NBER WORKING PAPER SERIES

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Working Paper 28685
http://www.nber.org/papers/w28685

NATIONAL BUREAU OF ECONOMIC RESEARCH
1050 Massachusetts Avenue
Cambridge, MA 02138
April 2021, Revised February 2024

This is an extensively revised version of our 2019 paper with a different title. We would like to thank Thomas Drechsel, Mark Gertler, Yueran Ma, Pablo Ottonello, and Thomas Winberry for extensive comments. We also would like to thanks participants at NBER SI-EFG, NBER ME, Berkeley, Brown, Columbia, Duke, MIT, NYU, AEA, ECB/CEPR for useful suggestions. We thank Jacob Faber, Jacob Fahringer, Alvaro Silva, Ben Schmiedt, and Adam Tucker for their invaluable research assistance. Kalemli-Özcan thanks NSF Grant 2018623 for support. The views in this paper are solely those of the authors and do not reflect the views of the Federal Reserve Board of Governors, anyone in the Federal Reserve System, or the National Bureau of Economic Research.

Collateral Heterogeneity and Monetary Policy Transmission: Evidence from Loans to SMEs and Large Firms

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NBER Working Paper No. 28685
April 2021, Revised February 2024
JEL No. E32,E44,E52,G20,O16

ABSTRACT

We study the role of heterogeneous financial frictions in investment and credit channels of monetary policy, using firm-bank matched administrative data for the U.S. We find that collateral heterogeneity in loan contracts explains the relaxing/tightening of financial constraints in response to monetary shocks. Small and risky firms rely on their earnings and intangibles as collateral, which means their leverage is backed by procyclical earnings. Monetary expansions lower the marginal cost of funds for these firms and expand their borrowing capacity. Monetary policy can be highly effective in economies dominated by small firms pledging their earnings and intangibles as collateral, even though these firms have high default risk.

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1 Introduction

The U.S. Federal Reserve over the past two years aggressively tightened monetary policy to combat inflation, after a decade of easy policy. Yet, there is a lot of uncertainty surrounding how the Fed's policy tightening will impact aggregate credit growth, investment, and employment. Part of this uncertainty stems from the lack of systematic evidence on the role that heterogeneity in financial frictions plays in the bank lending and investment channels of monetary policy. This paper aims to fill this gap.

Using firm-bank matched administrative data for 2012Q3–2019Q4, we evaluate how monetary policy shocks heterogeneously relax or tighten firms' borrowing constraints, conditional on bank and firm time-varying unobservables. We do this by zooming in on the exact form of the financial friction in loan contracts that is important for the investment and credit channels of monetary policy transmission. Performing an aggregation exercise, we show that 60 percent of the effect of monetary shocks on credit growth during our time frame is explained by the heterogenous financial frictions we identify.

We start by asking which firms are the most responsive to monetary policy changes, and investigate how the heterogeneous responses relate to monetary policy's role in relaxing or tightening the financial frictions. Ottonello and Winberry (2020) show that the answer to this question is theoretically ambiguous. On the one hand, high default risk firms suffer from higher cost of funds. Thus, high default risk firms' investment and borrowing may be less responsive to monetary policy changes. On the other hand, the financial accelerator mechanism developed in the work of Bernanke and Gertler (1989), Bernanke, Gertler, and Gilchrist (1996) argues that monetary expansions (contractions) may flatten (steepen) the marginal cost of funds curve by increasing (decreasing) cash flows and/or improving (deteriorating) collateral/asset values. As a result, high risk firms may respond more to monetary shocks since these shocks change their cost of funds relatively more than low risk firms.

We show that the sensitivity of marginal cost of funds to monetary policy shocks depends on the type of collateral pledged by firms. High default risk firms respond more to monetary shocks if their borrowing is secured by their earnings. Such collateral heterogeneity matters in the aggregate because these most responsive high default risk firms in our data are small firms, which in the U.S. comprise 99.6 percent of all firms.[1] Our results imply that the effect of monetary policy is larger in an economy full of small, high default risk firms.[2] During

[1] See U.S. Census Bureau, Center for Economic Studies, Business Dynamics Statistics.

[2] Thus, our results are consistent with Ottonello and Winberry (2020) as they show that monetary policy transmission is more powerful in a model with firm default risk compared to a model without any default risk.

contractions, the earnings of small and risky firms are lower and collateral values are lower. In response, these firms borrow and invest less. By contrast, monetary expansions increase earnings and raise collateral values, lowering the cost of funds. In response, firms increase borrowing and investment. This channel we uncover is similar to the standard collateral channel where procyclical asset values, such as real estate, change the borrowing capacity of debt secured by such fixed assets. However, our channel operates via earnings-based collateral, which is extensively pledged by small and risky firms.

Our paper makes three novel contributions. First, we utilize a representative U.S. firm-level data set to analyze the heterogeneous responses of firms with and without financial constraints to monetary policy shocks. We use two different financial constraint measures: firm-level leverage as a measure of default risk, and loan-level collateral as a measure of access to finance through its effect on cost of funds. We show that highly leveraged firms are more responsive than low leveraged firms to monetary policy shocks. Moreover, firms who pledge collateral are also more responsive to monetary shocks.

Second, we show that the relative responsiveness of financially constrained firms (high leverage firms and/or firms who post collateral) to monetary shocks is driven by private firms—a group that is largely composed of small-and-medium-sized enterprises (SMEs). By contrast, highly leveraged publicly listed firms respond less to monetary policy shocks. In addition, we show that public firms who pledge collateral also respond less. Our results on public firms not only confirm the results in Ottonello and Winberry (2020)[3] with two different measures of financial frictions (firm- and loan-level), but they also demonstrate that both leverage and collateral cannot capture *changes* in financial frictions in response to policy shocks in the cross-section of public and private firms. Various studies document that firm size is a better measure of financial frictions in the cross-section of firms (e.g. Gopinath, Kalemli-Ozcan, Karabarbounis, and Villegas-Sanchez (2017), Gertler and Gilchrist (1994)), but to measure the relaxation and/or tightening of financial frictions in response to policy shocks, we need both the quantity and the price of credit, *e.g.* micro-level interest rates.

Thus, our third contribution is to measure the *changes* in financial frictions as a response to monetary shocks, by investigating *changes* in marginal cost of funds through loan-level spreads. We document that private firms' and SMEs' borrowing costs fall (rise) in response to monetary expansions (contractions) on loans backed by earnings and intangibles as collateral. On the other hand, large publicly listed firms that post collateral, regardless of what type of collateral they pledge, have higher borrowing costs even under monetary expansions. We

[3]These authors showed that high leverage firms respond less to monetary shocks in Compustat dataset that is composed of publicly listed firms.

show that this result is driven by selection: large, listed firms mostly borrow unsecured. Thus, public firms using collateral to secure borrowing signals distress and is reflected in higher borrowing costs regardless of the monetary shock.

The fact that SMEs almost always pledge collateral but large firms borrow unsecured,[4] implies that there is a one-to-one mapping between firm size and financial frictions, in terms of access to finance. Hence, using administrative data, we confirm what an extensive finance literature has already shown using survey data—datasets such as Small Business Finance Survey, and/or QFR of the Census Bureau. Mainly, that small firms are financially constrained. New to our paper is the fact that pledged collateral is also a good measure of financial frictions capturing the fact that small firms are constrained and these constraints can relax as a response to monetary shocks if the pledged collateral is earnings and intangibles.

Our comprehensive administrative data set is at the firm-bank-loan-quarter level and comes from the quarterly data report (FR Y-14Q) collected by the Federal Reserve as part of the Comprehensive Capital Analysis and Review (CCAR) process for bank holding companies, and U.S. Intermediate Holding Companies of foreign banking organizations, covering the period 2012Q3–2019Q4.[5] The firms in our data set cover a large part of the U.S. output and corporate credit: nearly 70% of total commercial and industrial lending (C&I loans), 65% of total corporate sector debt, and most importantly almost 75% of total U.S. gross output.[6]

We estimate panel OLS regressions and local projections for credit growth and investment to quantify the average and dynamic effects of the monetary policy shocks on firms with heterogenous financial frictions. To capture exogenous changes in monetary policy, we identify monetary policy shocks using the high frequency methodology in Gertler and Karadi (2015). Since these shocks are small during our sample period characterized by ZLB, we run several robustness checks using longer maturity Fed Funds Futures, monetary shocks based on

[4]Public firms borrowing unsecured is already documented by a large finance literature. For example, Benmelech, Kumar, and Rajan (2020) show that the unsecured borrowing among large publicly listed firms has become more ubiquitous over time.

[5]The data covers systemically important banks, defined as all financial institutions with $50 billion or more in total consolidated assets. The asset threshold has changed at the end of our sample in December, 2019 to $100 billion and some banks between $100-250 billion were further dropped after 2020. We end our sample in 2019Q4 in order not to confound the standard monetary policy shocks with the COVID-era shocks including pandemic, fiscal, and monetary shocks.

[6]For the share of C&I loans, we divide the total loan originations in the FR Y-14 H.1 schedule by total C&I loans from bank call reports. For the share of corporate sector debt, we divide total long and short-term debt liabilities among firms in our data by sum of total debt securities and loan liabilities from the Z.1 National Accounts, tables B.103 & 104, for non-financial corporate and non-corporate balance sheet tables. For the share of U.S. gross output we divide total sales among firms in our data by total output from the Bureau of Economic Analysis Gross Output by Industry (excluding the same industries we exclude in our data as described in Appendix A).

sentiments, other surprise measures and dummies for expansionary policy stance.

Our empirical specifications estimate the semi-elasticity of firm investment and credit with respect to a monetary policy shock. Our identification strategy is based on interacting time varying exogenous monetary policy shocks with static firm- (leverage) and loan-level (collateral) financial frictions. Firm leverage is persistent and time-invariant (e.g. Lemmon, Roberts, and Zender (2008)). Therefore, our identification assumption for the investment response is that leverage is not endogenous to monetary shocks at the quarterly frequency, conditional on observed time-varying sales growth that captures firm growth and customer demand. We include firm fixed-effects to absorb unobserved static firm characteristics, such as size. For the credit growth regressions, we follow the same approach, but we also control for unobserved firm-bank relationships with firm-bank fixed effects and time-varying bank characteristics through bank-quarter fixed effects. Notice that such a strategy of identifying from banks lending to multiple firms does not lead to loss of observations since any given bank lends to multiple firms at all times. In addition, we also control for sector×quarter fixed effects to capture differences in how sectors respond to aggregate shocks.

Our second measure of financial frictions, loan-level pledged collateral, is endogenous to firm size, bank characteristics, and monetary shocks. We tackle this endogeneity using bank-firm-quarter fixed effects and identify responses from variation between multiple loans for a given firm-bank pair in a given quarter. This specification absorbs all time-varying firm and bank characteristics. To avoid capturing the increased use of higher valued collateral in response to monetary expansions, we focus on existing loan exposures of a given bank-firm pair rather than 'new' loans. In fact, using existing loans biases our results downwards if most of the effect of monetary policy expansions comes from new loans. However, it gives us clean identification because we do not use the value of the existing collateral, which also changes in response to monetary shocks. Instead, we use a dummy for the *type* of collateral pledged ex-ante before the shock. The ex-ante dummy variable identifies the impact of monetary policy from firms who can ex-post draw relatively more credit following monetary expansions from earnings-based collateral versus other types of collateral.

We measure the *changes* in financial frictions through the endogenous response of loan spreads by showing that drawing more credit after monetary expansions from credit lines previously secured with earnings-based collateral is associated with lower spreads on these ex-post drawings. Our interpretation of this result is that earnings-based collateral eases financial frictions by lowering marginal cost of funds (lower spreads) since such collateral is more valuable under monetary expansions. Since we know which loan is tied to what collateral

(real estate, cash/marketable security, accounts receivable/inventory, fixed assets, blanket lien), its origination, maturity, specific use, lien order and so forth, these *within-firm-bank* regressions identify via the intensive margin to rule out any differences in the marginal benefit of credit or any other firm-time level confounders. The within firm-bank regressions also show that even in the absence of monetary shocks, SMEs face lower cost of funds when they use any type of collateral. But when they borrow against collateral whose value is inextricably tied to firm operations, intangibles, and hence enterprise continuation values rather than collateral whose value is market or re-sale based such as fixed assets and real estate, then the sensitivity of their cost of funds to policy shocks increases. These results are consistent with the notion that expansionary shocks increase borrowing capacity when earnings-based constraints are the dominant form of collateral as modeled in Drechsel (2022).[7]

We have run extensive robustness analysis on our results. For example, although there were no systemic banking/financial crisis during our period of study, we have checked whether our results were driven by bank heterogeneity. We looked into the behavior of sales and inventories. We have also studied dynamic effects that deliver persistent results over 10 quarters, which lends additional support to the importance of heterogeneity in financial frictions for the aggregate economy especially because of the fact that monetary shocks during our period are small.

Last but not least, we conduct two additional exercises to connect the leverage and collateral results, our two measures of financial frictions. First, we horse race between high leverage firms and high earnings-based collateral firms–firms with more than 70 percent of their debt secured by earnings and intangibles. The horse race shows that the leverage of "high leverage" firms is backed by earnings-based collateral. The second exercise defines a new firm-level "borrowing capacity" variable based on the distance between each firm's leverage backed by earnings-based collateral and the maximum leverage value in the industry to which the firm belongs to. The higher the borrowing capacity, the closer the firm is to the industry leverage maximum. We show that during monetary expansions borrowing capacity expands and firms with higher borrowing capacity based on earnings-based collateral borrow more. Overall, these exercises provide further support that we capture changes in financial frictions as a result of exogenous monetary policy shocks and small private firms (SMEs) with high default risk, who borrow by pledging their earnings, are important for monetary policy transmission in the aggregate.

[7]See Lian and Ma (2020) who show that most of the corporate sector debt in the U.S. is backed by earnings-based collateral. See also Ivashina, Laeven, and Moral-Benito (2022) for similar results in Peru, and di Giovanni, Kalemli-Özcan, Ulu, and Baskaya (2022) in Turkey.

We proceed as follows. Section 2 summarizes the literature. Section 3 describes the data. Section 4 presents the results. Section 5 presents additional robustness analysis. Section 6 concludes.

2 Related Literature

There is an extensive theoretical literature studying monetary policy transmission in heterogeneous agents macro models focusing on household heterogeneity for consumption channel (e.g Kaplan, Moll, and Violante, 2018; Auclert, 2019; Wong, 2019), through HANK models. Our work relates to this literature from the quantification perspective since these models show that it is important to measure the strengths of different forces at play. There are direct channels that affect consumers' decisions to postpone purchases when interest rates increase. Indirect channels arise through the impact of the policy rate on other interest rates and on dividends, wages, and government taxes and transfers. The relative size of indirect versus direct channels depends mainly on the marginal propensity to consume (MPC).

Our paper quantifies these channels on the firm investment and credit side. As predicted by these HANK models, and also by the HANK model for firms of Ottonello and Winberry (2020), we show opposing effects on firms with heterogeneous frictions and that heterogeneity matters for the aggregate impact of monetary policy through investment and credit channels. Our empirical exercise, focusing on financial frictions via collateral use is complementary to other empirical papers focusing on other firm characteristics such as firm age and size (e.g Jeenas, 2019; Cloyne, Ferreira, Froemel, and Surico, 2022).

Our paper also relates too Kiyotaki and Moore (1997) and Kiyotaki, Moore, and Zhang (2021), in terms of the importance of collateral as a measure of access to finance. In these papers, entrepreneurs borrow against fixed assets and real estate (trees). If a firm uses these assets as collateral and defaults, then lenders confiscate the assets and sell them to other buyers. Hence, the market or liquidation value of the asset determines its collateral value to lenders and final borrowing capacity. In these models, entrepreneurs use collateral to generate output (fruit) but cannot borrow against that output. However, in our data, SME loans are most frequently secured by accounts receivable and inventory (AR&I) collateral and blanket liens. The common property of AR&I and blanket lien collateral is that their values derive from firm operations, *i.e*, *current* fruit. In particular, firm sales combine ideas, intangible capital, marketing of products, etc., which are embedded in the value of the fruit they produce and become capitalized and pledgeable on the balance sheet as AR&I and blanket liens.

We find that monetary policy not only changes the relative price of fixed assets as in these traditional models, it also impacts firms' ability to produce its own assets that are used as collateral (fruit). The framework of Benmelech and Bergman (2012) can rationalize our findings. They argue that monetary policy, through the general equilibrium impact on aggregate demand, increases firm sales (and accounts receivable), which increases borrowing capacity. Our contribution to this literature is to provide evidence on how monetary policy shocks relax or tighten different constraints differently interacting with the pricing of loans.

We also contribute to the new empirical literature that draws a distinction between debt secured by assets (asset-based loans) and debt tied to firm cash-flows and earnings (earnings-based or going concern debt) (e.g Lian and Ma, 2020; Drechsel, 2022). Our contribution here is to draw on brand-new granular data on pledged collateral, which allows us to show that the firm itself *creates* its own collateral value through production rather than purchasing it as it does with land or machines. We show that the inability to separate the liquidation value of AR&I from going-concern value embedded in blanket liens is particularly important for SMEs who do not have large amounts of tangible fixed assets to pledge. Our results on monetary policy transmission show that these two types of collateral, AR&I and blanket liens, work exactly the same because their values derive from firm operations and continuation values.

3 Data

We present a brief description of FR Y-14Q data here and provide details in Appendix A.

3.1 Coverage and Representation

The U.S. Census Bureau defines SMEs as firms with less than 500 employees. Based on this employment definition, the Small Business Administration (SBA) reports that SMEs account for 99.6 percent of all U.S. firms, 52 percent of private sector employment and 50 percent of private sector gross output in the U.S. There is not a well-established asset and/or revenue cut-off to define SMEs in the U.S. across all the industries. Since FR Y-14Q data does not cover employment, we follow the OECD definition of SMEs as firms with assets less than $10 million, and/or revenue less than $50 million. As shown in Panel (a) of Figure 1, most of the private firms (red bars) in our data are SMEs with assets less than $10 million, while there are almost no SMEs among public firms (blue bars).

The typical thresholds for being a "small" firm in the U.S. studies are based on firms with assets less than $100 million in Compustat or QFR, corresponding to bottom 10-15th

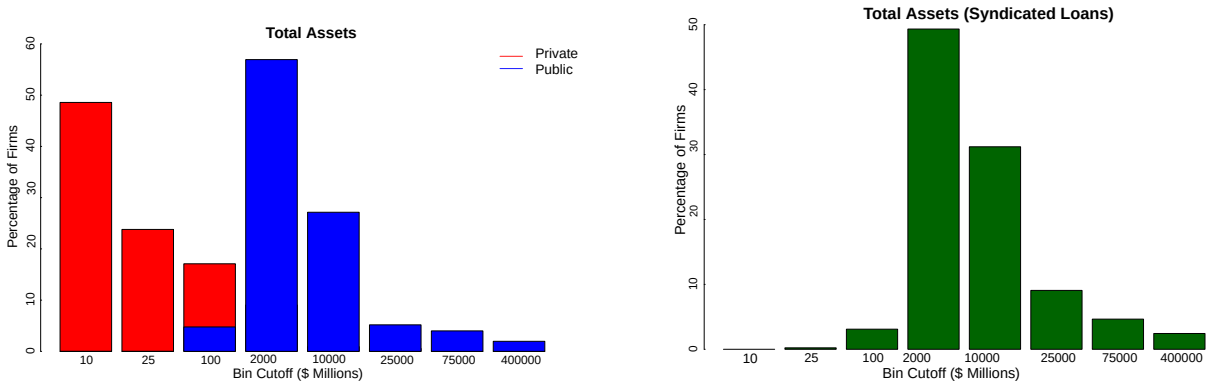


Figure 1.— Firm Size Distribution: Private vs. Public Firms and Syndicated Loan Borrowers. Notes: The figure shows firm size distribution based on assets, for all private firms (red bars) and public firms (blue bars), in Panel (a), and for firms who borrow in syndicated loan markets, Panel (b).

