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ABSTRACT

Using confidential regulatory firm-bank-loan level data from the U.S., we document four new facts about the credit market. First, private SMEs typically utilize all available bank credit which comprises their entire balance sheet debt, compared to large listed firms who can switch between corporate bonds and drawing from credit lines. Second, SMEs borrow shorter maturity and pay higher interest rates relative to large publicly listed firms. Third, SMEs more frequently use future claims to their enterprise value as collateral rather than physical assets and real estate that can be liquidated upon default. Fourth, the relation between collateral and risk—where risk is measured by the loan spread—is positive for large listed firms but negative for SMEs. Motivated by these facts, we investigate the transmission of monetary policy and risk-taking behavior. We show that, when monetary policy is expansionary, banks do not lend differently to risky and non-risky firms, whether they are private SMEs or publicly listed firms. Instead, risk-taking is driven by credit demand since SMEs who lack collateral in terms of physical assets increase their leverage due to low interest rates, which increases their ability to payback the loan. Since SMEs cover 99 percent of all U.S. firms and over 50 percent of U.S. employment and output, our results have important implications for the aggregate boom-bust cycles in a low interest rate environment.

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1 Introduction

Many academics and policy makers argued that if interest rates are too low for too long, there will be risks that threaten financial stability, as low interest rates not only lead to more borrowing but also will affect the quality of that borrowing (See Borio and Zhu (2012), Adrian and Shin (2009, 2010), Acharya and Naqvi (2012)). This risk-taking channel of monetary policy implies that banks will extend loans to riskier firms when interest rates are too low and when those firms default on those loans, banks will experience a negative shock to their net worth, increasing systemic risk. Thus, monetary policy transmission in a low interest rate environment implies not only higher credit growth, investment and output, but also riskier debt and potential future corporate defaults.

In order to quantify the extent of such risk-taking as a result of changes in monetary policy, we need a representative sample of lenders and borrowers. As there can be heterogeneity in taking risk based on the size of lenders/borrowers and types of loans/bonds, results based on a select sample of large borrowers and/or lenders participating only in certain factions of the financial markets can be incomplete. In addition, in order to estimate the extent of risk-taking during episodes of changing monetary policy, one needs a benchmark, that is the extent of risk-taking during normal times.

So far, the literature lacked the data required to undertake these tasks as in the U.S. only publicly listed firms are required to report their financing sources. We use a new confidential supervisory data set that covers a much more representative set of U.S. firms and most U.S. bank holding companies that includes the universe of systemically important banks. We specifically ask, whether or not *high leverage banks* are knowingly taking risk by lending to firms who are more likely to default (*high leverage and/or low collateral firms*) or is it simply that low interest rates lead to a rise in demand for credit among small and less collateralized firms because lower rates increases their ability to repay debts?

Our data come from the Capital Assessments and Stress Testing Report (FR Y-14Q report) and is collected by the Federal Reserve as part of the Comprehensive Capital Analysis and Review (CCAR) for bank holding companies, U.S. Intermediate Holding Companies of foreign banking organizations, covering all financial institutions with $100 billion or more in total consolidated assets.[1] The data covers approximately 70% of Corporate and Industrial (C&I) loans in the U.S. from Q3:2012 to Q4:2019. During this period, the federal funds rate was at the effective zero lower bound from 2012-2015, and remained beneath 1 percent until 2017Q2.

[1] The appendix provides a list of the financial institutions that report information as part of the CCAR process.

To the best of our knowledge, this is the first time this data is used to evaluate the effects of low interest rates on risk-taking and how monetary policy transmission works in an economy with heterogeneous firms and banks.[2] Although there is an extensive theoretical literature in heterogeneous agents macro models (HANK), the empirical literature has been lagging due to data unavailability, especially in terms of the policy transmission with heterogeneous agents. There are several advantages of our data set that can directly speak to this literature. First, this data is collected at the firm-bank-loan level, a first for the U.S. Second, in addition to the loan quantity, which is generally the only variable available in other advanced country credit registries, we observe the price as well as the type and amount of collateral posted both at the loan level.[3] This allows us to evaluate whether risk-taking operates through credit supply (bank) or credit demand (firm), and if other dimensions of heterogeneity, such as collateral type and financial constraints at the firm and/or loan level affect transmission of monetary policy and/or allocation of credit across firms (e.g. Kaplan et al. (2018), Gopinath et al. (2017), Ivashina et al. (2020), Drechsel (2019), Ottonello and Winberry (2020) and Greenwald et al. (2020)). Finally, the data is at the quarterly level, allowing us to analyze monetary policy transmission at the business cycle frequency.

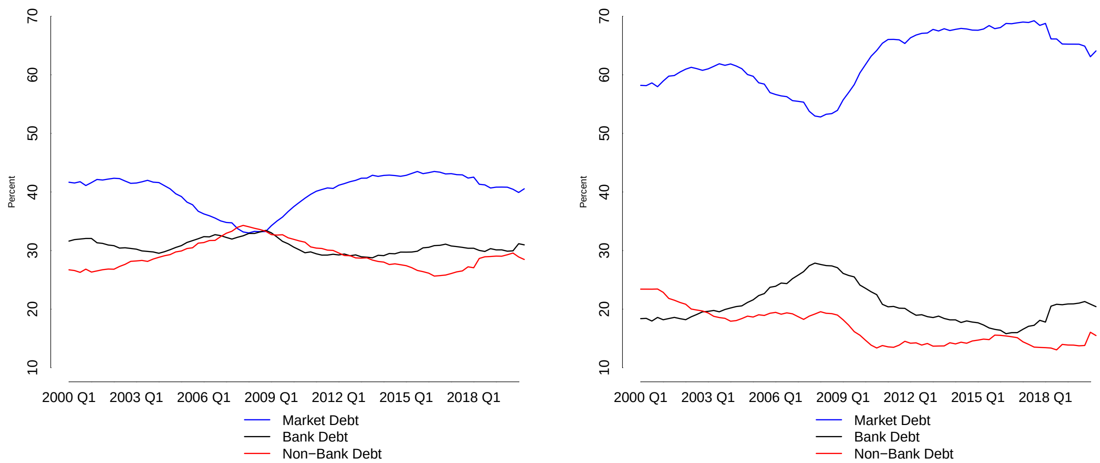
Figures 1 plots official aggregate data for the non-financial business sector from the Financial Accounts of the United States. Figure 1, right panel, shows the debt share for publicly listed and large private firms (C and S corporations), known as "non-financial corporate businesses" in the Financial Accounts data. The share of bank finance, shown by the line "Bank Debt" is small for these companies, around 20 percent on average. In the left panel, which includes not only publicly listed firms, large private C and S corporations, but also other smaller private firms, known as "non-financial businesses" in Financial Accounts data, the share goes up to 30 percent. In addition, market debt declines sharply.[4] This difference

