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Abstract

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JEL Classification: E52, G32

Keywords: monetary policy transmission, Supply Chain, aggregate demand, cost channel

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Bottleneck effects of monetary policy*

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Abstract

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1 Introduction

Textbook economics argues that changes in monetary policy affect the cost of borrowing for investment, thereby altering aggregate demand (e.g. Mishkin, 1996). Besides this "interest rate" or "demand" channel of conventional monetary policy transmission, a strand of the literature contends that monetary policy actions can also exert an influence on economic activity through aggregate supply. As firms must pay their factors of production before they receive revenues from sales —and must borrow to finance these payments, changes in the monetary policy rate may affect the marginal costs of production. This so-called "cost" channel of transmission is discussed for example in Christiano et al. (1997) and Barth and Ramey (2001). Empirical testing for the demand channel typically analyzes firms' responses in terms of quantities demanded (Kashyap et al., 1993; Gertler and Gilchrist, 1994), whereas tests for the cost channel focus on the price responses by firms to changes in monetary conditions (Gaiotti and Secchi, 2006). The identification strategy usually rests on the "financial accelerator" theory (Bernanke and Gertler, 1989), and consists in testing whether financially weak firms respond more to changes in monetary conditions than healthy firms.

This paper studies how conventional monetary policy transmits through both the demand and supply of intermediate goods, and more generally the role of input–output linkages as a channel for the propagation of monetary policy shocks. Firms indeed produce customized goods and rely on a variety of different and specific inputs for production. If a firm cannot substitute its financially constrained business partners easily in the face of an adverse monetary policy shock, then the fall in supply and demand may create bottlenecks and induce the firm to cut back its own activities. We refer to these specific changes in the level of activities of the "middle firms" as the "bottleneck effects" of monetary policy. By shifting firms' individual supply and demand curves in the same direction, such effects may amplify the variations in aggregate output and dampen those in prices.

To study the bottleneck effects of monetary policy, we exploit detailed information on existing firm supply chains and inter–sectoral input–output linkages. More particularly, we study the demand channel by analyzing how firms' sales react to changes in monetary conditions as a function of their *clients'* financial health, and we study the cost channel by analyzing the reaction of firms' purchases to changes in monetary conditions as a function of their *suppliers'* financial health. What is new in our approach is that we allow for the financial accelerator to work through the balance sheets of the firms' clients and suppliers, as well as through the firms themselves. Thus, we identify the demand and cost channels through their effects on downstream firms' demand (which should affect the sales of the studied firms "in the middle") and on upstream firms' supply (which should ultimately be reflected in purchases of the studied firms "in the middle").

In most of our analysis, we use firm-level data from Compustat, and rely on the input-output matrices provided by the Bureau of Economic Analysis to calculate the weighted averages of the financial health in the downstream and upstream sectors buying from or selling to the firm. We then relate the interaction of monetary conditions and downstream (upstream) firms' financial health with firm sales (purchases). Identification of the demand channel is based on the assumption that the average financial conditions in the downstream industries are largely exogenous to an individual firms' ability to supply the product. Similarly, identification of the cost channel relies on the assumption that the average financial conditions in the upstream industries are largely exogenous to an individual firm's demand for inputs. In both cases, we also control for the variation in the firm's own supply and demand induced by changes in monetary conditions by interacting the latter with the firm's own financial conditions. Our results are robust to using different measures of monetary conditions (including monetary policy surprises), and to different measures of firm financial health.

To validate our identification strategy, we use data from actually existing business rela-

tionships that are observable to us. This data allows us to measure the financial health of the firms' business partners with precision and to observe the studied firms' sales to their actual clients. With this data we identify bottleneck effects by introducing firm $\times$ time fixed effects to control for all firm-level, observed and unobserved time-varying factors that could affect firms' operations, and by exploiting the heterogeneity across client or supplier financial health. The key identifying assumption in this approach is that changes in monetary conditions affect the firms' sales (purchases) uniformly across clients (suppliers) (Khwaja and Mian, 2008).

Our analysis uncovers three main findings. First, the balance sheet structure of downstream and upstream firms is a salient, yet mostly overlooked, element in the transmission of monetary policy. In particular, our estimates show that firm sales fall with a tightening of monetary conditions when downstream clients have weak balance sheets, and that inputs purchased fall with a tightening of monetary conditions when suppliers have weak balance sheets. To benchmark these estimates economically, we calculate the impact of a yearly increase of 100 basis points in the monetary reference rate. Such an increase leads to a 11.2% reduction in the sales growth rate of firms with clients that have a one standard deviation lower financial health. Similarly, it leads to a 10.7% lower growth of input purchases of firms with suppliers having a one standard deviation lower financial health. These results suggest that the demand and cost channels operate through the weakest links within the supply chain, and have a sizable and comparable immediate impact on the studied firms' operations.

Second, our results show that changes in monetary conditions have a quantitatively larger impact on firms' operations through the changes in demand and supply induced by downstream and upstream firms' financial health, than through the firms' own balance sheets. A yearly increase of 100 basis points in the monetary reference rate leads to approximately 4.5% lower sales and purchase growth rate of firms with a one standard deviation lower financial health. This result suggests that the firm's own balance sheet is less important as a monetary

transmission channel than the demand and cost channels of transmission, and is consistent with Acemoglu et al. (2016), who show that the propagation of shocks through the supply chain is quantitatively larger than the direct effects of these shocks.

Third, dynamic estimations using local projections show that the demand channel of transmission is milder and peaks around four quarters after the initial shock, but subsequently reverts to zero after nine quarters. In contrast, the cost channel of monetary policy transmission has an increasingly stronger effect on firms' activities that stabilizes around nine quarters after the initial shock. The cost channel also leads to more protracted reductions in downstream firms' economic activities. These results suggest that the cost channel and the associated supply chain bottleneck effect are overall a more potent mechanism than the demand channel for the propagation of monetary policy.

In extensions to our analysis, we find that the documented bottleneck effects of monetary policy are not undone within the supply chain, for example through the provision of trade credit; if anything, they are instead amplified through trade credit. Firms provide lower amounts of trade credit to financially weak clients following a monetary tightening. This result is akin to the "flight-to-quality" effect observed in the lending decisions of banks to firms, where banks are reluctant to lend to firms with weak balance sheets (Bernanke et al., 1996). Firms also receive less trade credit from their weak suppliers, meaning that weak upstream firms propagate the effects of a monetary tightening by reducing their liquidity provision.

Overall, our results suggest that bottlenecks in the supply chains, which prevent firms from swiftly switching to less constrained business partners, may magnify the effects of monetary tightening. These results are particularly relevant as the world emerges from the Covid-19 shock with higher overall levels of corporate leverage and significant supply chain disruptions.

Related literature. Ours is one among very few studies that analyze the specific transmission of monetary policy through supply chains. It bridges a gap between two strands of

the literature on the aggregate propagation of shocks. The first consists of the papers that emphasize the role of input–output linkages as a mechanism for propagation and amplification of shocks (e.g. Acemoglu et al., 2012, 2016). Boissay and Gropp (2013), Jacobson and Von Schedvin (2015) and Demir et al. (2022) show that upstream liquidity shocks are transmitted to customers. Caliendo et al. (2017) study the role of inter–sectoral and inter–regional trade linkages in propagating disaggregated productivity changes across US states. Barrot and Sauvagnat (2016) and Carvalho et al. (2021) focus on natural disasters to study whether firm–level shocks propagate or whether they are absorbed in production networks. Carvalho et al. (2021), in particular, provides evidence for the propagation of the 2011 Japan earthquake shock both upstream and downstream along the supply chain. In a similar way, Crosignani et al. (2020) document the propagation of a cyberattack through supply chains. Our findings suggest that such propagation mechanisms also operate for, and contribute to amplifying the effects of, monetary policy shocks. Consistent with our results, Ozdagli and Weber (2017) show that a large fraction of industry stock price reactions to changes in monetary policy can be attributed to changes in demand from downstream firms. Our contribution is to show that monetary policy can also have real effects transmitted through both downstream and upstream firms, and to uncover an instrumental role of these firms' financial health in this transmission.

Our paper also complements the literature on the transmission channels of monetary policy. Prior academic and policy research has primarily focused on how monetary policy is transmitted from financial intermediaries to firms (Bernanke and Blinder, 1988; Bernanke and Gertler, 1995; Stein, 1998; Kashyap and Stein, 2000; Van den Heuvel, 2002; Bolton and Freixas, 2006; Jiménez et al., 2012) and how changes in monetary policy affect demand by end consumers (Calza et al., 2013; Di Maggio et al., 2017).

Our findings also relate to the recent literature documenting a key role of leverage in the transmission of shocks (Mian and Sufi, 2010; Korinek and Simsek, 2016; Mian and Sufi, 2014;

Giroud and Mueller, 2017). What is new here is that we link firms and then compare the leverage effect incoming from downstream firms through a demand effect with the leverage effect at the upstream firms through a supply effect, to find that these two effects can be compounded. Our results therefore have important policy implications as they show that monetary policy can have differential effects on industrial sectors depending on the degree of leverage of firms within the supply chain.

2 Data and methodology

The main source of data for our analysis consists of quarterly balance sheet information for all non-financial, non-government, publicly traded firms in the US during the period 1990 Q1 to 2016 Q4, obtained from Compustat. Our empirical analysis rests on measures of the average financial weakness of a given firm's clients and suppliers. To derive these measures, we proceed in two stages. First, we calculate the weakness of each industrial sector at the 4-digit SIC code as the average across this sector's firms. Second, we use the weighted average of the financial weakness of the sectors buying from (selling to) each firm as a proxy for clients' (suppliers') balance sheet weakness. As weights, we use the fraction of this firm's sales to (or purchases from) each sector from the input-output matrices provided by the Bureau of Economic Analysis. Following the literature in this field (e.g. Bernanke and Gertler, 1995), we use the inverse of the coverage ratio, i.e. the ratio of interest expenses to earnings before interest and taxes, as our main measure of financial weakness. In extensions of our analysis we use the debt to assets ratio as an alternative measure. The resulting measures of client and supplier financial weakness are admittedly rough proxies for the health of the *actual* clients and suppliers of the firm; however, the advantage of this approach is that we can obtain proxies of the upstream and downstream financial weakness for every firm in our sample.

To investigate whether the financial weakness of downstream and upstream firms affects the transmission of monetary conditions, we estimate regressions of the following general

form:

$$\Delta \ln \text{sales}_{i,t} = \beta_c \Delta r_{t-1} x^c_{i,t-1} + \beta_f \Delta r_{t-1} x^f_{i,t-1} + \Gamma'_c X^c_{i,t-1} + \Gamma'_f X^f_{i,t-1} + \mu_t + \eta_{s(i)} + \psi_{q(i)} + \epsilon_{it} \quad (1)$$

$$\Delta \ln \text{purch}_{i,t} = \beta_s \Delta r_{t-1} x^s_{i,t-1} + \beta_f \Delta r_{t-1} x^f_{i,t-1} + \Gamma'_s X^s_{i,t-1} + \Gamma'_f X^f_{i,t-1} + \mu_t + \eta_{s(i)} + \psi_{q(i)} + \epsilon_{it} \quad (2)$$

Equation 1 examines the bottleneck effects of monetary conditions through the aggregate demand channel. The dependent variable is the quarterly change in the natural logarithm of firm i's total sales, i.e. $\Delta \ln \text{sales}_{i,t} = \ln \text{sales}_{i,t} - \ln \text{sales}_{i,t-1}$. The focus of the demand channel is on the interaction coefficient of monetary conditions with the financial health of the firm's clients, β_c. x^c_{it} is a measure of the average weakness of the balance sheets in the downstream industries buying from firm i, and Δr_t is our measure of monetary conditions. X^c_{it-1} is a vector containing client controls (average client industry sales growth, size, debt, Tobin's Q, property, plant and equipment ratio). Similarly, x^f_{it} is a measure of the average weakness of firm i's balance sheet, and X^f_{it-1} is a vector containing firm-level controls (industry sales growth, size, debt, Tobin's Q, property, plant and equipment ratio, firm financial health). We always include time fixed effects, μ_t, to control for changes in economic activity that are common to all firms in a given period; industry sector fixed effects, $\eta_{s(i)}$, to control for time-invariant industry characteristics, and firm fiscal-year end quarter to account for seasonality and accounting period adjustments, $\psi_{q(i)}$. In our most saturated specifications we substitute the industry sector fixed effects $\eta_{s(i)}$ with firm fixed effects η_i to control for all time-invariant firm characteristics.

Equation 2 analyzes the cost channel. The dependent variable is the quarterly change in the natural logarithm of firm i's total purchases, i.e. $\Delta \ln \text{purch}_{i,t} = \ln \text{purch}_{i,t} - \ln \text{purch}_{i,t-1}$. For the cost channel the main focus is on the interaction of monetary conditions with the financial health of the firm's suppliers, β_s. x^s_{it} is a measure of the average weakness of the balance sheets in the upstream industries selling inputs to firm i, and X^s_{it-1} is a vector average supplier controls including industry sales growth, size, debt, Tobin's Q, and property,

plant and equipment. As before, X^f_{it-1} is a vector containing firm-level controls (industry sales growth, size, debt, Tobin's Q, and property, plant and equipment ratio, firm financial health). The fixed effects are the same as in Equation 1. In both equations, we cluster the standard errors at the firm level.

Tests for the demand and cost channels focus on the coefficients of the interaction terms, β_c and β_s, respectively. If there are bottleneck effects of monetary conditions through the aggregate demand channel, then a tightening of monetary policy should affect the demand for the firm's products more when dealing with financially weaker clients, $\beta_c < 0$. Similarly, bottleneck effects of monetary conditions through the cost channel should imply that a tightening of monetary policy affects the amount of inputs purchased by firms buying from financially weaker firms more than for firms buying from stronger firms, or $\beta_s < 0$.

As a measure of the stance of monetary policy, we use the quarterly differences in the federal funds rate, $\Delta r_t = \Delta \text{FF}$. We obtain this data from the economic data repository of the Federal Reserve Bank of St. Louis (FRED). Our estimated coefficients of interest are those on the interactions of these changes in monetary conditions with client or supplier financial health, which are plausibly exogenous to the firms' economic decisions. Admittedly, however, the changes in the fed funds rate could be correlated with the firms' sales and purchases due to unobserved changes in economic activity. To account for this potential impact, in extensions to our main analysis we use a series of surprise changes in the federal funds rate target from Gürkaynak et al. (2005) as an alternative measure of the stance of monetary policy.[1] For additional robustness, we also use changes in the 2-year Treasury bond rate.

Table 1 contains summary statistics for the main variables used in our analysis. Table A1 in the Appendix provides variable definitions. Panel A shows that firms in our sample have the same average quarterly growth rates for sales and purchases (1%), with a large

[1]Monetary policy surprises are used to account for unexpected changes in monetary conditions. The methodology to obtain these monetary surprises is detailed in Gürkaynak (2005). We thank Refet Gürkaynak for sharing the series of surprises updated until year 2017.

variation. Panel A also shows that firms have slightly better financial health than their suppliers and clients (lower debt and coverage ratios, higher industry sales growth), but clients and suppliers are on average larger. Firms, clients and suppliers have similar average values for Tobin's Q and PPE ratios. All variables have been winsorized at the 1 and 99% levels to minimize the influence of outliers in the estimations.