Table 1.— Firms Sales and Assets by Decile (millions)

Variable/Decile	1	2	3	4	5	6	7	8	9	10
Assets	1.239	3.500	6.233	10.223	16.801	29.622	63.784	210.982	1081.471	69431
Sales	5.938	13.997	23.861	38.630	63.394	108.453	209.839	472.919	1488.500	63404

Notes: The figure shows firm size distribution based on assets and sales (in millions, for the all sample of firms in the FR Y14Q data).

percentile, due to low coverage of truly small firms in those datasets. As shown in Table 1, our smallest firms have assets less than 1 million and sales less than 5 million. This is why our data captures a significant number of SMEs, and hence representative of U.S. Census Bureau Revenue enhanced Longitudinal Business Dynamics (RLBD) data that covers the true population of the U.S. firms via its universal coverage.[8] To be clear, our data does not capture the universe of firms and hence universe of firm-borrowers. To be included in our data, a firm must borrow at least 1 million USD from banks subject to CCAR. However, this low threshold and extensive coverage of the banking sector makes our data the most representative firm-level dataset for the U.S. that connects firms' real and financial outcomes both through firm balance sheets—that cover other types of debt and assets—and through credit transactions between firms and their banks.

For example, a typical dataset used in this literature is on firms who borrows in the syndicated loan market. Panel (b) of Figure 1 shows the firm-size distribution for firms who borrow in syndicated loan markets. Only 0.8 percent of the firms in our sample borrow in syndicated loan markets, since most of our small firms cannot access these markets. Importantly, the green bars in Panel (b) mimic the blue bars in Panel (a) indicating that the

[8]The two-hump firm size distribution shown in Figure 1, Panel (a) is very similar to studies using RLBD data, although first hump is higher given many more small firms in the Census data; see for example Dinlersoz, Kalemli-Ozcan, Hyatt, and Penciakova (2018).

firm-size distribution in the syndicated loan market is almost identical to the distribution of public companies. Hence, the popular data sources, LCD Dealscan and the Shared National Credit Registry (SNC), do not seem to contain a representative set of U.S. corporate borrowers.[9]

This of course begs the question whether the private firms in our data are important for U.S. corporate sector debt. The answer is yes. As noted in the introduction our data, FR Y-14Q, covers 65 percent of the aggregate U.S. corporate sector debt. The publicly listed firms in FR Y-14Q account less than half of this— 31 percent of the U.S. corporate debt. Even though, not all publicly listed firms borrow from banks and hence are not covered in FR Y-14Q data, we are not far from the true representation of public firms' share of U.S. corporate sector debt: The share of U.S. corporate debt attributable to the universe of publicly listed firms in Compustat is 48 percent. Hence, more than 50 percent of the U.S. corporate sector debt is born by private firms, which our data is representative of: 52 percent of the U.S. corporate sector debt is accounted by private firms both in our data and in true population.

3.2 What is a private firm and a public firm?

For each quarter, we define private firms in FR Y-14Q data as those that cannot be matched to COMPUSTAT either via 6-digit CUSIP or via tax ID (EIN). We track for initial public offerings (IPOs) and leveraged buy-outs (LBOs). In particular, we match FR Y-14 data to COMPUSTAT quarter-by-quarter. Therefore, a private firm undertaking an IPO will move from private to public in that quarter. That said, the number of firms that move between samples during our time period is very small.

Large public firms generally report consolidated financial statements to banks. To avoid double counting of financial variables for the subsidiaries, we match our data to the Bloomberg Corporate Structure Database with EIN, when possible, or name matching. We roll up loans to subsidiaries to their parent company when banks report parent company rather than subsidiary financial information. In these cases, treating subsidiaries as separate "firms" would introduce errors in firm size and other distributional cuts of the data.[10]

The final data has 3,798,946 loan-level observations for 155,589 unique U.S. corporations,

[9] This is not surprising since in order to be included in SNC, firms need to borrow a minimum of 20 million USD from at least 3 banks.

[10] Relying on the tax ID without the full corporate structure to identify unique firms in the data is also problematic because banks frequently report identical tax ids for both parent companies and their subsidiaries. This results in different balance sheet information for the same tax id because the balance sheet information is attributed to two distinct firms.

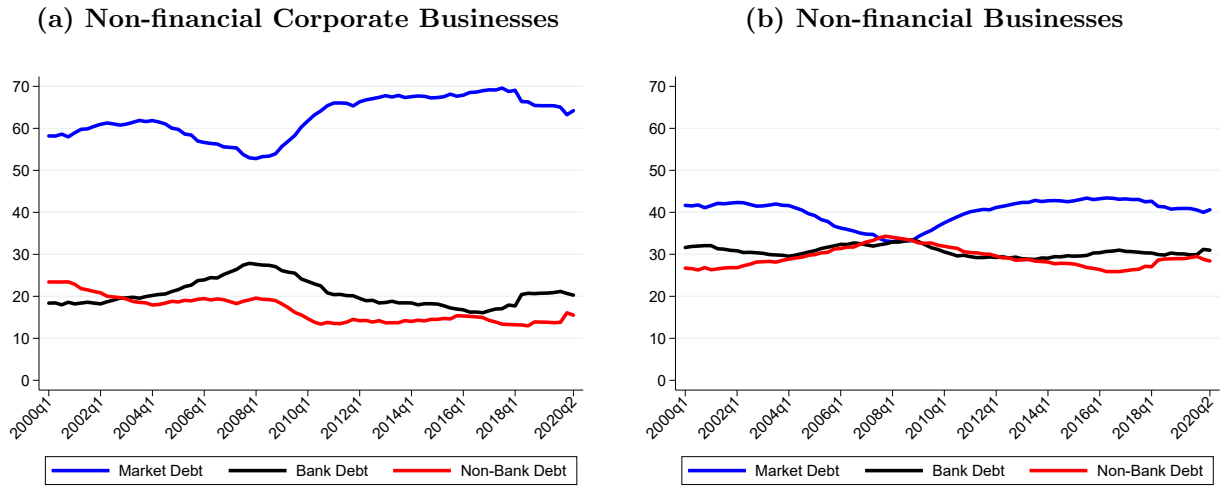


Figure 2.— Debt Shares from Different Lenders from Financial Accounts of the United States. Notes: The panel (a) represents the debt share from different lenders for the "non-financial corporate businesses" in the U.S. The panel (b) represents similar debt share for all "non-financial businesses" in the U.S. The "Bank Debt" include Corporate and Industrial (C&I) loans and non-residential mortgages held by banks. "Non-bank Debt" includes, among others, syndicated loans held by non-banks, non-residential mortgages held by non-banks, and finance company loans. "Market Debt" comprises corporate bonds, commercial paper, and industrial revenue bonds.

where 153K are private firms, covering all sectors of the U.S. economy.

3.3 Bank Dependence of SMEs

Figure 2 plots financing sources for the non-financial business sector from the Financial Accounts of the United States (Flow of Funds). Panel (a) shows the debt share for publicly listed and large private firms (such as C and S corporations), known as "non-financial corporate businesses," an aggregate category that is extensively used by researchers. The share of bank finance, shown by the line "Bank Debt" is small for these companies–around 20 percent on average. Panel (b) plots the "non-financial businesses" aggregate which includes other small private firms.[11] In this panel, the bank-finance share goes up to 30 percent. In addition, the share of market debt declines sharply. Although bank financing overall plays a small role in the aggregate data, the difference between the two panels hints at the importance of bank financing for SMEs.

SMEs, which constitute most of the FR Y-14Q firms, as shown in Figure 1, borrow entirely from banks with almost no presence in the bond market. Figure 3 plots the share of

[11]The private firms included in the "non-financial non corporate" series (L.104 in the Financial Accounts of the U.S.) comprise partnerships, limited liability companies and sole-proprietorships. In the Financial Accounts of the United States, detailed liabilities for private firms, in both non-financial non-corporate and non-financial corporate categories, are not built from the bottom up using firm-level tax records. Total liabilities are based on aggregates from Statistics of Income (SOI) from IRS. The share of each liability type is estimated using lender data sources, for example, Call Reports for the total of bank deposits.

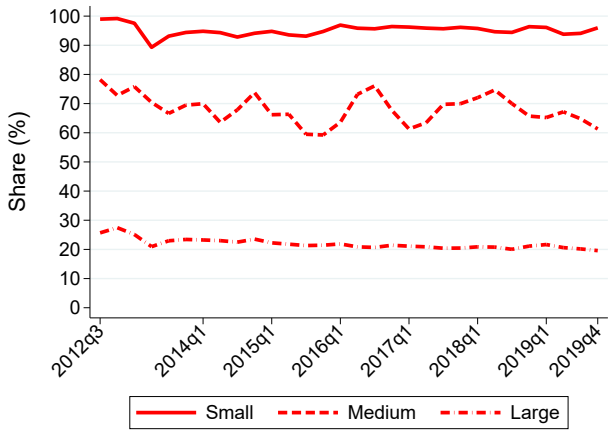


Figure 3.— Share of Bank Debt in Non-financial Private Firms' Financing. Notes: The figure plots bank debt (the median loan *utilization*) as share of total balance sheet debt (loans and bonds) for various points in the asset-size distribution among private borrowers. Figure 19 in the Online Appendix plots shares for median loan *commitment*.

Table 2.— Summary Statistics – Bank Level

	1st Qu. (1)	Median (2)	Mean (3)	3rd Qu (4)	SD (5)
Liabilities-to-Assets	0.868	0.884	0.882	0.897	0.024
Short-Term-Debt-to-Assets	0.690	0.769	0.727	0.808	0.14
Charge-off$_b$ (millions)	0	10.415	22.618	29.295	38.887
Charge-off/Loan$_b$ (%)	0	2.645	5.857	7.347	10.351

Notes: Liabilities-to-assets use total liabilities and the short-term-debt-to-assets ratio uses only financial debt liabilities due within one year. Charge-off is the cumulative dollar value of all net charge-offs across all outstanding loans on a bank's balance sheet. Charge-off/loan is the ratio of the cumulative charge off associated with a given loan over the remaining committed value of the loan. Source Y9C and FR Y-14Q H.1.

bank debt on private firm balance sheets in the FR Y-14Q. For large private firms, defined as firms in the upper quartile of the asset distribution, the FR Y-14Q data matches the aggregate data in Figure 2 (a); bank lending accounts for only 22 percent of their financing. However, financing for the remaining private firms–small and medium size categories–is almost exclusively bank-based. Private firms below the 75th percentile of the asset distribution have assets less than $43 million and revenue less than $86 million. The median firm has $12 million in assets and $28 million in sales, making the typical private firm in the U.S. an SME.

3.4 Descriptive Statistics

3.4.1 Banks under Regulation

Table 2 shows descriptive statistics for the 39 banks subject to administrative regulation (CCAR) which accounts for 85 percent of the U.S. banking industry in terms of assets. Total (0.882) and short-term (0.727) bank leverage during our sample period are lower than before the financial crises due to various post-crisis regulatory reforms. The last two rows report

Table 3.— Summary Statistics – Firm Level

	All Firms (1)	Private Firms (2)	Public Firms (3)
Levels (millions $)			
Fixed Assets	169.575	38.673	6298.168
Capital Expenditures	650.642	20.965	19611.266
Total Assets	419.795	137.144	10012.128
EBITDA	60.842	17.764	1518.326
Ratios			
Liabilities-to-Assets	0.626	0.627	0.582
Account Receivable-to-Sales	0.117	0.092	0.957
Inventory-to-Sales	0.112	0.102	0.433
Short-Term-Debt-to-Assets	0.140	0.144	0.014
Investment	0.133	0.134	0.093
Sales Growth	0.348	0.350	0.313
Share of firms issuing bond	0.012	0.006	0.337
Share of firms issuing securities	0.060	0.040	0.990

Notes: Sample includes 155,600 U.S. firms for the period 2013-2019, excluding financial and government owned firms, and 2,043,008 firm-quarter pairs. All dollar amounts in the table are expressed in millions. Liabilities-to-Assets is defined as total liabilities over total assets while short-term-debt-to-assets is defined as total short-term financial debt over total assets. Investment is defined as the annual change in tangible fixed assets. Sales growth is defined at the annual percentage change in total sales. Private firm balance sheet accounting and income statement data come from the FR Y-14 H.1 Schedule and are winsorized at 4 percent; public firm data are from the S&P Compustat database and are winsorized at 1 percent.

bank charge offs, which are non-performing loan losses on banks' balance sheets. The average bank charge-off is about $22 million and represents on average 6 percent of a given loan.

3.4.2 Firm Balance Sheets, Collateral and Loan Outcomes

Tables 3, 4, and 5 provide summary statistics for a number of firm balance sheet variables and loan-level information on pricing, collateral and maturity. These summary statistics suggest that financial constraints are tighter for private than public firms and also for small rather than large firms.

Table 3 shows that the average private firm has $137 million in assets compared to $10 billion for the average public firm. The average private borrower is more leveraged in terms of short term debt and has higher sales growth and investment than the average public firm. The average private firm does not have access to other financing sources aside from banks. They have almost no outstanding bonds, nor any other form of security outstanding–for example, commercial paper, privately placed or expired bonds. By contrast, a large part of publicly listed firms have current bonds outstanding (34 percent) and almost all have issued some form of security (99 percent).

Table 4 compares firms along the size distribution and leverage dimensions. SMEs have average assets of $18.5 million compared to the average large firm–defined by the upper quartile of the asset distribution–with $1.08 billion, and have slightly higher sales growth.

Table 4.— Summary Statistics by Firm Size and Leverage – Firm Level

			All Firms		SME	
	All SME	Large	High Leverage	Low Leverage	High Leverage	Low Leverage
	(1)	(2)	(3)	(4)	(5)	(6)
Levels (millions $)						
Fixed Assets	6.647	449.472	147.622	168.480	7.404	5.922
Capital Expenditures	2.693	496.268	153.077	209.865	1.919	2.832
Total Assets	18.527	1086.888	357.883	426.989	17.711	17.990
EBITDA	2.543	157.381	56.009	65.165	2.437	2.354
Maturity	3.549	2.766	3.308	2.852	3.940	3.240
Ratios						
Total Debt-to-Assets	0.355	0.381	0.587	0.155	0.631	0.118
Account Receivable-to-Sales	0.118	0.149	0.095	0.134	0.089	0.133
Inventory-to-Sales	0.124	0.128	0.131	0.109	0.134	0.110
Short-Term-Debt-to-Assets	0.143	0.119	0.195	0.068	0.231	0.077
Investment	0.102	0.048	0.059	0.075	0.057	0.089
Sales Growth	0.025	0.020	0.026	0.025	0.022	0.023
Credit Lines	0.625	0.645	0.587	0.664	0.557	0.671
Observations						
Firms	116157	55843	88882	105325	62936	78350
Firm-Quarter	1267683	766629	884048	1080736	526547	691637

Notes: See Table 3 for the definition of variables. 'SME' are firms with sales less than 50 million on average throughout the sample. 'High Leverage' firms those with leverage greater than the median leverage in the sample on average.

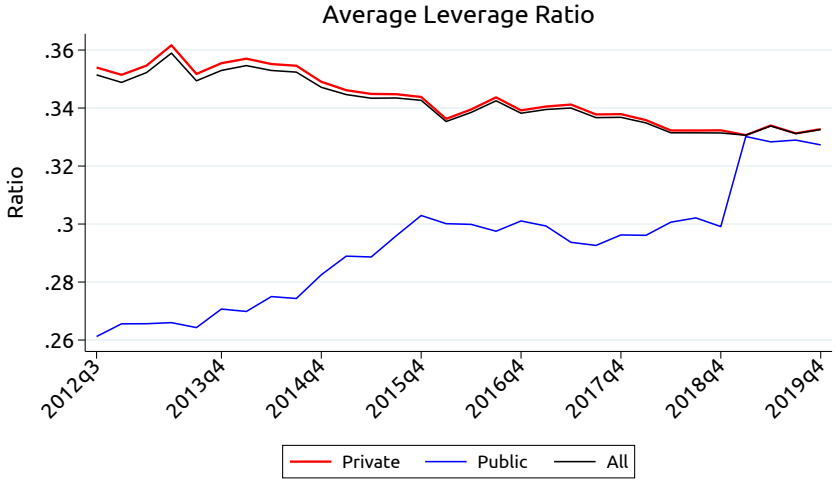


Figure 4.— Average Leverage Ratio Across Firms. Notes: The figure plots the mean total debt-to-asset ratio for all firms, private firms, and public firms.

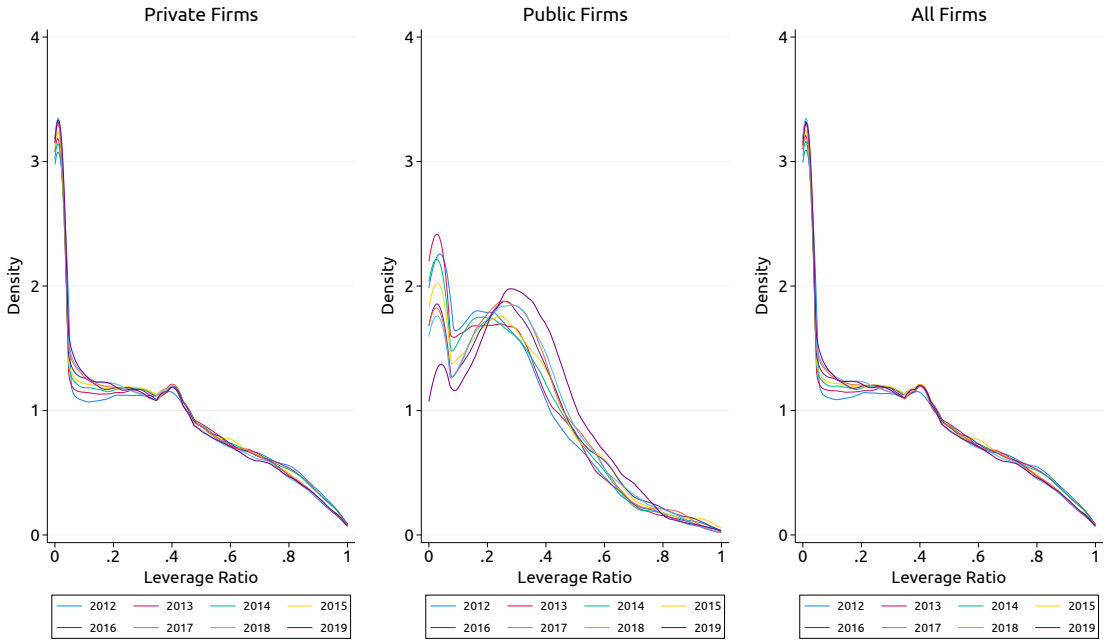


Figure 5.— Leverage Distribution by Firm Type. Notes: The figure plots the distribution of leverage in each year of our sample from 2012-2019. The left panel is the leverage distribution for private firms, the middle is the same distribution for public firms, and the right is the same distribution for all firms.

