocks, for example, would give rise to such effects. Seminal papers in this literature are Bernanke and Gertler (1989) and Kiyotaki and Moore (1997). More recent work includes Cloyne et al. (2020), Ottonello and Winberry (2020), Caglio, Darst and Kalemli-Özcan (2021).

The rest of the paper proceeds as follows. Section 2 describes our empirical methodology. Section 3 describes the data and presents summary statistics. Section 4 provides regression results that focus on the role of country-level characteristics, while Section 5 provides our analysis of country-sector level trade and firm-level financial constraint heterogeneity. Section 6 concludes.

2 Methodology

We first estimate the impact of U.S. monetary policy shocks on the average foreign firms' annual change in investment, sales, and employment. Our regression analysis follows the approaches used

[3] While finalizing our first draft, we became aware of contemporaneous work in progress by Arbatli-Saxegaard, Firat, Furceri and Verrier (2022). These authors also examine the cross-border effects of U.S. monetary policy shocks in a large panel of firm-level data. Although we do much more analysis of trade network channels and use different measures of Fed monetary policy shocks and investment, the two papers have a similar focus.

in a closed-economy setting by running panel regressions, where we allow for the possibility of tracing out the dynamic impulse of endogenous variables using local projections (Jordà, 2005). The baseline regression that estimates the average effect of monetary policy shocks on all firms is:

$$Y_{fsc,t+h} - Y_{fsc,t-1} = \boldsymbol{\alpha} + \beta MP^{US}_{t-1} + \mathbf{Z}_{fsc,t-1}\boldsymbol{\gamma'} + \mathbf{X}_{c,t-1}\boldsymbol{\delta'} + \varepsilon_{fsc,t+h}, \quad (1)$$

where f denotes a firm, s the sector and c the country. $Y_{fsc,t+h}$ is the firm-level outcome measured in year $t+h$, $h = 0, 1, 2, \ldots, T$. The firm-level outcomes are either (i) the investment-to-lagged fixed capital ratio (I_t/K_{t-1}), (ii) the sales-to-lagged fixed capital ratio (S_t/K_{t-1}), or (iii) log employment ($\ln E_t$). Given the use of annual data, our baseline is to estimate the model for $h = 0$ only. In this case, the left-hand side of (1) measures either the annual change in the investment or sales shares, or annual employment growth. MP^{US}_{t-1} is the U.S. monetary policy shock variable from Bu, Rogers and Wu (2021) (henceforth the 'BRW' shock) at $t-1$, thus accounting for the lagged impact of monetary policy on the real economy. As described below, the BRW shock is a measure of monetary surprises centered on each of the eight FOMC meetings per year. To match our annual firm-level real variables, we aggregate the eight shock observations over the calendar year, which is customary in the literature. This timing issue further motivates the use of a lagged monetary policy shock variable as opposed to a contemporaneous one.[4] If a monetary policy tightening (loosening), in which $MP^{US} > 0$ ($MP^{US} < 0$), depresses (stimulates) firms' activity, we would expect that $\beta < 0$.

We further control for other standard firm-level covariates, $\mathbf{Z}$, which we lag by one period. These variables include firm size (measured as the log of total assets), net worth, and the change in the cash flow-to-asset ratio.[5] We also include the lag of macroeconomic controls, $\mathbf{X}$, which may vary at the country or global levels. These include domestic real GDP growth, change in the log nominal exchange rate against the U.S. dollar, the change in short-term domestic interest rates, and log VIX. Given the panel setup, we are also able to include a set of non-time-varying fixed effects, $\boldsymbol{\alpha}$ (e.g., at the country, sector, or firm level). Finally, ε is the error term. Given that the monetary policy shock is repeated across all firms in a given year, we cluster standard errors at the annual level and further cluster at the firm level to control for potential autocorrelation in the errors.

The inclusion of the short-term domestic interest rates is of particular importance given that it helps control for domestic monetary policy changes. This allows us to interpret the β coefficient as the independent effect of the U.S. monetary policy shock on foreign firms' outcomes, as opposed to confounding this effect with the impact of potentially correlated domestic monetary policy changes.

[4] We experimented with additional lags, but this did not yield any additional insights.

[5] We also experimented with including firm age, Tobin's Q, and other measures of firms' financial health, such as the changes in its leverage ratio. Including these regressors did not impact our results, but cut the sample size substantially in several cases (for example, Italian firms do not report the age variable in our dataset). Therefore, in order to maximize sample size, we constrain the inclusion of firm-level controls in the final analysis to those mentioned in the main text.

Equation (1) is a useful baseline specification to estimate the impact of U.S. monetary policy on the average firm in a given country. We can then "unpack" the potential heterogeneous impacts of monetary policy by allowing for β to vary across multiple dimensions. To begin, we examine how the impact of U.S. monetary policy on foreign firms varies across countries via simple sample splits and interactions with country characteristics. For example, we examine whether β differs between emerging market economies (EMEs) and industrial countries. We also examine how financial account and trade openness at the aggregate levels impact the estimates of β.

Role of Trade Linkages

Changes in U.S. monetary policy may impact foreign firms' activity directly given the resulting contraction/expansion of demand in U.S. and other countries. This channel might be expected to have an outsized impact on firms or sectors depending on their level of involvement in international trade. Further, given the expansion of global production networks over time, firms that are more integrated in global value chains may be even more impacted due to spillovers across countries arising from the change in U.S. monetary policy. Due to data limitations, we are forced to exploit trade heterogeneity at the country-sector level rather than at the firm level in our estimation.[6]

Thus, our first extended regression specification exploits heterogeneity across country-sectors within a year:

$$\begin{aligned} Y_{fsc,t+h} - Y_{fsc,t-1} = \boldsymbol{\alpha} + \beta_1 MP^{US}_{t-1} + \beta_2 (Trade_{cs,t-1} \times MP^{US}_{t-1}) \\ + \theta Trade_{cs,t-1} + \mathbf{Z}_{fsc,t-1}\boldsymbol{\gamma'} + \mathbf{X}_{c,t-1}\boldsymbol{\delta'} + \varepsilon_{fsc,t+h}, \end{aligned} \tag{2}$$

where $Trade_{cs}$ is a measure of a country-sector's trade exposure. We exploit heterogeneity in a country-sector's export links to the world or the U.S. to construct several measures of its exposure to demand shocks. In particular, we focus on four possible dimensions: a country-sector's (i) total exports-to-output ratio, (ii) final goods exports-to-output ratio, (iii) intermediate goods exports-to-output ratio, and (iv) export-based weighted outdegree. As we describe in Section 3, the weighted outdegree measure quantifies the importance of a country-sector's output for all other country-sectors' production. Put differently, the outdegree captures the importance of a country-sector in the global value chain.[7] Note that we also explored related import-based measures, consistent with the idea that the general equilibrium impact of U.S. monetary policy shocks may also feed through to firms'/sectors' costs via imports. These results were never significant, so we omit them for brevity. Conditional on U.S. monetary policy having a greater impact on firms in sectors that have larger trade exposure measures, we would expect that $\beta_2 < 0$.

[6]See di Giovanni, Levchenko and Mejean (2023) for evidence that sales growth of firms more exposed to trade are more sensitive to changes in world GDP.

[7]See Carvalho (2014) for a more detailed discussion of the weighted outdegree and other possible production network sufficient statistics.

A notable difference between this and our baseline estimation is that the set of fixed effects ($\boldsymbol{\alpha}$) may now vary over time, allowing us to control for unobserved time-varying country- and/or sector-level characteristics (e.g., how a country's trade openness varies over time).[8] Regression (2) is similar to the regression with firm heterogeneity that we describe below, though here the time-varying fixed effects cannot be as granular because the trade variables only vary at the country×sector level within a year. However, by exploiting differences in trade patterns as well as the type of trade (intermediate vs. final goods), we are able to estimate micro-level responses that vary for a firm given its country-sector's exposure to different trade channels, while also controlling for time-varying firm-level variables.

Role of Firm Financial Constraints

We also estimate how firm financial constraints affect the transmission of U.S. monetary policy shocks. To do so, we extend the baseline regression (1) to allow for heterogeneous effects at the firm level, conditioning on standard firm-level measures of financial constraints:

$$Y_{fsc,t+h} - Y_{fsc,t-1} = \boldsymbol{\alpha} + \beta_1 MP^{US}_{t-1} + \beta_2 (Z_{fcs,t-1} \times MP^{US}_{t-1}) + \mathbf{Z}_{fsc,t-1}\boldsymbol{\gamma'} + \mathbf{X}_{c,t-1}\boldsymbol{\delta'} + \varepsilon_{fsc,t+h}, \quad (3)$$

where we now allow for the impact of monetary policy to vary by firm characteristic Z through β_2. Given that firm characteristics may vary both within and across countries (e.g., the largest firm in Germany is likely larger than the largest firm in Thailand), we normalize all firm-level interaction variables within a country-year as we describe below in the data section. Following the literature, two firm characteristics that we use to proxy for firm financial constraints are size and net worth. We use the log of total assets for our measure of size. While this may generate a natural correlation with the two endogenous variables that are deflated by the lag of fixed assets (investment and sales ratios), we have also estimated all regressions with log employment as a measure of size instead and obtained similar results.[9] The net worth variable is defined as the difference in total assets and total liabilities, and is one measure that proxies for the differences in firms' collateral/ability to borrow (see Gopinath et al. (2017); di Giovanni, Kalemli-Özcan, Ulu and Baskaya (2021); and Caglio et al. (2021)). If larger and/or higher net worth firms are less impacted by U.S. monetary policy shocks because their financial constraints are less binding, we would expect that $\beta_2 > 0$.[10]

[8] Note that including time-varying fixed effects eliminates the possibility of estimating the average impact of monetary policy, β_1. Therefore, we first run regressions without time fixed effects in order to estimate the importance of firm heterogeneity relative to the average effect of monetary policy on all firms in an economy.

[9] As noted in the firm dynamics literature (Cloyne et al., 2020, and others), age also plays a role independently of size or net worth. We have also run regressions with age, and results were qualitatively similar to using size or net worth. However, this cut the sample size quite substantially, so we omit these results.

[10] Another common measure of financial constraints is a firm's leverage (e.g., Jeenas, 2019; Elena Durante, 2022). However, given that the variable is highly correlated with firm size in our dataset, as found for European firms by Gopinath et al. (2017) and U.S. ones by Dinlersoz, Kalemli-Özcan, Hyatt and Penciakova (2018), we omit the analysis of this variable for brevity.

The most stringent set of fixed effects may now vary at more granular levels along the time dimension – specifically at the country×sector×year level – since the interaction term is identified by exploiting variation at the firm×year level. Therefore, we are able to identify differential impacts of financial constraints within a year along the firm distribution while controlling for time-varying country×sector characteristics or shocks.

Given the literature that studies the balance sheet effect of external shocks (e.g., exchange rate changes), we extend the estimation of (3) along several dimensions. For example, we interact other macro variables, such as changes in the exchange rate or VIX, with financial constraint proxies, thus estimating several interaction coefficients. Further, we allow β_2 to vary across different cross-sections of the data, such as the country level. We consider such further "unpacking" of the financial constraint channel (and trade channel) in robustness analysis.

Firm-Level and Country-Sector Trade Heterogeneity

Our final specification combines the insights from regressions (2) and (3) in order to estimate the relative importance of the interest rate and trade channels. Specifically, we estimate the following:

$$\begin{aligned} Y_{fsc,t+h} - Y_{fsc,t-1} = \boldsymbol{\alpha} + \beta_1 MP^{US}_{t-1} + \beta_2 (Z_{fcs,t-1} \times MP^{US}_{t-1}) + \beta_3 (Trade_{cs,t-1} \times MP^{US}_{t-1}) \\ + \theta Trade_{cs,t-1} + \mathbf{Z}_{fsc,t-1}\boldsymbol{\gamma}' + \mathbf{X}_{c,t-1}\boldsymbol{\delta}' + \varepsilon_{fsc,t+h}, \end{aligned} \tag{4}$$

where variables are defined as above. Importantly, relative to the firm heterogeneity regressions of (3), we cannot exploit time-varying fixed effects at the country×sector×year level given the inclusion of the trade variables.

This regression specification allows us to quantify the relative importance of financial constraints and trade channels across the distribution of firms and country-sectors in our sample. We detail this quantification exercise when presenting results below. We further experimented with more granular specifications by interacting the firm-level Z, country-sector $Trade$, and monetary policy shock variables together. Besides being difficult to interpret, the triple-interaction coefficients were statistically insignificant for the majority of specifications.[11]

3 Data

3.1 Monetary Policy Shocks

As our baseline, we use the Bu et al. (2021) monetary policy shock series, which is plotted at the annual frequency in Figure 1. This series is derived from a two-step, partial-least squares estimation using daily interest rate data across a wide spectrum of maturities. The general idea

[11] Our intuition for the root cause of these insignificant results is a lack of power arising from insufficient variation in the trade variables, since they are measured at the country-sector level rather than at the firm level. Therefore, it is hard to isolate sufficient variation in the triple interactions that is not already soaked up by the firm-level interaction variables.

behind construction of the measure is to use Fama and MacBeth (1973) two-step regressions to estimate the unobservable monetary policy shock. In the first step, time-series regressions are run to estimate the sensitivity of interest rates at different maturities to FOMC announcements. This is equivalent to the asset beta in the original Fama-MacBeth method. In the second step, all outcome variables are regressed onto the corresponding estimated sensitivity index from step one, for each time t. In this way, the monetary policy shock is derived from the series of estimated coefficients from the Fama-MacBeth style second step regressions. Bu et al. (2021) scale the shock series such that it has a one-to-one contemporaneous effect on the 2-year Treasury Bill rate.[12]

The Bu et al. (2021) shock measure has three appealing features, which together distinguish it from other shock series in the literature. First, by using the full maturity spectrum of interest rates, this series stably bridges periods of conventional and unconventional monetary policy. Second, the shock is largely devoid of the central bank information effect, which is the notion that monetary policy announcements, in addition to providing a pure monetary surprise, also reveal information regarding the central bank's future macroeconomic outlook (Nakamura and Steinsson, 2018). Third, the Bu et al. (2021) shock series is largely unpredictable from available information, including Blue Chip forecasts, "big data" measures of economic activity, news releases and consumer sentiment.[13]

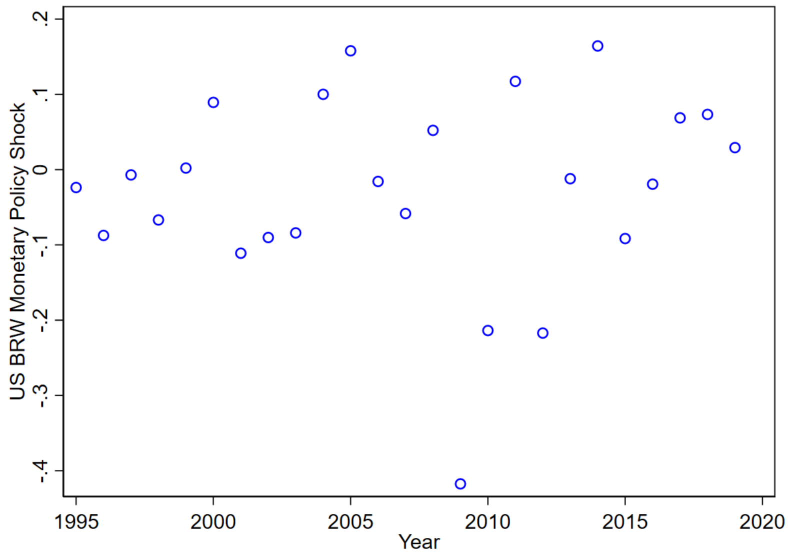
For robustness, we also examine two alternative U.S. monetary policy shock series. The first is the policy news shock of Nakamura and Steinsson (2018), which we depict in Figure A1. The authors construct their measure using changes in five interest rate futures: the Fed Funds futures for the current month and the month of the next FOMC meeting, and the 3-month Eurodollar futures at horizons of two, three, and four quarters. The policy news shock is the first principle component of the change in these five interest rate futures over a 30-minute window around scheduled FOMC announcements. Our second robustness check uses Swanson (2021)'s forward guidance shock, depicted in Figure A2. A noticeable difference in both of these series relative to BRW is the large negative values in 2001, almost all of which occurred after the 9/11 terrorist attack.[14]

[12]To provide further meaning, Bu et al. (2021) regress contemporaneous changes in interest rates of different maturities on the shock. The response coefficient reaches its maximum at the 2-year interest rate (normalized to be 1.0). The response of the 5-year interest rate is of comparable (large) magnitude and significance. Response coefficients for all other maturities (3-mo., 6-mo., 1-yr, 10-yr and 30-yr) are significant but smaller. Thus, both the short and long ends of the yield curve respond to the BRW shock to a lesser degree than 2- and 5-yr rates. This is similar to the experiment in Gürkayanak, Sack and Swanson (2005), who show that the long rate responds relatively more to their estimated "path factor" while the short rate responds relatively more to the "target factor."

[13]See, for example, Ramey (2016), Miranda-Agrippino (2016), and Bauer and Swanson (2020) for critiques of earlier monetary policy shock series that exhibited predictability.

[14]Note that the scales of the policy news shock and the forward guidance shock are also arbitrary. Nakamura and Steinsson (2018) rescale their series such that its effect on the 1-year nominal Treasury yield is equal to one. Swanson (2021) offers one natural way to interpret his forward guidance shock: a 25bp change in the expected federal funds rate one year ahead, which would be very large by historical standards (about 4.4 standard deviations). Applying that to his estimates suggests that a forward guidance surprise of this magnitude would raise the 2-yr Treasury bill rate by around 20bp. Concerning values in 2001, Cochrane and Piasezzi (2002) argue that it is problematic to interpret movements in interest rates around September 11, 2001 as a shock versus an expected movement. Their measure, like ours, does not exhibit this feature.

Figure 1. U.S. Monetary Policy Shocks



Notes: This figure plots the annual aggregate of the pure monetary policy shock constructed by Bu et al. (2021) (updated March 4, 2021).

Finally, we also examine the shock Bu et al. (2021) constructed for the ECB (Figure A3) to examine robustness to the precise source of the monetary policy impulse.