Panel B contains a description of the monetary policy variables used in our analysis. Our main policy rate, the fed funds rate, has an average value of 2.97% throughout our sample period. This variable has a lot of variation, with values that peak at levels above 8% at the beginning of our sample period, and a long period of very low interest rates starting in 2009 and lasting until the end of our sample period. The average (median) quarterly difference in the monetary policy rate equals -10 (-0.6) basis points (bps), also with large variation across the quarters. The monetary surprises, i.e., the unexpected component of the difference in the quarterly rates, are highly correlated with the changes in the fed funds rate, with a correlation coefficient of 0.79. However, they have a lower sample variation, and their average (median) quarterly value corresponds to of -4 (-1.6) bps.

3 Results

3.1 Baseline results

We start by exploring whether there are bottleneck effects of monetary conditions through the demand channel. Table 2 contains the results of estimating several versions of Equation 1 on the firm-level sample using the inverse coverage ratio as an inverse measure of client financial health. The table shows that monetary conditions can amplify the negative effect of client financial weakness on firm sales: The interaction between average client financial weakness and the monetary policy is negative and statistically significant at the 99 percent confidence level. The coefficients are also economically meaningful. For example, the coefficient in column 4 implies that a 0.25pp increase in the monetary policy rate leads to -0.12pp lower

growth in sales for firms selling to financially weaker clients that have a one standard deviation larger inverse coverage ratio (= -0.029 × 0.172 × 25). This is economically relevant, and corresponds to 11.2% of firms' average quarterly growth rate of sales in our sample (1.1%). In contrast, firms' own balance sheet weakness has a smaller impact on monetary policy transmission. The coefficient for the interaction term with the firm's own financial weakness in column 4 (-0.002) implies that a 0.25pp interest rate hike in a quarter leads to a 0.05pp reduction in the growth rate of sales for firms whose inverse coverage ratio is one standard deviation higher. We obtain very similar results when we repeat the estimations using the clients' debt to assets ratio as an alternative measure of client financial weakness (Table A2 in the Appendix). In addition, Table A3 in the Appendix shows that the demand channel of monetary policy transmission is confirmed if we follow an alternative estimation method that accounts for contemporary changes in the monetary policy rate and four of its lags (as in Kashyap, 1995; Gomez et al., 2021).

We next estimate Equation 2 on our sample to explore the cost channel of transmission of monetary policy. Estimated coefficients are contained in Table 3. Results show that monetary conditions can also amplify the negative effect of supplier financial weakness on firm purchases: The interaction between average supplier financial weakness and the monetary policy is negative and statistically significant at the 99 percent confidence level in all specifications. The coefficient in column 4 implies that a 0.25pp increase in the quarterly monetary policy rate leads to a -0.11pp difference in growth in purchases for firms buying from suppliers with a one standard deviation higher inverse coverage ratio (= -0.035 × 0.130 × 25). The cost channel therefore accounts for 10.7% of the quarterly growth in purchases. Firms' own balance sheet has a much smaller impact on firm purchases, accounting only for 4.6% of their average growth rate. Table A4 repeats these baseline estimations using the suppliers' debt to assets ratio as an alternative measure of supplier financial weakness, yielding very similar results. As before, we also estimate alternative specifications for the cost channel, accounting

for the contemporary and four lags of the changes in the monetary policy rate, and results for the cost channel of transmission are confirmed (Table A4 in the Appendix).

3.2 Dynamics

We next estimate the dynamics of the demand and cost channels of monetary policy using local projections Jordà (2005). For this purpose we modify Equations 1 and 2 as follows:

$$\begin{aligned}\Delta y_{i,t+h} =& \beta_c^h \Delta r_{t-1} x_{i,t-1}^c + \beta_s^h \Delta r_{t-1} x_{i,t-1}^s + \beta_f^h \Delta r_{t-1} x_{i,t-1}^f \\ &+ \Gamma_c^{h\prime} X_{i,t-1}^c + \Gamma_s^{h\prime} X_{i,t-1}^s + \Gamma_f^{h\prime} X_{i,t-1}^f + \mu_t^h + \eta_{s(i)}^h + \psi_{q(i)}^h + \epsilon_{it}^h\end{aligned} \tag{3}$$

For the demand channel estimations, the dependent variable is the h-quarter difference in the natural logarithm of firm i's total sales for $h \in \{0, 1, ..12\}$, i.e. $\Delta y_{i,t+h} = \ln \text{sales}_{i,t+h} - \ln \text{sales}_{i,t-1}$. For the cost channel, $\Delta y_{i,t+h} = \ln \text{purch}_{i,t+h} - \ln \text{purch}_{i,t-1}$. Coefficients β_c^h, β_s^h and β_f^h respectively measure how the cumulative response of sales or purchases to a monetary policy shock in quarter t depends on the financial weakness of clients, suppliers and the firm itself, h quarters after the shock. As before, our main coefficients of interest will be β_c^h when the dependent variable is the cumulative increase in sales (demand channel), and on β_s^h for purchases (cost channel).

Figure 1 illustrates the dynamics of the demand and cost channels of transmission, estimated using the same specifications as in column 4 of Tables 2 and 3, respectively. For the demand channel, Panel A shows that the differences in responses to monetary policy for firms with weak clients peak around four quarters following the changes in the monetary rate, but revert towards zero until they become statistically indistinguishable from zero around the ninth quarter. Panel B illustrates that the peak of the differential response of firms with weak suppliers to changes in monetary policy occurs in the fifth quarter, and it is much larger than the initial effect at $h = 0$. Differently from the demand channel of transmission, the cost channel persists at least for 12 quarters. The evidence presented in this figure suggests that the cost channel may be more prominent for the transmission of monetary policy.

3.3 Discussion: Balance sheet channel and bottleneck effects

The theory behind our baseline results is the "financial accelerator" or "balance sheet channel" of monetary policy transmission, operating through clients' and suppliers' balance sheets. The financial accelerator refers to the idea that tight monetary conditions affect firms with weak balance sheets, leading to reductions in investment (Blinder, 1987; Bernanke and Gertler, 1995). Constrained firms demand a lower quantity of inputs from their suppliers (the demand channel); this in turn affects the production process and hence also the supply side (the cost channel).

Figure 2 shows estimated coefficients β_f^h for a version of Equation 3 that does not control for client or supplier characteristics nor their interactions with the monetary policy rate. We plot the coefficients corresponding to estimations with firm fixed effects. In Panel A, the dependent variable is $\Delta \ln$ purch and hence the interaction term captures differential demand effects of changes in monetary policy for firms with weak financial weakness. In Panel B, the dependent variable is $\Delta \ln$ sale and hence the interaction term captures differential supply effects of changes in monetary policy for firms with weak financial health. Consistently with the balance sheet channel being at the heart of our baseline findings, results show that the interaction coefficients are negative and statistically significant over a long horizon. These dynamic results continue to hold after controlling for client and supplier characteristics and the interaction of client and supplier financial weakness with changes in monetary policy (untabulated). The interaction coefficients β_f^h are however several orders of magnitude lower than β_c^h and β_s^h such as the ones reported in Figure 1. This is consistent with the findings in Acemoglu et al. (2016), who show that the propagation of shocks through the supply chain is quantitatively larger than the direct effects of the shocks.

A related question is whether firm outcomes are more affected by changes in monetary conditions through the bottleneck effects operating through client demand or through the cost channel, or through the balance sheet channel. To address this issue, we perform horse-

race estimations of both channels, by estimating versions of Equations 1 and 2 that include interactions of the monetary policy rate and (i) the clients' financial conditions, (ii) the suppliers' financial conditions, and (iii) the firm's own financial conditions. Table 4 contains these estimations for the immediate effect of changes in the policy rate, and Figure 3 contains the dynamic estimates.

Results in Table 4 show that a monetary tightening has a similar initial impact on sales and purchases through upstream and downstream firm financial weakness, but that the firms' own financial weakness has a secondary impact on monetary policy transmission.[2] From Figure 3, we can observe that the effect of clients' financial weakness on firm sales and purchases peaks at a slightly more negative level around the fourth quarter after the shock, and then slowly goes to zero. In contrast, the effect of supplier financial weakness is steeper and peaks around the fifth or sixth quarter after the shock at a more negative level. Supplier financial weakness has a permanent effect on firm purchases, which lasts at least for 12 quarters after the shock. Overall, these results suggest that supplier financial weakness plays a more relevant role in the transmission of monetary policy, through the cost channel of transmission, confirming the results obtained in Figure 1.

4 Identification and internal validity

4.1 Monetary policy surprises

In the results presented so far, identification of the demand (cost) channel is based on the assumption that average financial conditions in the downstream (upstream) industries are largely exogenous to an individual firms' ability to sell their products or their input demand.

[2]For example, coefficients in column 2 imply that the reduction in sales due to a 0.25pp quarterly increase in the monetary policy rate is 10% higher when clients are in bad financial health, 7% higher when suppliers are in bad financial health, and only 4% higher when the firm itself is in bad financial health. The differential impact on purchases estimated in column 4 is 9.7% for weak client financial health, 8.8% for weak supplier financial health, and not statistically different from zero for firms' financial weakness. These calculations are based on estimating the difference in sales or purchases between clients, suppliers, and firms with inverse coverage ratios that are one standard deviation higher, in a similar fashion as we did in Section 3.

In addition, we control for variations in the firm's own supply and demand induced by changes in monetary conditions by interacting the latter with the firm's own financial conditions. However, our estimates cannot perfectly account for changes in economic conditions that simultaneously affect the monetary policy stance, the demand for a firm's products (firm sales), and input supplies (purchases).

To deal with this issue, as an alternative measure to changes in the policy rate we use unexpected changes in the federal funds (Gürkaynak et al., 2005). As explained in more detail in Gürkaynak (2005), these surprises are calculated using changes in asset prices within short windows around the FOMC announcements, and capture changes in the target rate that are unexpected by market participants and hence exogenous to economic activity. Results of estimating Equation 3 using monetary surprises and firm fixed effects are summarized in Figure 4. Results are similar to those found in our main estimations.

4.2 Estimations with supplier-client pairs

Equations 1 and 2 rely on admittedly rough measures of the balance sheet strength of clients and suppliers which are based on weighted sector averages rather than on the actual balance sheet weakness of firms' business partners. These measures also have limited cross-sectional variation, as they are identical for all firms in a given industrial sector. In addition, estimations of Equations 1 and 2 are potentially subject to omitted variable bias, to the extent that the included controls fail to capture time-varying unobserved supply- or demand-side factors which correlate with our variables of interest and explain a part of the variation in the dependent variables.

To overcome these issues, we use a complementary approach that relies on actual business relationships (i.e., supplier-client pairs), hence measures the financial weakness of clients and suppliers with precision. We obtain this sample from the Segment files of Compustat. Information gathered in these files relies on US regulations SFAS numbers 14 and 131, which

require publicly listed firms in the United States to disclose, in their yearly 10-K SEC filings, the identity of clients and the sales to clients whose purchases represent more than 10% of total sales. To test for the demand channel, we retrieve from these files the text names of the firms' most important clients for the period 2000 - 2015. Using text-searching algorithms complemented with manual searches, we match the reported client names back to Compustat to obtain their balance sheet information and calculate their financial health. We refer to the resulting sample as the "(paired) client leverage sample", and we use it to test for the demand channel. Similarly, to test for the cost channel, we take each of the clients identified through this procedure, and match them to all firms (suppliers) in Compustat reporting them as an important client. We henceforth shall refer to this second paired sample as the "(paired) supplier leverage sample". To differentiate these two relationship-level samples from our baseline Compustat sample, from now on we shall refer to the latter as the "firm-level sample".

The pair-level data sets obtained from the Segment files provide us with two important advantages in terms of the identification of the bottleneck effects of monetary policy. First, the financial health of the firms' clients and suppliers is precisely observed, obviating the need to summarize this information through industry averages using the input-output matrices. Second and most importantly, the actual amount of sales to each client and of purchases from each suppliers is also observed, allowing us to identify bottleneck effects of monetary policy by exploiting the heterogeneity in the business partners' financial health while controlling for all time-varying and time-invariant unobserved characteristics of the firm itself. This approach enhances the internal validity of our estimations.

To achieve identification, we modify Equations 1 and 2 to accommodate the use of the pair-level data, and estimate the following equations for a firm i with clients indexed by j and suppliers indexed by k:

$$\Delta \ln \text{sales}_{ijt} = \beta_c \Delta r_t x_{j,t-1} + \Gamma_c' X_{j,t-1} + \Gamma_f' X_{i,t-1}^f + \mu_{it} + \epsilon_{ijt} \tag{4}$$

$$\Delta \ln \text{purch}_{ikt} = \beta_s \Delta r_t x_{kt-1} + \Gamma_s' X_{k,t-1} + \Gamma_f' X_{i,t-1}^f + \mu_{it} + \epsilon_{kit} \tag{5}$$

Equation 4 analyzes bottleneck effects of monetary policy through the demand channel. We estimate this equation on the paired client leverage sample. The dependent variable in this equation, $\Delta \ln \text{sales}_{ijt}$, is the change in the natural logarithm of sales from a firm i to its client j; Δr_t is the change in the monetary policy reference rate between years $t-1$ and t;[3] and x_{jt} corresponds to the actual balance sheet weakness of client j. We add different sets of fixed effects to identify the bottleneck effects. In our least saturated specifications, we include firm fixed effects and time fixed effects to account for time-invariant supply-side factors and for changes in economic activity that affect all firms in a similar fashion. In intermediate specifications, we add the interaction of time fixed effects with the firm's industry, size, and age group, to account for changes in supply-side factors that are similar for firms in a given year, industry, size, and age group (Degryse et al., 2019). Our most saturated specifications include firm $\times$ year fixed effects, μ_{it}. These fixed effects control for all time-varying and time-invariant firm characteristics. Identification in this case is achieved by comparing how demand for one firm's products changes across clients with varying degrees of balance sheet strength, while controlling all for supply-side factors, observed and unobserved, which are fixed within a given year.

Equation 5 analyzes bottleneck effects of monetary policy through the cost channel, which we estimate on the paired supplier leverage sample. The dependent variable is $\Delta \ln \text{purch}_{ikt} \equiv \Delta \ln \text{sales}_{kit}$, the change in the natural logarithm of the purchases of firm i from supplier k, and x_{kt-1} is the balance sheet weakness of supplier k. Similarly as before, we achieve identification by adding either firm and year fixed effects, firm industry $\times$ size group $\times$ age group fixed effects, or firm $\times$ year fixed effects. In the latter specifications, identification is

[3] The pair-level sample is available with a yearly frequency.

achieved by comparing the change in purchases of a given firm from suppliers with different degrees of financial health, while controlling for all observed and unobserved demand-side factors that are fixed within a given year.

While the paired samples provide a good framework to identify the bottleneck effects of monetary policy, we would like to acknowledge some of their limitations. First, clients in these samples, as well as the dependent variables in Equations 4 and 5, are observed with a yearly frequency. Therefore, we lose quarterly variation that is available in the firm-level sample. Second, these samples provide an incomplete picture of the business relationships of the firms, and hence, potentially have somewhat less external validity. Indeed, the reporting regulations imply that we cannot identify clients that buy small amounts (representing less than 10% of the firms' total sales) nor aggregate clients.In addition, we can only obtain the financial health for clients that are themselves publicly traded firms with financial information available in Compustat, hence excluding all potentially important clients that are individuals, private firms, governments, or firms based outside of the United States. Finally, while clients in the paired client sample are, by definition, important business partners for the firms, the same is not true for suppliers in the the paired supplier sample. By construction, suppliers identified with our procedure are selling large amounts of their output to the firms, but they are not necessarily the firms' most important supplier. This potentially reduces the information content in the paired supplier leverage sample. To address this issue, in the estimation of Equation 5 we place higher weights to suppliers operating in sectors from which the firms purchase more inputs. We obtain these weights from the BEA's input-output matrices.