Large firms are more leveraged than SMEs. In general, sales growth and investment are similar among high and low leveraged firms, for all firms and for SMEs. The difference in debt maturity across firm size is minimal. SME loans are on average 3.5 years compared to 2.7 years for large firms. Among SMEs, loan maturity for high versus low leverage firms is comparable, at 3.9 versus 3.2 years. Moreover, the type of loan–credit line versus term loan–does not vary across firm size. 62% of SME loans are credit lines compared to 64% for large firms. Low leveraged firms have slightly more credit lines.

Figure 4 plots the average leverage ratio among all, private, and public firms. The figure shows that leverage for private borrowers is quite stable around 34 percent, while public firm leverage grew noticeably over time. Moreover, leverage for the average firm in the sample will be closely approximated by the average private firm.

Figure 5 plots the kernel density for leverage among all, private, and public firms for each year in our sample. The full and private firm sample show very clearly that the overall distribution of leverage does not shift year to year. Hence, while individual firm leverage may fluctuate, the distribution of leverage remains constant. Leverage, on average, is time-invariant, which is important to document in order to interpret our regression results as being driven by monetary policy innovations rather than variation in leverage. Another thing to notice is that leverage distribution for all and private firms mimics firm-size distribution both

Table 5.— Summary Statistics – Loan Level

	All Firms (1)	Private Firms (2)	Public Firms (3)
Interest Rate (Percent)	2.80	3.00	1.90
Collateral: Fixed assets and real estate	0.243	0.266	0.14
Collateral: Cash and marketable sec	0.024	0.022	0.034
Collateral: Act. receiv. and inventory	0.284	0.308	0.172
Collateral: Blanket lien and other	0.304	0.322	0.224
Collateralized	0.854	0.916	0.567
Maturity (in years)	3.079	3.1	2.994

Notes: The collateral categories are the fraction of total loans collateralized by each respective category. For example, among all firms, 24 percent of all loans are collateralized by fixed assets and real estate. Collateralized is the fraction off all loans that are collateralized by any collateral category. For example, among all firms, 85.4 percent of loans are collateralized.

in our data and also in the universe of firms of the Census. This finding further supports the high correlation between size and leverage.

Table 5 shows that private borrowers pay higher interest rates than public borrowers on their loans, despite almost always pledging collateral. Accounts receivable and inventory and blanket liens are the most common forms of collateral used by private firms. Figure 6 plots the share of all, private, and public firms pledging earnings- and asset-based collateral in our data. The figure does not show "the most" used collateral but rather the share of firms use these type of collateral. The shares do not sum to 1 because the same firm may use both collateral types to obtain different loans. The important take away from this figure is that the fraction of firms using the different types of collateral is stationary, especially private firms. Moreover, the average collateral share among all firms is closely approximated by the collateral share for the average private firm.

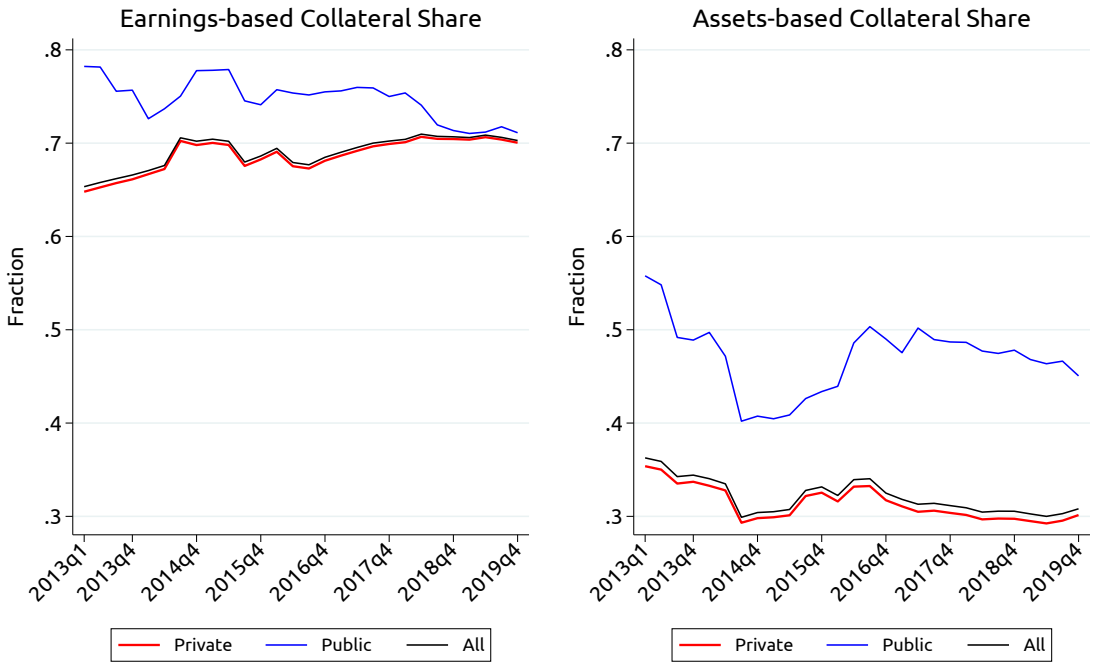


Figure 6.— Collateral Use by Firm Type. Notes: The left (right) panel of the figure plots the share of firms that use earnings-based (asset-based) collateral across all, private, and public borrowers. Many firms borrow using both types of collateral. Hence, the shares do not sum to 1.

4 Empirical Analysis

4.1 Measuring Monetary Policy Surprise Shocks

We estimate monetary policy surprises, denoted with 'MP', based on high frequency identification in Gertler and Karadi (2015). We compute the surprise component of a policy announcement at the monthly level as:

$$MP_t^m = \gamma_t \times \left(\text{ffr}_t^m - \text{ffr}_{t-\Delta t}^m\right); \gamma_t \equiv \frac{\tau^n}{\tau^n - \tau^d} \tag{1}$$

where m denotes the month, ffr_t is the implied Fed Funds Rate from a Federal Funds future contract at time t, and the adjustment factor, γ_t, controls for the timing of the announcement within the month. τ^n is the number of days in the month of the FOMC meeting, and τ^d is the day of the FOMC meeting.[12] It is common to use a combination of current month, 3-month ahead and 6-month ahead futures. Our data begin in 2012Q4 when policy rates were operating at the zero-lower bound (ZLB). Thus, the size of the raw surprises from 1

[12]Note that the multiplier becomes quite large for FOMC events at the end of the month. This could magnify measurement errors. When the adjustment factor is greater than 4, we follow the literature and replace the adjustment factor with the rate change in the following month federal futures contract without a multiplier.

month or 3 month futures are small. To address this issue, we use the 6-month ahead and 9-month ahead futures contract following the work by Miranda-Agrippino and Rey (2020) and Kalemli-Ozcan (2019), who both study international spillovers of U.S. monetary policy during the ZLB, based on high frequency identification of U.S. monetary policy shocks. To extract the surprise component, we measure price changes of the futures 15 minutes before and 45 minutes after the FOMC.[13]

We follow Ottonello and Winberry (2020) and convert the surprise series to a quarterly variable using a weighted moving average of the surprises based on the number of days in the quarter after the surprise has occurred. This ensures that the surprises are weighted according to the amount of time banks and firms have to react to the changes. For the OLS regressions that deliver average effects, we construct 4 and 8-quarter moving averages of the quarterly surprises. The moving average representation allows for monetary policy to have delayed and persistent effects. For example, Romer and Romer (2004) find that monetary policy transmits to real variables and prices with a several quarters' delay and has persistent effects over twenty quarters in the future. Hence, a moving average representation of the quarterly surprises links the surprises to the intermediate-term stance of the monetary policy. Both the surprises and the policy stance were largely expansionary during our sample period. For the dynamic impulse responses that we present in the additional analysis section below, we use the quarterly surprises directly without the moving average representation.

4.2 Firm Leverage and Risk of Default

We measure firm leverage in the standard way as ratio of debt to assets. We use both short-term debt and total debt. We use leverage as a firm-level financial friction measure, a proxy for firm default risk. We confirm, in Table 6 that firm leverage in previous quarters predicts default in next quarters, both unconditionally and conditional on having non-performing loans, both for private and public firms. These results are robust to the way we measure firm leverage: based on short-term debt to total assets or total debt to total assets.

4.3 Firm Investment and Firm-Bank Credit Regressions

Why does monetary policy impact the investment and credit decisions of high and low leverage firms differently? As we show above, firm leverage is a good proxy for firm default risk, which

[13] If we use price changes in 2-year treasuries, we obtain similar results. These results are available upon request. For a visual presentation of these surprises, and a historical comparison, please see Figure 20 in the Online Appendix.

Table 6.— Firm Leverage and Default

	Default Probability								
	All Firms			Private Firms			Public Firms		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Firm Leverage$_{q-1}$	0.0448***		0.0496***	0.0412***		0.0367***	0.1044***		0.1266***
	(0.0028)		(0.0074)	(0.0027)		(0.0063)	(0.0214)		(0.0327)
Non-Performing Loan$_{q-1}$		0.0181***	0.0175**		0.0525***	0.0519***		0.0002	-0.0007
		(0.0049)	(0.0048)		(0.0115)	(0.0114)		(0.0038)	(0.0038)
Observations	1656049	535836	535836	1454694	415830	415830	201355	120006	120006
Adjusted R^2	0.601	0.810	0.811	0.601	0.822	0.822	0.576	0.663	0.673
Firm F.E.	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Quarter F.E.	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: $^{+}$ $p < 0.1$,* $p < 0.05$,** $p < 0.01$, and *** $p < 0.001$. The loan-weighted default probability is the each bank's one-year ahead default probability for firm i weighted by the loan commitment amount for each bank. The default probability is the bank-provided probability that a firm fails to repay a loan in the next 12 months. The non-performing loan dummy is equal to 1 if a firm has any non-performing loans in the prior period. Leverage is the ratio of total debt liabilities over total assets.

is informative for borrowing capacity and cost of funds. Recall that high and low leverage firms have similar sales growth rates. Hence, the impact of monetary policy on the credit and investment demand of high and low leverage firms should be similar unless monetary policy has a differential impact on firms' cost of funds.

We start by aggregating all loans between a firm and a bank to the pair–quarter level. We create 'High Leverage Firm' as a dummy equal to one for firms with leverage in the first quarter of the sample (or average leverage) higher than the median leverage, and zero otherwise. Credit regressions are at firm-bank-quarter level and investment regressions are at firm-quarter level, as shown below:

$$\log \sum_{l \in \mathcal{L}(f,b,q)} L_{f,b,q}(l) = \alpha_{f,b} + \alpha_{b,q} + \alpha_{s,q} + \kappa \left(\textbf{High Leverage Firm}_f \times \frac{1}{N} \sum_{k=0}^{N} \text{MP}_{q-k} \right) + \vartheta_{f,b,q} \tag{2}$$

$$\Delta \log K_{f,q} = \alpha_f + \alpha_q + \alpha_{s,q} + \kappa \left(\textbf{High Leverage Firm}_f \times \frac{1}{N} \sum_{k=0}^{N} \text{MP}_{q-k} \right) + \vartheta_{f,q} \tag{3}$$

where, in equation (2) $\log \sum_{l \in \mathcal{L}(f,b,q)} L_{f,b,q}(l)$, is the total loan amount for a given firm-bank pair, (b, f), and quarter, (q). $\alpha_{f,b}$ is the firm×bank fixed effect and $\alpha_{b,q}$ is the bank×quarter fixed effect. This fixed effect specification accounts for the cross-sectional variation in banking relationships and time variation in differential bank credit supply. N captures either a 4 or

8-quarter moving average, indexed by k. Quarter fixed effects absorb the common risk-free rate and direct effect of monetary policy. The log of total loans as a dependent variable allows expansionary monetary policy to create new firm entry into the credit market. A Δ log formulation (credit growth for a given firm) would restrict the analysis to existing firms throughout the sample.

In equation (3) $\Delta \log K_{f,q}$, is investment measured as change in log of fixed assets of a given firm. α_f is the firm fixed effect and α_q is the quarter fixed effect. We also use sector $\times$ quarter fixed effects, $\alpha_{s,q}$, in both specifications. This is important given the differences in loan outcomes across sectors as detailed in our Online Appendix B.1.1

Table 7 reports the result on investment. In the top panel, we show the leverage measure used in the literature relying on firm-level data, which is firm demeaned leverage (e.g Ottonello and Winberry (2020)). The bottom panel uses the high leverage dummy variable defined above, as typically used in the literature using firm-bank matched data (e.g di Giovanni, Kalemli-Özcan, Ulu, and Baskaya (2022)).[14] The results in both specifications show that high leverage firms' investment responds more to monetary policy shocks, unless they are publicly listed firms. All firms sample and private firms sample both show a negative coefficient: high default risk (leveraged) firms' investment contracts with monetary contractions and expands with monetary expansions more relative to other firms. This result is consistent with a large class of macro-finance models. However, the result is opposite for leveraged public firms, as shown by the positive coefficient of the interaction term between leverage and monetary policy surprise. Leveraged public companies increase investment with monetary contractions and decrease investment with expansions, relative to others, that is they are less responsive to monetary policy, as also shown by Ottonello and Winberry (2020).

Table 8 shows results for credit growth that are consistent with investment. If monetary policy impacts the real economy through the credit market, then firms who invest more during monetary expansions should also be borrowing more and firms who invest less during monetary contractions should be borrowing less. This is exactly what we find: more leveraged firms receive more credit during monetary policy easing, unless they are public firms, where leveraged or not leveraged public firms do not differ in credit outcomes. These results rely on conditioning on time-varying bank unobservables, so cannot be driven by credit supply side. The results are consistent with financial frictions (measured by leverage) relaxing for

[14]Because we are not interested in the direct effect of leverage, our preferred leverage variable is the dummy variable and is presented throughout the rest of the paper. The direct effect of leverage will be absorbed by the firm fixed effect. The direct effect of leverage is estimated in the specification that uses the demeaned firm leverage variable reported in the top panel of Table 7 where the estimated coefficient is not shown for space considerations.

Table 7.— Monetary Policy and Investment: The Role of Firm Leverage

	Investment		
	All Firms	Private Firms	Public Firms
	(1)	(2)	(3)
Firm Leverage × MP Surprise$_q$	-0.127***	-0.130***	0.0297*
	(0.0465)	(0.0473)	(0.0175)
Observations	1627876	1596557	31307
Controls	Yes	Yes	Yes
Sector × Quarter F.E.	Yes	Yes	Yes
Firm F.E.	Yes	Yes	Yes
High Leverage Firm × MP Surprise$_q$	-0.0373*	-0.0452**	0.0184**
	(0.0208)	(0.0213)	(0.00851)
Observations	1627876	1596557	31307
Controls	Yes	Yes	Yes
Sector × Quarter F.E.	Yes	Yes	Yes
Firm F.E.	Yes	Yes	Yes

Notes: $^{+}$ $p < 0.1$,* $p < 0.05$,** $p < 0.01$, and *** $p < 0.001$. Investment is measured by log difference in fixed assets. Firm leverage in the top panel is within-firm demeaned leverage investment as in Ottonello and Winberry (2020), while leverage in the bottom panel is a time-invariant dummy variable equal to 1 if the firm's leverage in the first quarter of the data is above the median leverage (avg firm leverage above the median definition of the dummy deliver the same result). All leverage measures are computed using total debt following Ottonello and Winberry (2020). Controls include the demeaned firm leverage not absorbed by firm fixed effects and sales growth. The monetary policy shock is measured using 1 and 6 months future contracts. Standard errors are clustered by firm times quarter and are reported in parentheses for all specifications.

the average firm during expansions and tightening during contractions and they are driven by private firms sample.

Recall that descriptive statistics that we have documented in section 3.4.2 highlight the correlation between leverage and size. It might be the case that since publicly listed firms are much larger and leveraged then the median U.S. firm, they are creating a selection problem. Hence a better cut of the data might be not by private and public, but rather by size and leverage. Thus, we rerun the credit regressions on the full sample of U.S. firms, where we keep the same definition for the leverage dummy and introduce a time-invariant SME dummy, that is equal to one if the firm's average revenue over the sample period is less than $50 million.

The results are reported in Table 9. The significance of the interaction term of leverage and monetary policy disappears moving from column (1) to (3). Column (3) shows that leveraged SMEs were driving the results before in all firms sample, that is leveraged SMEs borrow relatively more during monetary expansions, responding more to policy shocks. Interestingly, the coefficient of the interaction term between the SME dummy and monetary policy surprise indicates, in column (2), that SMEs borrow less than large firms during expansions and borrow more than large firms during contractions. This is consistent with the fact that it is leveraged SMEs who suffer from financial constraints that relax and tighten with monetary

Table 8.— Monetary Policy and Credit Outcomes: The Role of Firm Leverage

	Log(Loan)		
	All Firms	Private Firms	Public Firms
	(1)	(2)	(3)
High Leverage Firm × MP Surprise$_q$	-0.2002**	-0.4630***	0.1003
	(0.0672)	(0.0810)	(0.2011)
Observations	2181847	1967601	270105
Adjusted R^2	0.948	0.941	0.849
Controls	Yes	Yes	Yes
Bank × Firm F.E.	Yes	Yes	Yes
Bank × Quarter F.E.	Yes	Yes	Yes
Sector × Quarter F.E.	Yes	Yes	Yes

Notes: $^{+}$ $p < 0.1$,* $p < 0.05$,** $p < 0.01$, and *** $p < 0.001$. High Leverage Firm is the time-invariant dummy defined before. Controls include sales growth and its interaction with monetary policy. Standard errors are clustered by firm times quarter and are reported in parentheses for all specifications.

Table 9.— Monetary Policy and Credit Outcomes: The Role of Firm Leverage and Size

	Log(Loan)		
	(1)	(2)	(3)
High Leverage Firm × MP Surprise$_q$	-0.2002**		-0.0089
	(0.0672)		(0.0916)
SME × MP Surprise$_q$		0.5293**	0.8848***
		(0.0982)	(0.1631)
High Leverage Firm × SME × MP Surprise$_q$			-0.5482***
			(0.1272)
Observations	2237716	223771	223771
Adjusted R^2	0.948	0.948	0.948
Controls	Yes	Yes	Yes
Bank × Firm F.E.	Yes	Yes	Yes
Bank × Quarter F.E.	Yes	Yes	Yes
Sector × Quarter F.E.	Yes	Yes	Yes

Notes: $^{+}$ $p < 0.1$,* $p < 0.05$,** $p < 0.01$, and *** $p < 0.001$. The specification is run on the all firm sample. SME is a dummy variable equal to 1 for firms with sales below $50 million. All other variables are as before. Double-clustered standard errors by firm and time are reported in parentheses.

policy shocks and not just any SME.