Given that we run regressions using annual firm-level data, we must aggregate the monetary policy shocks to the annual level as well. This aggregation has the potential of netting out positive and negative monetary policy innovations within a year and thus may bias the estimated impact of monetary policy on investment towards zero. Therefore, for identification we will rely on the persistent nature of monetary policy action within a year as well as the lagged effect of monetary policy on the real economy.

3.2 Firm Data

We source firm-level data from Worldscope for a large cross-section of countries and sectors spanning the time period 1995-2019 at the annual level. These data are reported for the headquarters of publicly listed firms, and are therefore skewed towards covering medium to large firms. This firm coverage is similar to those in studies of the impact of monetary policy on firm outcomes in the United States that rely on Compustat data, and studies in an international setting such as Claessens et al. (2012). Our cleaned sample covers twenty countries, which we choose based on the availability of a sufficient number of firms over the whole time period (at least 5,000 firm-year observations per country) and an approximately equal split between emerging market economies (EMEs) and industrial countries.[15] We further constrain the final regression sample to firms with at least five years of data.[16]

Table A1 presents summary statistics for the firm-level outcome variables, explanatory variables, and controls we experimented with and that are commonly used in the literature. The three outcome variables are the investment-to-(lagged) fixed capital ratio, where we follow Cloyne et al. (2020) and define fixed capital by *net property, plant and equipment*, the sales-to-(lagged) fixed capital ratio, and employment growth. We winsorize the data at the 1% level to clean outliers.[17]

The summary statistics indicate substantial cross-sectional heterogeneity in the three outcome variables, with the medians approximately centered around zero. Turning to the firm-level explanatory variables, there is also a good deal of cross-sectional heterogeneity. We focus on two key firm-level variables both because they proxy for financial constraints and because they offer maximal coverage: size and net worth. Size is defined as the logarithm of total assets and net worth as the log of the difference between total assets and total liabilities. In looking at Table A1, we see that these variables are quite skewed, which is not surprising given the granular nature of many firm-level characteristics, such as the size distribution (Gabaix, 2011). This also holds true for other possible proxies for size, such as employment and the age distribution. Furthermore, the absolute size of firms within a country correlates positively country size, as larger countries generally have larger firms (di Giovanni and Levchenko, 2012). We take this cross-country difference in distributions of our firm variables into account before running regressions by normalizing both size and net worth. Specifically, for each country-year we normalize each variable around its mean, so that the distribution is centered at zero. This normalization ensures that we do not confound estimates that vary across the firm distribution for country-level differences in our regressions below.[18]

3.3 Trade Data

We use the 2013 edition of the World Input-Output Database (WIOD) from Timmer et al. (2015) to construct trade exposure measures at the country-sector level. This database contains information on bilateral trade flows in final and intermediate goods and services across 35 sectors for 40 countries and the rest of the world.[19] The database also contains country-sector value added and gross

[15] The country sample includes Australia, Brazil, Canada, China, France, Germany, India, Indonesia, Italy, Japan, South Korea, Malaysia, Poland, Russia, Sweden, Taiwan, Thailand, Turkey, United Kingdom, and Vietnam.

[16] We also ran baseline regressions, which do not require information on trade exposure, with the full set of Worldscope countries, and our results are robust. Note that the sample size only increases by roughly twenty percent in these regressions, since our cleaning procedure results in a set of firms in the largest industrial and emerging market countries, which also have the most comprehensive data coverage in Worldscope.

[17] One exception is the sales ratio, which we winsorize at the 5% level.

[18] The inclusion of country or country-sector fixed effects would also help assuage this concern. However, given that we run interaction regressions with firm characteristics and the monetary policy shock, it is best to first demean the firm variables.

[19] We use the rest-of-the-world (ROW) variables for three countries that are missing data: Malaysia, Thailand and Vietnam. Given the sparse data for Asia, the ROW data cover many of the smaller Asian economies, so we view this approximation to be reasonable. If anything, this assumption will bias against our regressions finding any trade

output measures. The database begins in 1995 and ends in 2011. We opt to use this version of the database rather than the more recent version (which covers 2000-2014) given that there is interesting monetary policy variation in the late 1990s that we would like to include. The downside to this approach is that we are forced to fill in trade data for 2012 onward in order to exploit the additional eight years of monetary policy shocks and firm-level data we have.[20] However, given the inertia of world trade since the Great Financial Crisis (Antràs, 2021) and the relative stability of the the world I-O matrix, we are not overly concerned about potential bias this extrapolation might create.

We construct four measures of trade exposure at the country-sector level. These are meant to capture exposure to demand shocks resulting from U.S. monetary policy shocks. The first is a country-sector's total exports-to-output ratio. We next break this measure into (i) the final goods exports-to-output ratio, and (ii) the intermediate goods exports-to-output ratio.[21] Our final measure is an export-based *weighted outdegree*. This variable captures the importance of a country-sector's exports for all of its customers' (i.e., foreign country-sectors') production. More specifically for this fourth measure, let

$$\omega_{mi,nj} = \frac{Sales_{mi \to nj}}{Output_{nj}}$$

be country-sector mi's sales to country-sector nj deflated by nj's output. Then the export-based weighted outdegree for country-sector mi is defined as:

$$\text{WtOutdeg}_{mi} = \sum_{n \neq m}^{N} \sum_{j=1}^{J} \omega_{mi,nj}.$$

Note that the weighted-outdegree measure only captures the *first-order* importance of a country-sector as a supplier in global production, given that it does not measure the importance of country-sector mi's customers in supplying their intermediate goods further downstream in global production process. However, given the relatively high level aggregation of the WIOD and the sparsity in international linkages, the cross-sectional heterogeneity of the first-order linkages are sufficient to capture the relative importance of a country-sector in the global production network. Indeed, the distribution of this weighted-outdegree measure is quite skewed and follows a power law (see di Giovanni and Hale, 2022, for example).

We construct all the trade measures with respect to world trade and bilateral U.S. trade only. With the production linkage measure, for example, the outdegree for each country m would only be summed over sectors in country $n =$ United States. We consider both sets of measures in order to help distinguish between the direct impact of the U.S.'s own demand shock, and the indirect

effects as we are killing some cross-sectional heterogeneity by imputing the same numbers for several country-sectors.

[20]In particular, we fill in the 2012-2019 country-sector trade and output data with values from 2011.

[21]Note that when we write "goods," these might be services depending on the export sector.

impact of U.S. monetary policy shocks on other foreign countries' import demand.[22] Tables A3 and A4 present summary statistics of these measures for the year 2000, where we calculate statistics across our country sample in a given sector, for world trade and U.S.-trade, respectively. There is considerable heterogeneity both across sectors (comparing the 'Mean' columns) and countries within a sector (comparing the 'St.Dev.' columns) across all trade exposure measures.

3.4 Other Macro Controls

Table A5 presents summary statistics across countries and over time for the annual macroeconomic data we use: (i) the log of the CBOE Volatility Index (VIX), (ii) real (domestic currency) GDP growth, (iii) the percentage change of the local currency-to-U.S. dollar nominal exchange rate, (iv) the change in the domestic short-term rate, (v) one minus the Fernández, Klein, Rebucci, Schindler and Uribe (2016) index of financial account repression that captures capital controls and other barriers to capital flows ('Fin. Openness'), and (vi) the (exports plus imports)-to-GDP ratio ('Trade/GDP'). We use exchange rate regime data from Shambaugh (2004), whose classification of "base" countries allows us to sort out whether a country is fixed to the U.S. dollar or not. Further, the classification provides a base for all countries, regardless of whether or not they are a pegger. For example, the U.S. is classified as the base country for Canada even though Canada has a floating exchange rate regime. We also opt for the Shambaugh (2004) classification in order to avoid potential measurement error by controlling for the fact that countries in our sample, such as European ones, are classified as fixed exchange regimes but are not pegged vis-à-vis the United States. All financial series are calculated using the annual average of the underlying variable, while macroeconomic and trade data are end-of-year series.

4 Baseline Results: The Role of Aggregate Factors

We begin with a set of baseline regressions that provide an interesting first look at the data and point to potential channels through which U.S. monetary policy may have differing effects on foreign firms. We also show that results are robust to several checks, including the split between emerging and developed economies and the choice of monetary policy shock. In order to better identify potential channels and quantify their relative importance, we then move on to exploiting cross country-sector and/or firm-level heterogeneity in the following section.

4.1 Baseline Specification

We begin by estimating regression specification (1) for $h = 0$. Table 1 presents our baseline results for investment, sales, and employment. For each variable, regressions include either country$\times$sector

[22]See di Giovanni and Hale (2022) for a structural econometric analysis of this problem.

or firm fixed effects. The negative coefficient on the MP^{US} shock variable indicates that a surprise monetary policy tightening ($MP^{US} > 0$) is associated with fall in investment, as seen in columns (1)-(2), and sales (columns (3)-(4)) in the following year. These results are robust across both sets of fixed effects and statistically significant at the one-percent level for the more stringent set of firm fixed effects. Turning to the employment growth regressions in columns (5)-(6), the coefficient on MP^{US} is also negative, but insignificant at standard confidence levels.

Quantitatively, the impact of a U.S. monetary policy shock is sizeable for both foreign firms' investment and sales. For example, in the regressions with firm fixed effects, a one-percentage point tightening (which would be very large by historical standards) implies that the investment ratio falls by 0.16 percentage points in the following year. This is large relative to the median change in the investment ratio across all firms over the sample period, which is 0.2 percentage points (see Table A1). A similar calculation holds for sales, with the sales ratio falling by 1.1 percentage points following a one hundred basis point tightening. This is almost four times as large as the median sales ratio change across firms in the sample (0.3 percentage points).[23]

The estimated coefficients on firm-level controls are consistent with those reported in the investment literature. As seen in Table 1, the coefficients on both cash flow and net worth are positive, while the coefficient on size is negative. Dao et al. (2021) also find negative and significant effects of firm size (measured by employment) on investment in a panel of firms similar to ours.[24] Turning to the macro controls, the VIX is negatively correlated with firm activity, as are changes in the domestic interest rate (though not robustly). Domestic real GDP growth tends to be negatively correlated with next period's firm investment and sales changes when including firm-level fixed effects, but is positively correlated with employment growth. Meanwhile, changes in the nominal exchange rate are typically not statistically significant, and only weakly so for the investment regression in column (2).

4.2 Cross-Country Heterogeneity and Robustness

Effects for Industrial versus Emerging Market Economies

Table 2 presents estimates of the baseline regression with firm fixed effects separately for industrial and EME country samples. Examining the coefficients on MP^{US}, we see that the results are very

[23] While the estimated coefficients on the monetary policy shock imply a large impact in our back-of-the-envelope calculations, the overall model fits are not strong, as indicated by the rather small R^2s for the within-identification of our regressions. These low R^2s are not surprising, however, as the endogenous variables are changes in micro-level variables, which are volatile given idiosyncratic shocks to firms. Indeed, finding low R^2s is common in micro studies like ours. For example, note the low R^2s in Table 1 of di Giovanni et al. (2023), where the dependent variable is sales growth.

[24] The authors further control for size, leverage, Tobin's Q, and sales growth. We have also explored including these variables. While doing so cuts sample size substantially, our baseline result does not change. Gulen and Ion (2016), who examine political uncertainty and investment, control for Tobin's Q, cash flow, and sales growth in regressions for U.S. firm-level investment and find all of these controls to be positive and significant, consistent with our regressions.

Table 1. Effect of U.S. Monetary Policy Shocks on Firms' Investment, Sales, and Employment: Baseline Estimates

	Δ(Investment$_t$/FixAssets$_{t-1}$)		Δ(Sales$_t$/FixAssets$_{t-1}$)		Employment Growth$_t$	
	(1)	(2)	(3)	(4)	(5)	(6)
MP^{US}_{t-1}	-0.134^b	-0.161^a	-1.119^a	-1.302^a	-0.020	-0.030
	(0.051)	(0.054)	(0.391)	(0.402)	(0.030)	(0.027)
Δ(CF/TA)$_{t-1}$	0.0005^b	0.001^a	0.001	2E-05	-3E-05	-8E-05
	(0.0002)	(0.0002)	(0.001)	(0.001)	(0.0001)	(0.0001)
Size$_{t-1}$	-0.007^a	-0.081^a	-0.008	-0.362^a	-0.027^a	-0.103^a
	(0.002)	(0.010)	(0.021)	(0.060)	(0.002)	(0.008)
Net Worth$_{t-1}$	0.003	0.002	-0.062^a	-0.212^a	0.022^a	0.047^a
	(0.002)	(0.004)	(0.018)	(0.032)	(0.002)	(0.003)
$\Delta\ln(\text{RGDP}^D)_{t-1}$	-0.0002	-0.004^b	-0.012	-0.039^a	0.003^b	0.002^c
	(0.001)	(0.002)	(0.010)	(0.013)	(0.001)	(0.001)
ln(VIX$_{t-1}$)	-0.076^a	-0.104^a	-0.622^a	-0.819^a	-0.026	-0.024
	(0.024)	(0.018)	(0.203)	(0.177)	(0.017)	(0.017)
$\Delta\ln(\text{NXR})_{t-1}$	-0.051	-0.099^c	-0.478	-0.794	-0.029	-0.044
	(0.042)	(0.051)	(0.455)	(0.493)	(0.028)	(0.031)
$\Delta\text{IntRate}^D_{t-1}$	-0.375^b	-0.201	-3.456^c	-2.295	-0.082	-0.042
	(0.179)	(0.216)	(1.785)	(2.041)	(0.119)	(0.132)
Observations	374,864	374,360	374,687	374,179	256,108	254,414
R^2	0.005	0.057	0.009	0.106	0.022	0.176
Country×sector FE	Yes	No	Yes	No	Yes	No
Firm FE	No	Yes	No	Yes	No	Yes

Notes: This table presents firm-level panel regression results based on the estimation of regression (1) for the change in the investment-to-fixed capital ratio (columns 1 and 2), the change in the sales-to-fixed capital ratio (columns 3 and 4), and employment growth (columns 5 and 6). The sample uses firms with at least five years of observations over 1995-2019. All regressors are lagged one period, where MP^{US} is the monetary policy shock from Bu et al. (2021), 'CF/TA' is a firm's cash flow-to-total assets ratio, 'Size' is the within country-year measure of a firm's size based on the log of total assets, 'Net Worth' is the within country-year measure of a firm's net worth based on the log of net worth (assets minus liabilities), 'RGDP^D' is a country's real GDP, 'NXR' is a country's nominal exchange rate against the U.S. dollar, 'VIX' is the CBOE Volatility Index, and 'IntRate^D' is a country's short-term interest rate (annual average). We include fixed effects at various levels of disaggregation. Standard errors are double clustered at the firm and year level, where ^{a} indicates significance at the 1% level, ^{b} at the 5% level, and ^{c} at the 10% level.

similar to the baseline regressions. Interestingly, and perhaps not surprisingly, the monetary policy shock coefficients (the only ones we report, to save space) are larger in absolute value for the emerging market economies. The coefficient differences across country samples are not statistically distinguishable given their overlapping confidence intervals, however.

Asymmetric Effects of U.S. Monetary Policy

We next explore potential asymmetric effects of U.S. monetary policy shocks on foreign firms' outcomes. Table A6 presents regressions where we split the BRW shock into variables indicating

Table 2. Effect of U.S. Monetary Policy Shocks on Firms' Investment, Sales, and Employment: Baseline Estimates for EMEs and Industrial Countries

	$\Delta(\text{Investment}_t/\text{FixAssets}_{t-1})$		$\Delta(\text{Sales}_t/\text{FixAssets}_{t-1})$		Employment Growth$_t$	
	Industrial	*Emerging*	*Industrial*	*Emerging*	*Industrial*	*Emerging*
	(1)	(2)	(3)	(4)	(5)	(6)
MP^{US}_{t-1}	-0.143^b	-0.168^a	-0.978^c	-1.515^a	-0.007	-0.053
	(0.064)	(0.052)	(0.484)	(0.459)	(0.029)	(0.035)
Observations	207,263	167,097	207,155	167,024	152,789	101,625
R^2	0.061	0.053	0.101	0.114	0.199	0.151
Macro controls	Yes	Yes	Yes	Yes	Yes	Yes
Firm controls	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes

Notes: This table presents firm-level panel regression results based on the estimation of regression (1) for the sample split between emerging market economies and industrial countries for the change in the investment-to-fixed capital ratio (columns 1 and 2), the change in the sales-to-fixed capital ratio (columns 3 and 4), and employment growth (columns 5 and 6). The sample uses firms with at least five years of observations over 1995-2019. All regressors are lagged one period, where MP^{US} is the monetary policy shock from Bu et al. (2021). We include lagged firm and macroeconomic variables as in the baseline estimation in Table 1, and firm-level fixed effects. Standard errors are double clustered at the firm and year level, where ^{a} indicates significance at the 1% level, ^{b} at the 5% level, and ^{c} at the 10% level.

either a positive monetary policy shock/a "tightening" (+) or or a negative monetary policy shock/ a "loosening" (−). In looking across all columns, one sees that the coefficients on both variables are negative, just as in the baseline regressions where we do not break up the shocks. However, the coefficient is only significant for the loosening episodes (MP^-) and the coefficient is also larger in absolute value for this variable relative to the tightening episodes.[25] While the asymmetric effect of U.S. monetary policy shocks has been noted previously in the literature,[26] we do not apply the asymmetric breakdown of the shocks for the heterogeneous regressions below in order avoid creating unwieldy sets of results. However, all results should be interpreted as primarily capturing the heterogeneous impacts of an easing in U.S. monetary policy in our sample period.[27]

Leave-One-Out Analysis

The large expansionary U.S. monetary policy shock in 2009 (Figure 1) and resurgence of global

[25] Note that the largest shock, in absolute value, occurs for a loosening, so we have run regressions dropping this year and results are robust.

[26] See, for example, Ravn and Sola (2004) and Barnichon et al. (2017) for evidence on the asymmetric impact of U.S. monetary policy shocks.