Table 5 contains a description of the paired samples, and Table 6 contains results of estimating different versions of Equation 4 on the paired client leverage sample. Specifications in columns 1 and 2 are estimated with industry $\times$ time fixed effects; in columns 3 and 4 we substitute these with industry $\times$ size $\times$ age $\times$ time fixed effects; and finally, in columns 5 and 6 we introduce firm $\times$ time fixed effects. The latter control for all supply-side factors

that affect a given firm and are fixed for a given year, and allow us to identify the effect of downstream leverage by exploiting the heterogeneity in financial health of clients buying from the same firm in a given year.

Results in Table 6 are consistent with our baseline results for the demand channel in Table 2. Indeed, the interaction of changes in monetary policy with the client coverage ratio is negative and statistically significant in all specifications. These results show that our firm-level estimates are robust to a better identified setup. The coefficient for the interaction term in these specifications are economically larger than in Table 2. For example, the coefficient in column 4 implies that a yearly increase of 1pp in the monetary reference rate leads to a difference in the sales growth rate from clients with a one standard deviation larger inverse coverage ratio of -0.85pp (=0.025 $\times$ 0.341), or 20.3% (=-0.0085/0.042) of the average yearly change in sales to a client. In addition, Appendix Table A6 shows that these results are robust to using the suppliers' debt ratio as a measure of financial weakness, and Table A7 show that the results are also robust to substituting the changes in the policy rate with monetary surprises. Overall, these results confirm the existence of bottleneck effects of monetary policy through a demand channel, using a well-identified estimation model albeit with potentially lower external validity.

We next focus on the cost channel. As mentioned before, that suppliers in the paired supplier leverage sample are not necessarily the most important input suppliers of the observed firms. To the extent that the products sold by the suppliers in this sample are not fundamental to the production of the downstream firms, we might expect that the financial weakness of the suppliers will be mostly irrelevant to the purchases of the downstream firms. This potentially reduces the information content of this sample when estimating the cost channel of transmission and might lead to an underestimation of the effect. We nevertheless try to extract meaningful information from this sample by following two alternative approaches when estimating Equation 5 on this sample: In Panel A of Table 7, we assign higher weights

to observations of suppliers belonging to sectors that sell large fractions of inputs to the firm. In Panel B, we select only those suppliers in the sectors representing most of the firm's inputs. The coefficients for the interaction of the monetary policy rate with suppliers' financial weakness are mostly negative, but not distinguishable from zero in most cases. Evidence for the cost channel is slightly stronger when we substitute the suppliers' inverse coverage ratio with their debt ratio in Table A8 in the appendix (see e.g. columns 1 and 2 in Panel B), but not when we use monetary surprises in Table A9. The absence of strong evidence for the cost channel using the paired supplier leverage sample is likely driven by the limited information content of this sample which, as mentioned before, may not contain the most important suppliers of the firms. This suggests an admittedly speculative qualification of our results, namely, that monetary conditions are transmitted through the supply chain mostly when *important* business partners have weak balance sheet positions. We unfortunately do not have the data to test this hypothesis, but it would be interesting to explore it with more adequate data.

4.3 Other endogeneity concerns

In Figure 5 we deal the concern that our average measures of client and supplier could be correlated with the firm sector's own financial conditions. This could occur to the extent that the industry sells an important fraction to, or buys an important fraction from, firms in its own industry, something that is not uncommon in the data. We deal with this issue by recalculating the measures of downstream and upstream financial weakness excluding the firms' own sector from the calculations. Results remain qualitatively unchanged.

A related endogeneity concern is that upstream firms might extend trade credit to the downstream firms. This might affect our estimations for the demand channel, because trade credit provision might simultaneously affect firm sales (Daripa and Nilsen, 2011) and downstream firms' leverage (Burkart and Ellingsen, 2004; Garcia-Appendini and Montoriol-

Garriga, 2013). By the same token, this might affect our estimations for the cost channel if the upstream firm has to borrow to finance the provision of trade credit. In this case, the use of trade credit by downstream firms would simultaneously affect their purchases and the upstream firms' financial health.

In Figure 6 we deal with this issue by estimating our main equations for firms with different levels of trade credit. For the demand channel, we repeat the estimations for Equation 3 for mutually exclusive subsamples of firms classified according to the extent of trade credit provided by the upstream firm. If there is an endogenous relationship between downstream sector leverage and upstream firm economic activity, we should find different results when upstream firms provide moderate amounts of trade credit (where the endogeneity issue should be less relevant) relative to heavy users of trade credit. We define high trade credit provision if the firms provide larger amounts of trade credit than the median firm in the sector. We measure trade credit provision using the ratio of accounts receivable to lagged assets. Results in Panel A show similar behavior of firms providing high and low levels of trade credit.[4]

For the cost channel, a potential endogenous relation could emerge between trade credit use and upstream firm leverage. We define high trade credit use if the firms take up larger amounts of trade credit than the median value in their sector. We measure trade credit extension using the average ratio of accounts payable to lagged assets. Results in Panel B once again show similar behavior of firms with high vs low use of trade credit. We conclude from the analysis based on subsamples of trade credit provision and trade credit use that the main results presented in the previous sections are not due to a potential correlation between leverage in downstream and upstream sectors and firm's economic activity. Overall, the results of the tests performed in this section support our interpretation of the main results, and show that our main results are robust to several endogeneity concerns.

[4]There is a large degree of overlap in the confidence intervals of the point estimates of the two groups. We do not draw the confidence intervals to improve the readability of the figure.

5 Extensions

5.1 The role of trade credit

In this section we investigate the role of trade credit in the propagation of monetary shocks. Existing theories yield ambiguous predictions about whether trade credit can amplify or mitigate the transmission mechanisms documented in the previous sections. Following a monetary tightening, firms with weak balance sheets might desire to resort to trade credit to compensate for the loss of their purchasing ability, especially if they are unable to borrow from other sources (Biais and Gollier, 1997; Burkart and Ellingsen, 2004). Suppliers might be willing to provide this trade credit required by downstream firms in order to dampen the drop in their own sales (Daripa and Nilsen, 2011), especially if they have access to cash or funding from other sources (Garcia-Appendini and Montoriol-Garriga, 2013; Adelino et al., 2021). These theories would imply that trade credit mitigates the drop in demand driven by changes in monetary policy. On the other hand, a tightening of monetary policy could affect the ability of suppliers' themselves to provide trade credit, and suppliers might be unwilling to provide credit to financially weak clients – especially if they perceive that their clients' financial difficulties are not temporary (Cuñat, 2007; Wilner, 2000). If this is the case, suppliers would not increase, and they might actually decrease the amount of trade credit provided to their clients.

To explore this issue, we analyze whether trade credit provision and trade credit use changes with changes in monetary policy, as a function of the financial health of clients and suppliers. That is, in Panel A of Figure 7 we estimate Equation 3 substituting the dependent variable with the h-quarter difference in accounts receivable, $AR_{t+h} - AR_{t-1}$ divided by lagged assets, and in Panel B the dependent variable is the h-quarter difference in accounts payable, $AP_{t+h} - AP_{t-1}$ divided by lagged assets.

Results in Panel A show that firms financially weak provide lower amounts of trade credit following a monetary tightening, relative to firms that have financially strong clients. These

findings suggest that trade credit provision might actually contribute to the demand channel of transmission of monetary policy, i.e., suppliers seem reluctant to lend to firms with weak balance sheets when monetary policy tightens. This result is similar to the flight-to-quality effect that has been documented for banks (Bernanke et al., 1996). Similarly, results in Panel B show that firms with financially weak suppliers use lower amounts of trade credit, relative to firms with financially strong suppliers, following a monetary tightening. These results suggest that struggling suppliers do not have the ability to provide more trade credit to their clients, and hence trade credit might amplify the cost channel of monetary policy.

5.2 Prices

The previous sections demonstrate that, by shifting the supply and demand curves in the same direction, the demand and cost channels can amplify the effect of monetary policy on aggregate output. Another implication of the shifting of these curves in the same direction is a potential dampening of the effect of monetary policy on prices (see Figure A1 in the Appendix). Our databases do not contain information about prices, which is why our main analysis focuses on quantities. However, our firm-level data does allow us to observe the firms' markups, which can be used as a signal of pricing behaviour. In this section, we use this information as an admittedly noisy proxy of prices to analyze how these are affected by changes in demand and supply of financially constrained clients and suppliers induced by changes in monetary policy.

Figure 8 contains the results of performing regressions in the spirit of Equation 3, but using the h-period difference in the markup as the dependent variable.[5] We find that the immediate effect of an increase in the monetary policy is negative, but that it increases subsequently (and remains statistically equal to zero from quarters two onwards) for firms that have financially weak clients. In contrast, the immediate effect for firms with financially weaker suppliers is positive (albeit it is not statistically different from zero), and it decreases

[5]Markups are defined as the difference between sales and costs of goods sold, scaled by cost of goods sold.

in the first two quarters. Markups of firms with financially weak suppliers subsequently become positive around five quarters following the changes in monetary conditions. These initial movements of the markups in opposite directions during the first few quarters following the change in monetary conditions is consistent with a shifting of the supply and demand curves in opposite directions. We see this result as further validating our identification of the two distinct monetary policy transmission channels.

5.3 The zero lower bound

A concern about our main estimations is that the effective monetary policy rate reached the zero lower bound (ZLB) in the aftermath of the Great Financial Crisis. During the ZLB period, variations in the Federal Funds rate are not suitable to measure the monetary policy stance, as policymakers resorted to unconventional tools of monetary policy. To deal with this issue, (i) in Figure 9 we repeat our estimations over the complete sample period using variations in the longer-term 2-year Treasury bond rate instead of the changes in the Federal Funds rate; and (ii) in Figure 10 we exclude the ZLB period (i.e., observations from 2009:Q1 to 2016:Q4) from our original estimation sample. In both cases, results are very similar to our original estimations.

6 Conclusions

In this paper, we show that the health of firms in downstream and upstream sectors is instrumental in transmitting demand and supply shocks driven by changes in monetary policy. Underlying our findings is a financial accelerator mechanism, in which a tightening of monetary policy leads firms with weak financial health to reduce their supply of products and their demand for inputs more sharply than firms with better financial health. The decreased supply and demand by these weak firms bottlenecks through the supply chain, as their suppliers are themselves affected through an aggregate demand channel of monetary

policy, and their clients are affected themselves through a cost channel of monetary policy.

Our findings suggest that the economic activity of firms with weak financial health is more affected by the bottleneck effects of changes in monetary conditions transmitted by weak clients and suppliers through the demand and cost channels, than through changes in the costs of financing due to their own financial situation. Dynamic estimations show that the effects of the cost channel of transmission can be larger and more protracted than those of the demand channel. We also find that trade credit provision does not play an important role in mitigating these transmission mechanisms. Importantly, our results are robust to an estimation method that can control for unobserved demand-side factors that are constant within a given year. Our results are also robust to using monetary surprises, and to two different measures of financial health.

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7 Tables

Table 1: Summary statistics

Variable	N	mean	p50	sd
Panel A: Firm-level sample				
Firm variables:				
$\Delta \ln \text{sales}_i$	339,028	0.011	0.003	0.213
$\Delta \ln \text{purch}_i$	322,568	0.011	0.003	0.266
Tobin's Q	339,028	3.892	1.429	11.502
Size	339,028	5.082	5.181	2.725
PPE ratio	339,028	0.331	0.242	0.284
Industry sales growth	339,028	1.054	0.229	2.609
Inverse coverage ratio	339,028	0.090	0.020	0.980
Debt ratio	531,374	0.302	0.187	0.562
Weighted client sector averages:				
Client average Tobin's Q	339,028	3.499	3.184	1.680
Client average size	339,028	5.774	5.663	0.980
Client average PPE ratio	339,028	0.309	0.287	0.120
Client average industry sales growth	339,028	0.742	0.422	1.306
Client average inverse coverage ratio	339,028	0.164	0.157	0.172
Client average debt ratio	531,374	0.343	0.336	0.073
Weighted supplier sector averages:				
Supplier average Tobin's Q	322,568	3.957	3.600	1.660
Supplier average size	322,568	5.505	5.475	0.665
Supplier average PPE ratio	322,568	0.306	0.291	0.102
Supplier average industry sales growth	322,568	0.868	0.526	1.175
Supplier average inverse coverage ratio	322,568	0.139	0.133	0.130
Supplier average debt ratio	500,363	0.326	0.322	0.058
Panel B: Monetary policy variables				
Federal Funds (level)	108	2.970	3.091	2.390
ΔFF (quarterly)	108	-0.098	-0.006	0.382
Surprise (quarterly)	108	-0.040	-0.016	0.062
2-y Treasury rate (level)	108	3.383	3.664	2.317
Δ 2-y Treasury rate (quarterly)	108	-0.132	-0.099	0.351

This table contains summary statistics for the main variables used in this paper. Data in Panel A is at the firm-quarter level level and corresponds to non-financial firms in the period 1990:Q1 to 2016:Q4. Information about the firms' clients and suppliers is obtained by computing mean values in each sector level, and calculating weighted average of these values across all sectors buying from or selling to each firm. Weights are obtained from the Input-Output matrices provided by the Bureau of Economic Analysis. Panel B contains the quarterly distribution of the monetary policy variables over the period 1990:Q1 to 2016:Q4. Please refer to Section 2 for more details about the construction of the samples, and to Table A1 for variable definitions.

Table 2: The demand channel of monetary policy transmission.

	(1)	(2)	(3)	(4)
Client inverse coverage ratio (x^c)	-0.000	0.001	0.003	0.003
	(0.002)	(0.003)	(0.003)	(0.003)
$x^c \times \Delta r_{t-1}$	-0.022***	-0.027***	-0.026***	-0.029***
	(0.005)	(0.005)	(0.005)	(0.005)
Inverse coverage ratio (x^f)			-0.002***	-0.003***
			(0.001)	(0.001)
$x^f \times \Delta r_{t-1}$			-0.002**	-0.002**
			(0.001)	(0.001)
Observations	339,028	339,028	339,028	337,911
R^2	0.029	0.073	0.073	0.128
Firm-level controls		Y	Y	Y
Client-level controls			Y	Y
Quarter FE	Y	Y	Y	Y
Fiscal Quarter FE	Y	Y	Y	Y
Industry FE	Y	Y	Y	
Firm FE				Y

This table contains coefficient estimates for Equation 1. The sample corresponds to all non-financial, non-government public firms in the US in the period 1990Q1 to 2016Q4. The dependent variable is the quarterly difference in the log of sales. The main independent variables are: the quarterly difference in the monetary policy rate (Δr_{t-1}), the lagged average clients' (inverse) coverage ratio (x^c), and the interaction between the differences in the monetary policy rate and the average lagged client (inverse) coverage ratio. Changes in monetary policy are the quarterly differences in the federal funds rate. Firm-level control variables are the average yearly growth in sales in the firms' industry, lagged values of Tobin's Q, firm size, debt to assets ratio, the ratio of PPE to total assets, and lagged changes in sales. Client controls are the client average industry growth rate and lagged values of client average Tobin's Q, client average size, and client average PPE to assets ratio. All variables are defined in Table A1. Standard errors are reported in parentheses and are clustered at the firm level.