Overall, the results so far show that expansionary monetary policy has a particular effect on the borrowing capacity of leveraged SMEs that is not *ex-ante* obvious. In Section 4.4 below, we dig deeper into the exact form of financial friction that explains the channel behind why leveraged SMEs borrowing capacity expands in spite of higher default risk, during monetary expansions (and contracts during contractions).

4.4 The Role of Collateral: What do Firms Pledge?

Following Kiyotaki and Moore (1997), many papers show that financial frictions via collateral constraints impact monetary policy transmission and can amplify business cycle fluctuations. In this class of models there is no default risk, but due to latent default risk, firm borrowing

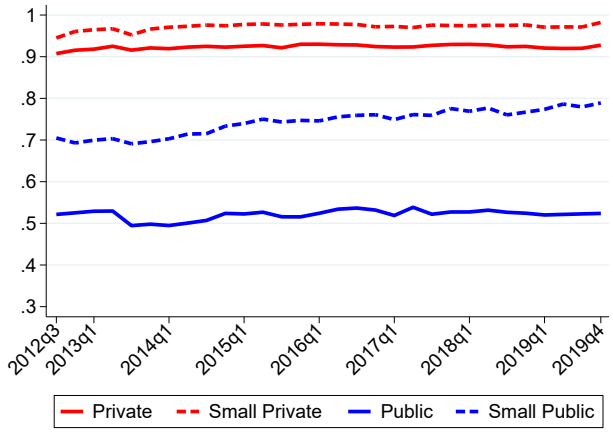


Figure 7.— Share of Loans that are Collateralized: Public vs. Private. Notes: The dashed line represents the share of total loans that are collateralized for firms in the 25th percentile of the asset distribution (small).

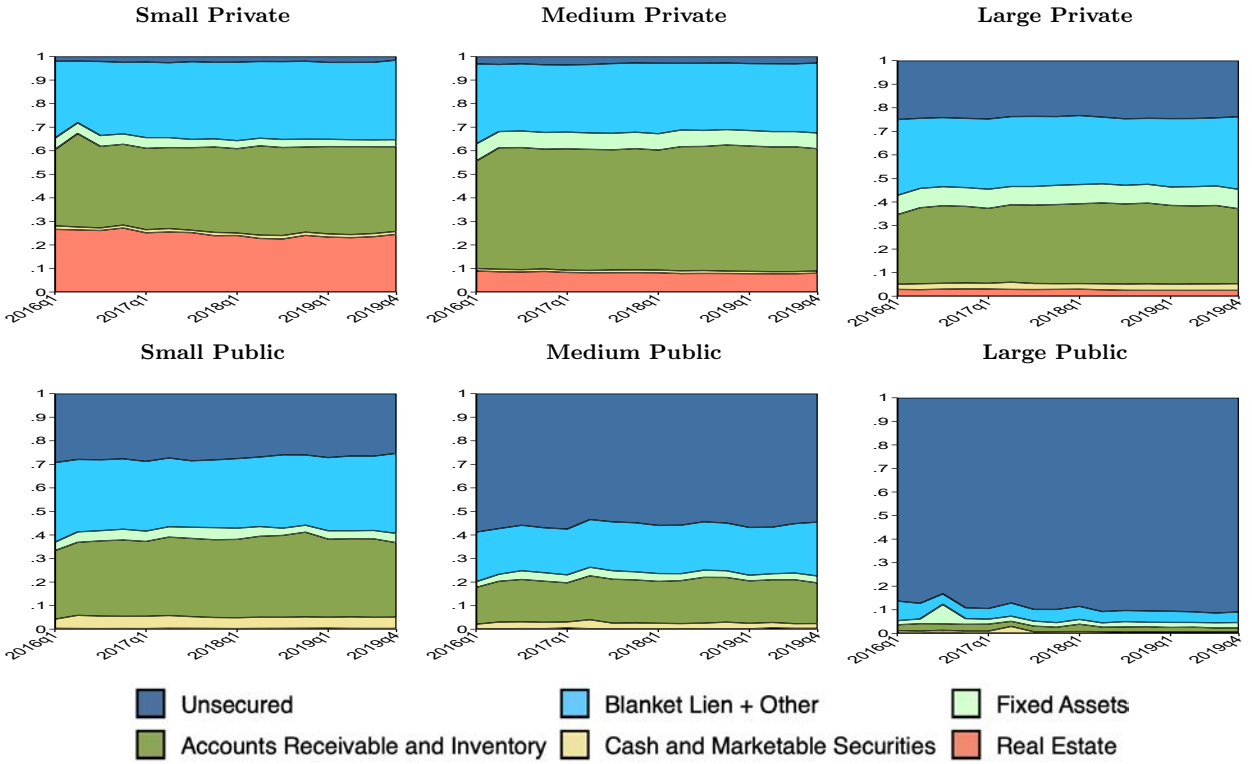
is collateralized. Hence firms cannot borrow without pledging a fraction of the resale value of the capital stock. Monetary policy changes the resale value of assets that generates changes in firms borrowing capacity. The collateral information in the FR Y-14 allows us not only to see what firms do pledge in real life, but it will also allow us to test the impact of monetary policy via *relaxation/tightening* of collateral constraints.

Figure 7 plots the share of loans secured by some form of collateral broken out by private and public borrowers. Slightly more than 90 percent of all private loans are collateralized (red solid line), compared to roughly 50 percent for public borrowers (blue solid line). Remarkably, 95 percent of all loans to smaller private firms are collateralized (red dotted line), while small public firms collaterize up to 70 percent of the loans (blue dotted line). Hence pledging collateral can be mapped one to one to firm size indicating small firms are more financially constrained than large firms.

The FR-Y14Q data contains granular information about the type of collateral used to secure a loan. Specifically, the banks report six collateral categories: real estate; fixed assets; cash and marketable securities; accounts receivable and inventory (AR&I); blanket liens, and other. Figure 8 shows loan shares (by value) secured by the different collateral types.[15] There are several remarkable features to highlight, where, to the best of our knowledge documented first time in our paper, for the U.S. firms. First, real estate collateral (in red) is important only for the smallest private borrowers and virtually absent among public borrowers. Second, fixed assets (light green) as a fraction of all collateralized loans is not an important source of collateral and may only reflect leases (Eisfeldt and Rampini, 2008). Third, AR&I (dark green) and blanket liens (light blue) are equally important collateral sources across the firm

[15]The Online Appendix Figure 22 shows the same figure based on number of loans instead of value.

Figure 8.— Collateral Types Across Firm Size Distribution by Public and Private Firms.



Notes: The figure plots the value share of loans secured by different collateral types over time. The top three panels from left to right show loan shares secured by the different collateral types for private borrowers in the bottom quartile of assets (small), between the bottom and top quartile of assets (medium), and above the top quartile of assets (large). The bottom three panels repeats the same exercise for public firms.

size distribution except for the medium and large public companies. In fact AR&I and blanket lien collateral are the most important collateral for all private firms and the smallest public firms. Finally, unsecured borrowing (dark blue) increases monotonically across firm size and dominates the borrowing pattern of large public firms. Figure 21 in the Online Appendix shows that SMEs collateral use mimics the pledged collateral by small private and medium private firms above, and that the most important form of collateral used to borrow by financially constrained SMEs are AR&I and blanket liens.

4.5 Loan-Level Regressions

To investigate the role of collateral, we start with a loan-level regression of the form:

$$\log \mathrm{Y}_{l,f,b,q} = \alpha_{f,b,q} + \beta \textbf{Collateralized Dummy}_l + \lambda(\textbf{Collateralized Dummy}_l \times \mathrm{MP}_q) + \vartheta_{l,f,b,q} \tag{4}$$

where loan-level credit quantity and interest rate are the two dependent variables denoted with $\log \mathrm{Y}_{l,f,b,q}$. Hence in these regressions we do not aggregate loans to the firm-bank pair

level.

The decision to collaterize or not (given by collateralized dummy equal to 1) in a given period is not exogenous. The endogenous dependence of collaterization on firm and bank factors will be soaked up by our triple firm-bank-quarter fixed effects, $\alpha_{f,b,q}$. The triple-fixed effects specification focuses on multiple loans in a given quarter between a given firm-bank pair. Since over 50% of firms have multiple loans from a single bank, this strategy has enough variation to identify the coefficient of interest, λ.

The choice to collaterize a loan is also endogenous to monetary policy shocks. Thus, we identify the impact of collateral using loans during the sample period based on the initial collateral posted. In other words, the collateral pledged the first time a loan appears in the data and ex-ante to the monetary policy shock. This strategy requires us to drop new loan issuances with new collateral pledged after the monetary policy shocks.

We begin by running regression equation (4) using a collateral dummy variable equal to one if the loan is collateralized and zero otherwise, regardless of the *type* of collateral pledged. The results in Table 10 highlight a stark difference in the way that pledging collateral interacts with access to and the pricing of credit across firm types. Recall that regressions solely identify from within firm-bank pair variation. The first row captures the effect of collateralizing a loan during normal times. The results show a positive (negative) association between collateral and loan quantity (price), for private firms. Collateralizing a loan is associated with improved access to credit (larger loans and more loans) and lower spreads on loans. The opposite is true for public borrowers: collateralization is associated with lower loan amounts and higher spreads on these loans. This can be due to a selection effect, even the firm and bank are fixed. It can be that only bad public firms borrow by posting collateral and pay higher spreads to cover higher monitoring costs.

To assess the impact of monetary policy, we interact the collateral dummy variable with the policy surprises. The results are shown in the second row of Table 10. The negative coefficient of the interaction term on loan quantity (column 1) implies that expansionary monetary policy strengthens the 'access to finance' effect of collateralizing loans by increasing loan amounts during expansions. The spread effect in column (3) goes the other way round, that is, during expansions collateralized loans seem to have higher spreads but this is the partial effect: the total effect of a monetary expansion on spreads is negative at mean level of policy surprise.[16] In fact both at the minimum and maximum level of policy surprises the total effect of monetary policy on credit is positive and on spreads is negative for private

[16]The mean level is 6 basis points and total effect of monetary expansions on spreads can be calculated as:$-.06 - 0.03(-0.06) = -0.06$, which is negative.

Table 10.— Monetary Policy and Loan Level Outcomes: The Role of Collateral

	Log (Loan)		Log $(1+i)$	
	Private Firms	Public Firms	Private Firms	Public Firms
	(1)	(2)	(3)	(4)
Collateralized	0.4181***	-0.8910***	-0.0058***	0.0108***
	(0.0606)	(0.0770)	(0.0012)	(0.0009)
Collateralized × MP Surprise$_q$	-2.3107***	-2.0066*	-0.0264*	-0.0092
	(0.4394)	(0.7709)	(0.0105)	(0.0100)
Observations	1371794	485440	1377795	481327
Adjusted R^2	0.282	0.284	0.357	0.378
Bank × Firm × Quarter F.E.	Yes	Yes	Yes	Yes

Notes: $^{+}$ $p < 0.1$,* $p < 0.05$,** $p < 0.01$, and *** $p < 0.001$. *Collateralized*$_q$ is a dummy variable equal to one if the loan is collateralized, and zero otherwise. Double-clustered standard errors by firm and time are reported in parentheses.

firms as even maximum surprise is not that contractionary during this period, and hence the stronger normal time effect dominates. Overall, columns (1) and (3) says that colleteralizing a loan gives more credit at lower cost to private firms.

The results for public firms, columns (2) and (4), reveal that, even during monetary expansions, public firms collateralizing a loan get less credit at higher spreads. This is also true for public firms during monetary contractions. Put differently, monetary shocks do not change the pricing of loans for public firms who collateralize relative to who do not. For public firms, collaterization means less credit and higher costs regardless of the shocks.

4.6 Loan-Level Regressions: The Role of Collateral Type

The next set of results replace the single collateral dummy with dummies for different collateral categories. Hence we run:

$$\log \mathrm{Y}_{l,f,b,q} = \alpha_{f,b,q} + \alpha_{s,q} + \beta \textbf{Collateral Type Dummy}_l + \lambda(\textbf{Collateral Type Dummy}_l \times \mathrm{MP}_q) + \vartheta_{l,f,b,q} \quad (5)$$

Each dummy is equal to one when a loan is collateralized with a given type of collateral and zero otherwise. To reduce the number of the categories, we combine fixed assets with real estate collateral because they represent physical assets. The 'unsecured' category is omitted, thus, all of the results are still interpreted against not collaterizing a loan with triple fixed effects within a firm-bank pair.

The results for private and public firms are reported in Table 11. For private firms, the result that collateralizing improves access to credit at lower spreads derives from three types of collateral: cash, AR&I, and blanket liens. To our surprise, there is not a statistically significant relationship between fixed assets and real estate on access to credit and marginal

Table 11.— The Role of Collateral: Private and Public Firms

	Log (Loan)		Log $(1+i)$	
	Private Firms	Public Firms	Private Firms	Public Firms
	(1)	(2)	(3)	(4)
Fixed assets and real estate	0.0332	-1.8022***	0.0000	0.0219***
	(0.0494)	(0.0757)	(0.0012)	(0.0011)
Cash and marketable sec.	0.3270***	-0.7002***	-0.0093***	0.0060**
	(0.0713)	(0.1222)	(0.0013)	(0.0020)
Act. receiv. and inventory	0.8924***	-0.2921*	-0.0102***	0.0028*
	(0.0535)	(0.1187)	(0.0013)	(0.0013)
Blanket lien and other	0.5787***	-0.5355***	-0.0053***	0.0073***
	(0.0514)	(0.0913)	(0.0010)	(0.0009)
Fixed assets and real estate × MP Surprise$_q$	-1.1313**	-0.3164	-0.0178*	0.0275*
	(0.2485)	(0.8001)	(0.0072)	(0.0127)
Cash and marketable sec. × MP Surprise$_q$	-0.7354$^+$	-2.5546$^+$	-0.0054	0.0760**
	(0.4310)	(1.4276)	(0.0093)	(0.0246)
Act. receiv. and inventory × MP Surprise$_q$	-2.3031***	-5.5757***	-0.0227**	-0.0465**
	(0.3342)	(1.1364)	(0.0077)	(0.0134)
Blanket lien and other × MP Surprise$_q$	-0.6990*	-2.2961*	-0.0120$^+$	-0.0203$^+$
	(0.3015)	(0.9398)	(0.0065)	(0.0116)
Observations	1192230	485440	1199252	481327
Adjusted R^2	0.307	0.339	0.376	0.398
Bank × Firm × Quarter F.E.	Yes	Yes	Yes	Yes

Notes: $^+$ $p < 0.1$,* $p < 0.05$,** $p < 0.01$, and *** $p < 0.001$. Each category is a dummy indicating collateralization by the given type. The category "Unsecured" is omitted. Double-clustered standard errors by firm and time are reported in parentheses.

cost of funds for private firms, once we account for other types of collateral that are more widely used than the real estate and fixed assets collateral.

We argue that the values of these three types of collateral, cash, accounts receivable and blanket lien, are inextricably linked to firm earnings and operations. Column (1) also shows that, during monetary expansions, the access to finance effect derives mostly from AR&I and blanket lien collateral. Though now real estate and fixed asset collateral also have a role, consistent with the large literature that argues prices of such assets go up during monetary expansions (down during contractions) increasing (decreasing) the borrowing capacity.

The results on spreads for private firms in column (3) are very interesting as they speak directly to what moves marginal costs of funds. During normal times, pledging any form of collateral means lower spread on that loan, with the exception of fixed asset and real estate. During monetary expansions, the total effect stays negative for all type of collateral, except fixed asset and real estate, mainly due to normal time effect. Interestingly, during contractions, only AR&I collateral help to reduce spreads, given the partial effect being negative and significant.

For public firms, column (2) and (4) in Table 11 shows that all collateral types signal distress in the sense that loans with pledged collateral, no matter the type, are smaller and associated with higher spreads. Interestingly, during monatary expansions, pledging AR&I

smooths out the negative effect and now public firms can also get more loans with this type of collateral during expansions. However, none of the collateral help to reduce spreads for public firms, during expansions and contractions, even cash and marketable securities.

The collateral-type results suggest a "collateral pecking order". For both sets of firms, AR&I and blanket liens seem to be the most valuable collateral-types. The values of AR&I and blanket lien collateral are both tied to firm earnings and operations in an important way that other fixed assets, such as real estate and machines, are not. The firm does not purchase blanket liens or accounts receivable like it would machines or land, it creates it. This is an important distinction because the value of AR&I and blanket lien collateral are not derived from resale value or what lenders can recover in a spot market transaction, which is where the value of fixed assets and real estate lie.[17]

To fix ideas, consider one-period debt as in Kiyotaki and Moore (1997) where the relationship between collateral value and borrowing is determined by the standard borrowing constraint $Rb_t \leq q_{t+1}k_{t+1}$, where Rb_t is the gross repayment amount on borrowing at time t and k_{t+1} and q_{t+1} are the holdings and price of capital in following period. The subtle but important distinction between tangible assets, such as real estate and machines, and AR&I embedded in the capital stock, k_{t+1}, is that the book value of AR&I collateral only exists because of the firm's ability to create sales that generate the receivables and inventory and not the market price q_{t+1}. In other words, the operations of the firm combine intellectual property, managerial talent, marketing, etc. to generate sales and the receipts in the current period t that serve as collateral. Hence, the fruit firms produce is not bruised and unusable, rather it is compost for further growth and collateralizable.[18]

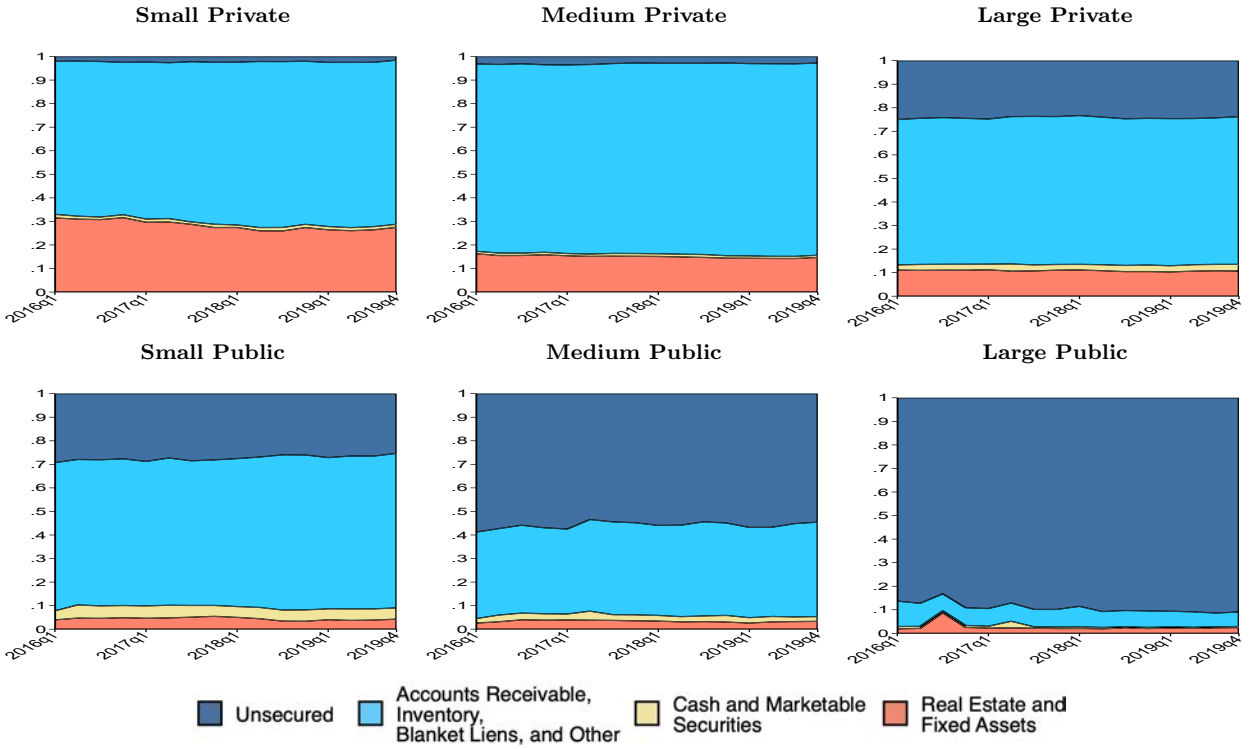
The inability to separate the liquidation value of AR&I from the going-concern value embedded in blanket liens is particularly important for small private borrowers who do not have large amounts of other tangible fixed assets to pledge. In these cases, blanket liens are thus close substitutes for AR&I that also give the lender additional security.[19]

[17] According to the standard industry dichotomy, loans secured by AR&I are technically asset-based loans because the advance rate on the loan is based on a fraction of the book value of receivables rather than the future value of receipts. The advance rate for accounts receivable is generally much higher (up to 85 percent of book value) than the advance rate for inventory (only up to 65 percent), which largely reflects differences in the liquidity of the assets. However, most AR&I loans are tied to the "AR" rather than the "I" (See the documentation in the OCC *Comptroller's Handbook on Asset-Based Lending*).