[2]The data are used to study various other issues including CDS use by banks on borrower credit risk (Caglio et al. (2019)), the relationship between U.S. exchange rates and banks credit supply to foreign firms (Niepmann and Schmidt-Eisenlohr (2018)), how banks re-balance their portfolios due to losses (Bidder et al. (2018)), how monetary policy transmits differently through credit lines versus terms loans (Greenwald et al. (2020)), the effects of COVID on credit line draw downs stemming from the differences between small and large firms in terms of their financing (Chodorow-Reich et al. (2020), the effect of corporate taxes on leverage (Ivanov et al. (2020)), and estimating the value of collateral in new loan originations Luck and Santos (2019).

[3]The only other credit registry with this information, to the best of our knowledge is from an emerging market, Turkey, see di Giovanni et al. (2019).

[4]The private firms included in the non-financial business series that are excluded from the non-financial corporate business series include, among others, partnerships and sole-proprietorships. Liabilities in the Financial Accounts for private firms both under "non-financial corporate" and "non-financial businesses" are not built from the bottom up. They are "estimates" apportioned into categories from sources than can be identified. For example, the loan liabilities in the "non-financial business" category are derived from tax data from the IRS-SOI year end bulletin, and an estimate of loan shares from FRB 2003 Survey of Small Business

Figure 1: Non-financial Firms' Financing in the Financial Accounts of the United States



(a) Non-financial Business (b) Non-financial Corporate Businesses

The panel on the left represents the debt share for all "non-financial businesses" in the U.S. The panel on the right represents the debt share for the "non-financial corporate 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. Source: Financial Accounts of the United States, FOF.

between plots (a) and (b) indicates the importance of bank financing for small and medium size enterprises (SMEs), as including small private firms increases the share of bank finance and decreases that of market finance. As the data on "non-financial corporate businesses" from Financial Accounts is widely used by researchers, and dominated by large listed firms, it led to a false narrative in the literature that bank financing is not important in the U.S.

Our data from FR Y-14 filings paints a drastically different picture as shown in Figure 2. Though, our data covers both private and public firms and encompasses most comprehensive SME borrowing in the US, we plot only the private firms to highlight the stark difference from the aggregate Financial Accounts data. For large private firms, defined as firms in the largest 75th asset quartile shown with red dashed line, we match the narrative of the aggregate Financial Accounts data of Figure 1 (a) as only 30 percent of their financing is from banks. Interestingly, for rest of the private firms, financing is almost exclusively from banks. These private firms that are below the 75th percentile of the asset distribution are firms with assets less than \$43 million, and revenue less than \$86 million. The median firm has \$12 million in assets and \$28 million in sales. In U.S., SMEs are defined as firms with less than 500 employees. There is not a well established asset and/or revenue cut-off to define

Finance, a survey that is discontinued.

Figure 2: Non-financial Private Firms' Financing in FR Y-14

The figures plots 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

SMEs. We follow the OECD definition of SMEs as firms with less than 250 employee and/or assets less than \$10 million, and/or revenue less than \$50 million. Hence most of our private firms are SMEs.[5]

Why it is important to understand borrowing and lending patterns of SMEs? In U.S. SMEs, defined as firms with less than 500 employees, account for 99.8 percent of all firms, 52 percent of private sector employment and 48 percent of private sector gross output.[6] We argue that, understanding how SMEs risk-taking behavior and borrowing patterns are affected differently from large firms as a result of changes in monetary policy is key to understanding monetary policy transmission in the aggregate U.S. economy.

Our identification methodology is as follows. We regress credit volume and price at

[5] Ivanov et al. (2020) and Chodorow-Reich et al. (2020) define SMEs as firms with less than \$250 million in assets. This definition comes from first truncating the sample by cutting firms with less than \$100 million in assets, and then taking the median in the remaining sample which is \$250 million in assets. This definition will cut most of the SMEs out of the sample and hence we opt for the OECD definition.

[6] See www.census.gov

the firm-bank-loan level, separating private and publicly listed firms, and also SMEs and others, on measures of bank and firm risk interacted with the monetary policy surprises measured by Gürkaynak et al. (2005) (GSS). Gertler and Karadi (2015) (GK) argue that, in the presence of financial frictions, the response of credit costs to monetary policy may in part reflect movements in risk spreads. They use GSS surprises as instruments in high frequency identification (a thirty minute window of the monetary policy announcement) to rule out the simultaneity of economic news and monetary policy. In a similar vein to GK, we investigate the response of both credit price (including loan risk premium/spread) and credit amount from time t to $t+1$ to a monetary policy surprise shock in time t. We interact these surprise monetary policy shocks with "ex-ante risk" measures for firms and banks with the idea that "ex-ante risky" firms and banks will respond differently to monetary policy surprises.

We use ex-ante leverage as a proxy for ex-ante firm and bank risk. We measure the leverage before the monetary policy surprise shock. As an additional measure, for banks, we use ex-ante accumulated "charge-offs" on their balance sheets for non-performing loans. We show that ex-ante firm leverage is correlated with probability of firm default.[7] As an alternative, we use collateral that the firm posts for a given loan at the time of issuance. Due to previous data limitations, loan level collateral has never been used in the U.S. to measure credit risk for a representative sample of firms.