***, **, and * indicate statistical significance at the 1, 5, and 10 percent levels, respectively.

Table 3: The cost channel of monetary policy transmission.

	(1)	(2)	(3)	(4)
Supplier inverse coverage ratio (x^s)	-0.006*	-0.007*	-0.005	-0.007*
	(0.004)	(0.004)	(0.004)	(0.004)
$x^s \times \Delta r_{t-1}$	-0.045***	-0.044***	-0.041***	-0.035***
	(0.008)	(0.008)	(0.008)	(0.008)
Inverse coverage ratio (x^f)			-0.002***	-0.002***
			(0.001)	(0.001)
$x^f \times \Delta r_{t-1}$			-0.001	-0.002
			(0.001)	(0.001)
Observations	322,568	322,568	322,568	321,375
R^2	0.016	0.102	0.102	0.141
Firm-level controls		Y	Y	Y
Supplier-level controls			Y	Y
Quarter FE	Y	Y	Y	Y
Fiscal Quarter FE	Y	Y	Y	Y
Industry FE	Y	Y	Y	
Firm FE				Y

This table contains coefficient estimates for Equation 2. The sample corresponds to all non-financial, non-government public firms in the US in the period 1990Q1 to 2016Q4. The dependent variable is the quarterly difference in the log of purchases. The main independent variables are: the quarterly difference in the monetary policy rate (Δr_{t-1}), the lagged average suppliers' (inverse) coverage ratio (x^s), and the interaction between the differences in the monetary policy rate and the average lagged supplier (inverse) coverage ratio. Changes in monetary policy are the quarterly differences in the federal funds rate. Firm-level control variables are the average yearly growth in sales in the firms' industry, lagged values of Tobin's Q, firm size, debt to assets ratio, the ratio of PPE to total asset, and lagged changes in purchases. Supplier controls are the average industry growth rate and lagged values of supplier average Tobin's Q, supplier average size, and supplier average PPE to assets ratio. All variables are defined in Table A1. Standard errors are reported in parentheses and are clustered at the firm level.
***, **, and * indicate statistical significance at the 1, 5, and 10 percent levels, respectively.

Table 4: Demand, cost, and balance sheet channels of transmission.

	Δ ln sales		Δ ln purch	
	(1)	(2)	(3)	(4)
Client inv. coverage ratio (x^c)	0.005*	0.004	-0.001	-0.002
	(0.003)	(0.003)	(0.003)	(0.003)
$x^c \times \Delta r_{t-1}$	-0.022***	-0.026***	-0.022***	-0.024***
	(0.005)	(0.005)	(0.006)	(0.006)
Supplier inv. coverage ratio (x^s)	-0.017***	-0.018***	-0.005	-0.007*
	(0.004)	(0.004)	(0.004)	(0.004)
$x^s \times \Delta r_{t-1}$	-0.031***	-0.026***	-0.036***	-0.029***
	(0.006)	(0.006)	(0.008)	(0.008)
Inv. coverage ratio (x^f)	-0.002***	-0.003***	-0.002***	-0.002***
	(0.001)	(0.001)	(0.001)	(0.001)
$x^f \times \Delta r_{t-1}$	-0.002**	-0.002**	-0.001	-0.002
	(0.001)	(0.001)	(0.001)	(0.001)
Observations	339,028	337,911	322,568	321,375
R^2	0.074	0.128	0.102	0.141
Firm-level controls	Y	Y	Y	Y
Client-level controls	Y	Y	Y	Y
Supplier-level controls	Y	Y	Y	Y
Quarter FE	Y	Y	Y	Y
Industry FE	Y		Y	
Fiscal Quarter FE	Y	Y	Y	Y
Firm FE		Y		Y

This table contains coefficient estimates for Equations 1 (columns 1 and 2) and 2 (columns 3 and 4). The sample corresponds to all non-financial, non-government public firms in the US in the period 1990Q1 to 2016Q4. The dependent variable is the quarterly difference in the log of sales (columns 1 and 2) or purchases (columns 3 and 4). The main independent variables are the interaction respectively between client (x_c), supplier (x_s), and firm (x_f) financial health and the quarterly difference in the monetary policy rate (Δr_{t-1}). Changes in monetary policy are the quarterly differences in the federal funds rate. Firm-, client- and supplier-level controls are the same as in Tables 2 and 3. All variables are defined in Table A1. Standard errors are reported in parentheses and are clustered at the firm level.
***, **, and * indicate statistical significance at the 1, 5, and 10 percent levels, respectively.

Table 5: Summary statistics for paired samples

Variable	N	mean	p50	sd
Client leverage sample:				
$\Delta \ln \text{sales}_{ij}$	26,133	0.042	0.036	0.521
Client Tobin's Q	20,860	1.879	1.436	1.676
Client size	26,133	9.352	9.882	1.670
Client PPE ratio	26,115	0.346	0.301	0.226
Client industry growth	26,132	0.942	0.166	2.987
Client debt ratio	26,103	0.274	0.263	0.178
Client inverse coverage ratio	26,133	0.161	0.110	0.341
Supplier leverage sample:				
$\Delta \ln \text{purch}_{ik}$	5,025	0.046	0.022	0.574
Supplier Tobin's Q	3,840	2.274	1.494	3.161
Supplier size	5,023	5.504	5.515	2.260
Supplier PPE ratio	5,023	0.396	0.322	0.290
Supplier industry growth	5,025	1.798	0.401	4.102
Supplier debt ratio	5,006	0.271	0.244	0.287
Supplier inverse coverage ratio	5,025	0.132	0.080	0.550

This table contains summary statistics for the paired samples used in estimations of Equations 4 and 5. Data is from the Customer Segment Files in Compustat. Information in this sample corresponds to actual client-supplier relationships; client and supplier variables are constructed from balance sheet information obtained from Compustat. The client leverage sample corresponds to supplier-client pairs where the supplier firm reports a firm in Compustat as an important client. The supplier leverage sample corresponds to client-supplier pairs where the client is reported by the supplier to be an important client, and the supplier belongs to an industry supplying large fractions of input to the client. Please refer to Section 4.2 for more details about the construction of the samples, and to Table A1 for variable definitions.

Table 6: Demand channel estimations on the paired client sample.

	(1)	(2)	(3)	(4)	(5)	(6)
Client inv. coverage ratio	-0.020	-0.012	-0.010	-0.010	-0.006	-0.020
	(-1.614)	(-1.032)	(-0.604)	(-0.624)	(-0.365)	(-1.116)
Client inv. coverage ratio $\times \Delta r_t$	-0.015*	-0.014*	-0.019*	-0.025**	-0.020**	-0.029**
	(-1.868)	(-1.760)	(-1.782)	(-2.066)	(-1.964)	(-2.487)
Observations	26,133	20,506	19,927	14,738	12,200	8,251
R^2	0.056	0.144	0.385	0.463	0.591	0.643
Client controls		Y		Y		Y
Industry $\times$ year FE	Y	Y				
Industry $\times$ size $\times$ age $\times$ year FE			Y	Y		
Firm $\times$ year FE					Y	Y

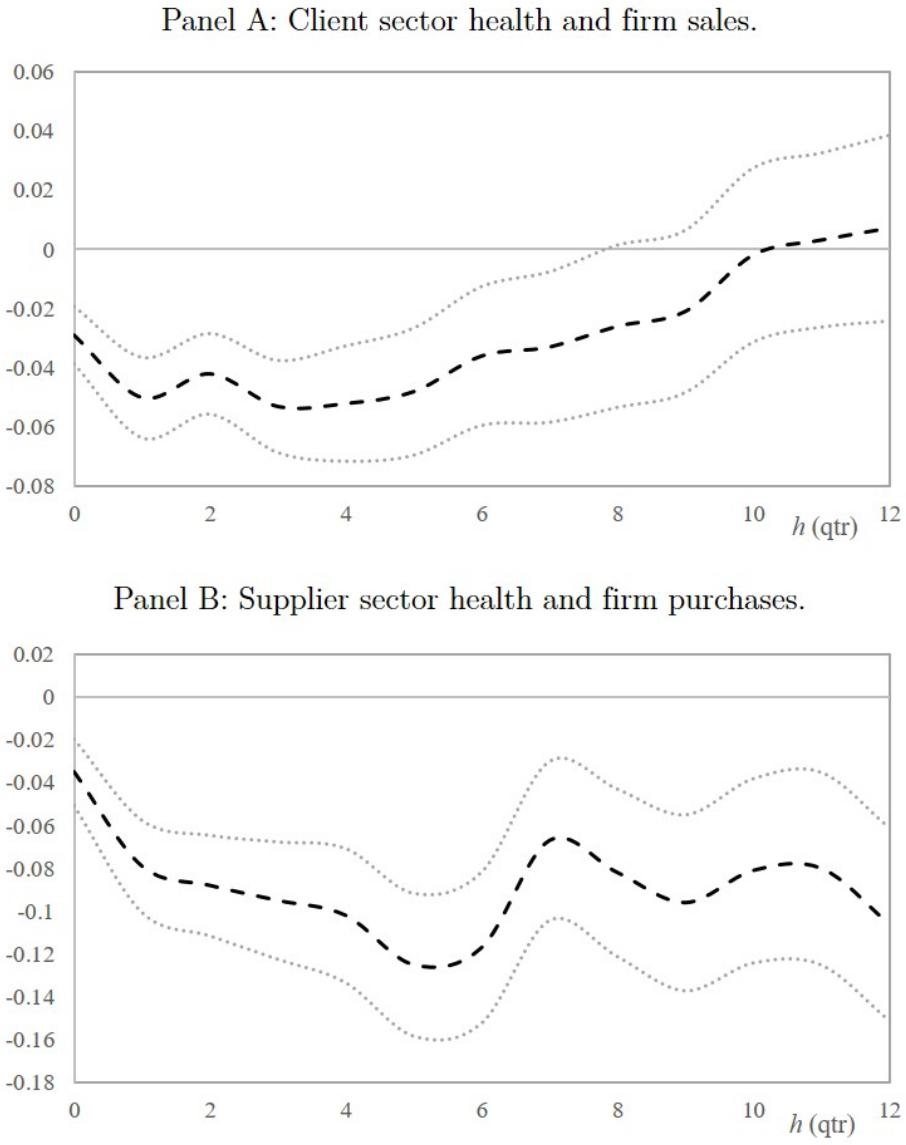
This table contains coefficient estimates for Equation 4. The sample corresponds to non-financial, non-government public firms in the US and their most important clients as reported in the Compustat Segment files for years 1990 through 2015. The dependent variable is $\Delta \ln \text{sales}_{ijt}$, or sales from firm i to client j in year t. The main independent variables are: the yearly difference in the monetary policy rate, the client's (inverse) coverage ratio (lagged one year), and the interaction between these two variables. Changes in monetary policy are the yearly differences in the federal funds rate. Estimations include industry times year fixed effects (columns 1 and 2), firm industry $\times$ size group $\times$ age group $\times$ year fixed effects (columns 3 and 4), and firm $\times$ year fixed effects (columns 5 and 6). Columns 3 and 4 include controls for the client's industry growth rate and lagged values of client's Tobin's Q, size, and PPE. Columns 5 and 6 additionally control for client monopsony and supplier monopoly power. T-statistics are reported in parentheses; standard errors are double clustered at the supplier and client level.
***, **, and * indicate statistical significance at the 1, 5, and 10 percent levels, respectively.

Table 7: Cost channel estimations on the paired supplier sample.

	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Observations weighted using BEA input matrices						
Supplier inv. coverage ratio	0.007	0.019	0.017	0.045	-0.010	-0.003
	(0.379)	(0.766)	(0.632)	(1.348)	(-0.568)	(-0.176)
Supplier inv. coverage $\times$ Δr_t	-0.028*	-0.030	-0.012	-0.017	0.000	0.004
	(-1.838)	(-1.483)	(-0.577)	(-0.663)	(0.013)	(0.230)
Observations	21,076	16,501	18,813	14,679	16,628	12,813
R^2	0.299	0.398	0.433	0.551	0.630	0.717
Panel B: Suppliers in important sectors						
Supplier inv. coverage ratio	-0.029*	-0.024	-0.039**	-0.036*	-0.030	-0.021
	(-1.795)	(-1.376)	(-2.162)	(-1.795)	(-1.352)	(-0.848)
Supplier inv. coverage $\times$ Δr_t	0.008	-0.003	-0.000	-0.009	-0.002	0.002
	(0.628)	(-0.198)	(-0.004)	(-0.659)	(-0.147)	(0.116)
Observations	5,025	3,744	4,381	3,232	3,759	2,658
R^2	0.096	0.182	0.171	0.236	0.318	0.378
Supplier controls		Y		Y		Y
Industry $\times$ year FE	Y	Y				
Industry $\times$ size $\times$ age $\times$ year FE			Y	Y		
Firm $\times$ year FE					Y	Y

This table contains coefficient estimates for Equation 5. This sample consists of non-financial, non-government public US firms and their suppliers such that firms are reported to be important clients of the suppliers and suppliers disclose the names of their clients in the Compustat Segment files between years 1990 through 2015. Estimations in Panel A weigh each supplier observation with the fraction of inputs purchased by the firm from suppliers in that sector. Estimations in Panel B only contain suppliers belonging to industries that account for up to 75% of the inputs used in the firms' main industry. The dependent variable is $\Delta \ln \text{purch}_{ikt}$, or purchases by firm i from supplier k in year t. The main independent variables are: the yearly difference in the monetary policy rate, the supplier's (inverse) coverage ratio (lagged one year), and the interaction between these two variables. Changes in monetary policy are the yearly differences in the federal funds rate. Estimations include industry times year fixed effects (columns 1 and 2), firm industry $\times$ size group $\times$ age group $\times$ year fixed effects (columns 3 and 4), and firm $\times$ year fixed effects (columns 5 and 6). Columns 3 and 4 include controls for supplier's industry growth rate and lagged values of supplier Tobin's Q, size, and PPE. Columns 5 and 6 additionally control for client monopsony and supplier monopoly power. T-statistics are reported in parentheses; standard errors are double clustered at the supplier and client level.
***, **, and * indicate statistical significance at the 1, 5, and 10 percent levels, respectively.

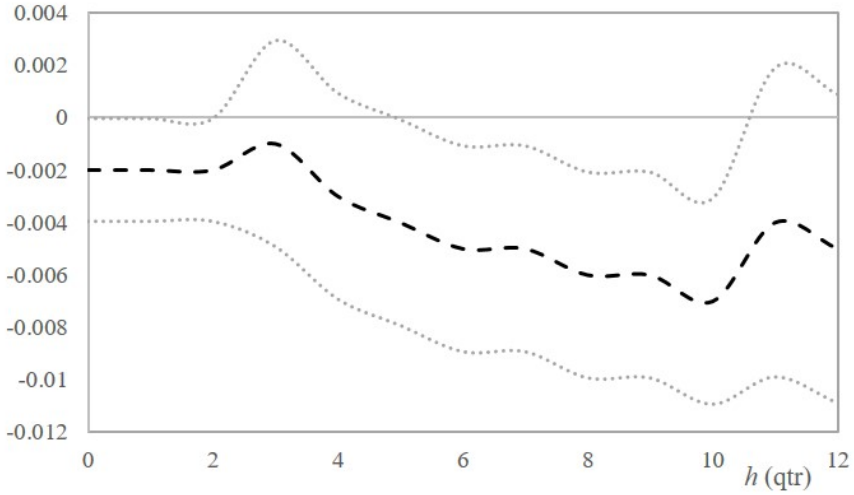
Figure 1: Dynamics of demand and cost channels of transmission.