[18] Based on our interviews with SME CEOs, we observe the following: Accounts receivable (AR) account for 20 percent of annual sales among firms with $50-100 million in annual sales. When obtaining working capital loans with "AR&I" collateral, they submit weekly AR and inventory reports to the bank. This means that if they obtain a $1 million revolver now and their AR continues to increase, then they will be eligible for a new revolver with a higher limit. Eligible AR collateral for loans is generally given 60 days in advance, which means that eligible AR collateral that is booked now must be paid within 60 days.

[19] This intuition that blanket liens and AR&I collateral are substitutes is confirmed in an interview with

Figure 9.— Collateral Grouping Across Firm Size Distribution.



4.7 Loan-Level Regressions: Earnings vs Asset-Based Collateral

Based on our results in Section 4.6, we group AR&I with blanket liens in Figure 9 as 'Earnings-Based Collateral' in light blue. The figure makes it clear that, for SMEs and private firms, earnings-based collateral dominates all others. The category depicted in orange is real estate and fixed assets. The unsecured category stays in dark blue and cash and marketable securities is in yellow. With this grouping, we create a new dummy variable for 'Earnings-Based Collateral' and horse-race it against 'Asset-Based Collateral' composed of fixed assets and real estate. We rerun our regressions with these two categories, leaving 'unsecured' as the omitted category.

The results are shown in Table 12. In columns (1) and (3), among private firms, 'Earnings-Based Collateral' drive the access to credit and loan pricing results during normal times. 'Asset-Based Collateral' also has an access to finance role, as before, for private firms, during monetary expansions, but no effect on marginal cost of funds. The decline in marginal costs of funds during monetary expansions in column (3) come from 'Earnings-based' collateral, based on the total effects.

For public firms, columns (2) and (4), show as before both types of collateral is associated

the CFO of a medium-sized private company, with annual sales of nearly $70mn. They note that in their multiple loan facilities with a large bank, their working capital loans (a standard term for AR&I loans) are secured by a blanket lien on the firm assets, and not just the AR&I.

Table 12.— The Role of Collateral: Earnings vs Asset-Based Collateral

	Log(Loan)		Log(1+i)	
	Private Firms	Public Firms	Private Firms	Public Firms
	(1)	(2)	(3)	(4)
Asset-based	0.0278	-1.6386***	-0.0010	0.0195***
	(0.0546)	(0.0719)	(0.0012)	(0.0010)
Earnings & Operations-based	0.6912***	-0.4388***	-0.0085***	0.0054***
	(0.0608)	(0.0949)	(0.0012)	(0.0009)
Asset-based × MP Surprise$_q$	-1.5839***	-0.3345	-0.0260*	0.0305*
	(0.4050)	(0.7612)	(0.0107)	(0.0120)
Earnings & Operations-based × MP Surprise$_q$	-2.5402***	-4.0888***	-0.0293*	-0.0300**
	(0.4689)	(0.9127)	(0.0107)	(0.0106)
Observations	1371794	485440	1377795	481327
Adjusted R^2	0.407	0.310	0.366	0.390
Bank × Firm × Quarter F.E.	Yes	Yes	Yes	Yes

Notes: $^{+}$ $p < 0.1$,* $p < 0.05$,** $p < 0.01$, and *** $p < 0.001$. "Asset-Based" is a dummy variable equal to one if the collateral pledge is either Real Estate, Fixed Assets or Cash and marketable securities; "Earning-Based" is equal to one if the collateral pledged is either blanket lien, account receivable and inventory or other; we drop the category "Unsecured". Double-clustered standard errors by firm and time are reported in parentheses.

with distress, both in terms of loan amounts and spreads and expansionary monetary policy cannot undo these effects. Even the largest expansion (min surprise) is not enough to undo lower loans and highest spread result for the public firms that come from both types of collateral.

The fact that the relationship between pledging collateral and cost of funds is the opposite for private versus public firms strengthens our argument that collateral is a measure of access to finance for private firms and signals default risk for public firms. The existing empirical literature is consistent with our results on public firms. Like us, for public firms, Berger and Udell (1990) show that collateralized loans have higher interest rates in the U.S. Rauh and Sufi (2010) shows that there is a positive relation between posting collateral and being a low quality 'public' firm in distress.

4.8 Collateral and Leverage

To recap our results: First, monetary expansions relax constraints for high-leverage SMEs since these firms borrow more during expansions (and less during contractions). Second, 'Earnings-Based Collateral' improves access to finance and lowers the marginal cost of funds for smaller private firms. During monetary expansions, both earnings-based and asset-based collateral improves access to finance to these firms as loans associated with such collateral are larger, but lower spreads are only on loans secured by earnings-based collateral of smaller private firms.

To show the strong connection between these two sets of results, we go back to our

Table 13.— The Role of Collateral and Leverage

	Log(Loan)		
	(1)	(2)	(3)
High Earnings-Based Collateral Firm × MP Surprise$_q$	-0.1759**		-0.1559*
	(0.0591)		(0.0575)
High Leverage Firm × MP Surprise$_q$		-0.5922***	-0.5870***
		(0.0845)	(0.0836)
Observations	2133266	2133266	2133266
Adjusted R^2	0.938	0.938	0.938
Bank × Firm F.E.	Yes	Yes	Yes
Sector × Quarter F.E.	Yes	Yes	Yes

Notes: High Earnings Collateral is a dummy variable equal to one for firms above the median in the distribution of the share of loans collateralized with earnings-based collateral, on average. $^{+}$ $p < 0.1$,* $p < 0.05$,** $p < 0.01$, and *** $p < 0.001$. Double-clustered standard errors by firm and time are reported in parentheses.

baseline regressions at the firm-bank level and run a horse-race on the full sample of firms, combining private and publicly listed firms. We only use firm×bank ($\alpha_{f,b}$) and sector×quarter ($\alpha_{s,q}$) fixed effects to take out average differences and sector-level shocks and trends. This specification allows both credit demand and credit supply side effects to drive the horse-race as we want to test whether leverage backed by earnings-based collateral, drives equilibrium credit outcomes. The direct effect of monetary policy is absorbed by the quarter fixed effects as before. We run:

$$\log \sum_{l \in \mathcal{L}(f,b,q)} L_{f,b,q}(l) = \alpha_{f,b} + \alpha_{s,q} + \kappa \left(\textbf{High Leverage Firm}_f \times \frac{1}{N} \sum_{k=0}^{N} \text{MP}_{q-k} \right) + \omega \left(\textbf{High Earnings-Based Collateral Firm}_f \times \frac{1}{N} \sum_{k=0}^{N} \text{MP}_{q-k} \right) + \vartheta_{f,b,q} \tag{6}$$

'High Earnings-Based Collateral Firm' is a dummy variable equal to one for firms above the median in the distribution of the share of loans collateralized with earnings-based collateral, on average. The 'High Leverage Firm' dummy is defined as before. The results in Table 13 column (1) clearly show that higher earnings-bases collateral firms borrow more relative to other firms during expansionary monetary policy. Column (2) shows the baseline result that high leverage firms borrow more during expansions. Finally, the horse race in column (3) shows that high leverage captures most of the earnings-based collateral effect because leverage among these firms is tied to earnings-based collateral, as most of the debt of private firms backed by such collateral as we have shown before.

Recall that earnings-based collateral is composed of AR&I and blanket liens. Technically, blanket liens are loans secured by all assets, which gives the lender a legal claim to all of a

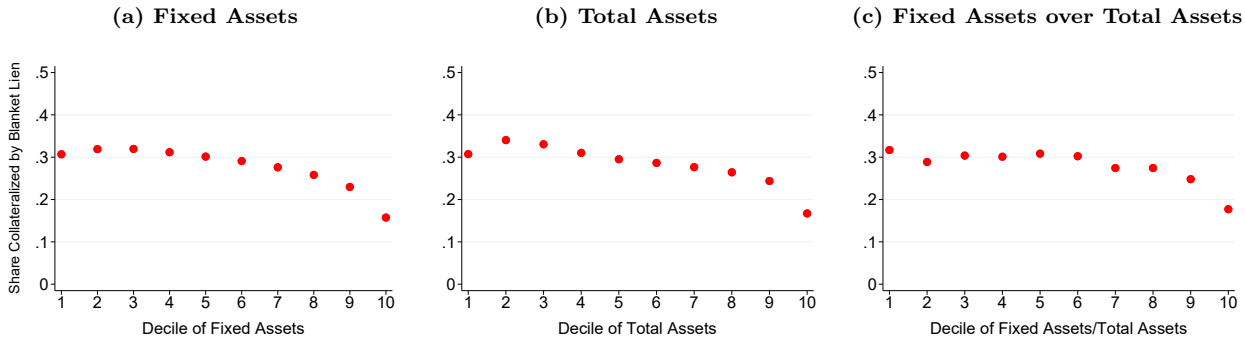


Figure 10.— Relation Between Blanket Liens and Fixed Assets. Notes: Each panel shows the share of loans secured by blanket liens across: (a) each decile of the fixed assets distribution, (b) each decile of the total assets distribution and (c) each decile of the ratio of fixed assets over total assets.

borrower's business assets in the event of default. A loan secured by a blanket lien will cover the entire firm and all unencumbered assets not already pledged as collateral. However, if a borrower previously pledged a specific asset–such as real estate or some other fixed asset–to secure a loan, then a future loan with a blanket lien is secured only by the firm's remaining unencumbered assets. Accounts receivable and inventory are usually what remain after other fixed assets have been pledged.

Figure 10 shows that use of blanket liens is due to a trade-off between lack of physical assets and a desire to borrow but being financially constrained. We plot the share of loans secured by blanket lien for each decile of the fixed assets distribution in panel (a), for each decile of total assets distribution in panel (b) and for each decile of fixed to total assets distribution in panel (c). If blanket lien collateral covers mostly fixed assets, then this relationship should be positive. The data shows that the relationship is negative; larger firms with more fixed assets use fewer blanket liens as collateral to secure funding.

Table 14 shows, for the average firm with existing collateralized loans, the share of subsequent loans secured by different collateral types. For example, the first row shows that, conditional on existing loans being collateralized by non-blanket lien, the share of new loans secured by blanket lien is 19.5 percent. More importantly, conditional on having already encumbered fixed assets and real estate, the share of additional loans secured by AR&I and AR&I and blanket liens is 17.2 percent and 35 percent respectively. This evidence further indicates that blanket liens, like AR&I, secure additional loans and do not simply proxy for liens against fixed assets and real estate.

4.9 Alternative Measure for Debt Capacity

As an alternative of using leverage and collateral type together, we measure borrowing capacity based on the type of collateral the firm uses for its leverage. Specifically, we create

Table 14.— Multiple Loans Secured by Different Types of Collateral

Share of Additional Loans Collateralized by	
Blanket Lien (1)	0.1950
AR&I (2)	0.1725
AR&I and Blanket Lien (3)	0.3508

Notes: (1) Firms with more than one loan and at least one non-blanket lien loan. (2) Firms with more than one loan and at least one fixed assets and real estate loan. (3) Consider firms with more than one loan and at least one fixed assets and real estate loan.

an earnings-based borrowing capacity measure as follows: i) for each firm i in industry j, we compute the ratio of total debt secured by earnings-based collateral to total debt; ii) we compute the maximum leverage ratio (debt-to-asset) among all firms in industry j; and iii) we take the difference between firm i's earnings debt capacity ratio and the industry maximum leverage ratio.

The idea is that the maximum value of leverage for a firm in a given industry measures the potential among all firms in the industry to borrow, and the difference between each individual firm and the maximum measures the firm's debt capacity; iv) finally, we compute a time invariant dummy variable for firm i equal to one if its debt capacity measure is above the sample median. Because the difference between the ratios is less-than or equal to 0, a value above sample median is closer to 0 and implies that the firm has high debt capacity close to the industry max. Firms with more negative values are constrained with lower capacity to borrow relative to their industry max.

The results of the regressions using this debt capacity variable are shown in Table 15. The negative coefficient on loan quantities in columns (1)-(3) imply that during monetary easing, high debt capacity firms, based on their earnings collateral, increase their borrowing more than low capacity firms. Interestingly, now we have the same result across all firm samples. This is because leverage and pledging collateral both measure being 'bad' firms for public firms since public firms who do not pledge collateral and who has low leverage are low default risk firms. The new borrowing capacity variable simply measures how much you are borrowing based on earnings-based collateral in terms of your distance to the maximum possible in your industry. Since monetary policy increases the value of earnings based-collateral through higher sales for all firms in the economy, firms that borrow through earnings-based collateral expand their borrowing capacity, regardless who they are. Overall, these results suggest that monetary policy operates by relaxing collateral constraints, which in turn reduces the cost of funds on firms even for the most constrained firms of all: SMEs with high default risk.

Table 15.— Debt Capacity and Monetary Policy

	Log(Loan)		
	(1) All firms	(2) Private Firms	(3) Public Firms
High Earnings-Based Borrowing Capacity Firm × MP Surprise$_q$	-0.5941***	-0.5305***	-0.2707***
	(0.0972)	(0.2188)	(0.0727)
Observations	2281525	1332744	302075
Adjusted R^2	0.946	0.952	0.844
Controls	Yes	Yes	Yes
Bank × Firm F.E.	Yes	Yes	Yes
Bank × Quarter F.E.	Yes	Yes	Yes
Sector × Quarter F.E.	Yes	Yes	Yes

Notes: $^{+}$ $p < 0.1$,* $p < 0.05$,** $p < 0.01$, and *** $p < 0.001$. High Earnings-Based Borrowing Capacity Firm is defined as a dummy variable equal to 1 if firm i's debt capacity from earnings-based loans is above the sample median. Controls include sales growth and its interaction with monetary policy shocks. Standard errors are clustered by firm-time and are reported in parentheses.

5 Additional Analysis

In this section we present several pieces of additional analysis and robustness results.

5.1 Bank Credit Supply

In the main text, we focused mostly on the impact of monetary policy on credit demand by controlling for supply effects with bank-quarter fixed effects. An alternative explanation may be that risky banks engage in risk-taking behavior by making loans to high leveraged firms or valuing collateral types differently. For example, Luck and Santos (2019), by comparing spreads on loans by the same bank, to the same borrower, but backed by different types of collateral showed that pledging collateral reduces borrowing costs with larger cost reductions coming from bank loans backed by certain types of collateral.

$$\log \sum_{l \in \mathcal{L}(f,b,q)} Y_{f,b,q}(l) = \alpha_{f,b} + \alpha_{f,q} + \omega \left(\textbf{High Leverage Bank}_b \times \frac{1}{N} \sum_{k=0}^{N} \text{MP}_{q-k} \right) + \vartheta_{f,b,q} \tag{7}$$

We start by checking whether high and low leverage banks behave differently in their lending and pricing, using the specification above. This is a much more restrictive specification than the one used for firm leverage because identifying ω requires variation from firms borrowing from multiple banks. Firms borrowing from a single bank will be dropped.

Equation (7) helps determine if our results so far are misinterpreted. For example, instead

Table 16.— Monetary Policy and Credit Outcomes: Supply-Side

	Log(Loan)		
	All Firms	Private Firms	Public Firms
	(1)	(2)	(3)
High Leverage Bank × MP Surprise$_q$	0.4026***	0.5429***	0.1605
	(0.1130)	(0.1319)	(0.1559)
Observations	656882	349527	307355
Adjusted R^2	0.910	0.929	0.862
Bank × Firm F.E.	Yes	Yes	Yes
Firm × Quarter F.E.	Yes	Yes	Yes

Notes: $^{+}$ $p < 0.1$,* $p < 0.05$,** $p < 0.01$, and *** $p < 0.001$. This table presents the results of OLS regressions for bank-firm level at a quarterly frequency. Bank Leverage is defined in a similar way to Firm Leverage. Double-clustered standard errors by firm and time are reported in parentheses.

of expansionary monetary policy causing high leverage firms to increase borrowing, the additional borrowing could be due to high leverage firms switching to high leverage banks during monetary expansions if those banks extend more credit. Our results based on the regression specification in (7) suggest this is not the case.

Table 16 shows the results. During monetary policy expansions, highly levered banks supply fewer loans. Column (2) shows that the results are mainly driven by private firms. Hence, the supply results for private firms are the exact opposite of the firm credit-demand regressions that we showed before. Moreover, the results are also inconsistent with the supply-side risk taking channel. Risk taking by banks should manifest as more lending to smaller and less transparent private borrowers, not less. This means that low leverage banks lend more to private borrowers, consistent with other papers using U.S. data.

The lack of risk-taking could reflect the time period of our data during which banks have been highly regulated and well capitalized. Therefore, the impact of leverage differences may be minimal. We perform an additional robustness check using bank charge-offs. Net charge-offs have the advantage of representing loan write off due to default, net of collateral values. Compared to charge-off values, loan default or delinquency rates on highly collateralized loans may not capture the true risk to the bank's balance sheet. The results reported in Table 18 in Appendix B.1.2 also suggest the opposite conclusion of the supply-side risk taking channel; private borrowers with higher past charge-off rates receive fewer loans in the future when interest rates are low.[20] Importantly, the charge-off results are identified from the same set of banks as the leverage results in Table 16, which taken together, suggest that high-risk banks (high leverage) cut lending more in the future to risky private borrowers based on past losses (charge-offs).

[20]The results on public borrowers are not statistically significant.