We first document new facts on borrowing and lending patterns of firms and banks in normal times and then we document the effects of monetary policy shocks on these patterns, with a focus on risk-taking behavior. First, we show that SMEs borrow shorter maturity and pay higher interest rates relative to large publicly listed firms. Second, SMEs more frequently use future claims to their enterprise value as collateral rather than fixed assets and real estate that can be liquidated upon default. Third, SMEs typically utilize all available bank credit which comprises their entire balance sheet debt, as oppose to large publicly listed firms who can switch between bonds and drawing from credit lines. Fourth, the relation between collateral and risk is positive for large listed firms but negative for SMEs, where we measure risk with loan level risk premium (loan spreads).

To establish the last fact relating collateral and risk, we show a positive correlation between collateral and credit growth for the SMEs who post more collateral and these SMEs also pay lower interest rates on those collateralized loans. Since loan rates include risk spreads, this implies a negative relation between collateral and risk.[8] For publicly-owned

[7]See also Ottonello and Winberry (2020), who uses firm leverage as an indicator of firm default both theoretically and empirically for U.S. publicly listed firms.

[8]In theoretical work, small private firms who lack collateral cannot access credit as they are screened out of the market (Dell'Ariccia and Marquez (2006), Darst et al. (2020). Although we do not observe this

large firms, the result is the exact opposite: large public firms who post more collateral obtain less credit and pay a higher interest rate. Hence, collateral does capture true "default risk" in the case of large public firms as argued by an extensive literature (see Holmstrom and Tirole (1997), Kiyotaki and Moore (1997), Geanakoplos (1996)), but collateral does not capture the default risk for SMEs. In the case of SMEs, collateral captures access to finance. Our second fact further supports this interpretation as the type of collateral SMEs post most is not physical assets that can be liquidated in the event of a default, but rather future claims to their enterprise value.

When we turn to the effects of monetary policy shocks, we find that risk-taking in the U.S. operates through private firms/SMEs' credit demand; that is when interest rates are low, ex-ante risky (high leverage) firms demand more credit, increasing the loan amount and loan price in equilibrium. As SMEs typically pledge going concern or future firm value as collateral instead of physical assets to borrow in normal times, lower interest rates help them to borrow even more by increasing their ability to pay, which pushes up the equilibrium loan price. Ex-ante risky banks (low capital-high leverage banks) do not charge different prices or alter their supply of credit differently to ex-ante risky vs non-risky firms, whether these firms are private SMEs or large publicly listed firms.

Our results are consistent with the recent work emphasizing earnings based constraints for "smaller firms"[9] rather than collateral constraints, where collateral is meant to capture a physical asset that can be liquidated upon default (e.g. Lian and Ma (2020), Ivashina et al. (2020), and Drechsel (2019)). Our new findings relative to this literature, based on a much more representative sample of firms are threefold: (i) the importance of collateral-types; small firms still use collateral to access finance but of different type, (ii) the relation between collateral and credit risk has the opposite sign for SMEs versus large listed firms, (iii) and the implications of these new facts on collateral, firm size, and risk on monetary policy transmission. These findings have important implications for understanding how risk-taking works in an economy with small and large firms, in the presence of shocks to monetary policy.

We proceed as follows. Section 2 summarizes the literature. Section 3 describes the data in detail. Section 4 presents stylized facts on firms' borrowing, banks' lending and loan types and collateral used highlighting the heterogeneity on several dimensions of financial contracts. Section 5 presents results on monetary policy transmission. Section 6 concludes.

extensive margin, as our data is on firms who borrow, our results show that the same intuition works at the intensive margin.

[9]This literature works with large listed firms and firms who have access to bond markets and not with SMEs.

2 Literature

Our paper contributes to the long literature on monetary policy transmission, though we use new regulatory data from the U.S. for the first time to contribute to this question. Starting with Bernanke and Blinder (1992), Bernanke and Gertler (1995) and Bernanke et al. (1999), the literature on the credit channel of monetary policy mostly focuses on monetary contractions. Kashyap and Stein (2000) and Jiménez et al. (2012) provide evidence of the credit channel where bank lending falls after monetary contractions. By contrast, the risk-taking channel of monetary policy focuses on the effect of low interest rates and monetary easing on credit supply. This literature highlights the importance of risk bearing/taking capacity of large, well-capitalized banks (e.g. Adrian and Shin (2011), Chodorow-Reich (2014)) during expansionary monetary policy, meaning low capitalized banks will expand less credit.

For the U.S., researchers generally focus on the lender side and rely on bank-level data. For example, Dell′Ariccia et al. (2017) use data on U.S. banks' loan ratings from the Federal Reserve's Survey of Terms of Business Lending (STBL) and find that banks take more risk when interest rates are low as the risk ratings of their loan portfolio go up. Interestingly, riskiness of the portfolio increases for the *high capital-low leverage* banks and not the other way round. Consistent with this finding, Paligorova and Santos (2017) show that high capital-low leverage banks charge lower spreads on syndicated loans, when interest rates are low.[10] The papers that use data from countries other than the U.S. rely on borrower data. These papers utilize measures of pre-existing default history and/or non-performing loans of borrowers to measure risk-taking and show that banks with *low capital-high leverage* lend to "riskier" borrowers who have defaulted more before and hence they are more likely to default later on (e.g. Jiménez et al. (2014), Ioannidou et al. (2014)).

Theoretically, the effect of low rates on risk-taking is ambiguous. It can be that when monetary policy is expansionary, the agency problems are less severe and so all borrowers' net worth expands allowing low net worth (risky) borrowers to also borrow (e.g. Bernanke and Gertler (1989), Bernanke et al. (1996)). Alternatively, a lower interest rate will induce a "search-for-yield" behavior as intermediaries reallocate their portfolio from low yielding safe assets to higher yielding risky ones (e.g. Rajan (2005)). Another possibility is that low interest rates reduce funding costs to entrepreneurs and reduce the incentive to produce risky projects (e.g. Stiglitz and Weiss (1981)). These effects can offset each other resulting in an equilibrium with zero risk-taking by banks (e.g. Dell′Ariccia et al. (2014)).