[27] There are several reasons why our finding greater significance of easing shocks contrasts with Ravn and Sola (2004) or Barnichon et al. (2017), who find stronger results for contractionary shocks. These include (1) use of different measures of monetary policy innovations (the other authors use the change in M1 or the Fed Funds rate, respectively); (2) the other authors examining U.S. outcome variables; and (3) different time periods for analysis.

investment coming out of the Great Recession motivates a sensitivity check of the baseline results for possible outliers. In Figure A4, we display the estimated β obtained by running regression (1) multiple times while omitting one year's observations at a time. As we see, every estimate is negative and significant. Leaving out financial crisis years (2009-11, which implies leaving out the 2008-10 shocks) weakens the negative effect of U.S. monetary policy on global investment, but none of the coefficients is significantly different from any of the others throughout the sample.

Alternative Measures of Monetary Policy Shocks

Table A7 shows how the baseline results are affected by using three alternative measures of monetary policy shocks: the Nakamura and Steinsson (2018) and Swanson (2021) measures for the Fed, and the Bu et al. (2021) shock for the ECB.[28] We also include lagged changes in either the 2-yr. or 5-yr. U.S. Treasury bill rate to control for the more general effects of U.S. interest rate changes on foreign firm investment. The first two columns indicate that the baseline results using the BRW shock are robust, with the coefficients on MP^{US} rising in magnitude in cases and even becoming statistically significant in the employment regressions. In columns (3)-(8) we replace the BRW shock with one of the alternatives. Results using the forward guidance shock are similar to the baseline findings: U.S. monetary policy tightenings significantly reduce foreign firm investment and sales growth. With the policy news shock, however, the coefficient estimates are insignificantly different from zero, likely reflecting the "central bank information effect" which is the subject of Nakamura and Steinsson (2018). The final two columns indicate that the ECB monetary policy shock is insignificantly different from zero. Notice that in all regressions the coefficients on lagged changes in U.S. T-bill rates are positive. This is consistent with higher U.S. aggregate demand, and thus interest rates, spilling over to increase investment, sales, and employment by foreign firms.[29]

Dynamics

Although our primary objective is to exploit the rich cross-section of firms, sectors, and countries in our annual data set, we also estimate dynamic effects of U.S. monetary policy shocks using Jordà (2005)'s local projections regressions. We re-estimate equation (1) for $h = 0, \ldots, 3$ and display the *cumulative* impulse responses of the investment share, sales share, and log employment in the three panels of Figure A5. The results indicate that U.S. monetary policy tightenings have fairly persistent negative effects on the levels of these variables, but that the initial response ($h = 0$) that we estimate in our static regression captures the largest impact. The results for employment are

[28] The Bu et al. (2021) shock series for the ECB were computed using the same method described above for the Fed.

[29] We also investigate whether the "information effect" of monetary policy spills over across countries in Table A8, where we use the information shock series estimated by Bu et al. (2021). The information variable is never significant and does not impact our baseline results for the monetary policy shock variable.

not statistically significant, however.

Country-Level Trade, Financial Openness and the Exchange Rate Regime

Before moving on to more micro identification, we run a set of regressions to examine how trade and financial openness at the *country level* and the exchange rate regime affect the transmission of U.S. monetary policy shocks at the firm level. We estimate these regressions by interacting measures of a country's total trade to GDP, its financial openness and an exchange rate regime dummy using the base-country classification from Shambaugh (2004), as described in Section 3, with the monetary policy shock variable. As Table A9 shows, the coefficient on the U.S. monetary policy shock is largely unchanged relative to the baseline estimation of regression (1). Turning to the exchange rate regime dummy variables, we first see that the coefficient on the interaction with the 'US Peg' variable is negative, but never significant across specifications. This implies that U.S. monetary policy spills over more to countries that peg to the U.S., but a lack of statistical power prevents us from identifying this impact at standard confidence levels. In particular, our country sample has few countries that peg to the U.S. in the sample period – a fact holds true both for our core country sample and the full set of Worldscope countries. Meanwhile, we see that the interaction coefficient for the 'Non-US Peg' variable is positive and significant for the investment regressions. This finding captures the fact that some countries in the sample, such as the those in the EMU, may be out of cycle with U.S. monetary policy. Finally, the coefficient on the interaction with the 'Base' country dummy varies across specifications. This interaction captures how floaters in general react to U.S. monetary policy shocks.

Turning to the financial and trade openness interaction coefficients, they are generally insignificant. The sign on the financial variable interaction ('FinOpen×Peg') appears to be positive in most regressions, and marginally significant in columns (3) and (6), indicating that if anything, more financially open countries are less impacted by U.S. monetary policy shocks. Looking at the trade variable interaction ('TrOpen×Peg'), the coefficients are negative, indicating the opposite result, where more trade-open countries are more impacted by U.S. monetary policy. However, the interaction coefficients are significant only in the employment regressions in columns (5) and (6). Overall, the results capturing foreign firms' reaction to U.S. monetary policy shocks given the firms' countries' trade and financial international exposure are inconclusive. This motivates exploiting more granular measures of trade and financial exposure for identification. We turn to these regressions next.

5 Firm Heterogeneity Results

To gauge the importance of the external demand and interest rate channels of U.S. monetary policy transmission abroad, we next focus on heterogeneity at a more granular level, with a particular focus on international trade exposure and proxies for firms financial constraints. We begin by extending the baseline specification to allow for heterogeneous effects of international trade linkages at the country-sector level, and report results for different specifications of regression (2). We then utilize proxies for firm-level financial constraints and report results for different specifications of regression (3). Finally, we combine the country-sector and firm-level data to examine the impact of trade and the interest rate channel jointly by reporting results for different specifications of regression (4). For the sake of brevity, we present tables for the investment regressions in the main text and relegate the sales and employment regressions to B.

5.1 Trade Exposure

Table 3 reports OLS estimates for regression (2) for the change in the investment share. We leave out time-varying fixed effects in order to retain the main coefficient on MP^{US}, but do include firm fixed effects in all specifications. Columns (1)-(4) use the trade measures based on global trade, while columns (5)-(8) use only trade flows with the United States.

The coefficient on the non-interacted U.S. monetary policy shock variable remains negative and strongly significant in all specifications. Turning to the coefficient on the total exports-to-output ratio ('TotExp/Output'), we see that country-sectors that are more dependent on trade with either the world or the U.S. alone are relatively more affected by U.S. monetary policy shocks. We dissect this result further by examining whether the type of trade matters, and find that it does. First, while the coefficients on the final goods exports-to-output ratio ('FinExp/Output') are negative, they are tiny and statistically insignificant. In contrast, when we turn to the intermediate goods exports-to-output ratio ('IntExp/Output') regressions, the coefficients are negative, significant, and large in magnitude for both for global and U.S.-only trade. This indicates the key role of intermediate goods trade in transmitting monetary policy shocks to firm investment. Finally, the coefficient on the interaction with the export weighted outdegree ('WtOutdeg'), which captures the importance of a country-sector as a supplier of inputs for other country-sectors' production, is also negative and significant, both for global trade and U.S. bilateral trade only.

Table 4 extends the regressions to include time-varying fixed effects at the country$\times$year level (thus eliminating the main effect of MP^{US}). The advantage of including these fixed effects is that we are able to control for time-varying country-level characteristics and shocks, such as overall trade openness or unobserved aggregate shocks, which may be correlated with U.S. monetary policy shocks. Looking across columns (1)-(8), we see that the coefficients on the trade variables are similar

Table 3. Effect of U.S. Monetary Policy Shocks on Firms' Investment: The Importance of Trade Integration, Non-Time-Varying FE Estimates

	$\Delta(\text{Investment}_t/\text{FixAssets}_{t-1})$							
	Global Trade				*U.S. Trade*			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
MP^{US}_{t-1}	-0.160^a	-0.161^a	-0.160^a	-0.161^a	-0.161^a	-0.161^a	-0.161^a	-0.161^a
	(0.054)	(0.054)	(0.054)	(0.054)	(0.054)	(0.054)	(0.054)	(0.054)
$MP^{US}_{t-1} \times \left(\frac{\text{TotExp}}{\text{Output}}\right)_{t-1}$	-0.089^b				-0.291^c			
	(0.038)				(0.156)			
$MP^{US}_{t-1} \times \left(\frac{\text{FinExp}}{\text{Output}}\right)_{t-1}$		-0.008				-0.012		
		(0.054)				(0.148)		
$MP^{US}_{t-1} \times \left(\frac{\text{IntExp}}{\text{Output}}\right)_{t-1}$			-0.149^b				-0.462^c	
			(0.061)				(0.259)	
$MP^{US}_{t-1} \times$ WtOutdeg$_{t-1}$				-0.025^b				-1.127^b
				(0.012)				(0.449)
Observations	374,360	374,360	374,360	374,360	374,360	374,360	374,360	374,360
R^2	0.058	0.057	0.058	0.058	0.058	0.057	0.058	0.058
Macro Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: This table presents firm-level panel regression results based on the estimation of regression (2) for the change in the investment-to-fixed capital ratio, where we interact different measures of country-sectors' trade integration with the monetary policy shock. Columns (1)-(4) use trade measures based on country-sector exports with the world, while columns (5)-(8) use U.S.-only exports data. The country-sector trade measures include the (i) total exports-to-output ratio ('TotExp/Output'), (ii) final goods exports-to-output ratio ('FinExp/Output'), (iii) intermediate goods exports-to-output ratio ('IntExp/Output'), and (iv) weighted outdegree ('WtOutdeg'). The sample uses firms with at least five years of observations over 1995-2019. All regressors are lagged one period, where MP^{US} is the monetary policy shock from Bu et al. (2021), 'Size' is the within country-year measure of a firm's size based on the log of total assets, and 'Net Worth' is the within country-year measure of a firm's net worth based on the log of net worth (assets minus liabilities). We include lagged firm and macroeconomic variables as in the baseline estimation in Table 1, and fixed effects at various levels of disaggregation. Standard errors are double clustered at the firm and year level, where ^{a} indicates significance at the 1% level, ^{b} at the 5% level, and ^{c} at the 10% level.

to those reported in Table 3. If anything, the coefficients on the interaction terms are larger (in absolute terms) and tend to be more statistically significant.[30]

Before quantifying the importance of trade in transmitting monetary policy shocks to foreign firms that are exposed differently, it is worth commenting on the regression results for sales and employment. Tables A10 and A11 present the results for the regressions without and with time-varying fixed effects, respectively. The coefficients on the trade interaction terms are generally insignificant in regressions for both variables, whether or not we include time-varying country fixed

[30]We also experimented with including sector×year fixed effects and obtained similar results as our baseline OLS regressions. Regressions including both country×year and sector×year fixed effects yield similar coefficients as our main regressions, though the majority of the coefficients are no longer significant. This finding is not surprising given that the inclusion of both country and sector time-varying fixed effects greatly reduces degrees the of freedom.

Table 4. Effect of U.S. Monetary Policy Shocks on Firms' Investment: The Importance of Trade Integration, Time-Varying FE Estimates

	$\Delta(\text{Investment}_t/\text{FixAssets}_{t-1})$							
	Global Trade				*U.S. Trade*			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$MP^{US}_{t-1} \times \left(\frac{\text{TotExp}}{\text{Output}}\right)_{t-1}$	-0.120^a				-0.387^b			
	(0.041)				(0.162)			
$MP^{US}_{t-1} \times \left(\frac{\text{FinExp}}{\text{Output}}\right)_{t-1}$		-0.011				-0.013		
		(0.054)				(0.150)		
$MP^{US}_{t-1} \times \left(\frac{\text{IntExp}}{\text{Output}}\right)_{t-1}$			-0.208^a				-0.820^b	
			(0.073)				(0.348)	
$MP^{US}_{t-1} \times$ WtOutdeg$_{t-1}$				-0.031^b				-1.614^a
				(0.012)				(0.570)
Observations	374,359	374,359	374,359	374,359	374,359	374,359	374,359	374,359
R^2	0.069	0.069	0.069	0.069	0.069	0.069	0.069	0.069
Country×year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: This table presents firm-level panel regression results based on the estimation of regression (2), with time-varying fixed effects, for the change in the investment-to-fixed capital ratio, where we interact different measures of country-sectors' trade integration with the monetary policy shock. Columns (1)-(4) use trade measures based on country-sector exports with the world, while columns (5)-(8) use U.S.-only exports data. The country-sector trade measures include the (i) total exports-to-output ratio ('TotExp/Output'), (ii) final goods exports-to-output ratio ('FinExp/Output'), (iii) intermediate goods exports-to-output ratio ('IntExp/Output'), and (iv) weighted outdegree ('WtOutdeg'). The sample uses firms with at least five years of observations over 1995-2019. All regressors are lagged one period, where MP^{US} is the monetary policy shock from Bu et al. (2021), 'Size' is the within country-year measure of a firm's size based on the log of total assets, and 'Net Worth' is the within country-year measure of a firm's net worth based on the log of net worth (assets minus liabilities). We include lagged firm variables as in the baseline estimation in Table 1, and fixed effects at various levels of disaggregation. Standard errors are double clustered at the firm and year level, where ^{a} indicates significance at the 1% level, ^{b} at the 5% level, and ^{c} at the 10% level.

effects. These results point to the external demand impact having its greatest impact on changes in firm-level investment in our sample.

Quantifying the Trade Channel

We exploit the country-sector distribution of the (normalized) trade measures in order to quantify their importance in transmitting U.S. monetary policy shocks to firm investment. First note that the normalized versions of these variables are constructed around a mean of zero in a given country and year. This implies that the distribution we exploit for the regressions is centered around zero (see Table A12). Therefore, the mean-firm's trade variables are equal to zero and the impact of the U.S. monetary policy shock on firm investment is simply equal to the non-interacted coefficient on MP^{US}. Indeed, this is confirmed by comparing the coefficients in the first row of Table 3 to that of the firm-level fixed effects specification in column (2) of Table 1.

We take two approaches to examining the relative importance of trade exposure on monetary policy transmission across firms. The first is to compute the impact of MP^{US} on firms across the interquartile range (IQR) of the trade exposure measures.[31] Second, given that the trade exposure measures are skewed, we also look at the differential impact between the top and bottom deciles of the distribution. To be clear, as we exploit differences across country-sector pairs, it is only possible to interpret the following exercises for a representative firm in a given country-sector, irrespective of its specific trading behavior or other firm-level characteristics.

Our calibration results in Table 5 are based on the coefficients in Table 4 in order to control for the more stringent set of fixed effects. Moving from the bottom quartile to the top quartile country-sector in the world total export-to-output ratio distribution shows that greater export exposure amplifies the spillover effects of U.S. monetary policy shocks. Specifically, the movement along the IQR implies that a one percentage point surprise contraction in U.S. monetary policy intensifies the decrease in the investment ratio by an additional 0.037 percentage points. This is equal to about one quarter of the average effect of the monetary policy shock. Performing a similar calculation using the difference between the top and bottom deciles implies that the same U.S. monetary policy contraction lowers the investment ratio by 0.066 percentage points when considering the world trade ratio, roughly equal to forty percent of the average effect of the shock. The calculations using the U.S.-only trade ratio yields about half of the effect relative to exposure to world trade.

Turning to intermediate exports, we also find an amplifying effect of trade exposure. Moving from the bottom quartile to the top quartile country-sector in the world intermediate goods exports-to-output ratio distribution implies that a one percentage point shock to U.S. monetary policy will have almost identical effects as moving over the IQR of the total exports ratio. However, a similar calculation using the difference between the top and bottom deciles of intermediate trade implies that the same U.S. monetary policy contraction will lower the investment ratio by an additional 0.093 percentage points when considering the world trade ratio, which is around sixty percent of the average effect of the monetary policy shock. The calculations using the U.S.-only intermediate trade ratio again yield about half of the effect relative to exposure to world trade.

Finally, we consider the network measure of international trade, the weighted outdegree. Moving from the bottom quartile to the top quartile country-sector in the world weighted outdegree distribution implies that a one percentage point contraction in U.S. monetary policy leads to firm investment falling by 0.016 percentage points, or about ten percent of the average effect of the monetary policy shock. Considering the difference between deciles roughly doubles the effect rela-

[31] This is akin to looking at a standard deviation of the distribution, but given that the normalized variables are still somewhat skewed, we opt for the IQR.

Table 5. Quantification Exercise of the Heterogeneous Impacts on Investment of Trade Exposure to U.S. Monetary Policy Shocks

	Global Trade			*U.S. Trade*		
	Coef.	IQR	P90-P10	Coef.	IQR	P90-P10
	(1)	(2)	(3)	(4)	(5)	(6)
$MP^{US}_{t-1} \times \left(\frac{\text{TotExp}}{\text{Output}}\right)_{t-1}$	-0.120^a	-0.037^a	-0.066^a	-0.387^b	-0.018^b	-0.034^b
	(0.041)	(0.013)	(0.023)	(0.162)	(0.007)	(0.014)
$MP^{US}_{t-1} \times \left(\frac{\text{FinExp}}{\text{Output}}\right)_{t-1}$	-0.011	-0.001	-0.002	-0.013	0.000	-0.001
	(0.054)	(0.005)	(0.012)	(0.150)	(0.003)	(0.008)
$MP^{US}_{t-1} \times \left(\frac{\text{IntExp}}{\text{Output}}\right)_{t-1}$	-0.208^a	-0.037^a	-0.093^a	-0.820^b	-0.017^b	-0.038^b
	(0.073)	(0.013)	(0.033)	(0.348)	(0.007)	(0.016)
$MP^{US}_{t-1} \times$ WtOutdeg$_{t-1}$	-0.031^a	-0.016^b	-0.035^b	-1.614^a	-0.013^a	-0.045^a
	(0.012)	(0.006)	(0.014)	(0.570)	(0.005)	(0.016)

Notes: This table presents quantification results based on firm-level panel regression results from the estimation of regression (2), with time-varying fixed effects as reported in Table 4, combined with information from Table A12. The 'Coef.' column reports the coefficients on the interacted variable, while 'IQR'/'P90-P10' measure the coefficient's implied impact of a U.S. monetary policy shock when moving from the lower quartile/decile to top quartile/decile of the given trade exposure variable. MP^{US} is the monetary policy shock from Bu et al. (2021), and the trade exposure variables are the (i) total exports-to-output ratio ('TotExp/Output'), (ii) final goods exports-to-output ratio ('FinExp/Output'), (iii) intermediate goods exports-to-output ratio ('IntExp/Output'), and (iv) weighted outdegree ('WtOutdeg'). Standard errors are double clustered at the firm and year level, where ^{a} indicates significance at the 1% level, ^{b} at the 5% level, and ^{c} at the 10% level.

tive to the IQR calculation. Interestingly, comparing the IQR of the U.S.-only weighted-outdegree distribution yields similar results as the world distribution, while moving between the deciles for the U.S.-only weighted outdegree implies a larger impact than moving along the world distribution. These facts capture the importance of the U.S. as customer country for our country-sector sample of suppliers, as well as the skewness of the weighted-outdegree distribution.