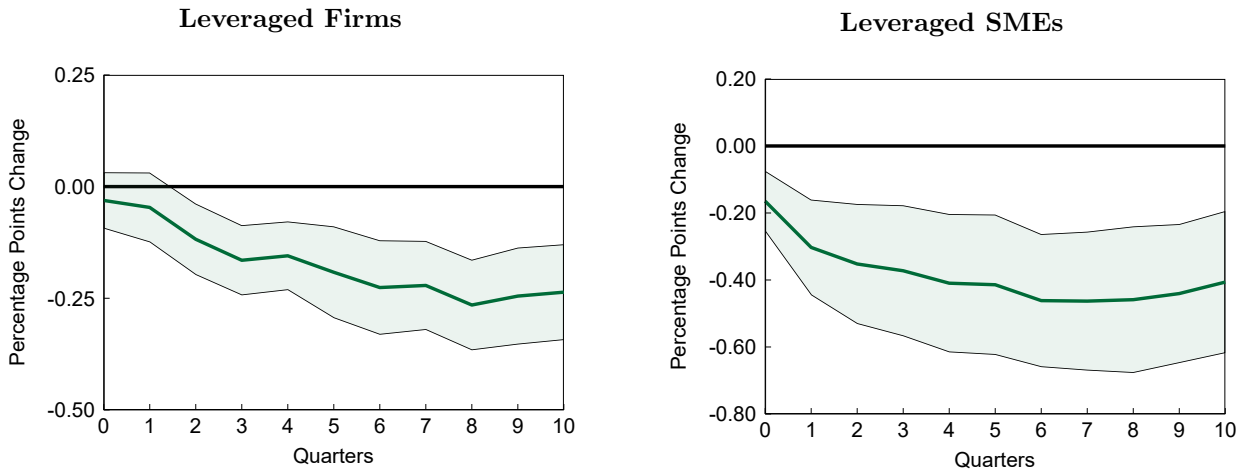


Figure 11.— Dynamic Effects of Monetary Policy on Loans. Notes: The figure shows the dynamics of the interaction coefficient, κ_h. Black lines report 95 percent error bands

5.2 Dynamic Effects of Monetary Policy on Credit Outcomes

We estimate the dynamic response of credit outcomes to monetary policy surprises through the following local projections:

$$\log \sum_{l \in \mathcal{L}(f,b,q+h)} Y_{f,b,q+h}(l) = \alpha_{f,b} + \alpha_{b,q} + \kappa_h \left(\textbf{High Leverage Firm/SME}_f \times \text{MP}_{q-k} \right) + \vartheta_{f,b,q+h} \quad (8)$$

Figure 11 shows the results for the full sample of firms, where first panel shows that leveraged firms get more (less) loans during monetary expansions (contractions). The effects are very persistent.

Second panel of the figure shows the dynamic triple interaction that include the leverage and SME dummy variables. The results are also persistent. Highly leveraged SMEs borrow more in response to expansionary monetary policy surprises over 10 quarters. In particular, a 1 basis point expansionary surprise causes high leveraged SMEs to borrow 0.4 percentage points (pp) more over 10 quarters relative to larger, safer firms.

5.3 Aggregation

In this section, we explore the quantitative effects in relation to the literature that uses aggregate data on credit growth. This literature finds a 30 percent increase in credit growth with one standard deviation increase in MP shocks, though their shocks are much larger given their long time series data.[21]

[21] See for example Gertler and Karadi (2015).

We start by running the following regression, without firm-time or bank-time fixed effects to mimic the regressions using aggregate data. We then predict 'average' credit growth:

$$\log \sum_{l \in \mathcal{L}(f,b,q)} Y_{f,b,q}(l) = \alpha_{f,b} + \kappa_0^{\text{Agg}} \text{MP}_q^{MA} + \vartheta_{f,b,q} \Longrightarrow \log \widehat{Y_{f,b,q}} = \hat{\alpha}_{f,b} + \hat{\kappa}_0^{\text{Agg}} \text{MP}_q^{MA}$$

Taking difference with respect to $q-1$

$$d \log \widehat{Y_{f,b,q}} = \hat{\kappa}_0^{\text{Agg}} \Delta \text{MP}_q^{MA}$$

Multiplying each side by $\omega_{f,b,q-1}$ such that $\sum_{f,b} \omega_{f,b,q-1} = 1$ and adding across all bank-firm (b,q) pairs at time q, predicted 'aggregate' credit growth is:

$$\begin{aligned} \omega_{f,b,q-1} \log \widehat{Y_{f,b,q}} &= \omega_{f,b,q-1} \hat{\kappa}_0^{\text{Agg}} \Delta \text{MP}_q^{MA} \\ d \widehat{\log Y_q} &= \hat{\kappa}_0^{\text{Agg}} \Delta \text{MP}_q^{MA} \\ \frac{\text{Average}\{d \widehat{\log Y_q}\}}{\text{Average}\{\text{Agg. Loan Growth}_q\}} &= 0.03 \end{aligned}$$

The last equation uses series on the observed MP surprises during our sample and shows these surprises can explain 3 percent of the observed credit growth (used on the denominator). This is in the ballpark of the literature that uses 5 times the MP surprises we use on average (25 basis points versus 5 basis points) and explain 30 percent of the credit growth.

As our focus is on the importance of heterogeneity in financial frictions on aggregate outcomes, what matters is what fraction of the aggregate 3 percent is driven by high leverage firms? To estimate that number, we run:

$$\begin{aligned} &\log \sum_{l \in \mathcal{L}(f,b,q)} Y_{f,b,q}(l) = \alpha_{f,b} + \kappa_0 \text{MP}_q^{MA} + \kappa_1 \times \textbf{High Leverage Firm}_f \times \text{MP}_q^{MA} + \vartheta_{f,b,q} \\ &\Longrightarrow d \widehat{\log Y_{f,b,q}} = \hat{\kappa}_0 \Delta \text{MP}_q^{MA} + \hat{\kappa}_1 \times \textbf{High Leverage Firm}_f \times \Delta \text{MP}_q^{MA} \end{aligned}$$

We multiply each side by $\omega_{f,b,q-1}$ such that $\sum_{f,b} \omega_{f,b,q-1} = 1$ and adding over (f,b)

$$d \log \widehat{Y}_q = (1 - \omega_{q-1}^{HL}) \hat{\kappa}_0 \Delta \text{MP}_q^{MA} + \underbrace{\omega_{q-1}^{HL}}_{\text{Share of Total Loans by High Leverage Firms}} (\hat{\kappa}_0 + \hat{\kappa}_1) \Delta \text{MP}_q^{MA}$$

$$\frac{\text{Avg}\left(\omega_{q-1}^{HL} (\hat{\kappa}_0 + \hat{\kappa}_1) \Delta \text{MP}_q^{MA}\right)}{\text{Avg}\left(d \log \widehat{Y}_q\right)} = 0.6$$

Hence, we can show that 60 percent of the observed credit growth due to MP shocks are driven by high leverage firms. We also know that high leveraged firms are mainly high leveraged SMEs, using earnings-based collateral. Thus, transmission of policy via high leveraged SMEs relying on their earnings to borrow is economically significant in driving the aggregate effects.

Is it ok to aggregate over different loan types? In Figure 15 in the Online Appendix B.2, we plot aggregate interest rates for public and private borrowers, for fixed versus floating rate loans, credit lines versus term loans, and new loan originations. The figures show that floating rate loans closely track monetary policy rates for all borrowers. Importantly, the data show that prices on floating-rate credit lines rose more quickly during lift-off in 2017 than fixed-rate term loans. Moreover, the share of term loans increased at the expense of credit lines over time. These dynamic compositional patterns justify our focus on all loan types rather than only on credit lines and/or on new originations throughout our analysis and also in our aggregation exercise.

5.4 Sales and Inventories

In this section, we investigate the heterogeneous impact of monetary policy transmission on sales and inventories, following Gertler and Gilchrist (1994). These authors show that small manufacturing firms' sales and inventories are more sensitive to monetary policy tightening episodes. Intuitively, a decline in sales for financially constrained firms impedes their ability to accumulate inventories compared to large firms who can borrow to continue offering products. We confirm their results from a broader set of SMEs.

We estimate both dynamic local projections and OLS panels for the impact of monetary policy shocks on SME sales, inventories, and the inventory-to-sales ratio. Since both approaches yield similar results, we focus here on the OLS panel, and show the dynamic local projections in Figure 18 in the Online Appendix, Section B.3. Recall that our sample period is mostly characterized by monetary easing, so we expect to see higher sales. Given the fact that SMEs use sales and inventory to access credit, monetary policy should loosen their constraints and allow them to accumulate additional inventory through expanded borrowing capacity.

Table 17 shows that monetary easing (negative monetary policy shocks) result in higher sales. As shown in column (4) these results are driven by leveraged SMEs. The inventory results are shown in columns (1) and (2). Monetary policy easing results in highly leveraged SMEs, who mostly use accounts receivables, inventory and blanket liens as collateral, to

Table 17.— The Effects of Monetary Policy on Sales and Inventories

	Inventory		Sales		Inventory to Sales Ratio
	(1)	(2)	(3)	(4)	(5)
SME × MP Surprise$_q$	-0.0485***	0.0196	-0.0753***	-0.0077	4.2500***
	(0.016)	(0.027)	(0.012)	(0.020)	(0.368)
High Leverage Firm × MP Surprise$_q$		0.1435***		0.1173***	1.6240***
		(0.024)		(0.021)	(0.382)
High Leverage Firm × SME × MP Surprise$_q$		-0.1087***		-0.1102***	-2.5280***
		(0.034)		(0.025)	(0.410)
Observations	1330266	1330266	1821646	1821646	1779287
R^2	0.0543	0.0543	0.0507	0.0507	0.6984
Firm F.E.	Yes	Yes	Yes	Yes	Yes
Quarter F.E.	Yes	Yes	Yes	Yes	Yes

Notes: $^{+}$ $p < 0.1$,* $p < 0.05$,** $p < 0.01$, and *** $p < 0.001$. The dependent variable in columns (1) and (2) is the growth rate of firm balance-sheet inventory defined as the difference in natural logarithm q-o-q; the dependent variable in columns (3) and (4) is the growth rate of firm sales defined as the difference in natural logarithm q-o-q; the dependent variable in columns (5) and (6) is the inventory to sales ratio. Standard errors are clustered by firm-time and are reported in parentheses.

have higher sales and inventory growth. Furthermore, column (5) shows that leveraged SME inventory-to-sales ratios rise after monetary expansions. This suggests that their inventory response is stronger than the sales response, which buttresses the notion that their financial constraints are relaxed, allowing them to accumulate more inventory. Another way to read this result is that, leveraged SMEs inventories fall more than sales during monetary contractions as these firms contract more and try to smooth this out using inventories.

5.5 A Primer on the Mechanism

In this section we interpret the results from the lens of the heterogeneous agents models.

Standard macroeconomic theory conceptualizes firm financial frictions in one of two ways. The first follows Bernanke and Gertler (1989) and Bernanke, Gertler, and Gilchrist (1996). These costly-state verification models do not feature collateral constraints but feature default. Monetary policy relaxes an agency friction by increasing net worth and lowering default risk. The second framework pioneered by Kiyotaki and Moore (1997) introduces a collateral constraint that specifies firms may borrow up to a fraction of their capital. However, all debt in this class of models is risk-free because collateral constraints bind and firms cannot borrow more than the value of what they can repay in the future. In the micro contracting literature, there is a clear relation between pledging collateral and default risk, where high default risk firms have to pledge collateral and their debt is limited by the liquidation value of this collateral; in a default event, the re-sale value of the collateral provides insurance to the lender.[22]

[22] Darst and Refayet (2018) offer a simplified 2-period model that features both endogenous default and a restriction on the value of promises firms make today based on the value of what they can produce tomorrow. However, we are not aware of any full-fledged macro model that incorporates both collateral constraints with

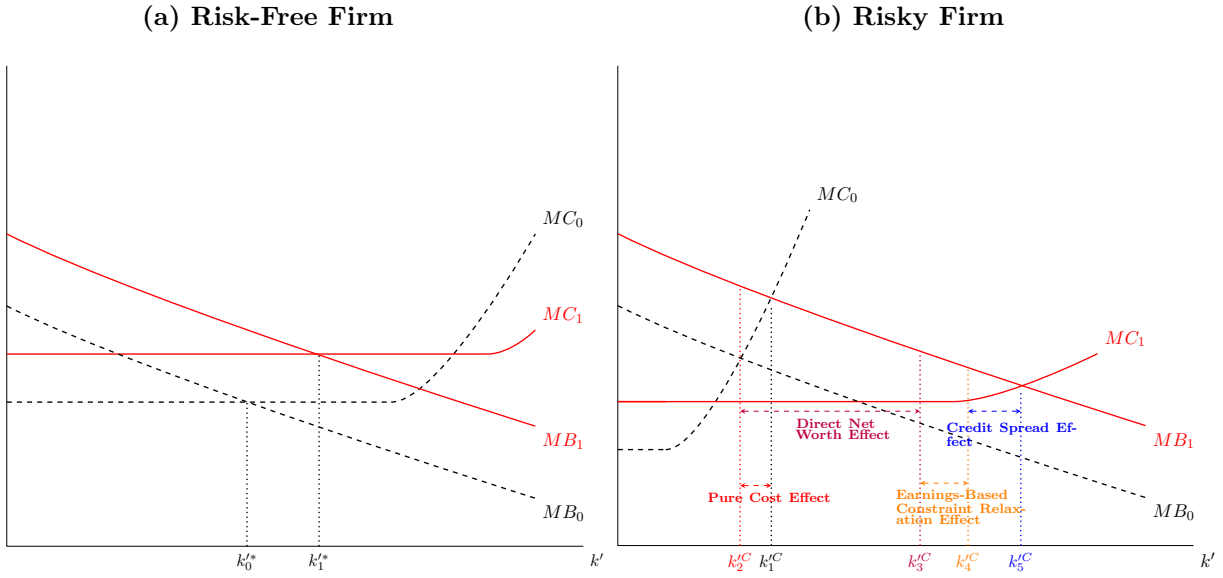


Figure 12.— Mechanism

The recent heterogeneous firm new Keynesian framework of Ottonello and Winberry (2020) features default, but does not have a collateral constraint. Nevertheless, a simple modification of their framework is suitable to interpret our empirical results.

Panel (a) in Figure 12 is the same as Ottonello and Winberry (2020), which shows that a low leverage/default risk firm operates on the flat portion of the marginal cost for investment curve. Equilibrium investment is determined by the intersection of the marginal cost and benefit curves, $k_0'^*$. A monetary expansion, shown by the shifts to the red lines, raises both marginal cost and benefit curves. The new investment level is given by $k_1'^*$.

Risky/high leverage firms operate on the upward sloping part of the marginal cost curve shown in panel (b). Expansionary monetary policy increases the price of capital shifting the marginal cost curve up. The movement from $k_1'^C$ to $k_2'^C$ captures this pure cost increase. Additionally, expansionary policy extends the flat portion of marginal cost curve due to a higher net worth. Higher net worth implies that firms can repay debt over a larger state-space. Expansionary policy may further extend the flat part of the marginal cost curve if there is borrowing backed by earnings-based collateral as the value of such collateral increases more with monetary expansions. Furthermore, as shown in the figure, the use of earnings-based collateral can amplify this effect by significantly flattening the cost curve—credit spread effect—leading to larger relative changes in risky firm investment shown by $k_5'^C$. This decrease in the slope of the cost curve that is flattening of supply of funds schedule is what we have provided strong evidence for, capturing the essence of our results.

risky debt.

6 Conclusion

We use administrative data, matched at firm-bank-loan-quarter level, to explore how monetary policy transmits in an economy with heterogeneous financial frictions. We find that collateral heterogeneity in loan contracts can explain relaxation/tightening of financial constraints as a response to monetary shocks. Monetary expansions lower the marginal cost of funds for firms who secure their debt mostly with earnings-based collateral and hence expand their borrowing capacity. Monetary policy can be highly effective in economies dominated by small firms pledging their earnings and intangibles as collateral, even though these firms have high default risk.

Our results show a dual-role of collateral: The relation between collateral and risk is positive for large firms but negative for small firms. Hence, posting collateral for large firms, who typically borrow unsecured, is a sign of distress. By contrast, posting collateral for SMEs is associated with more credit and lower spreads. Our results suggest that the effectiveness of the investment and credit channels of monetary policy depends on the firm size distribution and the different types of collateral used to obtain financing to maintain and expand operations.

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Online Appendix (For Online Publication Only)

A Data Details

A.1 FR Y-14Q Schedule H.1

The FR Y-14Q report collects detailed information on bank holding companies' (BHCs), savings and loan holding companies' (SLHCs), and U.S. intermediate holding companies' (IHCs) of foreign bank organizations (FBOs) on a quarterly basis. The data are collected as part of the Federal Reserve's Comprehensive Capital Analysis and Review (CCAR) for BHCs, SLHCs and IHCs with at least $50 billion ($100 billion starting from 2019) in total assets.[23] The banks that submit FR Y-14Q data since 2012 comprise over 85 percent of the total assets in the U.S. banking sector.

For our study, we use the Wholesale Risk Schedule, or H.1. Schedule, which collects loan level data on corporate loans and leases together with corporates' balance sheets. The H.1 Schedule has two sections: (1) Loan and Obligor Description section, which collects information related to the firm and the loan itself; and (2) Obligor Financial Data section, which collects data related to the financial health (balance sheet and income statement) of the firm. Hence we also have time varying information on bank and firm balance sheets.

Banks report details on corporate loans and leases that are either held-for-investment (HFI) or held-for-sale (HFS) in the loan book at each quarter end. Loans and leases with HFI designation are those that the bank has the "intent and ability to hold until the foreseeable future or until maturity or payoff." Loans and leases that are HFS are those that the bank intends or expects to sell at some indefinite date in the future. Both HFI and HFS loans and leases are categorically distinct from those that are reported as trading assets. Trading assets of banks are not reported on FR Y-14 Schedule H.1 and are instead reported on Schedule B (Securities Schedule). The vast majority of loans in the FR Y-14 data (on average 98 percent by dollar amount) are designated as HFI.

The population of loans is reported at the credit facility level (loan level) and is limited to commercial and industrial loans with a committed balance greater than or equal to $1

[23] The assessment is conducted annually and consists of two related programs: Comprehensive Capital Analysis and Review and Dodd-Frank Act stress testing (DFAST).

million.[24] Each facility is reported separately when borrowers have multiple facilities from the same bank. The facility level information includes total committed and utilized amounts, pricing and spread information, origination and maturity dates, and information on the value and type of underlying collateral. We use facility and loan interchangeably throughout the paper.

The total committed value of the loans reported on the H.1 Schedule as of 2019Q4 is nearly $3.3 trillion.[25] To get a sense for what fraction of total U.S. C&I lending our data comprise, we compare it to what is reported by the universe of BHCs, in the aggregate form, on the FR Y-9C (schedules HC-C and HC-L). BHCs commitments in the FR Y-9C total nearly $4.6 trillion. Thus, our data from the FR Y-14Q accounts for nearly 70 percent of all C&I equivalent lending in the U.S.[26]

The FR Y-14Q information on the financial health of the borrowers (firm balance sheet and income statement variables) is an invaluable source of information for private firms in the U.S. as this information does not exist anywhere else. The data also contains borrower identifiers such as tax identification numbers, CUSIPS, and company names and addresses. These firm identifiers allow us to match the data with other data sources to cross-check information and determine the relative importance of different sets of borrowers *e.g.* public versus private companies, SMEs versus large firms, and syndicated versus non-syndicated loans.