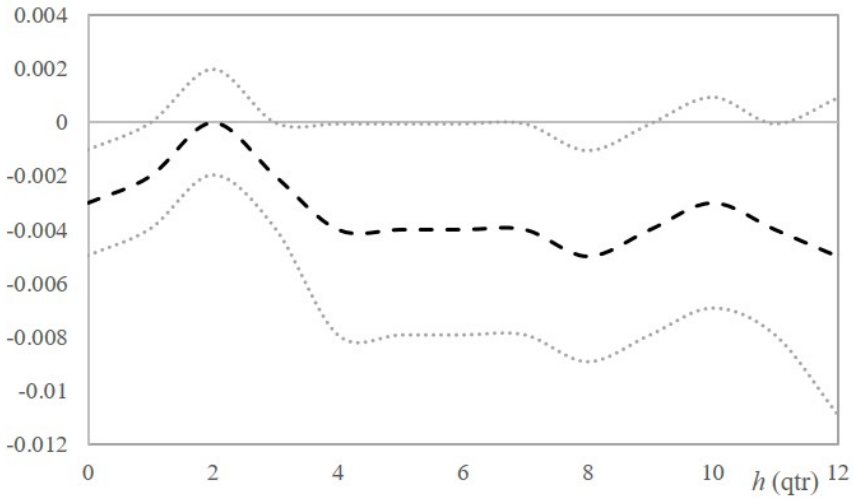
This figure reports the point estimate and 95% confidence intervals for the coefficient of the interaction terms in Equation 3. Panel A illustrates the dynamics of the demand channel of transmission, estimated using the model in column 4 of Table 2. The dependent variable is $\Delta \ln \text{sales}_{i,t+h}, h \in \{0, ..., 12\}$ and the plotted coefficient is the interaction between client weakness and the monetary policy rate (β_c^h). Panel B illustrates the dynamics of the cost channel of transmission, estimated using the model in column 4 of Table 3. The dependent variable is $\Delta \ln \text{purch}_{i,t+h}, h \in \{0, ..., 12\}$ and the plotted coefficient is the interaction between supplier financial health and the monetary policy rate (β_s^h).

Figure 2: The balance sheet channel of transmission.

Panel A: Financial health and firm purchases.

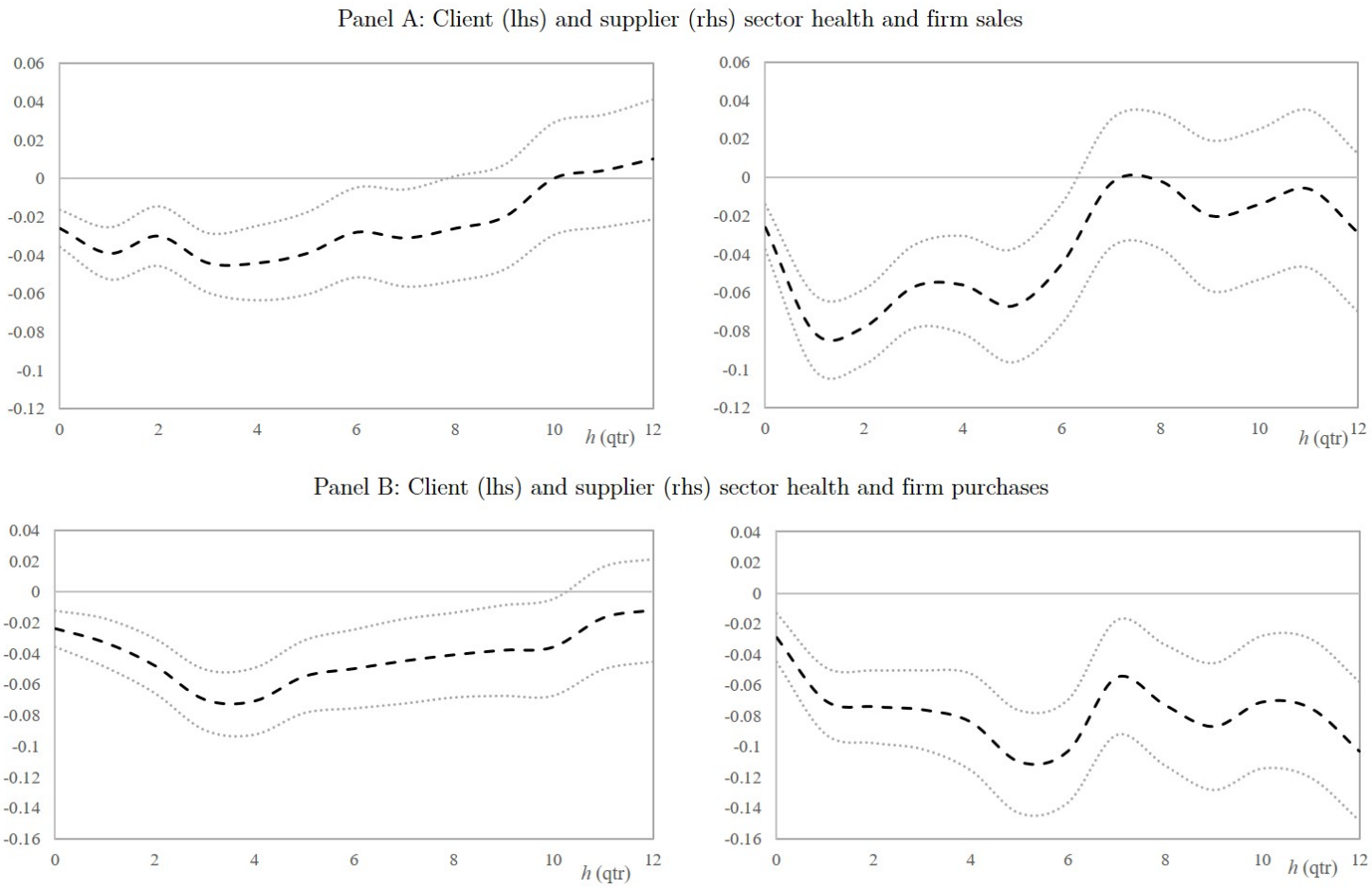


Panel B: Financial health and firm sales.



This figure reports the point estimate and 95% confidence intervals for coefficient β_f^h in Equation 3 (i.e., the interaction between the firm's own financial health and the changes in the monetary policy rate). Panel A illustrates the dynamics of the balance sheet channel of transmission affecting the demand for inputs, estimated using the model in column 4 of Table 3. The dependent variable is $\Delta \ln \text{purch}_{i,t+h}, h \in \{0, ..., 12\}$. Panel B illustrates the dynamics of the balance sheet channel of transmission operating through the supply of inputs, estimated using the model in column 4 of Table 2. The dependent variable is $\Delta \ln \text{sales}_{i,t+h}, h \in \{0, ..., 12\}$.

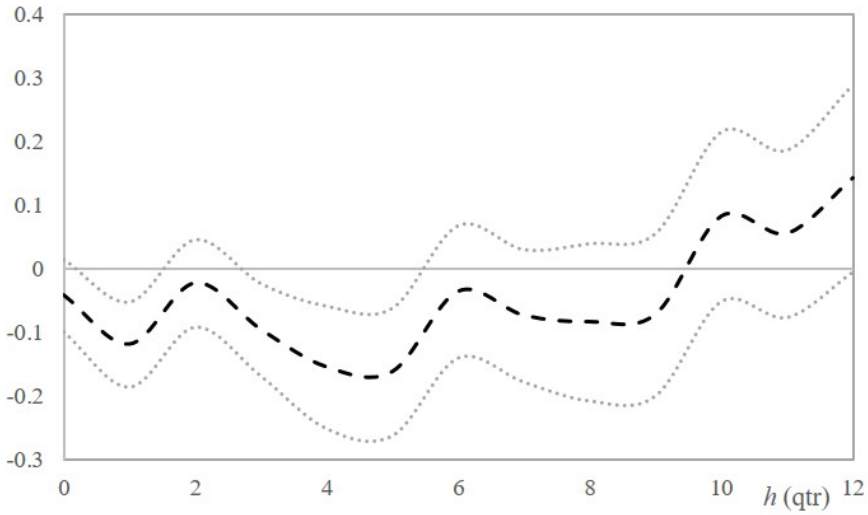
Figure 3: Bottleneck effects of client and supplier financial health.



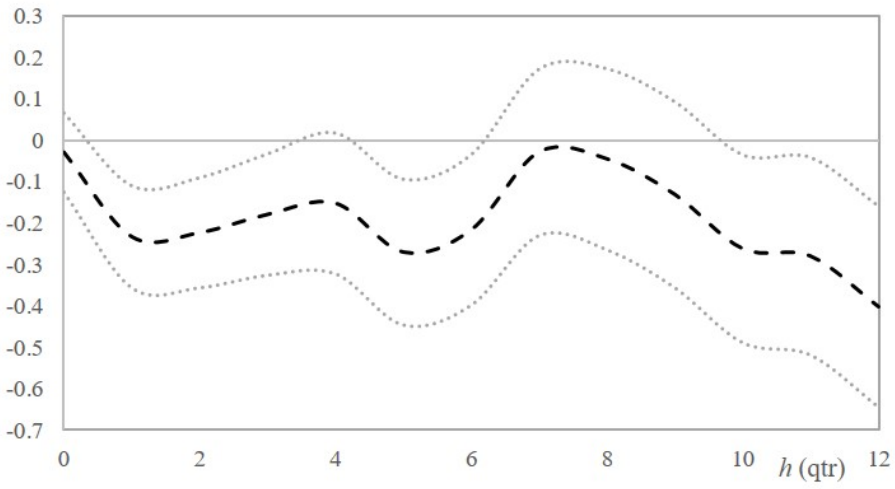
This figure reports the point estimate and 95% confidence intervals for coefficients β_c^h, β_s^h and β_f^h in Equation 3 (i.e., the interaction between clients', suppliers' and the firm's own financial health and the changes in the monetary policy rate). Panel A illustrates the dynamics of the balance sheet channel of transmission affecting the demand for inputs. The dependent variable is $\Delta \ln \text{purch}_{i,t+h}, h \in \{0, ..., 12\}$. Panel B illustrates the dynamics of the balance sheet channel of transmission operating through the supply of inputs. The dependent variable is $\Delta \ln \text{sales}_{i,t+h}, h \in \{0, ..., 12\}$.

Figure 4: Demand and cost channels of transmission with monetary surprises.

Panel A: Client sector health and firm sales.

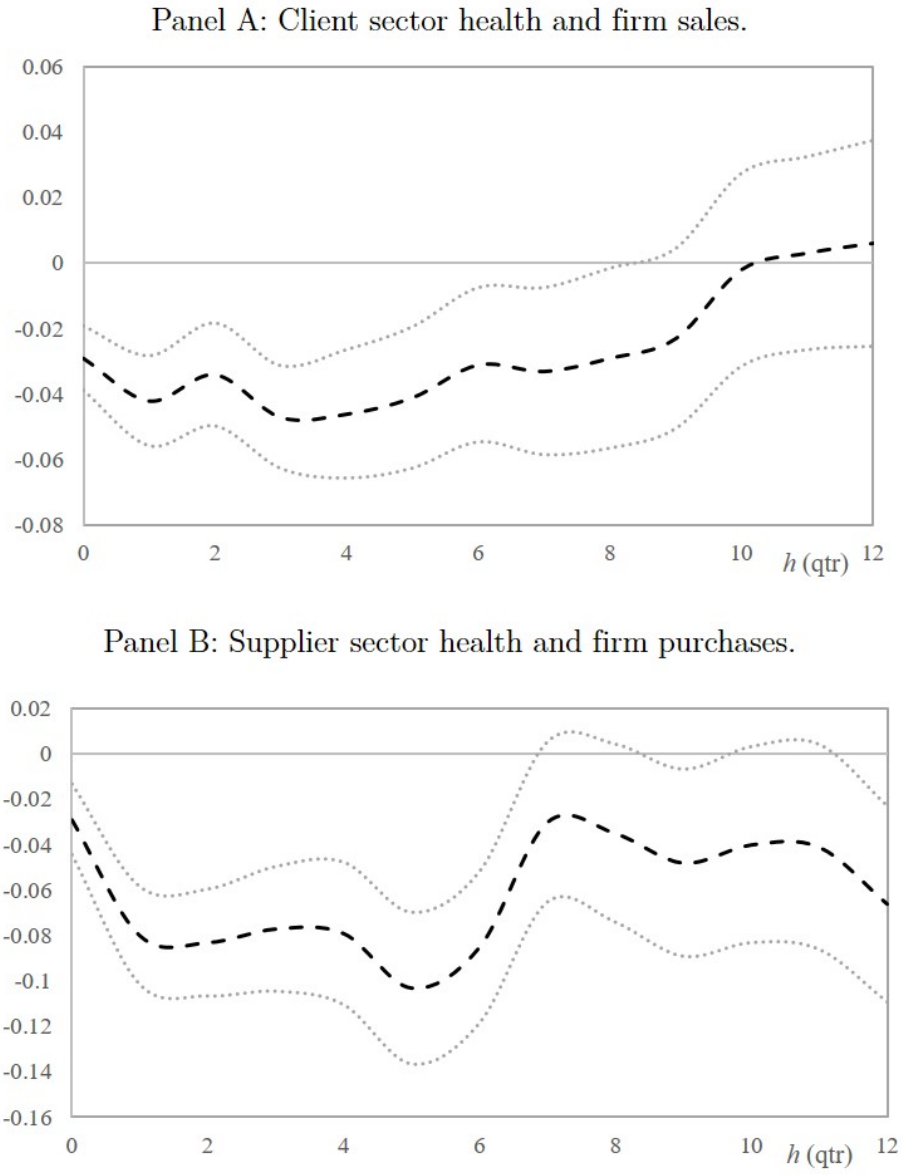


Panel B: Supplier sector health and firm purchases.