Overall, we show that there are important heterogeneous effects on firms conditional on their sector's exposure to the transmission of demand shocks being transmitted via exporting behavior. The magnitude of the amplifying effect arising from the interaction between U.S. monetary policy shocks and intermediate goods trade and global production linkages on firm-level investment is large.

5.2 Financial Constraints

We next examine the importance of financial constraints at the firm-level, conditioning on standard firm-level measures as in regression (3). Here we allow for transmission to vary by firm characteristic Z. The two characteristics we use to proxy for firm financial constraints are size and net worth.[32]

[32]Results are qualitatively similar if we instead use age or measure size by employment using a smaller subset of firms for which these data exist.

As noted in Section 2, in this specification the set of fixed effects ($\boldsymbol{\alpha}$) may now vary over time, allowing us to control for unobserved time-varying country- and/or sector-level characteristics (e.g., how a country's trade openness varies over time).

Results are reported in Table 6. We display results for investment only, with sales and employment results in B. Moving from left to right, we begin by omitting time-varying fixed effects, then include country×year fixed effects, and finally include the most stringent set of fixed effects at the country×sector×year. Looking at columns (1) and (4), which omit time-varying fixed effects and control for size and net worth respectively, we see that a contractionary U.S. monetary policy shock has a slightly larger negative effect on investment growth than in our baseline estimation. As indicated in rows two and three, where the coefficient on the interaction of either size or net worth and MP^{US} is positive and significant, the contractionary effect is smaller for firms that are less financially constrained. This finding holds irrespective of the proxy for financial constraints and the set of fixed effects. Our interaction results are consistent with the bulk of the literature that analyzes the effect of U.S. monetary policy on U.S. firm investment, which finds a smaller impact of monetary policy shocks on the investment of firms with less binding financial constraints (e.g., Cloyne et al., 2020; Jeenas, 2019).[33]

Table A13 presents the size and net worth interaction results for sales and employment. The results for sales in Panel A of the table are qualitatively similar to those using investment shares. Turning to the employment regressions in Panel B, we see that there is no significant effect of MP^{US} on employment growth, as in the baseline regressions. However, the coefficients on the interactions with size or net worth are negative and significant when not including the most stringent set of time-varying fixed effects, indicating that large/high net worth firms contract employment more than small/low net worth firms during periods of monetary tightening.

We conduct further robustness checks by allowing for heterogeneous firm-level responses to other macro or financial shocks (e.g., of domestic monetary policy changes) in Tables A14 and A15. Importantly, we examine whether year-on-year exchange rate movements or appreciation/depreciation episodes have heterogeneous effects along the firm size or net worth distributions.[34] Across the various regressions, the coefficients on the interaction of firms' financial constraint proxies and U.S. monetary policy shocks remain strongly significant and do not change in size relative to the baseline estimations. Further, we cannot detect heterogeneous impacts of either exchange rate changes or domestic monetary policy operating via our measures of balance sheet constraints. Of course, a balance sheet effect may still exist given currency mismatches between firms' assets and liabilities, but unfortunately Worldscope does not provide such information to further explore this channel.

[33]The firm-size results also match findings on how small (U.S.) firms cut investment by more than large firms following a monetary contraction, the key result in early work by Gertler and Gilchrist (1994).

[34]We follow di Giovanni et al. (2021) and define a country episode dummy variable as a depreciation (appreciation) when the annual exchange rate change falls within the country's top (bottom) quartile of exchange rate changes vis-à-vis the U.S. dollar over the sample period.

Table 6. Effect of U.S. Monetary Policy Shocks on Firms' Investment: Firm-Level Heterogeneity

	$\Delta(\text{Investment}_t/\text{FixAssets}_{t-1})$					
		Size			*Net Worth*	
	(1)	(2)	(3)	(4)	(5)	(6)
MP^{US}_{t-1}	-0.165^a			-0.164^a		
	(0.055)			(0.054)		
$MP^{US}_{t-1}\times\text{Size}_{t-1}$	0.018^a	0.020^a	0.021^a			
	(0.005)	(0.006)	(0.006)			
$MP^{US}_{t-1}\times\text{Net Worth}_{t-1}$				0.017^a	0.018^a	0.018^a
				(0.005)	(0.005)	(0.005)
Observations	374,360	374,359	373,241	374,360	374,359	373,241
R^2	0.058	0.069	0.096	0.058	0.069	0.096
Country×year FE	No	Yes	No	No	Yes	No
Country×sector×year FE	No	No	Yes	No	No	Yes
Macro Controls	Yes	No	No	Yes	No	No
Firm Controls	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes

Notes: This table presents firm-level panel regression results based on the estimation of regression (3) for the change in the investment-to-fixed capital ratio, where we interact firm characteristics with the monetary policy shock. The sample uses firms with at least five years of observations over 1995-2019. All regressors are lagged one period, where MP^{US} is the monetary policy shock from Bu et al. (2021), 'Size' is the within country-year measure of a firm's size based on the log of total assets, and 'Net Worth' is the within country-year measure of a firm's net worth based on the log of net worth (assets minus liabilities). We include lagged firm and macroeconomic variables as in the baseline estimation in Table 1, and fixed effects at various levels of disaggregation. Standard errors are double clustered at the firm and year level, where ^{a} indicates significance at the 1% level, ^{b} at the 5% level, and ^{c} at the 10% level.

Quantifying the Financial Constraints Channel

We next utilize the firm-level distribution of firm characteristics to quantify the heterogeneous impact of firms' financial constraints on their investment reaction to monetary policy shocks. Similar to the trade exposure quantification exercise above, we examine the differential impact across the firm-size distribution, in this case focusing on size and net worth where each variable is normalized around mean zero (see Table A2). Notably, in contrast to trade exposure, the impact of U.S. monetary policy shocks on firms that are in the upper tail of the distribution is attenuated rather than amplified relative to those firms in the lower tail of the distribution.

Given the similarity in point estimates across the set of fixed effects in Table 6, we provide numbers based on the country×sector×year specifications of columns (3) and (6) in Table 7. Heterogeneity in the impact of monetary policy shocks across the firm distribution is large. First, moving across the IQR of the size distribution from smaller to larger firms implies an attenuation of the impact of U.S. monetary policy shocks of 0.051 percentage points, approximately one-third

Table 7. Quantification Exercise of the Heterogeneous Impacts on Investment of Financial Constraints to U.S. Monetary Policy Shocks

	Coef. (1)	IQR (2)	P90-P10 (3)
$MP^{US}_{t-1} \times \text{Size}_{t-1}$	0.021^a	0.051^a	0.106^a
	(0.006)	(0.014)	(0.029)
$MP^{US}_{t-1} \times \text{Net Worth}_{t-1}$	0.018^a	0.043^a	0.088^a
	(0.005)	(0.012)	(0.025)

Notes: This table presents quantification results based on firm-level panel regression results from the estimation of regression (3) with time-varying fixed effects as reported in Table 6, combined with information from Table A2. The 'Coef.' column reports the coefficients on the interacted variable, while 'IQR'/'P90-P10' measure the coefficient's implied impact of a U.S. monetary policy shock when moving from the lower quartile/decile to top quartile/decile of the given firm constraint variable. MP^{US} is the monetary policy shock from Bu et al. (2021), 'Size' is the within country-year measure of a firm's size based on the log of total assets, and 'Net Worth' is the within country-year measure of a firm's net worth based on the log of net worth (assets minus liabilities). Standard errors are double clustered at the firm and year level, where ^{a} indicates significance at the 1% level, ^{b} at the 5% level, and ^{c} at the 10% level.

the impact on the mean firm (based on column (1) of Table 6: 0.165 p.p.). Moving from the lower to upper decile of the firm-size distribution implies a large attenuation arising from the loosening of financial constraints: 0.106 percentage points, or two-thirds of the impact on the average firm. Second, the net worth measure of financial constraints yields similar results to what we find for size. Moving across the IQR of the net worth distribution from more financially constrained to less financially constrained firms implies an attenuation of 0.043 percentage points, which is approximately one quarter of the impact of the shock on the mean firm (based on column (4) of Table 6: 0.164 p.p.). Moving from the lower to upper decile of the firm-net worth distribution implies a large attenuation arising from the loosening of financial constraints: 0.088 percentage points, or over half the impact on the average firm.

5.3 Trade Exposure and Financial Constraints

Our final set of core estimation results examines the heterogeneous impact of monetary policy shocks on foreign firms conditional on their trade exposure and financial constraints *jointly*. Table 8 presents results for the investment regressions using the size interaction, while we relegate the net worth regressions to Table A16 since results are qualitatively similar.[35] All regressions are run with country×year fixed effects. Looking across coefficients for the size and trade variables in Table 8 and contrasting them with Tables 4 and 6 (country×year specifications), we see that the coefficients are remarkably similar even when controlling for trade exposure and financial constraint proxies

[35] For completeness, we also present the sales and employment regressions in Tables A17 and A18.

Table 8. Effect of U.S. Monetary Policy Shocks on Firms' Investment: The Importance of Size and Trade Integration

	$\Delta(\text{Investment}_t/\text{FixAssets}_{t-1})$							
	Global Trade				*U.S. Trade*			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$MP^{US}_{t-1}\times\text{Size}_{t-1}$	0.019^{a}	0.020^{a}	0.018^{a}	0.019^{a}	0.019^{a}	0.020^{a}	0.018^{a}	0.019^{a}
	(0.006)	(0.006)	(0.005)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)
$MP^{US}_{t-1}\times\left(\frac{\text{TotExp}}{\text{Output}}\right)_{t-1}$	-0.095^{b}				-0.284^{c}			
	(0.038)				(0.155)			
$MP^{US}_{t-1}\times\left(\frac{\text{FinExp}}{\text{Output}}\right)_{t-1}$		0.026				0.083		
		(0.059)				(0.150)		
$MP^{US}_{t-1}\times\left(\frac{\text{IntExp}}{\text{Output}}\right)_{t-1}$			-0.178^{b}				-0.683^{b}	
			(0.069)				(0.329)	
$MP^{US}_{t-1}\times$ WtOutdeg$_{t-1}$				-0.027^{b}				-1.426^{b}
				(0.012)				(0.536)
Observations	374,359	374,359	374,359	374,359	374,359	374,359	374,359	374,359
R^2	0.069	0.069	0.069	0.069	0.069	0.069	0.069	0.069
Country×year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: This table presents firm-level panel regression results based on the estimation of regression (4) for the change in the investment-to-fixed capital ratio, where we interact firm size in addition to different measures country-sectors' trade integration with the monetary policy shock. Columns (1)-(4) use trade measures based on country-sector exports with the world, while columns (5)-(8) use U.S.-only exports data. The country-sector's trade measure include (i) total exports-to-output ratio ('TotExp/Output'), (ii) final goods exports-to-output ratio ('FinExp/Output'), (iii) intermediate goods exports-to-output ratio ('IntExp/Output'), and (iv) the weighted outdegree ('WtOutdeg'). The sample uses firms with at least five years of observations over 1995-2019. All regressors are lagged one period, where MP^{US} is the monetary policy shock from Bu et al. (2021), 'Size' is the within country-year measure of a firm's size based on the log of total assets, and 'Net worth' is the within country-year measure of a firm's net worth based on the log of net worth (assets minus liabilities). We include lagged firm and macroeconomic variables as in the baseline estimation in Table 1, and fixed effects at various levels of disaggregation. Standard errors are double clustered at the firm and year level, where ^{a} indicates significance at the 1% level, ^{b} at the 5% level, and ^{c} at the 10% level.

jointly. A similar story holds for the net worth regressions as well as the employment and sales regressions presented in B.

We next move to quantification exercises. Although comparing the impact of heterogeneity in the trade exposure and financial constraint proxies' distributions is not perfect given that the trade variables are based on sector-level data, it is useful to remember that the largest firms in a given sector also dominate exports (Melitz, 2003; Freund and Pierola, 2015). Therefore, comparing impacts of the trade and interest rate channels when looking at firms along the size distribution across sectors may indeed be a good approximation to having firm-level trade data to exploit.

We begin by asking how small firms compare to large ones when moving from low to high trade exposed sectors in Table 9. Focusing on intermediate goods trade exposure in the first two

Table 9. Quantification Exercise of the Heterogeneous Impacts on Investment of Trade Exposure and Financial Constraints to U.S. Monetary Policy Shocks

	Global Trade			*U.S. Trade*		
	Coef.	IQR	P90-P10	Coef.	IQR	P90-P10
	(1)	(2)	(3)	(4)	(5)	(6)
$MP^{US}_{t-1} \times \text{Size}_{t-1}$	0.018^a	0.045^a	0.093^a	0.018^a	0.045^a	0.094^a
	(0.005)	(0.013)	(0.027)	(0.006)	(0.014)	(0.029)
$MP^{US}_{t-1} \times \left(\frac{\text{IntExp}}{\text{Output}}\right)_{t-1}$	-0.178^a	-0.032^a	-0.080^a	-0.683^b	-0.015^b	-0.032^b
	(0.069)	(0.012)	(0.031)	(0.329)	(0.007)	(0.015)
Total		0.013	0.013		0.031^a	0.063^b
		(0.012)	(0.028)		(0.014)	(0.028)
$MP^{US}_{t-1} \times \text{Size}_{t-1}$	0.019^a	0.048^a	0.099^a	0.019^a	0.046^a	0.096^a
	(0.006)	(0.014)	(0.029)	(0.006)	(0.014)	(0.029)
$MP^{US}_{t-1} \times \text{WtOutdeg}_{t-1}$	-0.027^b	-0.014^b	-0.031^b	-1.426^a	-0.012^a	-0.040^a
	(0.012)	(0.006)	(0.013)	(0.536)	(0.004)	(0.015)
Total		0.034^a	0.069^a		0.034^a	0.056^b
		(0.011)	(0.023)		(0.013)	(0.026)

Notes: This table presents quantification results based on firm-level panel regression results from the estimation of regression (4) as reported in Table 8 combined with information from Tables A2 and A12. The 'Coef.' column reports the coefficients on the interacted variable, while 'IQR'/'P90-P10' measure the coefficient's implied impact of a U.S. monetary policy shock when moving from the lower quartile/decile to top quartile/decile of the given firm constraint variable. MP^{US} is the monetary policy shock from Bu et al. (2021), 'Size' is the within country-year measure of a firm's size based on the log of total assets, and 'Net Worth' is the within country-year measure of a firm's net worth based on the log of net worth (assets minus liabilities). Standard errors are double clustered at the firm and year level, where ^{a} indicates significance at the 1% level, ^{b} at the 5% level, and ^{c} at the 10% level.

rows, we utilize coefficients from either columns (3) or (7) of Table 8. First, looking at the IQR for the size variable, the differential impact between a less financially constrained (larger) and a more constrained (smaller) firm from a one percentage point monetary policy tightening is 0.045 p.p., an attenuation of roughly one quarter relative to the total impact on the mean firm (0.161 p.p. contraction in investment). However, once we include the impact difference in the IQR of the intermediate world trade exposure and consider a movement from a less open to more open sector, this attenuation falls to 0.013 percentage points (i.e., $0.045 - 0.032 = 0.013$). Assuming that the distribution of intermediate trade openness within a sector is similar to that across sectors (i.e., the power law distributions of both trade exposures have the same slope), then this quantitative experiment would imply that, on net, the impact of large firms being less financially constrained while also being more exposed to world demand shocks via trade produces a slight attenuation of the effect of U.S. monetary policy shocks relative to the average firm. Put concretely, this indicates that the exacerbation of the impact of U.S. monetary policy shocks due to increased trade exposure may be dominated by the attenuation associated with being less financially constrained. This result is not statistically significant for global trade in intermediates goods in columns (2) and (3), indicating that the impact of the two channels cancel each other out. Further calculations yield somewhat different results for firms' exposures to U.S. intermediate goods trade, as well as their exposure to world production networks as measured by weighted outdegree. In these cases, the financial channel dominates and is statistically significant, thus indicating that the amplification of the spillover of U.S. monetary policy shocks to foreign firms via the trade channel is attenuated for less financially constrained firms.

5.4 Heterogeneous Effects across Countries

We exploit the cross-country dimension of our dataset in order to ask whether there is any heterogeneity in the relative impact of either the trade exposure or financial constraint variables by estimating regressions (2) and (3) while allowing the coefficients on the trade exposure or financial constraint interaction terms (the β_2s) to vary across countries.[36] Figure A6 plots the cross-country distribution of twenty different estimated coefficients on the interaction of the monetary policy shock with the four world trade exposure measures. The estimates are based on regressions with country$\times$year fixed effects and we include 95% confidence intervals in the figures. We reject homogeneity across the three coefficients that appear significant in Table 4 in panels (a), (c), and (d) – total exports, intermediate exports, and weighted outdegree, respectively. It clear from the figures that there is heterogeneity in the estimates, with some coefficients being positive rather than negative and others insignificant. However, given the unbalanced nature of the panel along with using country-sector variables rather than firm ones, it is hard to draw any concrete conclusions. We repeat this for the financial constraint interactions in Figure A7, which plots coefficients for the size and net worth interactions in panels (a) and (b), respectively. We reject homogeneity of coefficients, but all coefficients are positive and many statistically significant.

Further Robustness Checks We conduct additional robustness checks for the interaction regressions. In particular, we first replace both the country-sector trade and firm-level financial constraint variables with beginning-of-period values rather than using time-varying values. Overall, results are robust and the coefficients on the interaction terms do not change dramatically, either quantitatively or in terms of statistical significance. Second, rather than using beginning-of-period values, we use the interaction variables averaged over time. Again, our main findings are robust to this change of specification.

[36] We also allow for heterogeneity in the non-interacted coefficients to avoid omitted variable bias.