[10] Maddaloni and Peydró (2011) find the opposite where banks with less stringent capital regulation lower lending standards when short-term interest rates fall.

Our work starts with documenting facts on heterogeneous patterns of borrowing/lending and risk-taking during normal times by firm size and type of financial contract before moving on investigating risk-taking when monetary policy changes. Particularly, our results on collateral and risk during normal times shows the importance of using a representative data set on all firms and how heterogeneity during normal times can be important for understanding the effect of policy transmission. The literature on the relation between collateral and risk either solely relies on large listed firms or uses select samples of small firms and finds mixed results. Berger and Udell (1990) use bank-level data from the U.S. Small Business Terms of Lending and show that collateralized loans have higher interest rates, opposite of our small firm result.[11] Berger and Udell (1995) use a one-year U.S. survey from the National Survey of Small Business Finances to show that most small firms need collateral to borrow, suggesting financial constraints, but firms with less asymmetric information need less. Both these papers suggest a positive relation between risk and collateral, since their samples are too small to fully separate the role of collateral in terms of capturing risk of default vs financial constraints, as we can do. Luck and Santos (2019), also using FR Y-14 data like us, though only focusing on a small sample of new loan organizations from multiple banks, find that smaller firms who post collateral pay lower rates, consistent with our result. Differently than us, they find that physical collateral such as real estate also matters like other types of collateral for this negative relation between collateral and risk. We find no role for physical collateral as in our large representative sample, SMEs mostly use future claims to their enterprise value as collateral.

Rauh and Sufi (2010), John et al. (2003), and Benmelech et al. (2020), all study the relationship between collateral and risk among large public borrowers and find different results. Rauh and Sufi (2010) result is similar to us that there is a positive relation between collateral and risk for large listed firms as public firms post collateral when they are in distress or if they are low quality firms. John et al. (2003) find a similar result that collateralized bonds have higher yields. However, Benmelech et al. (2020) result differs that among large listed firms, collaterized debt have lower spreads relative to unsecured debt.

Rampini and Vishwanathan (2020) argues that both secured and unsecured debt have some sort of collateral backing. In the case of unsecured debt, lenders effectively have a claim on all of the firm's assets that are not explicitly pledged as in secured debt contracts. From the lens of their model, they interpret the findings of Benmelech et al. (2019) as securing debt being costly, so more financially constrained firms switch to secured debt and large listed

[11] Berger et al. (2011, 2016) using large firms from Bolivia also finds a positive relation between collateral and risk, whereas di Giovanni et al. (2019) using universe of firms from Turkey finds a negative relation between collateral and risk.

firms being less financially constrained decrease use of secured debt over time. Lian and Ma (2020), on the other hand, calls cash-flow/earnings based lending unsecured and physical asset based lending secured (collateral and secured debt being synonymous), where there is very little of the latter among large listed firms. Their interpretation is that collateral constrains are not as relevant for large firms, whereas Rampini and Vishwanathan (2020)'s interpretation is that collateral is also relevant for unsecured debt of large firms, which is backed by the net present value of the firm. Our detailed results on collateral type can bridge these different interpretations. SME debt is more secured then large listed firms since SMEs are financially constrained, but the type of collateral used to secure that debt is not generally composed of physical assets and real estate. Hence, SMEs are both financially constrained and also lack physical assets to use as collateral so they use future claims to their enterprise value to secure their borrowing.

Our work is closely related to the literature on heterogeneous firm responses to monetary policy shocks (e.g. Ottonello and Winberry (2020) and Greenwald et al. (2020)). These papers show that high leverage firms are less sensitive to monetary policy shocks and large firms can draw from their credit lines to smooth out the effects of these shocks. Our work bridges these papers as it shows that financial leverage has increased more among large publicly listed firms than SMEs and SMEs' loan financing responds more to interest rate movements. However, the extent of this response is still a function of SMEs' leverage. Consistent with our results, Greenwald (2019) shows that firms with interest rate coverage covenants, that is, firms who cannot borrow more than an amount set by the ratio of interest payments to earnings, are important in understanding the asymmetry (state-dependence) in monetary policy transmission: when interest rates are high, interest coverage limits are tighter, amplifying a larger influence of monetary policy in slowing down credit growth.

3 Data

3.1 FR Y-14Q Schedule H.1

The FR Y-14Q report collects detailed information on bank holding companies' (BHCs), 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 and IHCs with at least $50 billion ($100 billion starting from 2020) in total assets.[12] The banks that submit FR Y-14Q data since 2012 comprise over 85% of the total assets in the U.S. banking sector.

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 had 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.

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% by dollar amount) are designated as HFI. The appendix contains additional information on how different assets are classified in the FR Y-14 schedules.

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 million.[13] 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 will call each facility a loan in the remainder of the paper.

The total committed value of the loans reported on the H.1 Schedule as of 2019Q4 is nearly $3.3 trillion.[14] 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

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

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

[14] 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)).

C&I equivalent lending in the U.S.[15]

The FR Y-14Q info 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 info does not exist anywhere else.[16] We, for the first time, heavily exploit information on a large cross-section of private borrowers to convey the importance of including private firms, most of which are SMEs, for aggregate economic activity and for the transmission of monetary policy. Finally, the data also contain 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.