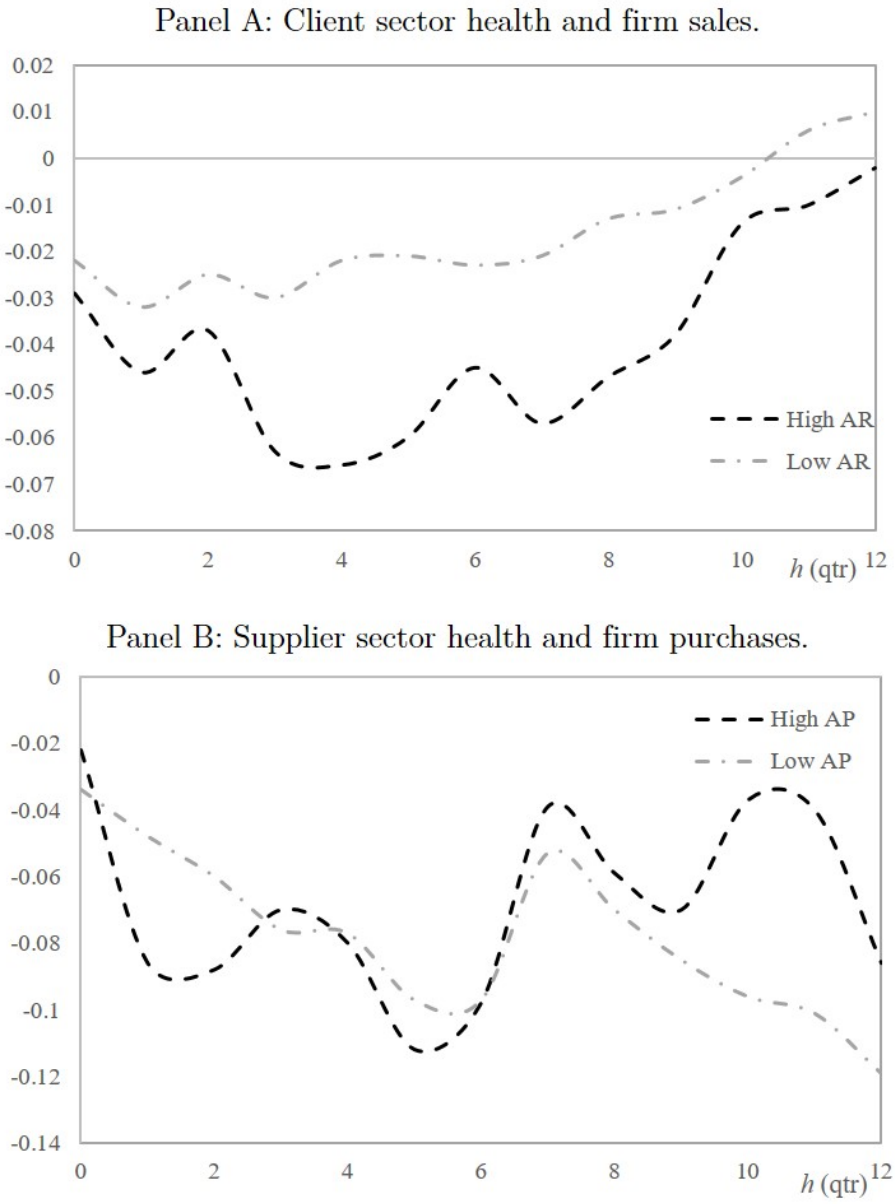
This figure reports the point estimate and 95% confidence intervals for the coefficient of the interaction terms in Equation 3. Estimations use monetary surprises in lieu of changes in the Federal Funds rate. Panel A illustrates the dynamics of the demand channel of transmission. The dependent variable is $\Delta \ln \text{sales}_{i,t+h}, h \in \{0, ..., 12\}$ and the plotted coefficient is the interaction between client financial health and the monetary policy surprises (β_c^h). Panel B illustrates the dynamics of the cost channel of transmission. The dependent variable is $\Delta \ln \text{purch}_{i,t+h}, h \in \{0, ..., 12\}$ and the plotted coefficient is the interaction between supplier financial health and the monetary policy surprises (β_s^h).

Figure 5: Dynamics of demand and cost channels of transmission. Excluding own sector.



This figure reports the point estimate and 95% confidence intervals for the coefficient of the interaction terms in Equation 3. Client and supplier average sector financial health have been calculated excluding the firm's own sector. Panel A illustrates the dynamics of the demand channel of transmission. The dependent variable is $\Delta \ln \text{sales}_{i,t+h}, h \in \{0, ..., 12\}$ and the plotted coefficient is the interaction between client financial health and the monetary policy rate (β_c^h). Panel B illustrates the dynamics of the cost channel of transmission. The dependent variable is $\Delta \ln \text{purch}_{i,t+h}, h \in \{0, ..., 12\}$ and the plotted coefficient is the interaction between supplier financial health and the monetary policy rate (β_s^h).

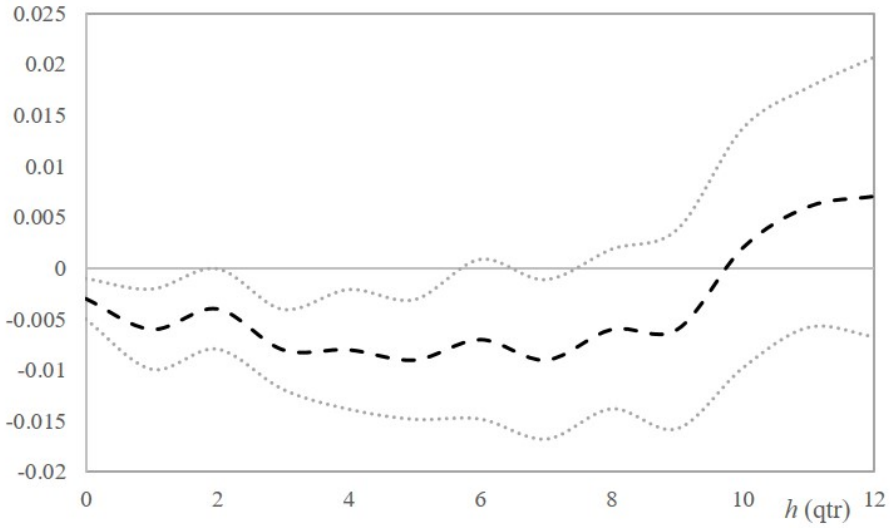
Figure 6: Demand and cost channels of transmission for high vs low users of trade credit.



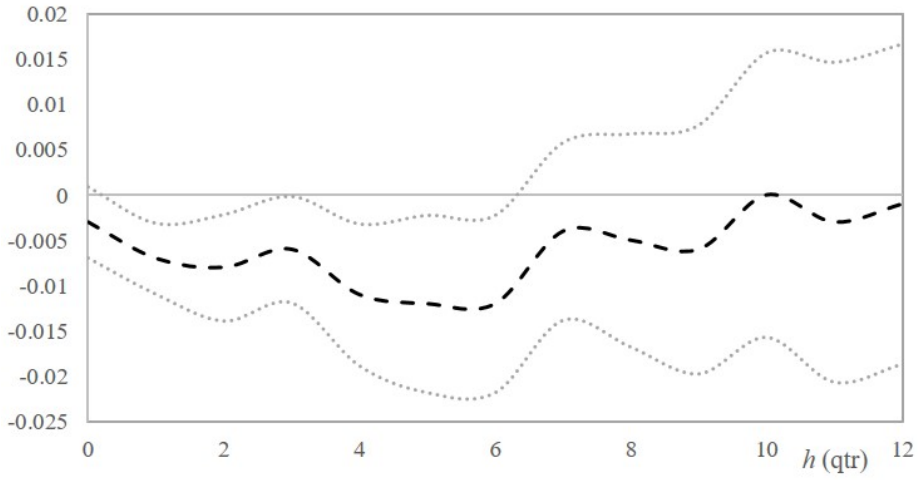
This figure reports the point estimate and 95% confidence intervals for the coefficient of the interaction terms in Equation 3. Client and supplier average sector financial health have been calculated excluding the firm's own sector. Panel A illustrates the dynamics of the demand channel of transmission. The dependent variable is $\Delta \ln \text{sales}_{i,t+h}, h \in \{0, ..., 12\}$ and the plotted coefficient is the interaction between client financial health and the monetary policy rate (β_c^h). Panel B illustrates the dynamics of the cost channel of transmission. The dependent variable is $\Delta \ln \text{purch}_{i,t+h}, h \in \{0, ..., 12\}$ and the plotted coefficient is the interaction between supplier financial health and the monetary policy rate (β_s^h).

Figure 7: Client and supplier financial health and use and granting of trade credit.

Panel A: Client sector health and firms' accounts receivable.



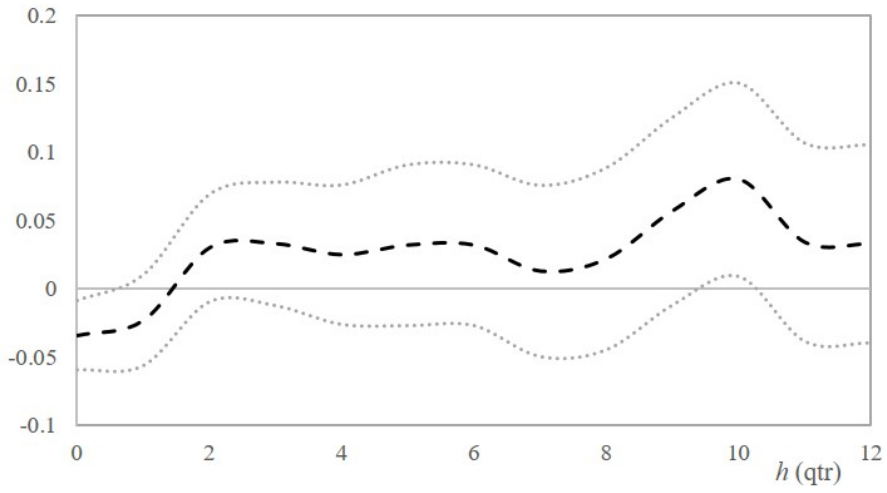
Panel B: Supplier sector health and accounts payable.



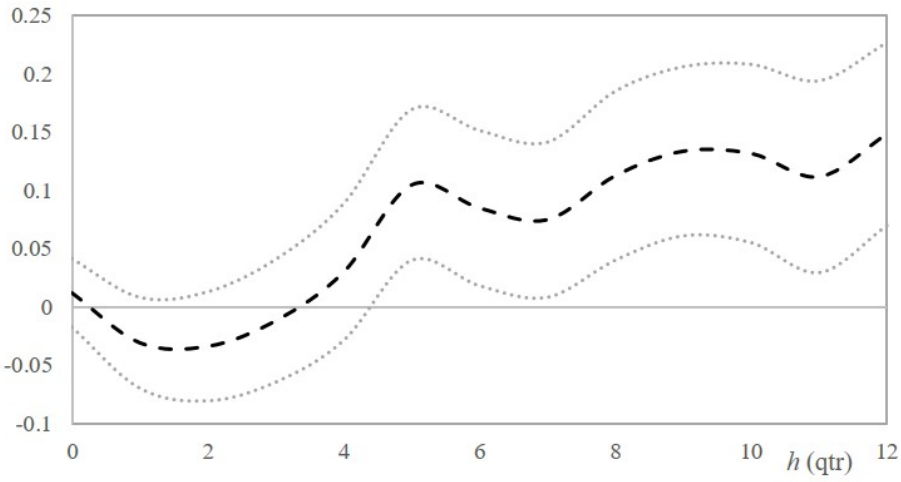
This figure reports the point estimate and 95% confidence intervals for the coefficient of the interaction terms in Equation 3. In Panel A, the dependent variable is ΔAR_{t+h}, the h-quarter difference in accounts receivable divided by lagged assets, $h \in \{0, ..., 12\}$ and the plotted coefficient is the interaction between client financial health and the monetary policy rate (β_c^h). In Panel B, the dependent variable is ΔAP_{t+h}, the h-quarter difference in accounts payable divided by lagged assets, $h \in \{0, ..., 12\}$ and the plotted coefficient is the interaction between suppliers' financial health and the monetary policy rate (β_s^h).

Figure 8: Client and supplier financial health and markups.

Panel A: Client sector health and firm markups.



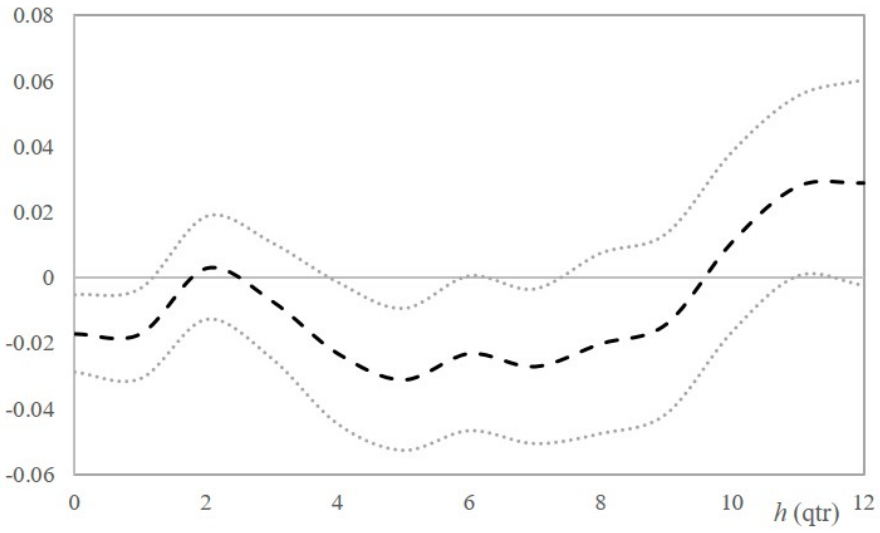
Panel B: Supplier sector health and firm markups.



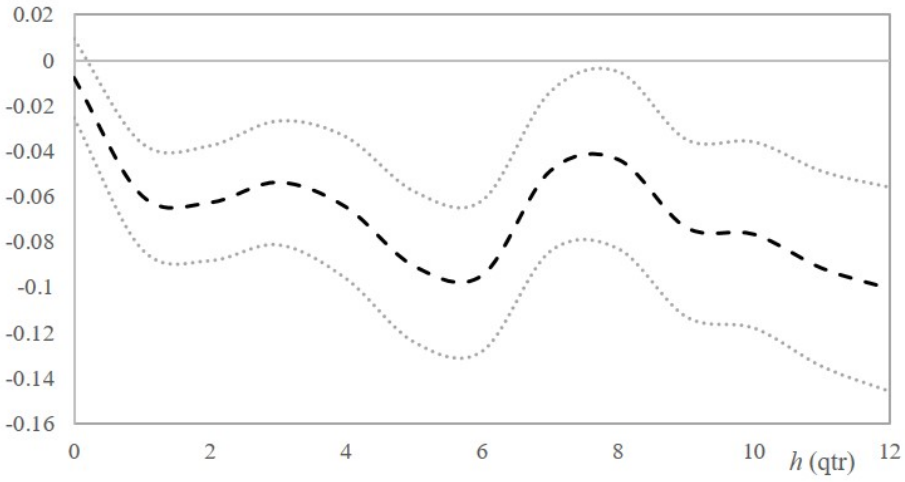
This figure reports the point estimate and 95% confidence intervals for the coefficient of the interaction terms in Equation 3. The dependent variable is $\Delta\text{Markup}_{t+h}$, the h-quarter difference in markups (defined as the difference between sales and cost of goods sold, scaled by cost of good sold), $h \in \{0, ..., 12\}$. In Panel A plotted coefficient is the interaction between client financial health and the monetary policy rate (β_c^h). In Panel B, the plotted coefficient is the interaction between suppliers' financial health and the monetary policy rate (β_s^h).

Figure 9: Demand and cost channels of transmission. Changes in 2-year Treasury bond rates.

Panel A: Client sector health and firm sales.



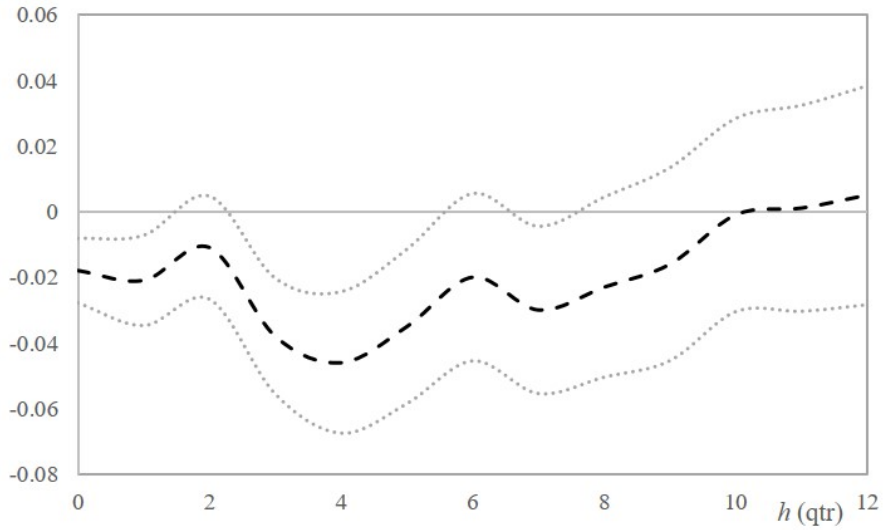
Panel B: Supplier sector health and firm purchases.