6 Conclusion

This paper documents two broad results. First, there are significant effects of Fed monetary policy shocks on foreign firms' investment and sales. This spillover effect varies between emerging market economies (EMEs) and advanced economies, but not by variation in country-level measures such as the degree of financial account and trade openness. Second, drilling down to more granular levels of heterogeneity across sectors and firms, we find interesting patterns in the data that suggest potential channels for the amplification or attenuation of the spillovers of U.S. monetary policy shocks. Namely, greater exposure to intermediate goods trade and global production linkages amplify the cross-country transmission of U.S. monetary policy shocks to firms. However, these effects are attenuated for larger firms and firms with greater net worth given less binding financial constraints, thereby dampening the interest rate channel of monetary policy. These findings highlight the importance of both the external demand channel and the interest rate channel for monetary policy spillovers to foreign activity. Our results contribute to help understanding the potential real consequences of the tectonic shift in monetary policy that began in 2022. They also have implications concerning welfare effects of the apparent reversal of the decades-long trend toward globalization.

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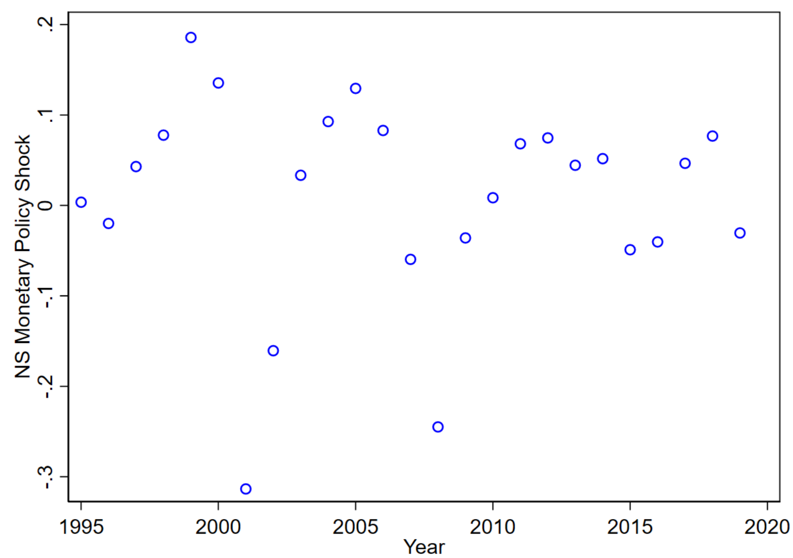
Appendix A Additional Figures

Figure A1. Alternative U.S. Monetary Policy Shocks: Nakamura and Steinsson

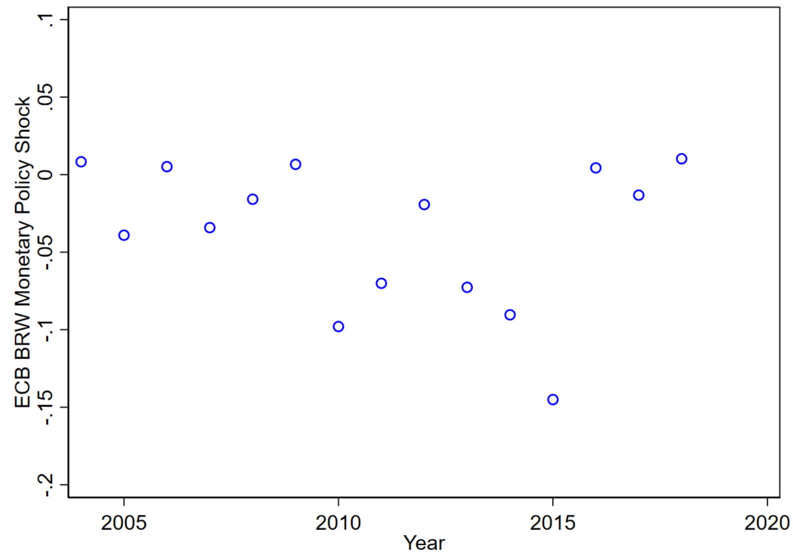


Notes: This figure plots the annual aggregate of the policy news shock constructed by Nakamura and Steinsson (2018) (updated).

Figure A2. Alternative U.S. Monetary Policy Shocks: Swanson's Forward Guidance

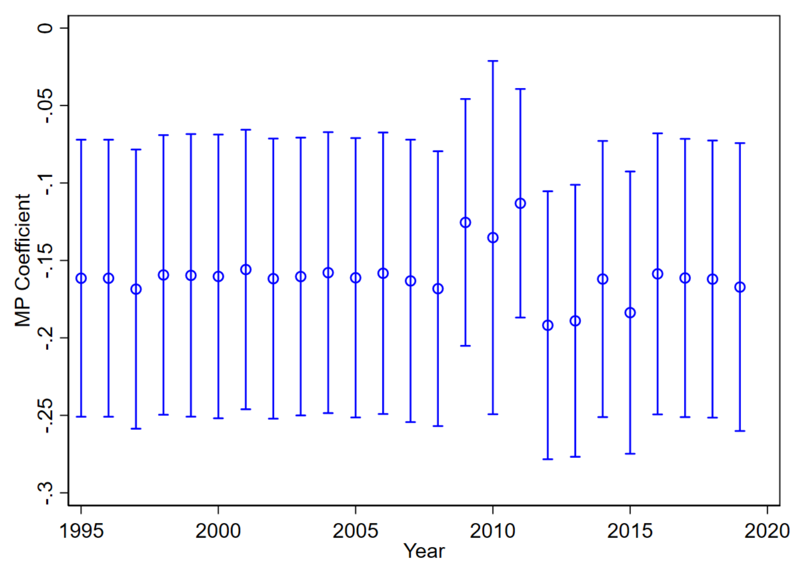
Notes: This figure plots the annual aggregate of the Forward Guidance factor estimated by Swanson (2021).

Figure A3. European Monetary Policy Shocks



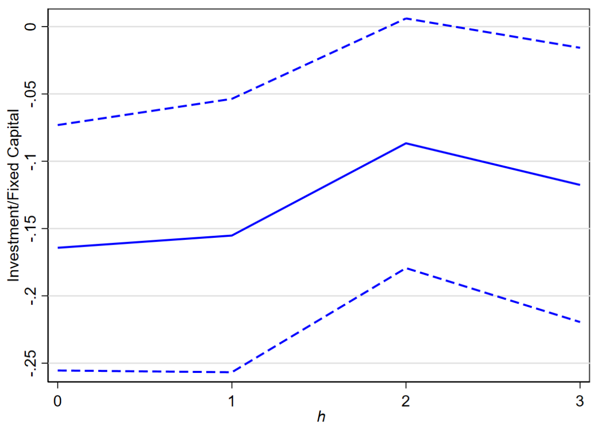
Notes: This figure plots the annual aggregate of the pure European monetary policy shock constructed by Bu et al. (2021).

Figure A4. Estimated Coefficient on U.S. Monetary Policy Shock Leaving Out One Year

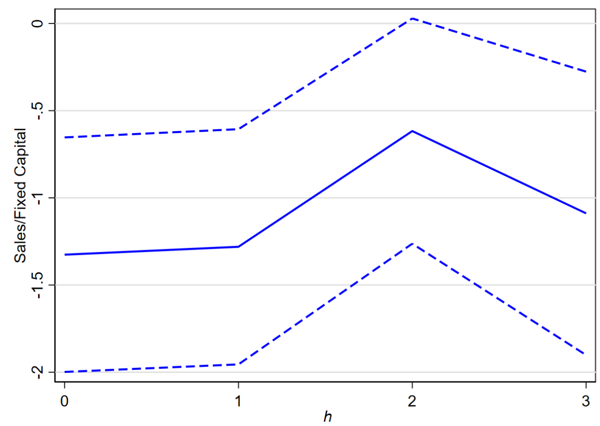


Notes: This figure plots the estimated β obtained from estimating Equation (1) multiple times leaving out one year's worth of observations at a time. The left-out year is indicated on the horizontal axis.

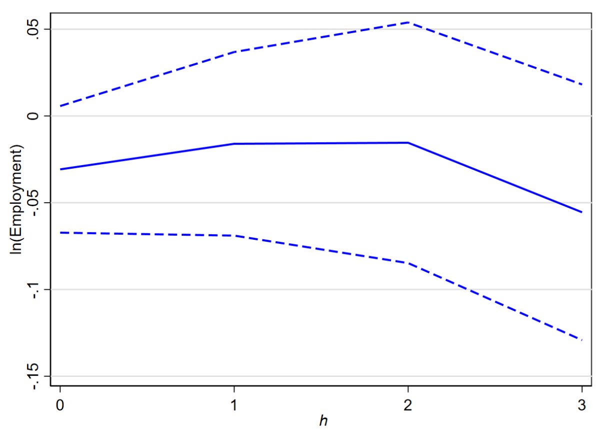
Figure A5. Cumulative Impulse Responses for Investment, Sales, and Employment of a One Percentage Point Contraction in U.S. Monetary Policy



(a) Investment/Fixed Assets



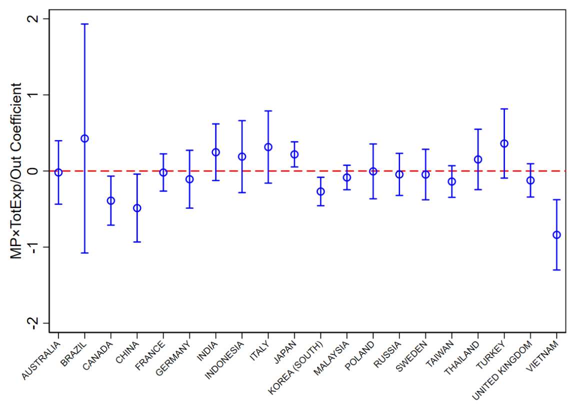
(b) Sales/Fixed Assets



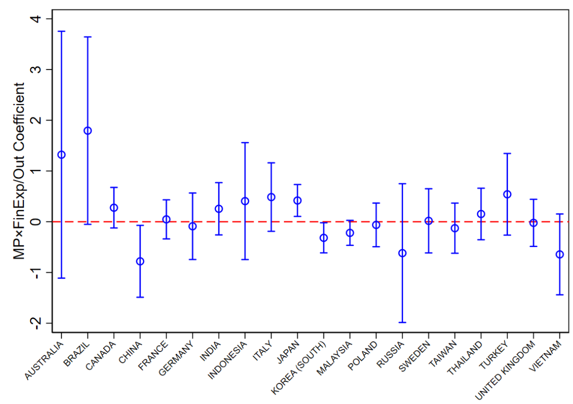
(c) ln(Employment)

Notes: This figure plots the cumulative impulse response function of a one percentage point contraction in U.S. monetary policy (Bu et al., 2021) for (a) investment ratio, (b) sales ratio, and (c) log employment (in millions). Estimation is based on local projection method (Jordà, 2005) of the baseline regression (1) with $h = 0, \ldots, 3$, controlling for firm-level fixed effects. 90% confidence intervals are plotted in dashed lines, and regressions are clustered at the firm and year levels.

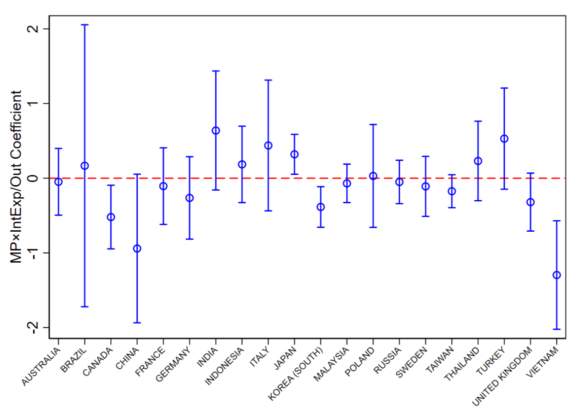
Figure A6. Heterogeneous Impact of Trade Exposure on the Transmission of U.S. Monetary Policy Shocks across Countries



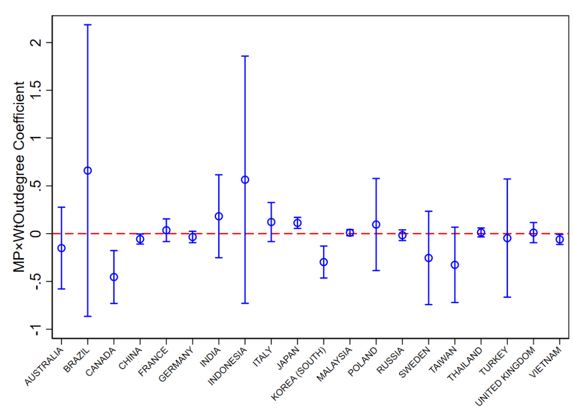
(a) TotExp/Output



(b) FinExp/Output



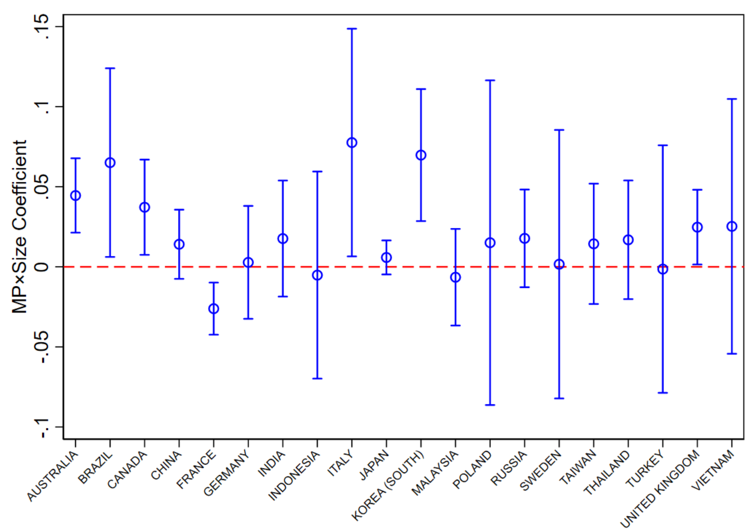
(c) IntExp/Output



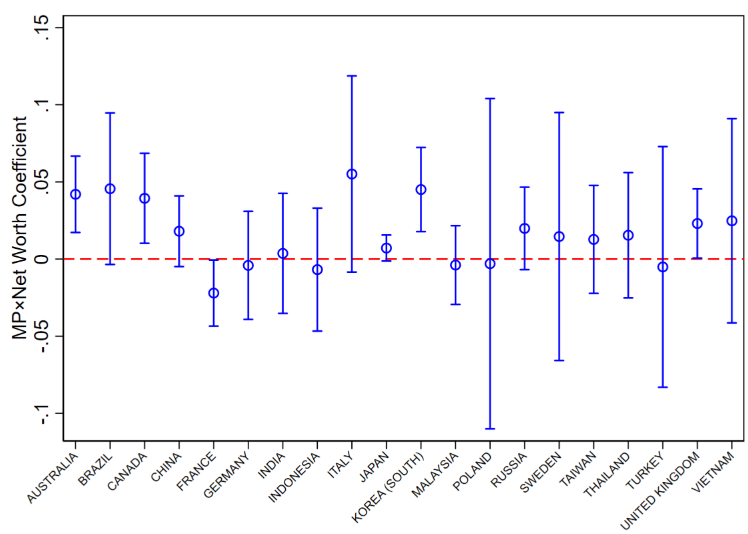
(d) WtOutdeg

Notes: This figure plots coefficients for the trade exposure interaction with the monetary policy shock from regression (2) (β_2) where we allow the coefficient to vary across countries. Panel (a) plots the coefficients for the 'TotExp/Out' variable interaction, panel (b) for the 'FinExp/Out' variable interaction, panel (c) for the 'IntExp/Out' variable interaction, and panel (d) for the 'WtOutdeg' variable interaction. All regressions were run with firm controls and country×year fixed effects, and with clustering at the firm and year levels. The blue standard error bounds are for the 95% level.

Figure A7. Heterogeneous Impact of Financial Constraints on the Transmission of U.S. Monetary Policy shocks across Countries



(a) Size



(b) Net Worth

Notes: This figure plots coefficients for the financial constraint interaction with the monetary policy shock from regression (3) (β_2) where we allow the coefficient to vary across countries. Panel (a) plots the coefficients for the 'Size' variable interaction, while panel (b) plots the coefficients for the 'Net Worth' variable interaction. All regressions were run with firm controls and country×sector×year fixed effects, and with clustering at the firm and year levels. The blue standard error bounds are for the 95% level.

Appendix B Additional Tables

Table A1. Firm-level Summary Statistics for Country Sample, 1995-2019

	Obs.	Mean	Median	St.Dev.	Min	Max
Δ(Investment/Assets)	438,300	-0.024	-0.002	0.533	-2	2
Δ(Sales/Assets)	438,039	0.064	0.003	3.774	-10	10
Employment growth	297,152	0.074	0.016	0.328	-1	2
log(Cash flow)	332,132	19.42	19.38	3.11	10.93	26.45
Sales growth	423,567	0.13	0.06	0.44	-1	2
log(Assets)	480,729	21.54	21.59	3.48	10.11	28.95
Age	387,649	28.51	21	23.89	0	211
log(Sales)	463,353	21.17	21.30	3.64	9.90	28.33
log(EBITDA)	375,453	19.77	19.71	3.02	11.94	26.67
Tobin's Q	143,779	2.08	1.28	4.19	0.42	80.80
Liquidity ratio	467,678	0.01	0.04	0.30	-4.23	0.40
Leverage	477,263	0.24	0.19	0.30	0	3.49
log(Debt)	411,667	20.06	20.24	3.70	9.74	27.84
log(Int. pay)	425,459	16.74	16.89	3.63	6.91	24.78
log(Collateral)	458,244	20.77	20.95	3.59	9.57	28.11
log(Dividends)	272,385	18.26	18.33	2.81	10.04	24.86
log(Equity)	439,239	21.13	21.40	3.26	12.93	28.09

Notes: This table presents firm-level summary statistics for all firms with at least five years of data and that are in our baseline regression sample over 1995-2019. Summary statistics are based on the pooled sample of firms, where all variables have been winsorized at the 1% level, except for the change in sales-to-asset ratio which is winsorized at the 5% level. All measures are in nominal terms and in USD.