3.2 Sample Construction

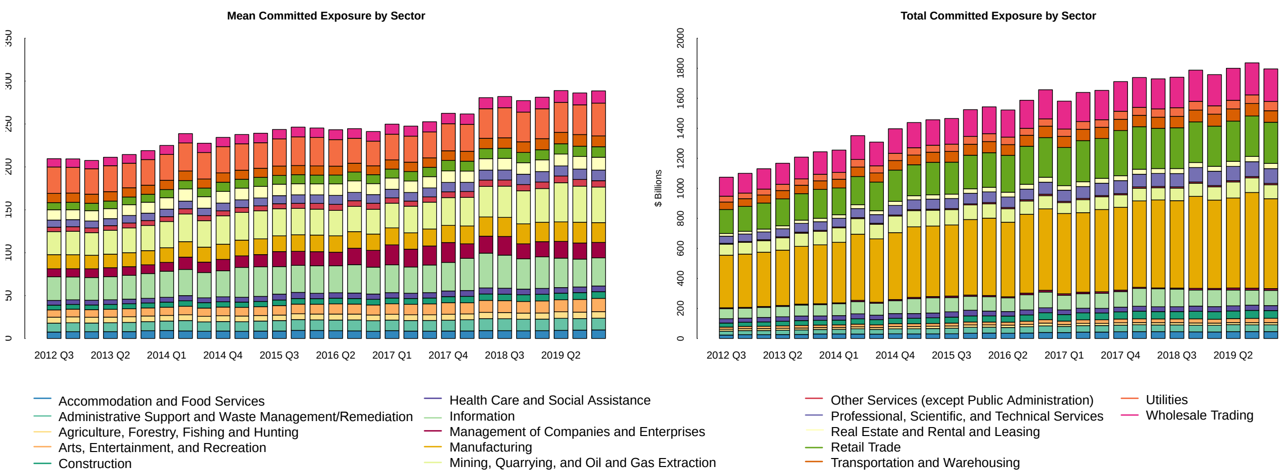
For each quarter, we define private firms in the data as those that cannot be matched to COMPUSTAT either via 6-digit CUSIP or via tax ID (EIN). Large public firms might report consolidated or unconsolidated accounts to banks. To avoid double counting of financial variables, we use Bloomberg's Corporate Structure Database and match it to our FR Y-14Q data through EIN when possible, or name matching. This way we can clean double counting arising from subsidiaries unconsolidated and their corporate headquarters' consolidated statements. We roll the loans issued to subsidiaries up to the parent company since banks use parent company financial information for loans made to subsidiaries. Treating these subsidiaries as separate "firms" will produce erroneous results for size and distributional cuts of the data.[17]

[15]The comparisons between FR Y-14Q and FR Y-9C are not one-to-one and are complicated by the 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.

[16]Few commercial data providers, such as, Moody's ORBIS and D&B provide some of this data but for a select set of private firms. Other sources such as FED's small business finance survey and U.S. Census Bureau's QFR data sets are also for select set of firms. See Dinlersoz et al. (2018) that goes details of the selection problems in the financial data for private firms in the U.S.

[17]Note that, relying on the tax ID without the full corporate structure to identify unique firms in the data is problematic because banks frequently report identical tax ids for both parent companies and their subsidiaries. This means that there will be different balance sheet information for the same tax id because the balance sheet information is attributed to two distinct firms. For robustness in all of our regressions, we

Figure 3: Loan Commitments by Sector



The panel on the left plots the mean dollar value of loan commitments made by CCAR banks to firms by the borrower's primary 2-digit NAICS industry. The panel on the right plots the total dollar value of committed loans made by CCAR banks to firms by the borrower's primary 2-digit NAICS industry. Source: FR-Y14Q H.1.

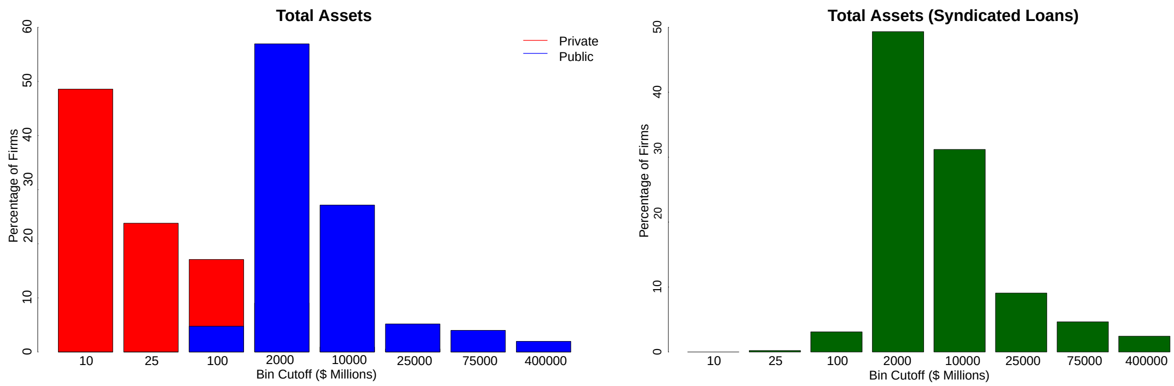
The final data has 3,798,946 loan-level observations for 155,589 U.S. corporations. Importantly, the data contain nearly 153,000 unique private firms of which 66,000 have balance sheet assets of less than \$10 millions. Hence, almost 50 percent of our sample are SMEs. All data cleaning details are provided in appendix.

3.3 Descriptive Statistics

This section provides statistics that highlight the key advantages of the FR-Y14Q data. First, the data allows for a broader cross-sectional representation of U.S corporate borrowers. Compared to COMPUSTAT, LCD Dealscan, and QFR, our data represents a major step forward in terms of firm and sector representation and hence will better inform us on the risk taking channel of monetary policy and firm level financial constraints. Unlike these datasets, our data not only captures SMEs, it also covers all sectors of the economy; not just manufacturing as in the QFR data of U.S. Census. Figure 3 shows the total and average dollar amounts committed to each two-digit NAICS sector. 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.

remove from the sample the loan amounts to identified subsidiaries and find that the results are qualitatively the same.

Figure 4: Distribution of Firm Size: Private vs. Public and Syndicated Loan Borrowers



Th 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 in our data who also borrow in syndicated loan markets, Panel (b).