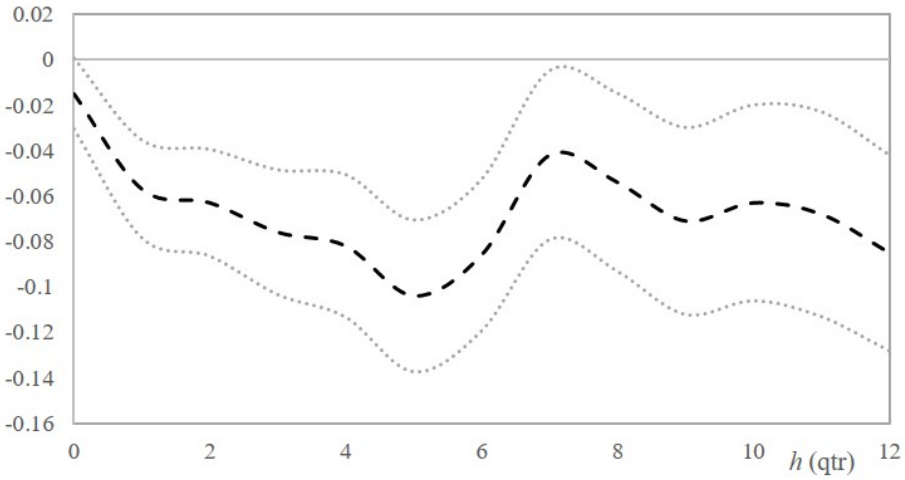
This figure reports the point estimate and 95% confidence intervals for the coefficient of the interaction terms in Equation 3. Estimations use changes in the 2-year Treasury bond rate in lieu of changes in the Federal Funds rate. Panel A illustrates the dynamics of the demand channel of transmission. The dependent variable is $\Delta \ln \text{sales}_{i,t+h}, h \in \{0, ..., 12\}$ and the plotted coefficient is the interaction between client financial health and the changes in the 2-year Treasury bond rate (β_c^h). Panel B illustrates the dynamics of the cost channel of transmission. The dependent variable is $\Delta \ln \text{purch}_{i,t+h}, h \in \{0, ..., 12\}$ and the plotted coefficient is the interaction between supplier financial health and the changes in the 2-year Treasury bond rate (β_s^h).

Figure 10: Dynamics of demand and cost channels of transmission, excluding the zero lower bound period.

Panel A: Client sector health and firm sales.



Panel B: Supplier sector health and firm purchases.



This figure reports the point estimate and 95% confidence intervals for the coefficient of the interaction terms in Equation 3. The sample contains observation for all Compustat non-financial, non-government public firms in the US in the period 1990:Q1 to 2008:Q4. Panel A illustrates the dynamics of the demand channel of transmission, estimated using the model in column 4 of Table 2. The dependent variable is $\Delta \ln \text{sales}_{i,t+h}, h \in \{0, ..., 12\}$ and the plotted coefficient is the interaction between client financial health and the monetary policy rate (β_c^h). Panel B illustrates the dynamics of the cost channel of transmission, estimated using the model in column 4 of Table 3. The dependent variable is $\Delta \ln \text{purch}_{i,t+h}, h \in \{0, ..., 12\}$ and the plotted coefficient is the interaction between supplier financial health and the monetary policy rate (β_s^h).

Online Appendix

Table A1: Variable definitions

Variable	Definition
$\Delta \ln \text{sales}_{i,t+h}$	$\ln \text{sales}_{i,t+h} - \ln \text{sales}_{i,t-1}$ (Compustat variable SALE)
$\Delta \ln \text{purch}_{i,t+h}$	$\ln \text{purchases}_{i,t+h} - \ln \text{purchases}_{it-1}$, where purchases in t are defined as $\text{Inventories}_t - \text{Inventories}_{t-1} + \text{Cost of goods sold}_t$ (Compustat INVT and COGS)
Δr_t	$\text{Fed Funds Rate}_t - \text{Fed Funds Rate}_{t-1}$ (from FRED)
Surprise_t	Sum of all surprise changes in the federal funds target rate between $t-1$ and t (provided by Refet Gürkaynak)
Inverse coverage ratio	Interest expenses/EBIT (Compustat XINT/(OIBDP − DP))
Debt ratio	Debt in current liabilities plus long-term debt, divided by total assets (Compustat (DLC + DLTT) / AT)
Tobin's Q	Total assets plus market value of equity minus book value of equity divided by total assets (Compustat {AT + CSHO × PRCC_F − [AT − (LT + PSTKL) + TXDITC]}/AT)
Size	Natural logarithm of real assets, $\ln(\text{AT}/\text{CPI})$ where CPI is the consumer price index (from FRED)
PPE ratio	Ratio of property, plant, and equipment (Compustat PPENT) to total assets (AT)
Sales growth	Ratio of the difference in sales between $t-1$ and t to lagged sales (Compustat SALE)
Industry growth	Average sales growth for firms in the same 3-digit SIC industry code
Client average Z	$\sum w_k x_k$, where k are all industries buying from the firm, x_k is the equally-weighted average value of Z (winsorized at the 1 and 99 percent levels) of all firms in the (4-digit SIC-code) downstream industry, and w_k are sales from the sector of the firm to each downstream industry, divided by total sales of the sector (obtained from the BEA)
Supplier average Z	$\sum w_k x_k$, where k are all industries selling to the firm, x_k is the equally-weighted average value of Z (winsorized at the 1 and 99 percent levels) of all firms in the (4-digit SIC-code) upstream industry, and w_k are input purchases by the sector of the firm from each upstream industry, divided by total input purchases of the sector (obtained from the BEA)
ΔAR_{t+h}	$\text{Accounts receivable}_{t+h} - \text{Accounts receivable}_{t-1}$ (RECTR), scaled by lagged assets. If variable RECTR is missing, we use variable RECT
ΔAP_{t+h}	$\text{Accounts payable}_{t+h} - \text{Accounts payable}_{t-1}$ (APQ), scaled by lagged assets.
Markup	sales − cost of goods sold, divided by cost of goods sold
$\Delta \ln \text{sales}_{ijt}$	$\ln \text{sales}_{ijt} - \ln \text{sales}_{ijt-1}$, where sales_{ij} are sales from firm i to client j (Compustat Segment Files variable SALECS)

Table A2: The demand channel, client debt.

	(1)	(2)	(3)	(4)
Client inv. coverage ratio (x^c)	0.004	0.005	0.003	-0.009
	(0.004)	(0.005)	(0.005)	(0.007)
$x^c \times \Delta r_{t-1}$	-0.065***	-0.069***	-0.069***	-0.077***
	(0.010)	(0.011)	(0.011)	(0.011)
Inv. coverage ratio (x^f)			-0.007***	-0.003***
			(0.000)	(0.001)
$x^f \times \Delta r_{t-1}$			-0.005***	-0.006***
			(0.001)	(0.001)
Observations	531,374	531,374	531,374	530,839
R^2	0.028	0.072	0.072	0.110
Firm-level controls		Y	Y	Y
Client-level controls			Y	Y
Quarter FE	Y	Y	Y	Y
Fiscal Quarter FE	Y	Y	Y	Y
Industry FE	Y	Y	Y	
Firm FE				Y

This table contains coefficient estimates for Equation 1. The sample corresponds to all non-financial, non-government public firms in the US in the period 1990Q1 to 2016Q4. The dependent variable is the quarterly difference in the log of sales. The main independent variables are: The quarterly difference in the monetary policy rate (Δr_{t-1}), the lagged average clients' debt ratio (x^c), and the interaction between the differences in the monetary policy rate and the average lagged client debt ratio. Changes in monetary policy are the quarterly differences in the federal funds rate. Firm-level control variables are the average yearly growth in sales in the firms' industry, lagged values of Tobin's Q, firm size, debt to assets ratio, the ratio of PPE to total assets, and change in sales. Client controls are the client average industry growth rate and lagged values of client average Tobin's Q, client average size, and client average PPE to assets ratio. All variables are defined in Table A1. Standard errors are reported in parentheses and are clustered at the firm level. ***, **, and * indicate statistical significance at the 1, 5, and 10 percent levels, respectively.

Table A3: Demand channel, alternative estimation method.

	(1)	(2)	(3)	(4)	(5)	(6)
Cl. inv. coverage ratio ($\overline{B^c}$)	0.001	0.001	0.002	-0.000	0.000	0.001
	(0.580)	(0.435)	(1.149)	(-0.224)	(0.068)	(0.589)
$\overline{B^c} \times \Delta r_t$	0.005	0.003	0.003	0.005	0.003	0.003
	(0.996)	(0.478)	(0.505)	(1.065)	(0.564)	(0.617)
$\overline{B^c} \times \Delta r_{t-1}$	-0.023***	-0.025***	-0.024***	-0.023***	-0.025***	-0.024***
	(-3.418)	(-3.329)	(-3.224)	(-3.519)	(-3.415)	(-3.300)
$\overline{B^c} \times \Delta r_{t-2}$	0.006	0.011	0.009	0.007	0.012	0.011
	(0.894)	(1.382)	(1.219)	(1.033)	(1.539)	(1.433)
$\overline{B^c} \times \Delta r_{t-3}$	-0.007	-0.006	-0.005	-0.007	-0.007	-0.006
	(-1.092)	(-0.851)	(-0.738)	(-1.201)	(-0.970)	(-0.877)
$\overline{B^c} \times \Delta r_{t-4}$	0.001	-0.005	-0.005	0.001	-0.005	-0.005
	(0.139)	(-0.998)	(-1.004)	(0.163)	(-0.870)	(-0.889)
Observations	613,093	500,408	500,408	613,093	500,408	500,408
R^2	0.285	0.266	0.266	0.286	0.267	0.267
Lags dependent var.	Y	Y	Y	Y	Y	Y
Firm controls		Y	Y		Y	Y
Client controls			Y			Y
Time FE	Y	Y	Y	Y	Y	Y
Industry FE				Y	Y	Y
$\sum_{u=0}^{4} \beta_u^c$	-0.0177	-0.0226	-0.0222	-0.0177	-0.0217	-0.0209
F-statistic	20.08	25.15	24.18	19.99	23.21	21.32
p-value	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01

This table contains coefficient estimates for the following equation:

$$\Delta \ln \text{sales}_{it} = \sum_{u=1}^{4} \alpha_u^c y_{,it-u} + \sum_{u=0}^{4} \delta_u^c \Delta r_{t-u} + \sum_{u=0}^{4} \beta_u^c \Delta r_{t-u} x_{i,t-1}^c + \gamma^c x_{i,t-1}^c + \Gamma^{c\prime} X_{i,t-1}^c + \mu_t + \theta_{s(i)} + \epsilon_{it}$$

The sample corresponds to all non-financial, non-government public firms in the US in the period 1990Q1 to 2016Q4. The dependent variable is the quarterly difference in the log of sales. The main independent variables are: The quarterly difference in the monetary policy rate and four of its lags, the average clients' (inverse) coverage ratio (lagged one quarter), and the interaction between the differences in the monetary policy rates and the average lagged client (inverse) coverage ratio. Changes in monetary policy are the quarterly differences in the federal funds rate. Firm-level control variables (not reported) are four lags of the dependent variable, the average yearly growth in sales in the firms' industry, and lagged values of Tobin's Q, firm size, debt to assets ratio, and the ratio of PPE to total assets. Client controls include: client average industry growth rate and lagged values of client average Tobin's Q, client average size, and client average PPE to assets ratio. All variables are defined in Table A1. The last three rows of this table contain, respectively: The sum of the coefficients of the interaction terms, an F-statistic for the null hypothesis that the sum of this coefficients equals zero, and its corresponding p-value. T-statistics are reported in parentheses; standard errors are clustered at the firm level.
***, **, and * indicate statistical significance at the 1, 5, and 10 percent levels, respectively.

Table A4: The cost channel, supplier debt.

	(1)	(2)	(3)	(4)
Supplier inv. coverage ratio (x^s)	-0.017**	-0.028***	-0.033***	-0.040***
	(0.007)	(0.008)	(0.008)	(0.010)
$x^s \times \Delta r_{t-1}$	-0.124***	-0.133***	-0.131***	-0.125***
	(0.017)	(0.018)	(0.018)	(0.019)
Inv. coverage ratio (x^f)			-0.014***	-0.015***
			(0.001)	(0.001)
$x^f \times \Delta r_{t-1}$			-0.004***	-0.005***
			(0.001)	(0.002)
Observations	500,363	500,363	500,363	499,729
R^2	0.014	0.102	0.103	0.130
Firm-level controls		Y	Y	Y
Supplier-level controls			Y	Y
Quarter FE	Y	Y	Y	Y
Fiscal Quarter FE	Y	Y	Y	Y
Industry FE	Y	Y	Y	
Firm FE				Y

This table contains coefficient estimates for Equation 2. The sample corresponds to all non-financial, non-government public firms in the US in the period 1990Q1 to 2016Q4. The dependent variable is the quarterly difference in the log of purchases. The main independent variables are: The quarterly difference in the monetary policy rate (Δr_{t-1}), the lagged average suppliers' debt ratio (x^s), and the interaction between the differences in the monetary policy rate and the average lagged supplier debt ratio. Changes in monetary policy are the quarterly differences in the federal funds rate. Firm-level control variables are the average yearly growth in sales in the firms' industry and lagged values of Tobin's Q, firm size, debt to assets ratio, the ratio of PPE to total assets, and changes in purchases. Supplier controls are the average industry growth rate and lagged values of supplier average Tobin's Q, supplier average size, and supplier average PPE to assets ratio. All variables are defined in Table A1. Standard errors are reported in parentheses and are clustered at the firm level.
***, **, and * indicate statistical significance at the 1, 5, and 10 percent levels, respectively.

Table A5: Cost channel, alternative estimation method.