Table A2. Summary Statistics for Normalized Firm-Level Financial Constraint Proxy Measures across Firms

	Obs.	Mean	St.Dev.	p10	p25	p50	p75	p90
Size	438,300	0.000	2.120	-2.382	-1.338	-0.208	1.132	2.761
Net Worth	438,300	0.000	1.965	-2.258	-1.237	-0.148	1.106	2.540

Notes: This table presents firm-level summary statistics on the normalized size and net worth variables. Each variable is normalized across firms within a country-year. Summary statistics are presented across all years.

Table A3. Summary Statistics Sector-Level Trade Measures for World Trade across Country Sample, 2000

Sector	Code	TotExp/Output		FinExp/Output		IntExp/Output		WtOutdeg	
		Mean	St.Dev.	Mean	St.Dev.	Mean	St.Dev.	Mean	St.Dev.
Agriculture	AtB	0.092	0.077	0.024	0.018	0.069	0.068	0.252	0.081
Air Transport	62	0.325	0.190	0.104	0.062	0.221	0.128	0.101	0.212
Automotive	50	0.014	0.029	0.005	0.013	0.009	0.017	0.003	0.035
Carbon/Nuclear Fuels	23	0.195	0.143	0.063	0.054	0.132	0.091	0.391	0.126
Chemicals	24	0.362	0.216	0.091	0.093	0.271	0.145	1.075	0.087
Construction	F	0.008	0.018	0.003	0.009	0.005	0.010	0.026	0.228
Education	M	0.004	0.006	0.001	0.002	0.003	0.004	0.007	0.151
Electrical Equipment	30t33	0.549	0.263	0.256	0.136	0.293	0.136	0.865	0.161
Financial Intermediation	J	0.045	0.047	0.007	0.006	0.037	0.041	0.126	0.197
Food	15t16	0.125	0.074	0.095	0.058	0.030	0.023	0.147	0.198
General Machinery	29	0.398	0.238	0.250	0.140	0.148	0.102	0.407	0.125
General Manufacturing	36t37	0.396	0.217	0.287	0.161	0.109	0.068	0.111	0.183
Health/Social Work	N	0.003	0.004	0.002	0.002	0.002	0.002	0.005	0.110
Hotels and Restaurants	H	0.065	0.073	0.023	0.025	0.042	0.050	0.090	0.153
Inland Transport	60	0.051	0.043	0.010	0.010	0.041	0.035	0.073	0.116
Leather	19	0.516	0.228	0.369	0.189	0.147	0.062	0.250	0.124
Metals	27t28	0.296	0.129	0.022	0.018	0.273	0.122	0.868	0.037
Mining	C	0.285	0.241	4E-04	0.028	0.284	0.225	1.606	0.011
Non-Metallic Minerals	26	0.171	0.095	0.022	0.016	0.149	0.091	0.126	0.040
Other Business Activities	71t74	0.098	0.081	0.013	0.015	0.086	0.070	0.499	0.072
Other Services	O	0.044	0.036	0.012	0.011	0.032	0.025	0.120	0.031
Other Transport	63	0.089	0.074	0.013	0.014	0.076	0.063	0.167	0.093
Paper	21t22	0.179	0.160	0.021	0.014	0.157	0.155	0.298	0.133
Post and Telecommunications	64	0.041	0.027	0.008	0.008	0.033	0.023	0.062	0.260
Public Administration	L	0.003	0.002	0.002	0.001	0.002	0.001	0.004	0.198
Real Estate	70	0.007	0.010	0.002	0.003	0.005	0.007	0.021	0.181
Retail Trade	52	0.029	0.043	0.020	0.037	0.009	0.014	0.020	0.081
Rubber and Plastics	25	0.276	0.177	0.056	0.046	0.220	0.139	0.326	0.123
Textiles	17t18	0.475	0.219	0.302	0.165	0.172	0.128	0.389	0.008
Transport Equipment	34t35	0.343	0.241	0.196	0.162	0.147	0.098	0.466	0.090
Utilities	E	0.021	0.029	0.005	0.006	0.016	0.023	0.044	0.007
Water Transport	61	0.415	0.367	0.098	0.101	0.317	0.283	0.082	0.014
Wholesale Trade	51	0.048	0.055	0.011	0.012	0.037	0.046	0.120	0.006
Wood	20	0.215	0.176	0.013	0.014	0.202	0.174	0.183	0.054

Notes: This table presents sector-level summary statistics on the (i) total exports-to-output ratio ('TotExp/Output'), (ii) final goods exports-to-output ratio ('FinExp/Output'), (iii) intermediate goods exports-to-output ratio ('IntExp/Output'), and (iv) export weighted outdegree ('WtOutdeg') at the sector level for trade with the world. The 'Mean' variable is the average value of the ratio across countries within a sector, while 'St.Dev.' is the standard deviation of the ratio across countries within a sector. We calculate both the mean and standard deviation of these ratios across countries for the year 2000.

Table A4. Summary Statistics for Sector-Level Trade Measures for U.S. Trade across Country Sample, 2000

		TotExp/Output		FinExp/Output		IntExp/Output		WtOutdeg	
Sector	Code	Mean	St.Dev.	Mean	St.Dev.	Mean	St.Dev.	Mean	St.Dev.
Agriculture	AtB	0.015	0.022	0.004	0.005	0.011	0.016	0.004	0.007
Air Transport	62	0.104	0.076	0.033	0.025	0.071	0.052	0.002	0.001
Automotive	50	0.002	0.004	0.001	0.002	0.001	0.002	1E-05	1E-05
Carbon/Nuclear Fuels	23	0.037	0.048	0.012	0.014	0.025	0.034	0.004	0.006
Chemicals	24	0.072	0.093	0.020	0.022	0.052	0.078	0.011	0.014
Construction	F	0.001	0.001	7E-05	1E-04	5E-04	0.001	8E-05	1E-04
Education	M	0.001	0.001	2E-04	4E-04	5E-04	0.001	3E-05	6E-05
Electrical Equipment	30t33	0.148	0.168	0.087	0.100	6E-02	0.071	0.014	0.021
Financial Intermediation	J	0.004	0.006	0.001	0.001	0.003	0.005	0.001	0.001
Food	15t16	0.020	0.032	0.017	0.027	0.003	0.006	0.001	0.001
General Machinery	29	0.093	0.099	0.057	0.055	0.037	0.046	0.003	0.003
General Manufacturing	36t37	0.179	0.168	0.135	0.121	0.044	0.051	0.003	0.005
Health/Social Work	N	0.001	0.001	3E-04	4E-04	4E-04	0.001	4E-05	5E-05
Hotels and Restaurants	H	0.002	0.006	0.001	0.005	3E-04	0.001	3E-05	9E-05
Inland Transport	60	0.002	0.004	4E-04	0.001	0.002	0.004	0.001	0.002
Leather	19	0.176	0.085	0.129	0.063	0.048	0.022	0.009	0.011
Metals	27t28	0.059	0.084	0.008	0.015	0.051	0.069	0.009	0.010
Mining	C	0.039	0.070	0.001	0.003	0.038	0.068	0.036	0.085
Non-Metallic Minerals	26	0.048	0.070	0.007	0.007	0.041	0.071	0.002	0.002
Other Business Activities	71t74	0.042	0.046	0.006	0.010	0.036	0.040	0.008	0.012
Other Services	O	0.006	0.008	0.002	0.003	0.005	0.006	0.001	0.001
Other Transport	63	0.004	0.012	0.001	0.004	0.003	0.008	6E-05	1E-04
Paper	21t22	0.038	0.075	0.008	0.008	0.030	0.070	0.003	0.007
Post and Telecommunications	64	0.001	0.002	2E-04	2E-04	0.001	0.001	1E-04	3E-04
Public Administration	L	4E-05	6E-05	2E-05	3E-05	2E-05	3E-05	1E-06	1E-06
Real Estate	70	4E-04	0.002	9E-05	3E-04	3E-04	0.001	4E-05	1E-04
Retail Trade	52	0.003	0.005	0.002	0.003	0.001	0.003	2E-04	4E-04
Rubber and Plastics	25	0.058	0.131	0.019	0.045	0.039	0.086	0.002	0.004
Textiles	17t18	0.122	0.135	0.110	0.122	0.012	0.023	0.002	0.002
Transport Equipment	34t35	0.095	0.170	0.064	0.131	0.031	0.042	0.006	0.010
Utilities	E	0.006	0.015	0.001	0.003	0.004	0.011	5E-04	0.001
Water Transport	61	0.004	0.005	0.001	0.001	0.003	0.004	5E-05	7E-05
Wholesale Trade	51	0.002	0.004	0.001	0.001	0.002	0.003	0.001	0.003
Wood	20	0.050	0.109	0.004	0.004	0.046	0.109	0.004	0.010

Notes: This table presents sector-level summary statistics on the (i) total exports-to-output ratio ('TotExp/Output'), (ii) final goods exports-to-output ratio ('FinExp/Output'), (iii) intermediate goods exports-to-output ratio ('IntExp/Output'), and (iv) export weighted outdegree ('WtOutdeg') at the sector level for trade with the U.S. only. The 'Mean' variable is the average value of the ratio across countries within a sector, while 'St.Dev.' is the standard deviation of the ratio across countries within a sector. We calculate both the mean and standard deviation of these ratios across countries for the year 2000.

Table A5. Summary Statistics for Macroeconomic Variables

	Obs.	Mean	Median	St.Dev.	Min	Max
ln(VIX)	25	2.932	2.864	0.305	2.406	3.487
$\Delta\ln(\text{RGDP}^{D})$	487	3.654	3.303	3.464	-12.90	19.90
$\Delta\ln(\text{NXR})$	492	0.041	0.010	0.184	-0.216	2.442
$\Delta\text{IntRate}^{D}$	490	-0.105	-0.0003	2.156	-47.71	0.350
Fin. Openness	468	0.559	0.604	0.358	0.000	1.000
Trade/GDP	449	0.646	0.551	0.364	0.156	2.204
Peg	465	0.620	1.000	0.480	0.000	1.000

Notes: This table presents summary statistic for annual macroeconomic data for the following series: (i) the log of the CBOE Volatility Index (‘ln(VIX)’), (ii) real GDP growth in domestic currency (‘$\Delta\ln(\text{RDGP}^{D})$’), (iii) the percentage change of the local currency-to-U.S. dollar nominal exchange rate (‘$\Delta\ln(\text{NXR})$’), (iv) the change in the domestic short-term rate (‘$\Delta\text{IntRate}^{D}$’), (v) one minus the Fernández et al. (2016) index of financial account repression (‘Fin. Openness’), (vi) the exports plus imports-to-GDP ratio (‘Trade/GDP’), and (vii) a binary variable of exchange rate regime (‘Peg’) based on data from **?**. All financial series are calculated using the annual average of the underlying variable while macroeconomic and trade data are based on end-of-year series.

Table A6. Effect of Asymmetric U.S. Monetary Policy Shocks on Firms' Investment, Sales, and Employment

	Δ(Investment$_t$/FixAssets$_{t-1}$)		Δ(Sales$_t$/FixAssets$_{t-1}$)		Employment Growth$_t$	
	(1)	(2)	(3)	(4)	(5)	(6)
$MP^{US,+}_{t-1}$	-0.028	0.024	-0.298	-0.045	0.045	0.064
	(0.059)	(0.092)	(0.575)	(0.628)	(0.078)	(0.073)
$MP^{US,-}_{t-1}$	-0.182^b	-0.249^a	-1.494^a	-1.896^a	-0.049	-0.073^c
	(0.066)	(0.063)	(0.507)	(0.477)	(0.051)	(0.040)
Δ(CF/TA)$_{t-1}$	0.0005^b	0.001^a	0.001	4E-05	-3E-05	-8E-05
	(0.0002)	(0.0002)	(0.001)	(0.001)	(0.0001)	(0.0001)
Size$_{t-1}$	-0.007^a	-0.083^a	-0.009	-0.371^a	-0.027^a	-0.104^a
	(0.002)	(0.010)	(0.021)	(0.057)	(0.002)	(0.008)
Net Worth$_{t-1}$	0.003	0.002	-0.061^a	-0.210^a	0.022^a	0.047^a
	(0.002)	(0.004)	(0.018)	(0.031)	(0.002)	(0.003)
$\Delta\ln(\text{RGDP}^D)_{t-1}$	0.0003	-0.003^c	-0.009	-0.034^b	0.004^b	0.003^c
	(0.001)	(0.002)	(0.010)	(0.013)	(0.001)	(0.001)
ln(VIX$_{t-1}$)	-0.078^a	-0.109^a	-0.641^a	-0.853^a	-0.027	-0.026
	(0.023)	(0.016)	(0.196)	(0.157)	(0.016)	(0.016)
$\Delta\ln(\text{NXR})_{t-1}$	-0.047	-0.094^c	-0.445	-0.758	-0.026	-0.041
	(0.042)	(0.050)	(0.462)	(0.492)	(0.029)	(0.032)
ΔIntRate$^D_{t-1}$	-0.355^b	-0.156	-3.301^c	-1.986	-0.067	-0.014
	(0.169)	(0.187)	(1.632)	(1.791)	(0.123)	(0.131)
Observations	374,864	374,360	374,687	374,179	256,108	254,414
R^2	0.005	0.058	0.009	0.106	0.022	0.176
Country×sector FE	Yes	No	Yes	No	Yes	No
Firm FE	No	Yes	No	Yes	No	Yes

Notes: This table presents firm-level panel regression results based on the estimation of regression (1) for the change in the investment-to-fixed capital ratio (columns 1 and 2), the change in the sales-to-fixed capital ratio (columns 3 and 4), and employment growth (columns 5 and 6). The sample uses firms with at least five years of observations over 1995-2019. All regressors are lagged one period, where MP^{US} is the monetary policy shock from Bu et al. (2021), where + indicates a positive innovation ("tightening") and a − indicates a negative innovation ("loosening"). 'CF/TA' is a firm's cash flow-to-total assets ratio, 'Size' is the within country-year measure of a firm's size based on the log of total assets, 'Net worth' is the within country-year measure of a firm's net worth based on the log of net worth (assets minus liabilities), 'RGDP^D is a country's real GDP, 'NXR' is a country's nominal exchange rate against the U.S. dollar, 'VIX' is the CBOE Volatility Index, and 'IntRate^D' is a country's short-term interest rate (annual average). We include fixed effects at various levels of disaggregation. Standard errors are double clustered at the firm and year level, where ^{a} indicates significance at the 1% level, ^{b} at the 5% level, and ^{c} at the 10% level.

Table A7. Effect of U.S. Monetary Policy Shocks on Firms' Investment, Sales, and Employment: Robustness to Including U.S. Rates and to Using Alternative Measures of Monetary Policy Shocks

	Panel A. $\Delta(\text{Investment}_t/\text{FixAssets}_{t-1})$							
	BRW-US		*Nakamura-Steinsson*		*Forward Guidance*		*BRW-ECB*	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
MP_{t-1}	-0.164[a]	-0.176[a]	0.047	0.077	-0.009[a]	-0.007[c]	-0.240	-0.227
	(0.048)	(0.043)	(0.085)	(0.067)	(0.003)	(0.004)	(0.147)	(0.148)
$\Delta(\text{2-year USTR})_{t-1}$	0.017[b]		0.010		0.028[b]		0.023	
	(0.007)		(0.013)		(0.012)		(0.014)	
$\Delta(\text{5-year USTR})_{t-1}$		0.025[b]		0.008		0.027		0.027
		(0.011)		(0.013)		(0.018)		(0.018)
Observations	374,360	374,360	374,360	374,360	374,360	374,360	315,155	315,155
R^2	0.058	0.058	0.056	0.056	0.057	0.057	0.064	0.064
	Panel B. $\Delta(\text{Sales}_t/\text{FixAssets}_{t-1})$							
	BRW-US		*Nakamura-Steinsson*		*Forward Guidance*		*BRW-ECB*	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
MP_{t-1}	-1.327[a]	-1.421[a]	0.853	0.942	-0.077[b]	-0.060[c]	-1.177	-1.058
	(0.332)	(0.293)	(0.799)	(0.640)	(0.028)	(0.031)	(1.105)	(1.106)
$\Delta(\text{2-year USTR})_{t-1}$	0.139[c]		0.031		0.232[b]		0.201[a]	
	(0.067)		(0.116)		(0.108)		(0.113)	
$\Delta(\text{5-year USTR})_{t-1}$		0.206[b]		0.024		0.224		0.233
		(0.095)		(0.126)		(0.156)		(0.148)
Observations	374,179	374,179	374,179	374,179	374,179	374,179	315,028	315,028
R^2	0.106	0.106	0.105	0.105	0.105	0.105	0.116	0.116
	Panel C. Employment Growth_t							
	BRW-US		*Nakamura-Steinsson*		*Forward Guidance*		*BRW-ECB*	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
MP_{t-1}	-0.033[c]	-0.039[b]	0.135[b]	0.128[a]	0.004	0.004[c]	0.022	0.028
	(0.019)	(0.016)	(0.064)	(0.042)	(0.003)	(0.002)	(0.091)	(0.092)
$\Delta(\text{2-year USTR})_{t-1}$	0.017[b]		0.001		0.011		0.014	
	(0.008)		(0.012)		(0.010)		(0.012)	
$\Delta(\text{5-year USTR})_{t-1}$		0.022[c]		0.003		0.013		0.015
		(0.012)		(0.014)		(0.013)		(0.017)
Observations	254,414	254,414	254,414	254,414	254,414	254,414	205,212	205,212
R^2	0.177	0.177	0.178	0.178	0.177	0.177	0.193	0.193

Notes: This table presents firm-level panel regression results based on the estimation of regression (1) for the change in the investment-to-fixed capital ratio, sales-to-fixed capital ratio, and employment growth. The sample uses firms with at least five years of observations over 1995-2019. All regressors are lagged one period, where MP is the U.S. monetary policy shock from Bu et al. (2021) in columns (1)-(2), Nakamura and Steinsson (2018) in columns (3)-(4), Swanson (2021)'s measure of forward guidance in columns (5)-(6), and the European monetary policy shock from Bu et al. (2021) in columns (7)-(8). '2-year and 5-year USTR are the annual average of the rate on U.S. 2-year or 5-year Treasury bills. We include lagged firm and macroeconomic variables as in the baseline estimation in Table 1, and fixed effects at various levels of disaggregation. Standard errors are double clustered at the firm and year level, where [a] indicates significance at the 1% level, [b] at the 5% level, and [c] at the 10% level.