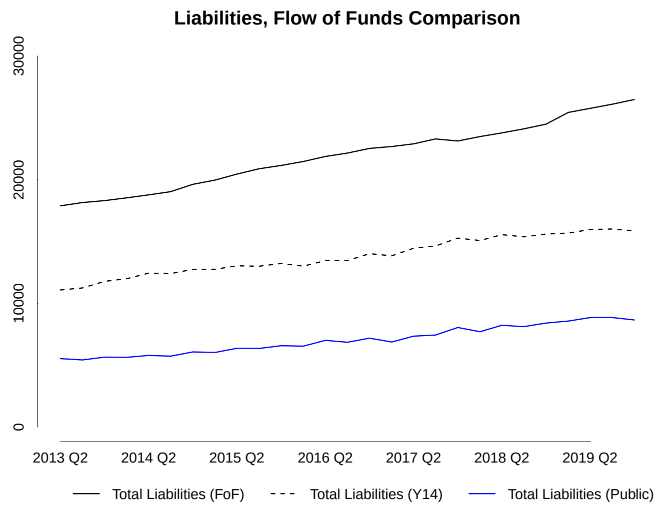
Figure 4 shows the firm size distribution based on assets. Panel (a) shows histograms for all private firms (red bars), public firms (blue bars). Panel (b) shows the histogram for firms in our data who also borrow in syndicated loan markets.[18] Two important features emerge. First, most private borrowers in our data have less that $10 million in total assets, that is they are SMEs. Second, panel (b) identifies the firms who borrow in syndicated loan markets and shows that these firms almost perfectly match the size distribution of public companies. LCD Dealscan and the Shared National Credit Registry (SNC) are two popular data sources for research in loan markets and our data show that the firms who borrow in these markets are clearly not representative of all corporate borrowers among large U.S. banks, much less the entire U.S. economy.

Another advantage of our data is that we observe loan-level details on prices, quantities, and non-price terms such as collateral and lien position, as well as ex-ante internal bank risk assessments for each borrower. These characteristics can be tracked over time. The data also include detailed information on loan losses and delinquencies, which enables us to assess ex-post loan performance and link this performance to ex-ante risk measures. This is a significant improvement as compared to LCD Dealscan data that contain loan information only at origination.

To highlight the quality of FR Y-14 data and the aggregate importance of private firms borrowing in the U.S economy, Figure 5 plots the aggregate dollar value of non-financial business debt liabilities from Flow of Funds data (which will include not only bank loans but also other forms debt financing such as bonds) with our aggregation of liabilities in the FR Y-14 data. In terms of total liabilities, our data cover over half of all total liabilities reported

[18]The FR Y14 data have a syndicated loan flag that allows one to identified syndicated loans.

Figure 5: Corporate Debt: Flow of Funds vs. Y-14



The figure shows the aggregate dollar value of non-financial business debt liabilities from the Financial Accounts of the U.S. data (black lines) and the aggregated liabilities computed using the FR Y-14 data (dashed line). The blue line reports the total liabilities computed using the the FR Y-14 data for the sample of private firms. Source: FR Y-14Q H.1 and Financial Accounts of the U.S. FoF.

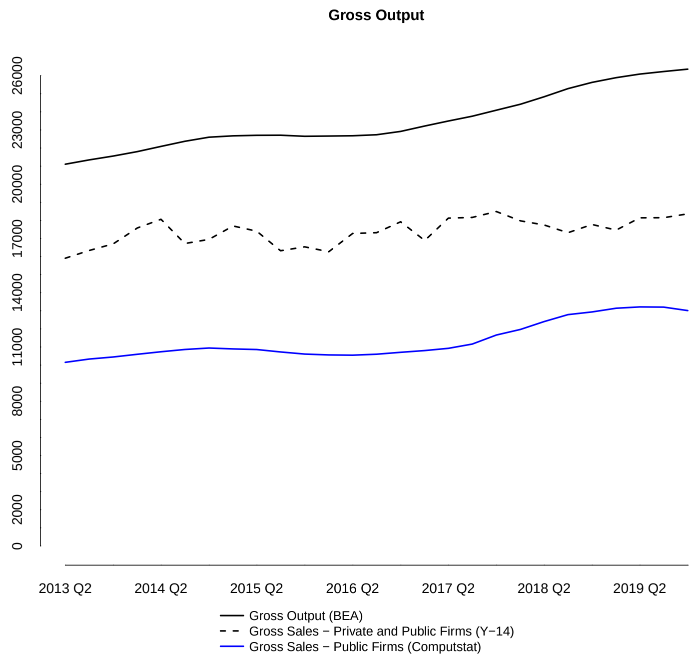
in the official Financial Accounts of the U.S.[19] As shown in this figure, publicly listed firm liabilities only account for about half of all firm liabilities in the FR Y14 data, and even less as a percent of total corporate sector debt shown in Flow of Funds data. Hence, private firm liabilities are an extremely important component of total corporate liabilities in the U.S. and studying only corporate debt of public firms will give an incomplete picture.

SMEs are also important for measures of aggregate output as shown in Figure 6. We plot gross sales among public companies from COMPUSTAT and private and public companies in the FR Y-14 compared to total output from the Bureau of Economic Analysis output tables. The figure clearly shows that relying only on public firm data severely under-represents the totality of firm output and misses the importance of private firms in the real U.S. economy.

Finally, we want to discuss a few drawbacks of the FR Y-14Q data. First, the time-series only dates back to 2012, which precludes studying issues related to the 2008 financial crisis. Second, though firm balance sheet data are reported quarterly, banks update balance sheet information for the larger borrowers on a quarterly frequency, for smaller borrowers the information is updated only on an annual or bi-annual basis. Finally, the $1 million loan reporting limit prevents one from studying the smallest establishments in the economy, which will cover the remaining 30 percent of the all U.S. C&I lending.

[19]Note that official data on non-corporate sector liabilities in the Flow of Funds data are partly derived from IRS tax records as a residual category because tax returns do not require liability reporting for private firms in the U.S.

Figure 6: FR Y-14Q and Compustat Coverage of Aggregate U.S. Output



The figure plots total private sector gross output by industry from the BEA Industrial Economic Account Data in black, excluding financial services and real estate. The black dashed line is the sum of all sales from firms in the FR Y-14Q H.1 data. The blue line is the sum of all sales among public borrowers from COMPUSTAT. Source: BEA, FR Y-14Q H.1, COMPUSTAT

4 Stylized Facts

In this section, we present novel stylized facts on C&I lending. The key message is that private firms/SMEs are fundamentally different in their financing sources and more financially constrained than publicly listed firms.