Bank Holding Companies subject to CCAR. The bank holding companies included in the sample are: beginning in Q3:2011 Ally Financial, Bank of America Corporation, BB&T Corporation, Bank of New York Mellon Corporation, Citigroup Incorporated, Capital One Financial Corporation, Fifth Third Bancorp, Goldman Sachs Group Incorporated, JPMorgan Chase & Co., Keycorp, Morgan Stanley, PNC Financial Services Group Incorporate,

[24] A credit facility is defined as a credit extension to a legal entity under a specific credit agreement, basically a loan contract.

[25] We keep loans identified on the FR Y-9C as C&I loans domiciled in the U.S. (item 4(a)), loans to finance agricultural production (item 3), loans secured by owner-occupied real estate domiciled in the U.S. (item 1(e)(1)), and other leases (item 10(b)).

[26] The comparisons between FR Y-14Q and FR Y-9C are not one-to-one and are complicated by at least three factors: 1) HC-C only reports utilized exposures; 2) the committed exposures reported on HC-L are aggregated differently and include loans that are not necessarily U.S. C&I loans. For example, HC-L reports total committed exposure for all C&I loans (Y-9C item 4), which includes loans to foreign addresses (item 4(b) in addition to those those domiciled in the U.S (item 4(a)). In addition, the HC-L reports the total committed amount of loans secured by real-estate (item 1), which includes various types of loans secured by real estate in addition to loans secured by owner-occupied real estate domiciled in the U.S. (item 1(e)(1)). 3) FR Y-14Q data only includes loans over $1mn. Therefore, FR Y-14Q comparisons of the total committed loans amounts to FR Y9-C represent lower bounds of the overall amount of C&I lending done in the U.S.

Regions Financial Corporation, Suntrust Banks Incorporated, State Street Corporation, U.S. Bancorp, Wells Fargo & Company. Beginning in Q3:2012 Comerica Incorporated, Huntington Bancshares Incorporated, HSBC North America Holdings Incorporated, M&T Bank Corporation, Northern Trust Corporation, RBC USA Holdco Corporation, Santander Holdings USA Incorporated, UnionBanCal Corporation (renamed to MUFG Americas Holding Corporation in Q3:2014), Zions Bancorporation. Beginning in Q2:2014 Discover Financial Services. Beginning in Q4:2014 BNP Paribas.

HFI, HFS, and Trading Assets. HFS loans and leases are also distinct from loans held on the trading book for market making purposes and subject to different different regulatory capital requirements. Specifically, loans and leases in the trading book are reported on a separate schedule (other than Schedule H1) and typically meet the following trading activities: a) regularly under-writing or dealing in securities; interest rate, foreign exchange rate, commodity, equity, and credit derivative contracts; other financial instruments; and other assets for resale, (b) acquiring or taking positions in such items principally for the purpose of selling in the near term or otherwise with the intent to resell in order to profit from short-term price movements, and (c) acquiring or taking positions in such items as an accommodation to customers or for other trading purposes.

Data Cleaning and Sample Construction. This section describes the intensive data cleaning process needed to use the FR Y14 data for our purposes.

1. Remove from the raw loan-level data loans issued to "Individuals" and loans to foreign addresses.

2. Remove any loans to financial firms (NAICS 52); real estate REITS (NAICS 513); educational servies (NAICS 611); religious, grantmaking, and civil and professional organizations (NAICS 813); and private household (NAICS 814).

3. Drop all observations for which there is no financial data reported and when total firm assets are missing or equal to 0.

4. Drop all facilities where the total value of commitments is less than $1 million (probable errors given reporting threshold).

5. To consistently identify firms across banks with missing or different tax ids, we first apply a name cleaning algorithm to make a consistent names for firms that are the

same based on string matches, zipcode, and city. For example Firm A LLC, 20002 Washington D.C, Firm A Limited Liability Corporation 20002 Washington D.C., and Firm a LLC, 20002 Washington D.C. are all treated as the same firm, etc.

6. Once we have a clean and uniform set of firm names, we can fill in missing tax ids. For observations loans where firm tax id is missing, we fill in missing observations if the bank reports a consistent tax id through any portion of the loan; for multi-bank borrowers for which one bank does not report the tax id, we use a consistent tax id reported by other banks.

7. To ensure that firm income statement and balance sheet variables are reasonable and reported in consistent units, we apply a cleaning algorithm that searches for large reporting discrepancies within and across banks over time for the same firm. We set threshold for potential misreported to be a difference in a variable either by the same bank or across different banks of either 10^3, 10^6, 10^9 since these are most common unit differences reported in the data. We also note that when there is miss reporting, all variables appear to be consistently miss reported in the same way, so financial ratios are correct.

Internal Consistency of Balance Sheet Information. We follow Gopinath, Kalemli-Ozcan, Karabarbounis, and Villegas-Sanchez (2017) to check the sensibility of our cleaning procedure by comparing the sum of variables belonging to some aggregate of their respective category:

1. The sum of tangible fixed assets, intangible fixed assets, and other fixed assets as a ratio of total fixed assets.

2. The sum of fixed assets and current assets as a ratio of total assets

3. The sum of long-term debt and other non-current liabilities as a ratio of total non-current liabilities

4. The sum of cash and securities, inventory, and accounts receivable as a ratio of current assets

5. The sum of current assets and tangible assets as a ratio of total assets

6. The sum of accounts payable, short-term debt, and current maturity long-term debt as a ratio of current liabilities

7. The sum of current liabilities, long-term debt and minority interest as a ratio of total liabilities

8. The sum of total liabilities, retained earnings, and capital expenditure as a ratio of total assets.

Information on credit facilities and reporting thresholds in FR Y-14. A credit facility is defined as any legally binding credit extension to a legal entity under a specific credit agreement. A credit facility may be secured or unsecured, term or revolving, drawn or undrawn (excluding informal advised lines). There is no materiality threshold for securities reporting at the individual obligor level. BHCs must report their securities holdings if the entire portfolio is greater than either $5 billion or five percent of Tier 1 capital on average for the four quarters preceding the reporting quarter.

Note on Total Liabilities: Flow of Funds. Total non financial corporate liabilities reported by the Flow of Funds in the National Accounts of the U.S. (Table B.3, Series i.d. FL104190005.Q) is computed as

$$Liabilities_{total} = taxes + debtsecurities + loans + miscellaneous + FDI.$$

The following source the total liability components:

- Tax data come from Internal Revenue Service, Statement Of Income – This item is smallest line item in the total;

- Debt securities are bond data is from Mergent Fixed Income Securities Database;

- Loan data are pulled from bank call reports – These data are all U.S. chartered bank depository institutions plus foreign bank offices in the U.S. These data also include credit unions;

- Miscellaneous is a catchall category and is the largest single component. This data is the sum of private pension fund contributions from the Department of Labor, and an unidentified category, which is the largest component of miscellaneous. The unidentified category is computed as a residual category from the IRS SOI and flow of founds:

  $$unidentified = total_{assets} - equity - liabilities,$$

  where *liabilities* are the individual liability sub-components in the Flow of Funds;

- FDI comes from BEA

B Robustness Appendix

This appendix provides a break down of loans by industry and some collateral-type statistics by industry. It also provides a key robustness exercise to rule out the heterogeneity in bank credit supply. We show below that our results are not driven by supply-side risk taking as is typically the case in the literature. This analysis includes the standard supply-side regressions in the literature that include firm-time fixed effects. Moreover, we explore the impact of bank-risk on non-performing loan performance. All told, we do not find evidence that risk banks make loans to risky firms. In fact, we generally find the opposite; risky banks cut lending to risk firms during monetary policy expansions. Finally, we discuss the potential financial stability risks stemming from the build up of loans to highly levered private firms.

B.1 Robustness Results

B.1.1 Industry Breakdown

Figure 13 shows the average and total dollar amounts committed to each two-digit NAICS sector in Panels (a) and (b) respectively. The Figure shows that, on average, the largest loans are committed to firms in the utilities; information; and mining, quarrying, and oil and gas extraction sectors. By contrast, aggregate commitments are largest for firms in the manufacturing and wholesale and retail trade sectors, indicating that there are many small loans to a large number of businesses in these sectors. There are also substantial differences in collateral types across sectors, even within the public and private firms, as shown in Tables 19 and 20. Although blanket liens and AR&I remain the most used collateral across all sectors, on average, there are important differences. For example, about 60% of loans to private accommodation and food services firms are secured by blanket liens compared to just 10% for retail trade. By contrast, AR&I collateral accounts for nearly 70% of secured loans to private retail trade firms and only 10% for accommodation and food service firms. Real estate and fixed assets account for just over 10% of the collateral in these industries used to secure loans, compared to nearly 40% of collateralized borrowing for firms in the real estate, transportation, and warehousing industries.

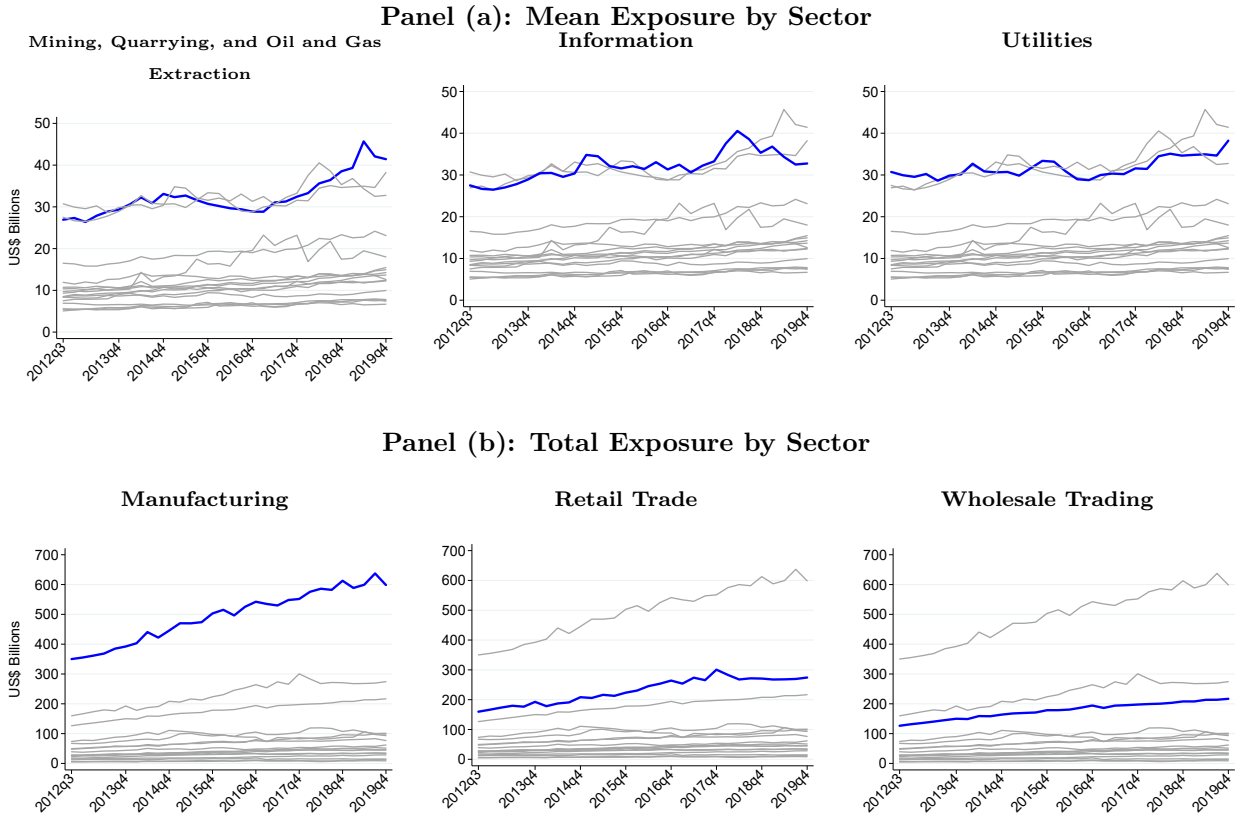

Figure 13.— Loan Commitments by Sector. Notes: Panel (a) plots the mean dollar value of loan commitments by the borrower's primary 2-digit NAICS industry. Panel (b) plots the total dollar value of committed loans by the borrower's primary 2-digit NAICS industry. Source: FR-Y14Q H.1.

B.1.2 The Role of NPLs

Each bank reports the cumulative net charge-off (or loan loss) amount for each loan that it makes. Net charge-offs represent the dollar value of non-performing loans that banks determine they will not recover in default and will have to write-down. Net charge-offs have a distinct advantage over other common measures in the literature such as default probabilities or simple delinquency dummies. Charge-offs are net of collateral confiscation, meaning they take into account the fact that loan recovery rates are, on average, 80 percent of face value. Moreover, the losses associated with defaulted loans that are highly collateralized are generally much smaller than uncollateralized loans. Hence, net charge-offs capture this difference.

The cumulative net charge-offs are aggregated to bank-firm level and normalized by the total committed loan amount for each borrower. The charge-off ratio varies by bank-firm-quarter. The charge-off results reported in Table 18 show a clear difference in the way that monetary policy easing impacts lending to private SMEs versus large public firms. The first column shows that private borrowers with higher charge-off rates on outstanding loans receive

Table 18.— Monetary Policy and Bank Risk-Taking via Loan Losses

	Log (Loan)	
	(1) Private Firms	(2) Public Firms
$(CCO/Loan)_{q-1}$	-0.0612	-0.2491
	(0.0553)	(0.2025)
$(CCO/Loan)_{q-1} \times$ MP Surprise$_q$	2.8959**	-1.4709
	(0.8349)	(1.6931)
Observations	310023	285175
Adjusted R^2	0.933	0.868
Bank × Firm F.E.	Yes	Yes
Firm × Quarter F.E.	Yes	Yes

Notes: $^{+}$ $p < 0.1$,* $p < 0.05$,** $p < 0.01$, and *** $p < 0.001$. This table reports OLS estimates of alternative risk measures for banks at the bank-firm level for the private firm sample (Panel A) and the public firm sample (Panel B) using quarterly data. The dependent variable in columns (1)-(4) is the natural logarithm of the total committed loan amount for a bank-firm pair. The measure of bank risk is the ratio of a bank-firm's total net charge off amount divided its committed loan amount for each firm, lagged one quarter. Each column sequentially adds different fixed effects. Standard errors are double clustered at the firm and quarter levels.

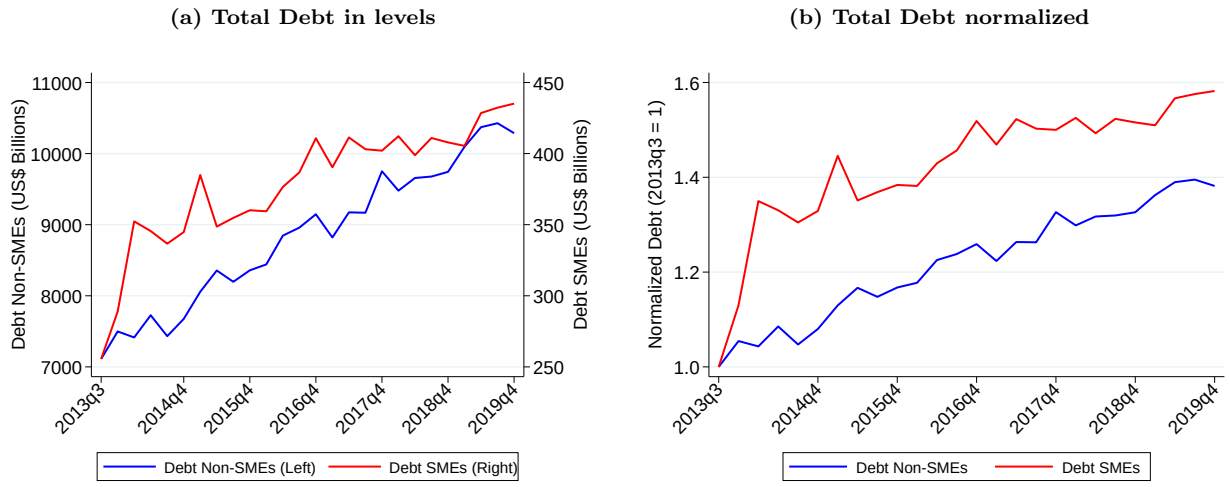

Figure 14.— Total Debt Growth for SMEs and Large Firms. Notes: This figure plots total debt amoung SMEs and non-SMEs in our sample. Total debt is the sum of short- plus long-term debt. SMEs are defined as firms with assets less than $10mn and or sales revenues less than $50mn. Panel (a) is total debt in levels and panel (b) normalizes total debt to 1 in 2012Q3.

less credit when policy rates fall. Banks cut lending to risky private borrowers for whom they book past losses. By contrast, there is no impact on credit among public firms.

B.1.3 Aggregate Variables

Figure 14 plots total debt growth among all firms in our data, split out by SME versus non-SME status. The normalized debt growth chart in panel (b) shows that total debt grew more rapidly initially for SMEs than non-SMEs in 2013, and has kept pace with debt growth among larger firms since.

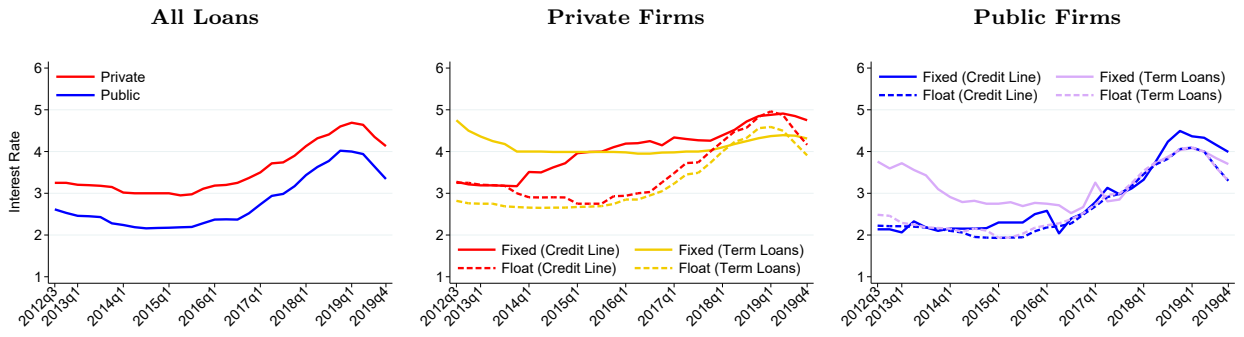

Figure 15.— Interest rates: Fixed versus Floating. Notes: The figure plots the median interest rates (in percent). The first chart plots interest rates for all loans for private borrowers in red and public borrowers in blue. The middle chart plots median interest rate for private borrowers for different loan types and rates. Solid lines plot rate on fixed rate loans (credit lines in red and term loans in gold). The dashed lines are rate on floating rate loans (credit lines in red and term loans in gold). The right chart plots median interest rate for public borrowers for different loan types and rates. Solid lines plot rate on fixed rate loans (credit lines in blue and term loans in purple). The dashed lines are rate on floating rate loans (credit lines in blue and term loans in purple). Source: FR Y-14Q H.1.