Table A8. The Information Effect of U.S. Monetary Policy Shocks on Firms' Investment, Sales, and Employment

	Δ(Investment$_t$/FixAssets$_{t-1}$)		Δ(Sales$_t$/FixAssets$_{t-1}$)		Employment Growth$_{t-1}$)	
	(1)	(2)	(3)	(4)	(5)	(6)
$Info^{US}_{t-1}$	0.087	0.022	0.761	0.252	0.061^b	0.058^c
	(0.057)	(0.059)	(0.453)	(0.487)	(0.027)	(0.029)
MP^{US}_{t-1}		-0.153^a		-1.203^a		-0.007
		(0.052)		(0.378)		(0.033)
Δ(CF/TA)$_{t-1}$	0.001^a	0.001^a	0.000	0.000	-0.000	-0.000
	(0.0002)	(0.0002)	(0.001)	(0.001)	(0.000)	(0.000)
Size$_{t-1}$	-0.079^a	-0.081^a	-0.347^a	-0.361^a	-0.103^a	-0.103^a
	(0.010)	(0.010)	(0.060)	(0.060)	(0.008)	(0.008)
Net Worth$_{t-1}$	0.002	0.002	-0.213^a	-0.212^a	0.047^a	0.047^a
	(0.004)	(0.004)	(0.032)	(0.032)	(0.003)	(0.003)
Δ ln(RGDP^D)$_{t-1}$	-0.005^c	-0.004^b	-0.044^b	-0.039^a	0.002^c	0.002^c
	(0.002)	(0.002)	(0.016)	(0.012)	(0.001)	(0.001)
ln(VIX$_{t-1}$)	-0.074^a	-0.103^a	-0.583^b	-0.808^a	-0.019	-0.020
	(0.025)	(0.019)	(0.227)	(0.184)	(0.016)	(0.019)
Δ ln(NXR)$_{t-1}$	-0.043	-0.094^c	-0.339	-0.739	-0.025	-0.028
	(0.051)	(0.050)	(0.509)	(0.467)	(0.035)	(0.031)
ΔIntRate$^D_{t-1}$	-0.518^c	-0.211	-4.822	-2.404	-0.067	-0.053
	(0.280)	(0.211)	(2.870)	(2.005)	(0.146)	(0.120)
Observations	374,360	374,360	374,179	374,179	254,414	254,414
R^2	0.056	0.057	0.105	0.106	0.177	0.177
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes

Notes: This table presents firm-level panel regression results based on the estimation of regression (1) for the change in the investment-to-fixed capital ratio (columns 1 and 2), the change in the sales-to-fixed capital ratio (columns 3 and 4), and employment growth (columns 5 and 6). The sample uses firms with at least five years of observations over 1995-2019. All regressors are lagged one period, where MP^{US} and $Info^{US}$ are the monetary policy information shocks, respectively, from Bu et al. (2021). 'CF/TA' is a firm's cash flow-to-total assets ratio, 'Size' is the within country-year measure of a firm's size based on the log of total assets, 'Net Worth' is the within country-year measure of a firm's net worth based on the log of net worth (assets minus liabilities), 'RGDP^D is a country's real GDP, 'NXR' is a country's nominal exchange rate against the U.S. dollar, 'VIX' is the CBOE Volatility Index, and 'IntRate^D' is a country's short-term interest rate (annual average). We include fixed effects at various levels of disaggregation. Standard errors are double clustered at the firm and year level, where ^{a} indicates significance at the 1% level, ^{b} at the 5% level, and ^{c} at the 10% level.

Table A9. Effect of U.S. Monetary Policy Shocks on Firms' Investment, Sales, and Employment: Impact of Country-Level Trade, Financial Openness, and Exchange Rate Regime

	Δ(Investment$_t$/FixAssets$_{t-1}$)		Δ(Sales$_t$/FixAssets$_{t-1}$)		Employment Growth$_t$	
	(1)	(2)	(3)	(4)	(5)	(6)
MP^{US}_{t-1}	-0.224^b	-0.209^a	-2.384^a	-2.119^a	-0.019	-0.058
	(0.098)	(0.067)	(0.633)	(0.532)	(0.084)	(0.046)
$MP^{US}_{t-1}\times$US Peg$_{t-1}$	-0.040	-0.022	-0.308	-0.348	-0.022	-0.010
	(0.081)	(0.047)	(0.659)	(0.423)	(0.065)	(0.046)
$MP^{US}_{t-1}\times$Non-US Peg$_{t-1}$	0.127^a	0.117^a	0.004	0.194	0.004	0.018
	(0.036)	(0.026)	(0.651)	(0.463)	(0.026)	(0.024)
$MP^{US}_{t-1}\times$US Base$_{t-1}$	0.072	0.057	0.957^c	0.796^b	-0.043^c	-0.031
	(0.047)	(0.034)	(0.529)	(0.375)	(0.024)	(0.025)
$MP^{US}_{t-1}\times$ FinOpen$_{t-1}$	0.008	-0.001	0.604^c	0.350	0.099	0.101^c
	(0.067)	(0.044)	(0.312)	(0.241)	(0.074)	(0.054)
$MP^{US}_{t-1}\times$ TrOpen$_{t-1}$	-0.018	-0.003	-0.131	-0.023	-0.078^a	-0.030^b
	(0.051)	(0.010)	(0.391)	(0.092)	(0.027)	(0.012)
US Peg$_{t-1}$	-0.026^c	-0.024^b	-0.158	-0.164^c	0.005	0.008
	(0.013)	(0.012)	(0.095)	(0.080)	(0.017)	(0.016)
Non-US Peg$_{t-1}$	0.041	0.009	1.381^a	0.428^b	-0.018	0.003
	(0.024)	(0.008)	(0.228)	(0.163)	(0.022)	(0.010)
FinOpen$_{t-1}$	0.098^a	0.080^a	1.065^a	0.920^a	0.100^a	0.093^a
	(0.033)	(0.025)	(0.272)	(0.221)	(0.030)	(0.025)
TrOpen$_{t-1}$	0.003	0.016	-0.082	0.038	0.012	-0.021
	(0.022)	(0.010)	(0.188)	(0.127)	(0.033)	(0.012)
Observations	340,441	439,481	340,273	439,134	238,168	293,312
R^2	0.059	0.056	0.107	0.104	0.180	0.173
Sample	Core	Full	Core	Full	Core	Full
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes

Notes: This table presents firm-level panel regression results based on the estimation of regression (1) along with interactions of the shock with country-level measures of trade openness ('TrOpen'), financial openness ('FinOpen'), base-country exchange rate regime variables ('US Peg' and 'Non-US Peg') and U.S. base-country dummy ('US Base'). Regressions are run for the change in the investment-to-fixed capital ratio, sales-to-fixed capital ratio, and employment growth. The sample uses firms with at least five years of observations over 1995-2019. All regressors are lagged one period, where MP^{US} is the monetary policy shock from Bu et al. (2021). We include lagged firm and macroeconomic variables as in the baseline estimation in Table 1 and fixed effects at various levels of disaggregation. Standard errors are double clustered at the firm and year level, where ^{a} indicates significance at the 1% level, ^{b} at the 5% level, and ^{c} at the 10% level.

Table A10. Effect of U.S. Monetary Policy Shocks on Firms' Sales and Employment: The Importance of Trade Integration, Non-Time-Varying FE Estimates

	Panel A. $\Delta(\text{Sales}_t/\text{FixAssets}_{t-1})$							
	Global Trade				*U.S. Trade*			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
MP^{US}_{t-1}	-1.297^a	-1.302^a	-1.297^a	-1.300^a	-1.300^a	-1.303^a	-1.298^a	-1.298^a
	(0.400)	(0.402)	(0.400)	(0.400)	(0.401)	(0.402)	(0.401)	(0.399)
$MP^{US}_{t-1} \times \left(\frac{\text{TotExp}}{\text{Output}}\right)_{t-1}$	-0.025				0.870			
	(0.317)				(0.879)			
$MP^{US}_{t-1} \times \left(\frac{\text{FinExp}}{\text{Output}}\right)_{t-1}$		-0.500				-1.706		
		(0.379)				(1.293)		
$MP^{US}_{t-1} \times \left(\frac{\text{IntExp}}{\text{Output}}\right)_{t-1}$			0.126				3.608^b	
			(0.459)				(1.633)	
$MP^{US}_{t-1} \times$ WtOutdeg$_{t-1}$				-0.078				3.433
				(0.054)				(2.035)
Observations	374,179	374,179	374,179	374,179	374,179	374,179	374,179	374,179
R^2	0.106	0.106	0.106	0.106	0.106	0.106	0.106	0.106
	Panel B. Employment Growth$_t$							
	Global Trade				*U.S. Trade*			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
MP^{US}_{t-1}	-0.030	-0.030	-0.029	-0.029	-0.029	-0.030	-0.029	-0.029
	(0.027)	(0.027)	(0.027)	(0.027)	(0.027)	(0.027)	(0.027)	(0.027)
$MP^{US}_{t-1} \times \left(\frac{\text{TotExp}}{\text{Output}}\right)_{t-1}$	-0.011				0.097			
	(0.030)				(0.132)			
$MP^{US}_{t-1} \times \left(\frac{\text{FinExp}}{\text{Output}}\right)_{t-1}$		-0.048				0.092		
		(0.052)				(0.211)		
$MP^{US}_{t-1} \times \left(\frac{\text{IntExp}}{\text{Output}}\right)_{t-1}$			0.002				0.180	
			(0.047)				(0.208)	
$MP^{US}_{t-1} \times$ WtOutdeg$_{t-1}$				0.004				0.380
				(0.010)				(0.423)
Observations	254,414	254,414	254,414	254,414	254,414	254,414	254,414	254,414
R^2	0.176	0.176	0.176	0.176	0.176	0.176	0.176	0.176
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: This table presents firm-level panel regression results based on the estimation of regression (2) for the change in the sales-to-fixed capital ratio and employment growth, where we interact different measures of country-sectors' trade integration with the monetary policy shock. Columns (1)-(4) use trade measures based on country-sector exports with the world, while columns (5)-(8) use U.S.-only exports data. The country-sector's trade measure include the (i) total exports-to-output ratio ('TotExp/Output'), (ii) final goods exports-to-output ratio ('FinExp/Output'), (iii) intermediate goods exports-to-output ratio ('IntExp/Output'), (iv) the weighted outdegree ('WtOutdeg'). The sample uses firms with at least five years of observations over 1995-2019. All regressors are lagged one period, where MP^{US} is the monetary policy shock from Bu et al. (2021), 'Size' is the within country-year measure of a firm's size based on the log of total assets, and 'Net Worth' is the within country-year measure of a firm's net worth based on the log of net worth (assets minus liabilities). We include lagged firm and macroeconomic variables as in the baseline estimation in Table 1, and fixed effects at various levels of disaggregation. Standard errors are double clustered at the firm and year level, where ^{a} indicates significance at the 1% level, ^{b} at the 5% level, and ^{c} at the 10% level.

Table A11. Effect of U.S. Monetary Policy Shocks on Firms' Sales and Employment: The Importance of Trade Integration, Time-Varying FE Estimates

	Panel A. $\Delta(\text{Sales}_t/\text{FixAssets}_{t-1})$							
	Global Trade				*U.S. Trade*			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$MP^{US}_{t-1} \times \left(\frac{\text{TotExp}}{\text{Output}}\right)_{t-1}$	-0.209				0.293			
	(0.334)				(0.981)			
$MP^{US}_{t-1} \times \left(\frac{\text{FinExp}}{\text{Output}}\right)_{t-1}$		-0.502				-1.660		
		(0.400)				(1.279)		
$MP^{US}_{t-1} \times \left(\frac{\text{IntExp}}{\text{Output}}\right)_{t-1}$			-0.230				1.416	
			(0.489)				(1.415)	
$MP^{US}_{t-1} \times$ WtOutdeg$_{t-1}$				-0.115^c				0.287
				(0.058)				(1.823)
Observations	374,178	374,178	374,178	374,178	374,178	374,178	374,178	374,178
R^2	0.118	0.118	0.118	0.118	0.118	0.118	0.118	0.118
	Panel B. Employment Growth$_t$							
	Global Trade				*U.S. Trade*			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$MP^{US}_{t-1} \times \left(\frac{\text{TotExp}}{\text{Output}}\right)_{t-1}$	-0.036				-0.071			
	(0.029)				(0.132)			
$MP^{US}_{t-1} \times \left(\frac{\text{FinExp}}{\text{Output}}\right)_{t-1}$		-0.072				0.008		
		(0.053)				(0.212)		
$MP^{US}_{t-1} \times \left(\frac{\text{IntExp}}{\text{Output}}\right)_{t-1}$			-0.032				-0.164	
			(0.050)				(0.303)	
$MP^{US}_{t-1} \times$ WtOutdeg$_{t-1}$				-0.002				-0.028
				(0.010)				(0.505)
Observations	254,412	254,412	254,412	254,412	254,412	254,412	254,412	254,412
R^2	0.200	0.200	0.200	0.200	0.200	0.200	0.200	0.200
Country×year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: This table presents firm-level panel regression results based on the estimation of regression (2), with time-varying fixed effects, for the change in the sales-to-fixed capital ratio and employment growth, where we interact different measures of country-sectors' trade integration with the monetary policy shock. Columns (1)-(4) use trade measures based on country-sector exports with the world, while columns (5)-(8) use U.S.-only exports data. The country-sector's trade measure include the (i) total exports-to-output ratio ('TotExp/Output'), (ii) final goods exports-to-output ratio ('FinExp/Output'), (iii) intermediate goods exports-to-output ratio ('IntExp/Output'), and (iv) weighted outdegree ('WtOutdeg'). The sample uses firms with at least five years of observations over 1995-2019. All regressors are lagged one period, where MP^{US} is the monetary policy shock from Bu et al. (2021), 'Size' is the within country-year measure of a firm's size based on the log of total assets, and 'Net Worth' is the within country-year measure of a firm's net worth based on the log of net worth (assets minus liabilities). We include lagged firm and macroeconomic variables as in the baseline estimation in Table 1, and fixed effects at various levels of disaggregation. Standard errors are double clustered at the firm and year level, where ^{a} indicates significance at the 1% level, ^{b} at the 5% level, and ^{c} at the 10% level.

Table A12. Summary Statistics for Normalized Sector-Level Trade Measures across Firms

	Obs.	Mean	St. Dev.	p10	p25	p50	p75	p90
TotExp/Output	438,300	0.000	0.223	-0.239	-0.131	-0.055	0.177	0.309
FinExp/Output	438,300	0.000	0.102	-0.086	-0.056	-0.034	0.032	0.136
IntExp/Output	438,300	0.000	0.169	-0.182	-0.086	-0.034	0.094	0.267
WtOutdeg	438,300	0.000	0.720	-0.678	-0.299	-0.096	0.211	0.455
TotExp/Output, U.S.	438,300	0.000	0.060	-0.035	-0.022	-0.009	0.024	0.053
FinExp/Output, U.S.	438,300	0.000	0.036	-0.021	-0.014	-0.008	0.003	0.029
IntExp/Output, U.S.	438,300	0.000	0.043	-0.019	-0.011	-0.004	0.010	0.027
WtOutdeg, U.S.	438,300	0.000	0.020	-0.014	-0.006	-0.001	0.003	0.014

Notes: This table presents sector-level summary statistics on the normalized (i) total exports-to-output ratio ('TotExp/Output'), (ii) final goods exports-to-output ratio ('FinExp/Output'), (iii) intermediate goods exports-to-output ratio ('IntExp/Output'), and (iv) export weighted outdegree ('WtOutdeg') at the sector level for trade with the world and U.S. only. Each variable is normalized across firms within a country-year. Summary statistics are presented across all years.

Table A13. Effect of U.S. Monetary Policy Shocks on Firms' Sales and Employment: Firm-Level Heterogeneity

Panel A. $\Delta(\text{Sales}_t/\text{FixAssets}_{t-1})$

	Size			*Net Worth*		
	(1)	(2)	(3)	(4)	(5)	(6)
MP^{US}_{t-1}	-1.320[a]			-1.315[a]		
	(0.402)			(0.402)		
$MP^{US}_{t-1}\times\text{Size}_{t-1}$	0.089[b]	0.100[b]	0.114[b]			
	(0.035)	(0.041)	(0.049)			
$MP^{US}_{t-1}\times\text{Net Worth}_{t-1}$				0.096[a]	0.104[b]	0.109[b]
				(0.033)	(0.039)	(0.042)
Observations	374,179	374,178	373,060	374,179	374,178	373,060
R^2	0.106	0.118	0.149	0.106	0.118	0.149

Panel B. Employment Growth$_t$

	Size			*Net Worth*		
	(1)	(2)	(3)	(4)	(5)	(6)
MP^{US}_{t-1}	-0.024			-0.025		
	(0.028)			(0.028)		
$MP^{US}_{t-1}\times\text{Size}_{t-1}$	-0.015[b]	-0.010[c]	-0.009			
	(0.005)	(0.005)	(0.005)			
$MP^{US}_{t-1}\times\text{Net Worth}_{t-1}$				-0.014[b]	-0.009[c]	-0.008
				(0.006)	(0.005)	(0.005)
Observations	254,414	254,412	252,777	254,414	254,412	252,777
R^2	0.176	0.200	0.243	0.176	0.200	0.243
Country×year FE	No	Yes	No	No	Yes	No
Country×sector×year FE	No	No	Yes	No	No	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes

Notes: This table presents firm-level panel regression results based on the estimation of regression (3) for the change in the sales-to-fixed capital ratio and employment growth, where we interact firm characteristics with the monetary policy shock. The sample uses firms with at least five years of observations over 1995-2019. All regressors are lagged one period, where MP^{US} is the monetary policy shock from Bu et al. (2021), 'Size' is the within country-year measure of a firm's size based on the log of total assets, and 'Net Worth' is the within country-year measure of a firm's net worth based on the log of net worth (assets minus liabilities). We include lagged firm and macroeconomic variables as in the baseline estimation in Table 1, and fixed effects at various levels of disaggregation. Standard errors are double clustered at the firm and year level, where [a] indicates significance at the 1% level, [b] at the 5% level, and [c] at the 10% level.