4.1 SMEs are more financially constrained

Tables 1-3 provide summary stats for a number of balance sheet and loan-level variables. Panel A of each table contains bank balance sheet items, panel B firm balance sheet and income statement items, and panel C contains the loan-level variables. The data are split into three samples: all firms, private firms, and public firms. All variables expressed in levels are reported in millions of dollars. In general, means are substantially larger than medians, indicating there are a large number of relatively small and few very large firms in the data. Of particular interest are comparisons between public and private borrowers in tables 2 and 3.

The summary stats in our data hint at higher level of financial constraints for private borrowers relative to public corporations. The median private firm has \$12.9 million in assets compared to \$1.8 billion for the median public firm. Similarly, the median private borrower has \$7.3 million in liabilities with a leverage ratio of 0.64 compared to \$1.1 billion and 0.56 for the median public firm. In terms of risk, the probability that the median private firm defaults within 12 month is 74 bps compared to 29 pbs for the median public firm, roughly 2.5 times more likely. Lastly, operating income for the median private (public) firm is \$956 thousand (\$268 million) with retained earnings of \$2.9 million (\$182 million).

Table 1: Summary Statistics - All firms

Panel A: All Firms, Bank-level Variables (levels reported in \$millions)

	1st Qu.	Median	Mean	3rd Qu	SD
Bank Liabilities-to-Assets	0.868	0.884	0.882	0.897	0.024
Bank Short-Term-Debt-to-Assets	0.69	0.769	0.727	0.808	0.14
Charge-off$_b$	0	10.415	22.618	29.295	38.887
Charge-off/Loan$_b$	0	2.645	5.857	7.347	10.351

Panel B: All Firms, Firm-level Variables (levels reported in \$millions)

	1st Qu.	Median	Mean	3rd Qu	SD
Firm Assets	5.102	13.714	420	49.374	5,067
Firm Liabilities-to-Assets	0.422	0.637	0.626	0.798	0.27
Firm Short-Term-Debt-to-Assets	0	0.014	0.144	0.206	0.23
Operating Income	0.187	1.026	103	4.359	3,303
Net Sales	10.869	29.975	617	94.729	17,203
Liabilities	2.734	7.817	271	28.862	3,394
Capital Expenditures	0	0.013	198	1.025	2,874
EBITDA	0.323	1.435	60.849	6.006	896
Retained Earnings	0.502	3.057	89.579	12.238	1,500
Tangible Assets	4.801	12.755	336	43.865	4,429
Probability of Default (Weighted)	0.003	0.007	0.026	0.018	0.095
Probability of Default (Percent)	0.23	0.67	2.567	1.65	9.621
Probability of Future Default	0	0	0.012	0	0.109
NPL$_4$	0	0	0.042	0	0.201
Charge-off$_f$	0	0	0.097	0	2.505
Charge-off/Loan$_f$	0	0	0.025	0	0.656
Obs.	3,798,946				
Firms	155,598				
Banks	39				
F-B Pairs	215,259				
F-B-T Triples	2,550,006				

This table reports summary statistics of the main variables used in the paper. The sample includes 155,598 U.S. firms for the period 2013-2019, excluding financial institutions and utilities. Loans data are from Schedule H1 in FR Y-14 report. Accounting data for firms are from Compustat database, when available, and they are supplemented with financial information reported in the Schedule H1 in FR Y-14 report. All dollar amounts in the table are expressed in millions. Refer to Table A.1 in the Appendix for variable definition.

Figure 7 shows that total leverage among different types of firms are not too dissimilar.[20] However, short-term leverage is much higher among smaller private borrowers than public firms, while firms that borrow in the syndicated loan market have similar average leverage ratios to public companies but are much more dispersed. This suggest that SMEs can only borrow short term indicating a higher degree of financial constraints. Below we show that SMEs are also collateral constrained.

[20]The distributions are in log-ratios.

Table 2: Summary Statistic - Private Firms

Panel A: Private Firms,Bank–level Variables (levels reported in $millions)

	1st Qu.	Median	Mean	3rd Qu	SD
Bank Liabilities-to-Assets	0.868	0.884	0.882	0.897	0.024
Bank Short-Term-Debt-to-Assets	0.69	0.769	0.727	0.809	0.139
Charge-off$_b$	0	9.712	20.828	27.232	35.107
Charge-off/Loan$_b$	0	2.564	5.469	7.011	9.233

Panel B: Private Firms, Firm–Level Variables (levels reported in $millions)

	1st Qu.	Median	Mean	3rd Qu	SD
Firm Assets	4.946	12.967	137	42.411	499
Firm Liabilities-to-Assets	0.423	0.639	0.627	0.8	0.271
Firm Short-Term-Debt-to-Assets	0	0.018	0.148	0.214	0.232
Operating Income	0.176	0.965	12.304	3.87	47.823
Net Sales	10.574	28.681	169	86.325	513
Liabilities	2.642	7.359	89.183	24.883	341
Capital Expenditures	0	0.004	6.189	0.746	28.567
EBITDA	0.31	1.351	17.771	5.285	67.915
Retained Earnings	0.516	2.984	30.181	11.324	109
Tangible Assets	4.652	12.075	108	38.073	379
Probability of Default (Weighted)	0.003	0.007	0.026	0.018	0.095
Probability of Default (Percent)	0.27	0.74	2.697	1.78	9.884
Probability of Future Default	0	0	0.009	0	0.094
NPL$_4$	0	0	0.013	0	0.115
Charge-off$_f$	0	0	0.099	0	2.494
Charge-off/Loan$_f$	0	0	0.026	0	0.62
Obs.	3,125,154				
Firms	152,409				
Banks	38				
F-B Pairs	193,976				
F-B-T Triples	2,224,680				

This table reports summary statistics of the main variables used in the paper for private firms. The sample includes 152,409 U.S. private firms for the period 2013-2019, excluding financial institutions and utilities. Loans data are from Schedule H1 in FR Y-14 report. Accounting data for firms are from Compustat database, when available, and they are supplemented with financial information reported in the Schedule H1 in FR Y-14 report. All dollar amounts in the table are expressed in millions. Refer to Table A.1 in the Appendix for variable definition.