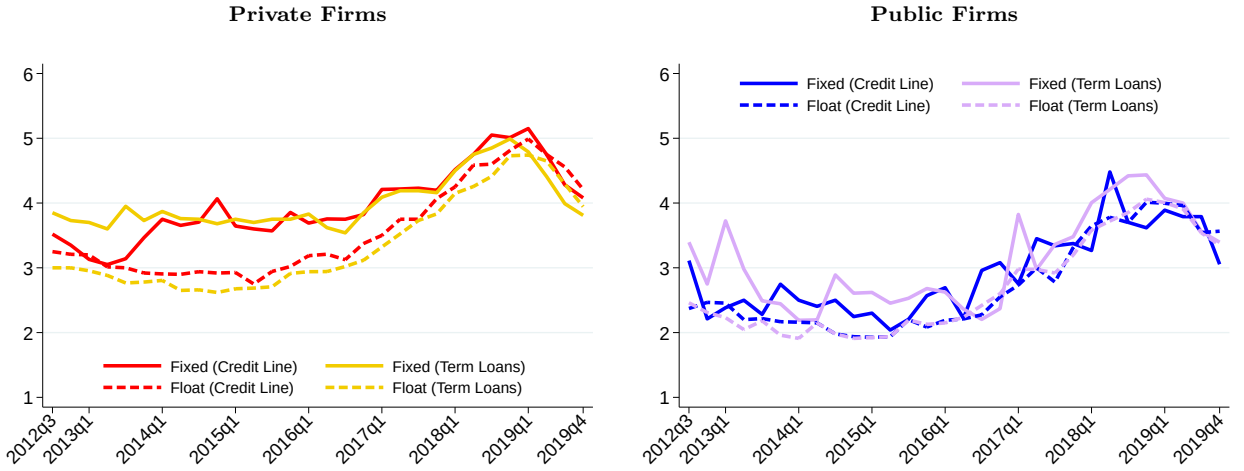

Figure 16.— Interest rates on New Originations. Notes: The figure plots the median interest rate (in percent) for new loan origination broken out by credit lines, term loans with fixed versus floating rates. The chart on the left plots the various loan rates for for private borrowers on the left and public borrowers on the right. The solid lines are fixed rate loans and the dashed lines are floating rate loans. Source: FR Y-14Q H.1. Source: FR Y-14Q H.1.

B.2 Aggregate effect on Loan Interest Rates

All dynamic results in Section 5.2 are based on identified relative effects. If we want to know the aggregate time series patterns, we can simply plot the borrowing costs for different types of firms (credit growth has increased overall in this period). Figure 15 plots interest rates for the typical public and private borrower. Public firms borrow at lower interest rates, as shown by the blue line in the first chart on the left. The middle and right charts show median interest rates by loan and rate type (fixed versus floating rate loans and credit lines versus

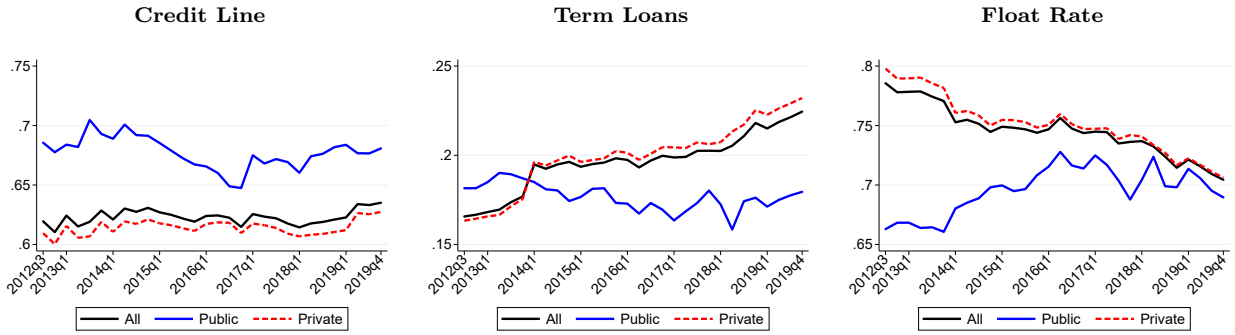

Figure 17.— Loan shares: Credit Lines/Term loans and Floating/Fixed Rates. Notes: The share of credit lines among all loan types in the left panel. The middle panel plots the term loans shares. The right panel plots the share of loans with floating interest rates. Source: FR Y-14Q H.1. Source: FR Y-14Q H.1.

term loans) for private and public firms. Floating rate loans (dashed lines) track monetary policy rates for both borrower types. By contrast, fixed-rate loans declined both for private firms (solid gold line) and for public borrowers (solid purple line) before increasing in 2017. Figure 16 focus on rates only for new loan originations and suggest that floating rate credit line prices rose faster during rate lift-off. This might have induced a compositional change as we show in Figure 17 below: the share of term loans among all loans has increased nearly 7 percent while the share of floating rate loans has fallen nearly 10 percent during our sample period. In order to shield our results from such compositional effects, we use all types of loans.

B.3 Dynamic Real Effects on Investment, Inventories, and Sales

This subsection compliments the OLS panel regression on investment, inventories, and sales presented in Section 5.4 with dynamic local projections. The local projections are estimated with the following equation:

$$\log Y_{f,q+h}(l) = \alpha_f + \alpha_q + \kappa_h \left(\textbf{High Leverage Firm}_f \times \textbf{SME}_f \times \text{MP}_{q-k}\right) + \vartheta_{f,q+h} \tag{9}$$

The results, shown in Figure 18, show that monetary easing (negative monetary policy shocks) result in higher sales.

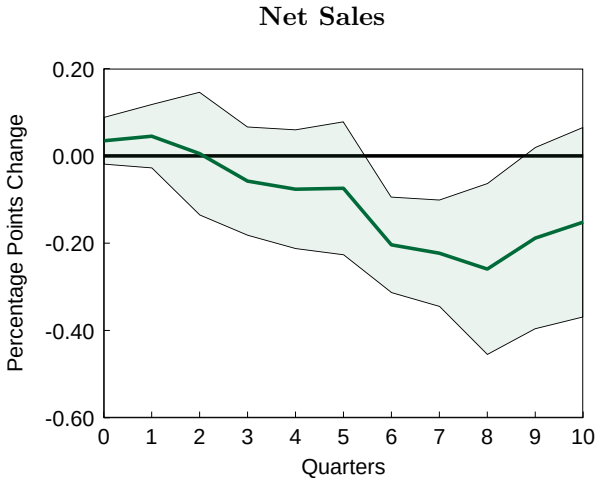

Figure 18.— Dynamic effects of monetary policy shocks on SME sales. Notes: The figure shows the dynamics of the triple interaction coefficient of, κ_h, SME$\times$ MP $\times$ Leverage over quarter h, from equation (9).

B.4 Additional Tables

Table 19.— Pledged Collateral Within Sectors: Private Firms

Sector	Real Estate	Cash and Marketable Securities	Accounts Receivable and Inventory	Fixed Assets	Blanket Lien and Other	Unsecured
Accomodation and Food	10.77	7.08	11.75	4.79	53.60	12.01
Agriculture	4.45	1.06	37.53	8.60	37.03	11.33
Arts and Entertainment	12.95	4.19	20.79	7.18	45.43	9.46
Construction	6.71	3.73	24.35	12.76	33.83	18.63
Educational Services	16.17	0.41	4.83	14.43	34.25	29.92
Healthcare	29.07	3.35	18.40	6.01	33.39	9.78
Information	2.70	3.68	19.51	4.19	34.14	35.78
Management	11.31	14.24	11.56	4.57	26.86	31.47
Manufacturing	4.67	1.70	33.33	7.45	32.97	19.89
Mining and Gas Extraction	1.47	2.41	30.78	9.35	44.35	11.64
Other Services	21.23	2.97	23.83	5.58	35.55	10.83
Professional, Science and Technology	5.21	2.72	28.29	3.67	35.06	25.04
Public Administration	0.00	1.67	36.40	0.64	33.55	27.75
Real Estate	5.53	1.43	26.84	27.95	28.63	9.63
Retail and Trade	9.16	2.53	61.17	3.17	17.08	6.88
Transportation and Warehousing	5.64	1.32	18.38	29.01	29.13	16.52
Utilities	1.08	4.83	6.30	5.56	27.45	54.79
Waste Management Administration	3.68	2.59	30.30	6.69	44.53	12.22
Wholesale Trading	4.39	1.43	43.57	4.26	32.29	14.06
Average	8.22	3.33	25.68	8.73	34.69	19.35

Notes: Average over time between 2012Q3 – 2020Q2

Table 20.— Pledged Collateral Within Sectors: Public Firms

Sector	Real Estate	Cash and Marketable Securities	Accounts Receivable and Inventory	Fixed Assets	Blanket Lien and Other	Unsecured
Accomodation and Food	3.69	6.05	8.16	1.71	23.64	56.74
Agriculture	0.96	0.04	2.00	1.18	2.80	93.03
Arts and Entertainment	0.70	4.97	35.13	2.13	52.30	4.77
Construction	0.59	3.72	18.61	5.01	25.67	46.41
Educational Services	0.00	0.00	3.97	0.00	0.00	96.03
Healthcare	1.45	6.57	27.71	3.40	35.03	25.85
Information	0.39	2.24	7.62	1.45	13.65	74.64
Management	0.01	18.46	4.84	0.67	8.53	67.50
Manufacturing	0.39	1.59	9.73	1.95	14.35	72.00
Mining and Gas Extraction	0.32	1.14	13.63	2.59	23.97	58.36
Other Services	0.56	3.58	9.64	3.59	19.08	63.56
Professional, Science and Technology	0.67	2.51	19.15	1.79	26.51	49.38
Public Administration	0.00	4.74	0.00	0.00	71.11	24.15
Real Estate	1.37	1.47	16.75	18.93	20.84	40.63
Retail and Trade	0.76	0.53	18.78	3.46	11.68	64.78
Transportation and Warehousing	0.65	1.99	9.52	8.18	15.61	64.05
Utilities	0.35	2.10	0.63	2.44	9.99	84.50
Waste Management Administration	0.74	1.90	17.28	2.18	19.72	58.17
Wholesale Trading	1.00	2.01	21.48	2.61	19.03	53.87
Average	0.77	3.45	12.87	3.33	21.76	57.81

Notes: Average over time between 2012Q3 – 2020Q2

Table 21.— Fraction of Loan Commitments by Collateral Type and Decile of Assets

	Decile based on Assets									
Category	1	2	3	4	5	6	7	8	9	10
Real Estate	44	18	11	8	7	5	4	2	1	0
Cash and Marketable Securities	2	3	3	2	2	2	2	3	3	1
Accounts Receivable and Inventory	12	26	40	45	48	45	40	34	24	09
Fixed Assets excluding Real Estate	6	9	8	8	8	8	8	6	5	3
Blanket Lien and Other	32	40	36	32	32	34	37	33	23	12
Unsecured	3	3	3	3	3	5	10	21	44	73

Notes: Decile based on Assets. Numbers are in percentage terms.

B.5 Additional Figures

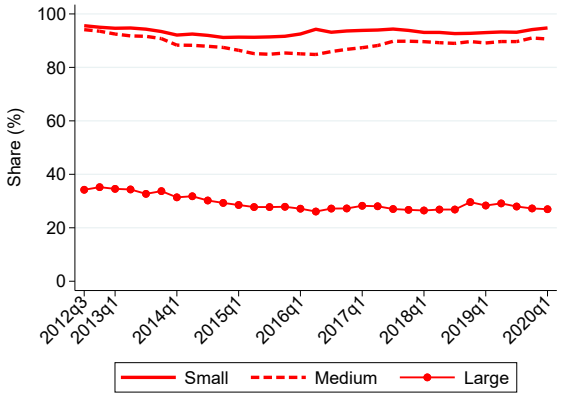

Figure 19.— Share of Bank Debt in Non-Financial Private Firms' Financing in FR Y-14. Notes: The figures plot the median loan commitment as share of total balance sheet debt for various points in the asset-size distribution among private borrowers. Source: FR-Y14Q H.1

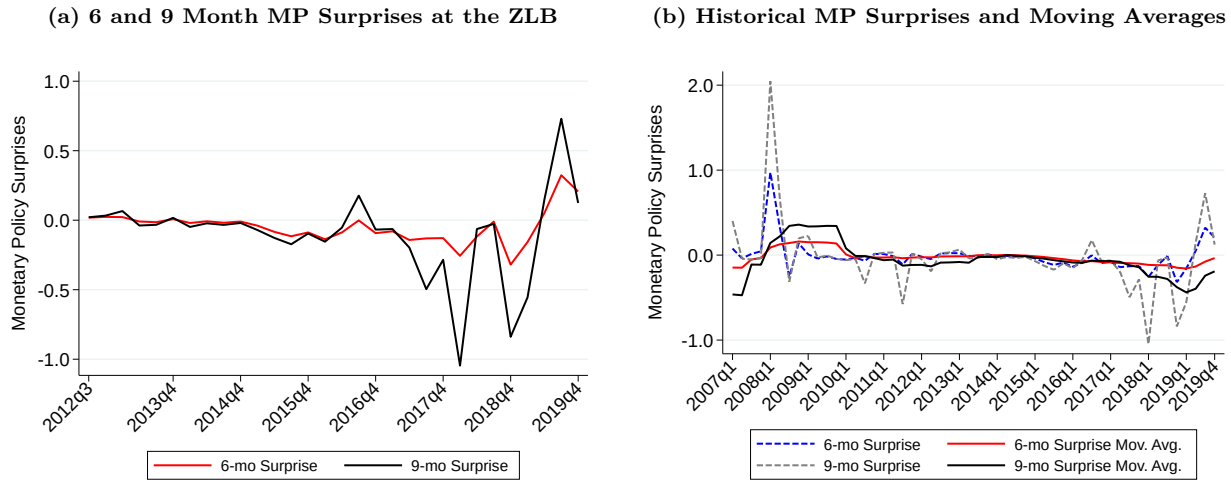

Figure 20.— Quarterly Monetary Policy Surprises. Notes: This figure plots monetary policy surprises in percentage points following the quarterly aggregation of Ottonello and Winberry (2020). Panel (a) plots the surprise component of the 6-mo and 9-mo feds funds future during our period, and panel (b) plots the historical-moving average of the same shocks to compare the size of the shocks during the ZLB period vs before.

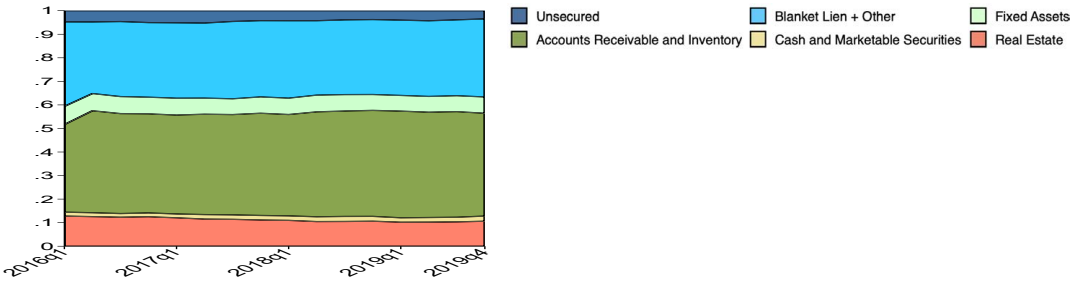

Figure 21.— Collateral Types among SMEs. Notes: The figure plots loan values secured by different collateral types over time for SME borrowers. SMEs are defined as firms with annual sales less than $50mn. The different types of collateral are real estate collateral (salmon); cash and marketable securities (yellow); accounts receivable, inventory (green); fixed assets (mint); blanket liens and other (light blue); and unsecured (dark blue). Source: FR Y14-Q H.1.

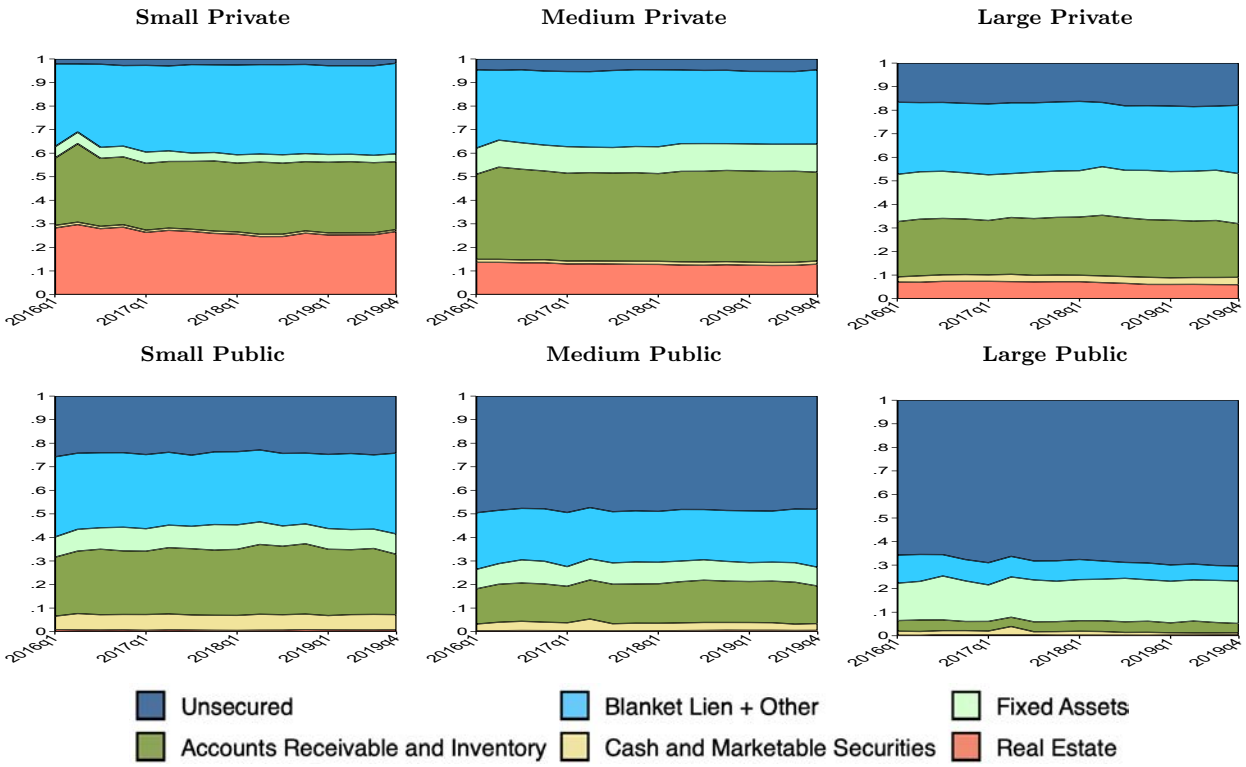

Figure 22.— Collateral Type: Public vs. Private (Based on Number of Loans). Notes: The figure plots the proportion of loans secured by different collateral types over time. The different types of collateral are cash and marketable securities (in yellow); accounts receivable, inventory (in dark green); blanket liens (in light blue); fixed assets (in light green); real estate (in orange); and unsecured loans (in dark blue). The top three panels from left to right show the proportion of loans secured by the different collateral types and unsecured for private borrowers in the bottom quartile of assets (small), between the bottom and top quartile of assets (medium), and above the top quartile of assets (large). The bottom three panels present the same information for public borrowers. Source: FR Y14-Q H.1.