Table A14. Effect of U.S. Monetary Policy Shocks on Firms' Investment: Firm-Level Heterogeneity Robustness

	$\Delta(\text{Investment}_t/\text{FixAssets}_{t-1})$					
		Size			*Net Worth*	
	(1)	(2)	(3)	(4)	(5)	(6)
MP^{US}_{t-1}	-0.165^a			-0.164^a		
	(0.055)			(0.055)		
$MP^{US}_{t-1}\times\text{Size}_{t-1}$	0.020^a	0.023^a	0.024^a			
	(0.005)	(0.006)	(0.006)			
$\Delta\ln(\text{NXR}_{t-1})\times\text{Size}_{t-1}$	0.003	0.011	0.008			
	(0.010)	(0.009)	(0.010)			
$\text{Appreciation}_{t-1}\times\text{Size}_{t-1}$	-0.001	-0.001	-0.002			
	(0.001)	(0.001)	(0.002)			
$\text{Depreciation}_{t-1}\times\text{Size}_{t-1}$	-0.003	-0.004^b	-0.003^c			
	(0.002)	(0.002)	(0.002)			
$\ln(\text{VIX}_{t-1})\times\text{Size}_{t-1}$	0.005	0.006^c	0.006^c			
	(0.003)	(0.003)	(0.003)			
$\Delta\text{IntRate}_{t-1}\times\text{Size}_{t-1}$	0.025	0.022	0.021			
	(0.049)	(0.048)	(0.046)			
$MP^{US}_{t-1}\times\text{Net Worth}_{t-1}$				0.019^a	0.020^a	0.021^a
				(0.006)	(0.006)	(0.005)
$\Delta\ln(\text{NXR}_{t-1})\times\text{Net Worth}_{t-1}$				0.003	0.005	0.003
				(0.009)	(0.008)	(0.008)
$\text{Appreciation}_{t-1}\times\text{Net Worth}_{t-1}$				-0.001	-0.001	-0.002
				(0.001)	(0.001)	(0.001)
$\text{Depreciation}_{t-1}\times\text{Net Worth}_{t-1}$				-0.003	-0.003	-0.003
				(0.002)	(0.002)	(0.002)
$\ln(\text{VIX}_{t-1})\times\text{Net Worth}_{t-1}$				0.004	0.005	0.004
				(0.004)	(0.003)	(0.003)
$\Delta\text{IntRate}_{t-1}\times\text{Net Worth}_{t-1}$				0.021	0.021	0.015
				(0.044)	(0.041)	(0.039)
Observations	374,360	374,359	373,241	374,360	374,359	373,241
R^2	0.058	0.069	0.096	0.058	0.069	0.096
Country×year FE	No	Yes	No	No	Yes	No
Country×sector×year FE	No	No	Yes	No	No	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes

Notes: This table presents firm-level panel regression results based on the estimation of regression (3) for the change in the investment-to-fixed capital ratio, where we interact firm characteristics with the monetary policy shock, VIX, nominal exchange rate change, appreciation/depreciation episodes, and change in the domestic interest rate. The sample uses firms with at least five years of observations over 1995-2019. All regressors are lagged one period, where MP^{US} is the monetary policy shock from Bu et al. (2021), 'Size' is the within country-year measure of a firm's size based on the log of total assets, and 'Net Worth' is the within country-year measure of a firm's net worth based on the log of net worth (assets minus liabilities). We include lagged firm and macroeconomic variables as in the baseline estimation in Table 1, and fixed effects at various levels of disaggregation. Standard errors are double clustered at the firm and year level, where ^{a} indicates significance at the 1% level, ^{b} at the 5% level, and ^{c} at the 10% level.

Table A15. Effect of U.S. Monetary Policy Shocks on Firms' Sales and Employment: Firm-Level Heterogeneity Robustness

	Panel A. $\Delta(\text{Sales}_t/\text{FixAssets}_{t-1})$						**Panel B.** Employment Growth$_t$					
	Size			*Net Worth*			*Size*			*Net Worth*		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
MP^{US}_{t-1}	-1.321^a			-1.321^a			-0.022			-0.023		
	(0.399)			(0.400)			(0.028)			(0.027)		
$MP^{US}_{t-1}\times\text{Size}_{t-1}$	0.033	0.041	0.067^c				-0.012^b	-0.007	-0.005			
	(0.028)	(0.032)	(0.038)				(0.005)	(0.006)	(0.006)			
$\Delta\ln(\text{NXR}_{t-1})\times\text{Size}_{t-1}$	-0.091	-0.036	-0.045				-0.022^b	-0.007	-0.0004			
	(0.102)	(0.092)	(0.091)				(0.008)	(0.007)	(0.008)			
$\text{Appreciation}_{t-1}\times\text{Size}_{t-1}$	-0.011	-0.010	-0.008				0.003^c	0.001	0.001			
	(0.018)	(0.018)	(0.019)				(0.001)	(0.001)	(0.002)			
$\text{Depreciation}_{t-1}\times\text{Size}_{t-1}$	-0.013	-0.013	-0.010				0.002	0.001	-0.001			
	(0.017)	(0.015)	(0.014)				(0.002)	(0.002)	(0.002)			
$\ln(\text{VIX}_{t-1})\times\text{Size}_{t-1}$	-0.016	-0.022	-0.012				0.006^c	0.004	0.005^c			
	(0.016)	(0.017)	(0.017)				(0.003)	(0.003)	(0.003)			
$\Delta\text{IntRate}_{t-1}\times\text{Size}_{t-1}$	0.855^a	0.938^a	0.863^b				0.010	-0.019	-0.012			
	(0.290)	(0.302)	(0.360)				(0.026)	(0.027)	(0.033)			
$MP^{US}_{t-1}\times\text{Net Worth}_{t-1}$				0.053^c	0.060^c	0.070^c				-0.011^b	-0.007	-0.004
				(0.028)	(0.032)	(0.035)				(0.005)	(0.006)	(0.006)
$\Delta\ln(\text{NXR}_{t-1})\times\text{Net Worth}_{t-1}$				-0.068	-0.047	-0.044				-0.025^a	-0.013^c	-0.008
				(0.084)	(0.081)	(0.074)				(0.009)	(0.007)	(0.008)
$\text{Appreciation}_{t-1}\times\text{Net Worth}_{t-1}$				-0.013	-0.013	-0.009				0.003^c	0.001	0.001
				(0.017)	(0.017)	(0.018)				(0.002)	(0.001)	(0.001)
$\text{Depreciation}_{t-1}\times\text{Net Worth}_{t-1}$				-0.010	-0.007	-0.006				0.003	0.001	0.0004
				(0.016)	(0.014)	(0.014)				(0.002)	(0.002)	(0.002)
$\ln(\text{VIX}_{t-1})\times\text{Net Worth}_{t-1}$				-0.016	-0.021	-0.021				0.007^b	0.005	0.005^c
				(0.015)	(0.016)	(0.017)				(0.003)	(0.003)	(0.003)
$\Delta\text{IntRate}_{t-1}\times\text{Net Worth}_{t-1}$				0.598^b	0.648^b	0.491				0.041	0.011	-0.0001
				(0.262)	(0.269)	(0.294)				(0.025)	(0.023)	(0.027)
Observations	374,179	374,178	373,060	374,179	374,178	373,060	254,414	254,412	252,777	254,414	254,412	252,777
R^2	0.106	0.118	0.149	0.106	0.118	0.149	0.177	0.200	0.243	0.177	0.200	0.243
Country×year FE	No	Yes	No	No	Yes	No	No	Yes	No	No	Yes	No
Country×sector×year FE	No	No	Yes	No	No	Yes	No	No	Yes	No	No	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: This table presents firm-level panel regression results based on the estimation of regression (3) for the change in the sales-to-fixed capital ratio and employment growth, where we interact firm characteristics with the monetary policy shock, VIX, nominal exchange rate change, appreciation/depreciation episodes, and change in the domestic interest rate. The sample uses firms with at least five years of observations over 1995-2019. All regressors are lagged one period, where MP^{US} is the monetary policy shock from Bu et al. (2021), 'Size' is the within country-year measure of a firm's size based on the log of total assets, and 'Net Worth' is the within country-year measure of a firm's net worth based on the log of net worth (assets minus liabilities). We include lagged firm and macroeconomic variables as in the baseline estimation in Table 1, and fixed effects at various levels of disaggregation. Standard errors are double clustered at the firm and year level, where ^{a} indicates significance at the 1% level, ^{b} at the 5% level, and ^{c} at the 10% level.

Table A16. Effect of U.S. Monetary Policy Shocks on Firms' Investment: The Importance of Net Worth and Trade Integration

	Global Trade				*U.S. Trade*			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$MP^{US}_{t-1} \times$ Net Worth$_{t-1}$	0.017^a	0.018^a	0.017^a	0.018^a	0.017^a	0.018^a	0.017^a	0.017^a
	(0.005)	(0.006)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
$MP^{US}_{t-1} \times \left(\frac{\text{TotExp}}{\text{Output}}\right)_{t-1}$	-0.106^b				-0.319^c			
	(0.040)				(0.158)			
$MP^{US}_{t-1} \times \left(\frac{\text{FinExp}}{\text{Output}}\right)_{t-1}$		0.013				0.057		
		(0.057)				(0.150)		
$MP^{US}_{t-1} \times \left(\frac{\text{IntExp}}{\text{Output}}\right)_{t-1}$			-0.192^b				-0.733^b	
			(0.071)				(0.336)	
$MP^{US}_{t-1} \times$ WtOutdeg$_{t-1}$				-0.029^b				-1.502^b
				(0.012)				(0.549)
Observations	374,359	374,359	374,359	374,359	374,359	374,359	374,359	374,359
R^2	0.0688	0.0687	0.0688	0.0688	0.0688	0.0687	0.0688	0.0688
Country×year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: This table presents firm-level panel regression results based on the estimation of regression (4) for the change in the investment-to-fixed capital ratio, where we interact firm net worth in addition to different measures country-sectors' trade integration with the monetary policy shock. Columns (1)-(4) use trade measures based on country-sector exports with the world, while columns (5)-(8) use U.S.-only exports data. The country-sector's trade measure include the (i) total exports-to-output ratio ('TotExp/Output'), (ii) final goods exports-to-output ratio ('FinExp/Output'), (iii) intermediate goods exports-to-output ratio ('IntExp/Output'), and (iv) weighted outdegree ('WtOutdeg'). The sample uses firms with at least five years of observations over 1995-2019. All regressors are lagged one period, where MP^{US} is the monetary policy shock from Bu et al. (2021) and 'Net Worth' is the within country-year measure of a firm's net worth based on the log of net worth (assets minus liabilities). We include lagged firm and macroeconomic variables as in the baseline estimation in Table 1, and fixed effects at various levels of disaggregation. Standard errors are double clustered at the firm and year level, where ^{a} indicates significance at the 1% level, ^{b} at the 5% level, and ^{c} at the 10% level.

Table A17. Effect of U.S. Monetary Policy Shocks on Firms' Sales and Employment: The Importance of Size and Trade Integration

	Panel A. $\Delta(\text{Sales}_t/\text{FixAssets}_{t-1})$							
	Global Trade				*U.S. Trade*			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$MP^{US}_{t-1} \times \text{Size}_{t-1}$	0.100^b	0.099^b	0.102^b	0.098^b	0.105^b	0.099^b	0.109^b	0.102^b
	(0.041)	(0.042)	(0.041)	(0.041)	(0.042)	(0.041)	(0.043)	(0.041)
$MP^{US}_{t-1} \times \left(\frac{\text{TotExp}}{\text{Output}}\right)_{t-1}$	-0.075				0.858			
	(0.325)				(0.972)			
$MP^{US}_{t-1} \times \left(\frac{\text{FinExp}}{\text{Output}}\right)_{t-1}$		-0.320				-1.191		
		(0.397)				(1.225)		
$MP^{US}_{t-1} \times \left(\frac{\text{IntExp}}{\text{Output}}\right)_{t-1}$			-0.063				2.224	
			(0.475)				(1.441)	
$MP^{US}_{t-1} \times \text{WtOutdeg}_{t-1}$				-0.096^c				1.317
				(0.053)				(1.673)
Observations	374,178	374,178	374,178	374,178	374,178	374,178	374,178	374,178
R^2	0.118	0.118	0.118	0.118	0.118	0.118	0.118	0.118
	Panel B. Employment Growth_t							
	Global Trade				*U.S. Trade*			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$MP^{US}_{t-1} \times \text{Size}_{t-1}$	-0.011^b	-0.010^b	-0.010^b	-0.010^b	-0.010^b	-0.010^b	-0.010^b	-0.010^b
	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
$MP^{US}_{t-1} \times \left(\frac{\text{TotExp}}{\text{Output}}\right)_{t-1}$	-0.047				-0.122			
	(0.028)				(0.124)			
$MP^{US}_{t-1} \times \left(\frac{\text{FinExp}}{\text{Output}}\right)_{t-1}$		-0.094^c				-0.059		
		(0.053)				(0.202)		
$MP^{US}_{t-1} \times \left(\frac{\text{IntExp}}{\text{Output}}\right)_{t-1}$			-0.045				-0.228	
			(0.049)				(0.297)	
$MP^{US}_{t-1} \times \text{WtOutdeg}_{t-1}$				-0.005				-0.117
				(0.010)				(0.490)
Observations	254,412	254,412	254,412	254,412	254,412	254,412	254,412	254,412
R^2	0.200	0.200	0.200	0.200	0.200	0.200	0.200	0.200
Country×year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: This table presents firm-level panel regression results based on the estimation of regression (4) for the change in the sales-to-fixed capital ratio and employment growth, where we interact firm size in addition to different measures country-sectors' trade integration with the monetary policy shock. Columns (1)-(4) use trade measures based on country-sector exports with the world, while columns (5)-(8) use U.S.-only exports data. The country-sector's trade measure include the (i) total exports-to-output ratio ('TotExp/Output'), (ii) final goods exports-to-output ratio ('FinExp/Output'), (iii) intermediate goods exports-to-output ratio ('IntExp/Output'), and (iv) weighted outdegree ('WtOutdeg'). The sample uses firms with at least five years of observations over 1995-2019. All regressors are lagged one period, where MP^{US} is the monetary policy shock from Bu et al. (2021) and 'Size' is the within country-year measure of a firm's size based on the log of total assets. We include lagged firm and macroeconomic variables as in the baseline estimation in Table 1, and fixed effects at various levels of disaggregation. Standard errors are double clustered at the firm and year level, where ^{a} indicates significance at the 1% level, ^{b} at the 5% level, and ^{c} at the 10% level.

Table A18. Effect of U.S. Monetary Policy Shocks on Firms' Sales and Employment: The Importance of Net Worth and Trade Integration

Panel A. $\Delta(\text{Sales}_t/\text{FixAssets}_{t-1})$

	Global Trade				*U.S. Trade*			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$MP^{US}_{t-1}\times$Net Worth$_{t-1}$	0.104^b	0.103^b	0.105^b	0.103^b	0.107^b	0.103^b	0.110^b	0.105^b
	(0.039)	(0.039)	(0.039)	(0.039)	(0.039)	(0.039)	(0.040)	(0.039)
$MP^{US}_{t-1}\times\left(\frac{\text{TotExp}}{\text{Output}}\right)_{t-1}$	-0.122				0.714			
	(0.330)				(0.972)			
$MP^{US}_{t-1}\times\left(\frac{\text{FinExp}}{\text{Output}}\right)_{t-1}$		-0.366				-1.269		
		(0.399)				(1.233)		
$MP^{US}_{t-1}\times\left(\frac{\text{IntExp}}{\text{Output}}\right)_{t-1}$			-0.129				1.983	
			(0.483)				(1.424)	
$MP^{US}_{t-1}\times$ WtOutdeg$_{t-1}$				-0.105^c				0.975
				(0.056)				(1.742)
Observations	374,178	374,178	374,178	374,178	374,178	374,178	374,178	374,178
R^2	0.118	0.118	0.118	0.118	0.118	0.118	0.118	0.118

Panel B. Employment Growth$_t$

	Global Trade				*U.S. Trade*			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$MP^{US}_{t-1}\times$Net Worth$_{t-1}$	-0.010^c	-0.010^c	-0.010^c	-0.009^c	-0.010^c	-0.009^c	-0.010^c	-0.009^c
	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
$MP^{US}_{t-1}\times\left(\frac{\text{TotExp}}{\text{Output}}\right)_{t-1}$	-0.041				-0.101			
	(0.029)				(0.127)			
$MP^{US}_{t-1}\times\left(\frac{\text{FinExp}}{\text{Output}}\right)_{t-1}$		-0.086				-0.037		
		(0.053)				(0.205)		
$MP^{US}_{t-1}\times\left(\frac{\text{IntExp}}{\text{Output}}\right)_{t-1}$			-0.037				-0.196	
			(0.049)				(0.300)	
$MP^{US}_{t-1}\times$ WtOutdeg$_{t-1}$				-0.004				-0.074
				(0.010)				(0.498)
Observations	254,412	254,412	254,412	254,412	254,412	254,412	254,412	254,412
R^2	0.200	0.200	0.200	0.200	0.200	0.200	0.200	0.200
Country×year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: This table presents firm-level panel regression results based on the estimation of regression (4) for the change in the sales-to-fixed capital ratio and employment growth, where we interact firm net worth in addition to different measures country-sectors' trade integration with the monetary policy shock. Columns (1)-(4) use trade measures based on country-sector exports with the world, while columns (5)-(8) use U.S.-only exports data. The country-sector's trade measure include the (i) total exports-to-output ratio ('TotExp/Output'), (ii) final goods exports-to-output ratio ('FinExp/Output'), (iii) intermediate goods exports-to-output ratio ('IntExp/Output'), and (iv) weighted outdegree ('WtOutdeg'). The sample uses firms with at least five years of observations over 1995-2019. All regressors are lagged one period, where MP^{US} is the monetary policy shock from Bu et al. (2021) and 'Net Worth' is the within country-year measure of a firm's net worth based on the log of net worth (assets minus liabilities). We include lagged firm and macroeconomic variables as in the baseline estimation in Table 1, and fixed effects at various levels of disaggregation. Standard errors are double clustered at the firm and year level, where ^{a} indicates significance at the 1% level, ^{b} at the 5% level, and ^{c} at the 10% level.