	(1)	(2)	(3)	(4)	(5)	(6)
Supp. cov. ratio ($\overline{B^s}$)	-0.000	0.004	0.007**	0.001	0.003	0.004*
	(-0.054)	(1.482)	(2.562)	(0.468)	(1.187)	(1.692)
$\overline{B^s} \times \Delta r_t$	0.007	0.004	0.004	0.005	0.004	0.003
	(0.844)	(0.462)	(0.417)	(0.678)	(0.402)	(0.363)
$\overline{B^s} \times \Delta r_{t-1}$	-0.020*	-0.028**	-0.025**	-0.018	-0.027**	-0.025*
	(-1.755)	(-2.172)	(-1.969)	(-1.573)	(-2.121)	(-1.927)
$\overline{B^s} \times \Delta r_{t-2}$	-0.006	0.000	-0.001	-0.006	-0.000	-0.000
	(-0.520)	(0.002)	(-0.058)	(-0.510)	(-0.019)	(-0.005)
$\overline{B^s} \times \Delta r_{t-3}$	0.007	0.008	0.009	0.008	0.010	0.009
	(0.663)	(0.688)	(0.741)	(0.760)	(0.793)	(0.733)
$\overline{B^s} \times \Delta r_{t-4}$	-0.018**	-0.020**	-0.019**	-0.018**	-0.020**	-0.019**
	(-2.217)	(-2.091)	(-2.023)	(-2.182)	(-2.119)	(-1.997)
Observations	557,562	460,216	460,216	557,562	460,216	460,216
R^2	0.181	0.180	0.180	0.182	0.180	0.180
Lags dependent var.	Y	Y	Y	Y	Y	Y
Firm controls		Y	Y		Y	Y
Supplier controls			Y			Y
Time FE	Y	Y	Y	Y	Y	Y
Industry FE				Y	Y	Y
$\sum_{u=0}^{4} \beta_u^s$	-0.0302	-0.0349	-0.0321	-0.0281	-0.0340	-0.0312
F-statistic	20.09	21.27	18.06	17.27	20.17	17.04
p-value	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01

This table contains coefficient estimates for the following equation:

$$\Delta \ln \text{purch}_{it} = \sum_{u=1}^{4} \alpha_u^s z_{it-u} + \sum_{u=0}^{4} \delta_u^s \Delta r_{t-u} + \sum_{u=0}^{4} \beta_u^s \Delta r_{t-u} x_{it-1}^s + \gamma^s x_{i,t-1}^s + \Gamma^{s\prime} X_{it-1}^s + \mu_t + \theta_{s(i)} + \epsilon_{it}$$

The sample corresponds to all non-financial, non-government public firms in the US in the period 1990Q1 to 2016Q4. The dependent variable is the quarterly difference in the log of purchases. The main independent variables are: The quarterly difference in the monetary policy rate and four of its lags, the average suppliers' (inverse) coverage ratio (lagged one quarter), and the interaction between the differences in the monetary policy rates and the average lagged supplier (inverse) coverage ratio. Changes in monetary policy are the quarterly differences in the federal funds rate. Firm-level control variables (not reported) are four lags of the dependent variable, the average yearly growth in sales in the firms' industry, and lagged values of Tobin's Q, firm size, debt to assets ratio, and the ratio of PPE to total assets. Supplier controls include: Supplier average industry growth rate and lagged values of supplier average Tobin's Q, supplier average size, and supplier average PPE to assets ratio. All variables are defined in Table A1. The last three rows of this table contain, respectively: The sum of the coefficients of the interaction terms, an F-statistic for the null hypothesis that the sum of this coefficients equals zero, and its corresponding p-value. T-statistics are reported in parentheses; standard errors are clustered at the firm level.
***, **, and * indicate statistical significance at the 1, 5, and 10 percent levels, respectively.

Table A6: Demand channel, paired client sample. Financial health = Debt.

	(1)	(2)	(3)	(4)	(5)	(6)
Client debt ratio	-0.076***	-0.081***	-0.094***	-0.086**	-0.051	-0.032
	(-2.806)	(-2.832)	(-2.964)	(-2.186)	(-1.241)	(-0.582)
Client debt ratio × Δr_t	-0.025	-0.046**	-0.030	-0.042*	-0.015	-0.012
	(-1.357)	(-2.387)	(-1.346)	(-1.844)	(-0.521)	(-0.417)
Observations	27,247	21,096	20,973	15,314	13,009	8,825
R^2	0.056	0.145	0.378	0.459	0.584	0.639
Client controls		Y		Y		Y
	Y					
Industry × year FE	Y	Y				
Industry × size × age × year FE			Y	Y		
Firm × Year FE					Y	Y

This table contains coefficient estimates for Equation 4. The sample corresponds to non-financial, non-government public firms in the US and their most important clients as reported in the Compustat Segment files for years 1990 through 2015. The dependent variable is $\Delta \ln \text{sales}_{ijt}$, or sales from firm i to client j in year t. The main independent variables are: The yearly difference in the monetary policy rate, the client's (inverse) coverage ratio (lagged one year), and the interaction between these two variables. Changes in monetary policy are the yearly differences in the federal funds rate. Firm-level controls are: Client's industry growth rate, lagged values of client's Tobin's Q, size, and PPE, client monopsony and supplier monopoly power. In addition, estimations contain industry times year fixed effects (columns 1 and 2), firm industry × size group × age group × year fixed effects (columns 3 and 4), and firm × year fixed effects (columns 5 and 6). T-statistics are reported in parentheses; standard errors are double clustered at the supplier and client level.
***, **, and * indicate statistical significance at the 1, 5, and 10 percent levels, respectively.

Table A7: Demand channel on paired client sample. Monetary surprises.

	(1)	(2)	(3)	(4)	(5)	(6)
Client inv. coverage ratio	-0.020	-0.010	-0.008	-0.007	-0.010	-0.027
	(-1.390)	(-0.684)	(-0.420)	(-0.348)	(-0.517)	(-1.297)
Cl. inv. coverage × Surprise$_t$	-0.100*	-0.078	-0.110	-0.146	-0.173**	-0.256**
	(-1.646)	(-1.353)	(-1.615)	(-1.500)	(-2.269)	(-2.551)
Observations	25,359	19,834	19,336	14,241	11,899	8,018
R^2	0.057	0.145	0.387	0.464	0.594	0.645
Client controls		Y		Y		Y
Industry × year FE	Y	Y				
Industry × size × age × year FE			Y	Y		
Firm × Year FE					Y	Y

This table contains coefficient estimates for Equation 4. The sample corresponds to non-financial, non-government public firms in the US and their most important clients as reported in the Compustat Segment files for years 1990 through 2015. The dependent variable is $\Delta \ln \text{sales}_{ijt}$, or sales from firm i to client j in year t. The main independent variables are: The yearly difference in the monetary policy rate, the client's (inverse) coverage ratio (lagged one year), and the interaction between these two variables. Changes in monetary policy are yearly monetary surprises. Firm-level controls are: industry times year fixed effects (columns 1 and 2), firm industry × size group × age group × year fixed effects (columns 3 and 4), and firm × year fixed effects (columns 5 and 6). Columns 2, 4 and 6 include controls for the client's industry growth rate and lagged values of client's Tobin's Q, size, PPE, client monopsony and supplier monopoly power. T-statistics are reported in parentheses; standard errors are double clustered at the supplier and client level. ***, **, and * indicate statistical significance at the 1, 5, and 10 percent levels, respectively.

Table A8: Cost channel on paired supplier sample. Supplier health = Debt.

	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Observations weighted using BEA input matrix						
Supplier debt ratio	-0.085	-0.123	-0.060	-0.113	-0.069	-0.193
	(-1.335)	(-1.300)	(-0.656)	(-0.829)	(-0.675)	(-1.199)
Supplier debt $\times$ Δr_t	-0.029	-0.058	-0.058	-0.090	-0.094	-0.117
	(-0.710)	(-1.231)	(-1.041)	(-1.336)	(-1.455)	(-1.582)
Observations	22,438	17,713	20,089	15,812	17,847	13,898
R^2	0.269	0.372	0.403	0.509	0.597	0.668
Panel B: Suppliers in most important input sectors						
Supplier debt ratio	-0.025	-0.001	-0.025	-0.003	-0.045	0.016
	(-0.858)	(-0.035)	(-0.731)	(-0.072)	(-1.159)	(0.322)
Supplier debt $\times$ Δr_t	-0.047**	-0.039*	-0.009	-0.009	-0.013	-0.039
	(-2.271)	(-1.729)	(-0.346)	(-0.303)	(-0.437)	(-1.168)
Observations	5,400	4,080	4,695	3,502	4,046	2,894
R^2	0.091	0.175	0.165	0.229	0.311	0.369
Supplier controls		Y		Y		Y
Industry $\times$ year FE	Y	Y				
Industry $\times$ size $\times$ age $\times$ year FE			Y	Y		
Firm $\times$ year FE					Y	Y

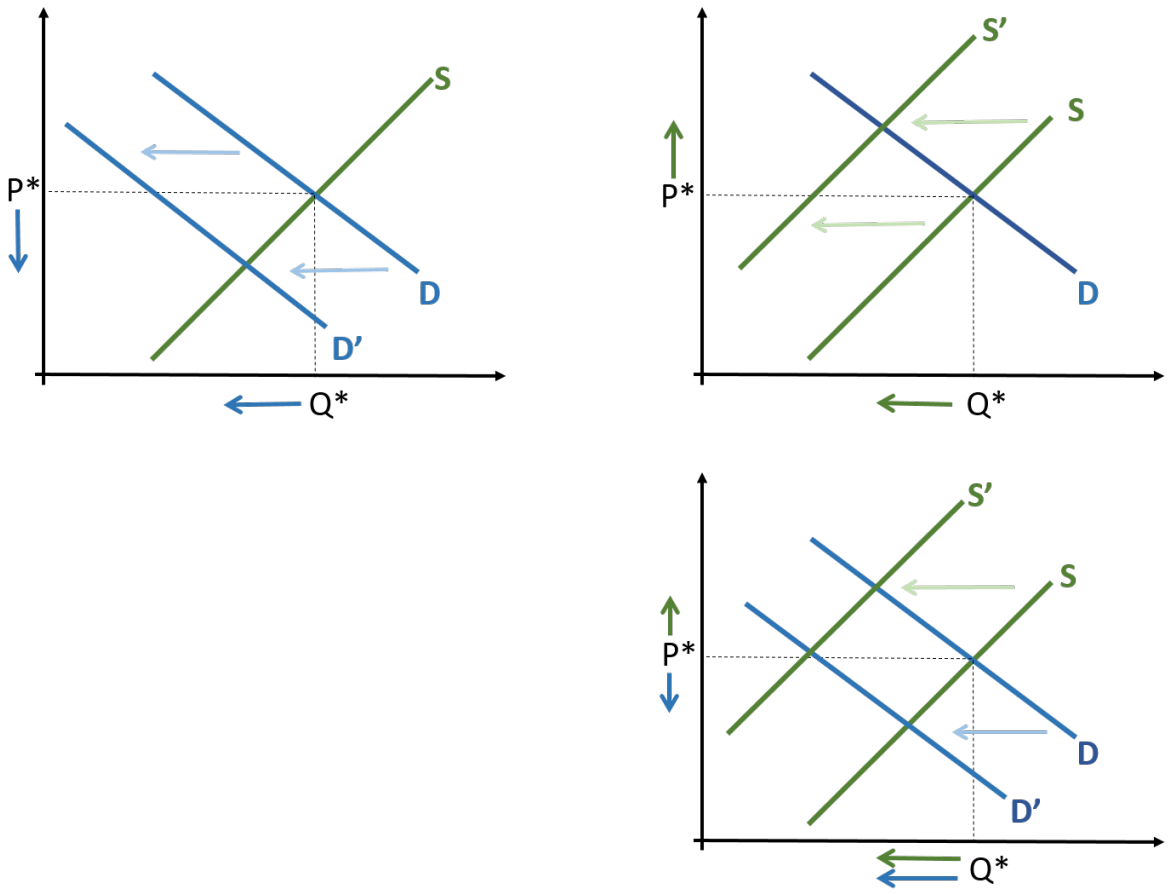
This table contains coefficient estimates for Equation 5. This sample consists of non-financial, non-government public US firms and their suppliers, such that firms are reported to be important clients of the suppliers, suppliers disclose the names of their clients in the Compustat Segment files between years 1990 through 2015, and the suppliers belong to industries that account for up to 75% of the inputs used in the firms' main industry. The dependent variable is $\Delta \ln \text{purchases}_{ikt}$, or purchases by firm i from supplier k in year t. The main independent variables are: The yearly difference in the monetary policy rate, the supplier's debt ratio (lagged one year), and the interaction between these two variables. Changes in monetary policy are the yearly differences in the federal funds rate. Firm-level controls are: Industry times year fixed effects (columns 1 and 2), firm industry $\times$ size group $\times$ age group $\times$ year fixed effects (columns 3 and 4), and firm $\times$ year fixed effects (columns 5 and 6). Columns 2, 4 and 6 include controls for supplier's industry growth rate and lagged values of supplier Tobin's Q, size, PPE, client monopsony and supplier monopoly power. T-statistics are reported in parentheses; standard errors are double clustered at the supplier and client level.
**, **, and * indicate statistical significance at the 1, 5, and 10 percent levels, respectively.

Table A9: Cost channel on paired supplier sample. Monetary surprises

	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Observations weighted using BEA input matrix						
Supplier inv. coverage	-0.013	-0.016	-0.024	-0.010	-0.037*	-0.025
	(-1.100)	(-1.058)	(-1.381)	(-0.515)	(-1.763)	(-1.016)
Supplier inv. coverage $\times$ Δr_t	-0.070	-0.107	-0.050	-0.070	-0.006	-0.014
	(-0.674)	(-0.876)	(-0.424)	(-0.527)	(-0.077)	(-0.182)
Observations	20,389	16,001	18,156	14,203	16,023	12,394
R^2	0.302	0.397	0.437	0.550	0.645	0.721
Panel B: Suppliers in most important input sectors						
Supplier inv. coverage	-0.041**	-0.033	-0.029	-0.014	-0.017	0.009
	(-2.100)	(-1.556)	(-1.237)	(-0.543)	(-0.536)	(0.256)
Supplier inv. coverage $\times$ Δr_t	-0.070	-0.107	-0.094	-0.052	-0.126	-0.054
	(-1.011)	(-1.396)	(-1.022)	(-0.479)	(-0.748)	(-0.284)
Observations	4,185	3,112	3,581	2,559	5,193	3,953
R-squared	0.172	0.239	0.320	0.382	0.093	0.179
Supplier controls		Y		Y		Y
Industry $\times$ year FE	Y	Y				
Industry $\times$ size $\times$ age $\times$ year FE			Y	Y		
Firm $\times$ Year FE					Y	Y

This table contains coefficient estimates for Equation 5. This sample consists of non-financial, non-government public US firms and their suppliers, such that firms are reported to be important clients of the suppliers, suppliers disclose the names of their clients in the Compustat Segment files between years 1990 through 2015, and the suppliers belong to industries that account for up to 75% of the inputs used in the firms' main industry. The dependent variable is $\Delta \ln \text{purch}_{ikt}$, or purchases by firm i from supplier k in year t. The main independent variables are: The yearly difference in the monetary policy rate, the supplier's (inverse) coverage ratio (lagged one year), and the interaction between these two variables. Changes in monetary policy are the yearly monetary surprises. Firm-level controls are: Industry times year fixed effects (columns 1 and 2), firm industry $\times$ size group $\times$ age group $\times$ year fixed effects (columns 3 and 4), and firm $\times$ year fixed effects (columns 5 and 6). Columns 2, 4 and 6 include controls for supplier's industry growth rate and lagged values of supplier Tobin's Q, size, PPE, client monopsony and supplier monopoly power. T-statistics are reported in parentheses; standard errors are double clustered at the supplier and client level.
***, **, and * indicate statistical significance at the 1, 5, and 10 percent levels, respectively.

Figure A1: Monetary policy transmission channels



This figure illustrates how an increase in the monetary policy rate is transmitted through the demand and cost channels of transmission. The demand channel of transmission shifts the demand curve of constrained customers from D to D', reducing equilibrium quantities Q^* and prices P^* (upper left-hand side figure). The cost channel of transmission shifts the supply curve of constrained suppliers from S to S', reducing equilibrium quantities but increasing prices (upper right-hand side figure). When both channels are at work, both the demand and the supply curve of constrained business partners shift to the left, reducing equilibrium quantities but with an ambiguous effect on prices (lower right hand-side figure).