Table 3: Summary Statistic - Public Firms

Panel A: Public Firms, Firm-Bank Variables (levels reported in $millions)

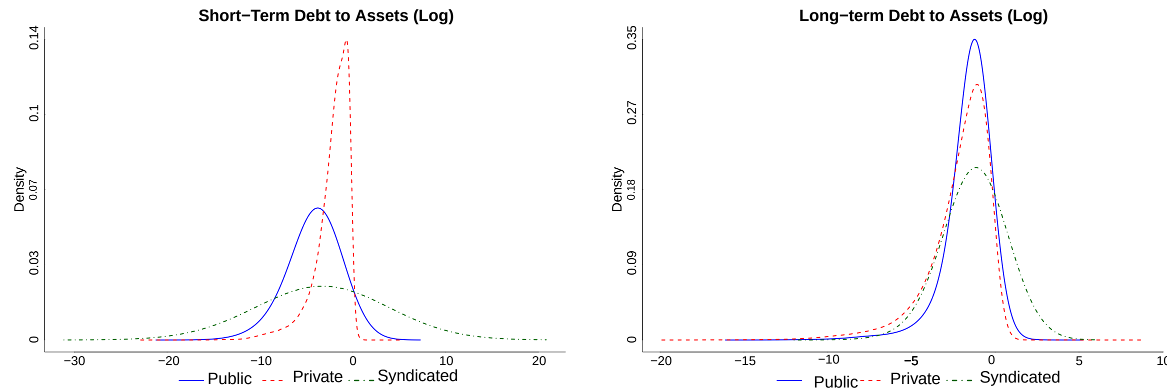
	1st Qu.	Median	Mean	3rd Qu	SD
Bank Liabilities-to-Assets	0.868	0.885	0.883	0.897	0.023
Bank Short-Term-Debt-to-Assets	0.692	0.77	0.728	0.809	0.139
Charge-off$_b$	0	0	1.936	0	7.372
Charge-off/Loan$_b$	0	0	0.426	0	2.321

Panel B: Public Firms, Firm–level Variables (levels reported in $millions)

	1st Qu.	Median	Mean	3rd Qu	SD
Firm Assets	557	1,864	10,010	6,317	28,169
Firm Liabilities-to-Assets	0.404	0.569	0.582	0.714	0.234
Firm Short-Term-Debt-to-Assets	0	0	0.014	0	0.061
Operating Income	68.581	268	3,540	930	20,281
Net Sales	587	1,740	20,105	5,462	113,045
Liabilities	253	1,076	6,457	3,969	18,946
Capital Expenditures	362	1,243	5,716	3,999	14,655
EBITDA	50.959	235	1,518	872	5,060
Retained Earnings	-58.801	182	2,164	1,115	8,720
Tangible Assets	380	1,347	8,106	4,706	24,950
Probability of Default (Weighted)	0.002	0.004	0.022	0.013	0.077
Probability of Default (Percent)	0.12	0.29	1.69	0.88	7.557
NPL$_4$	0	0	0.177	0	0.382
Charge-off$_f$	0	0	0.084	0	2.604
Charge-off/Loan$_f$	0	0	0.018	0	0.923
Obs.	673,792				
Firms	3,189				
Banks	39				
F-B Pairs	21,283				
F-B-T Triples	325,326				

This table reports summary statistics of the main variables used in the paper for public firms. The sample includes 3,189 U.S. public firms for the period 2013-2019, excluding financial institutions and utilities. Loans data are from Schedule H1 in FR Y-14 report. Accounting data for firms are from Compustat database, when available, and they are supplemented with financial information reported in the Schedule H1 in FR Y-14 report. All dollar amounts in the table are expressed in millions. Refer to Table A.1 in the Appendix for variable definition.

Figure 7: Distribution of Leverage: Private vs. Public



The left panel plots the density of long-term debt-to-assets ratios (in logs) for all public (in blue) and private (in red) borrowers in the FR Y14Q data. The green density plots are the the same leverage ratios for borrowers in FR-Y14Q that are identified as borrowers in the syndicated loan market used a the syndicated loan flag available in the FR-14Q data. The right-panel plots the same densities defining leverage as short-term debt-to-assets (in logs). Source: FR Y-14Q H.1

4.2 Faster loan growth is driven by public firms and risky SMEs

Figure 8 breaks down public and private firm leverage ratios by the following credit rating bins: investment grade firms with AAA-A and BBB ratings, and high yield firms with ratings BB and below. The ratios are normalized to 1 at the beginning of our sample period. The figure shows that most of the financial leverage increase in the U.S. post the Global Financial Crisis is due to rapid growth in public firm leverage. The leverage growth is equally prominent among high investment grade (rated AAA-A), BBB-rated, and high-yield borrowers. The figure shows that, among private firms, financial leverage has steadily increased only for high-yield equivalent borrowers and is otherwise at a similar level or even slightly lower for investment grade private borrowers over the 6 year period.

There are two interesting facts here. First, most of the loan growth in the banking system post financial crisis is due to larger, public borrowers. Second, even-though SMEs have slower loan growth, this is driven by high yield-more risky SMEs and hence constitutes a challenge for financial stability as these firms are more likely to default in the future (documented below).

4.3 SMEs need collateral to borrow, pay higher interest rates, borrows short-term, and use their enterprise value as collateral

Table 4 shows summary stats for loan pricing, quantity, maturity, collateral value, and net charge-offs. The median loan for private borrowers is \$3 million, at 3.2 percent interest

Table 4: Loan-level Variables (levels reported in $millions)

Panel A: All Firms

	1st Qu.	Median	Mean	3rd Qu	SD
Loans	1.654	3.65	14.913	12.534	43.705
Interest Rate	0.011	0.03	0.028	0.041	0.022
Charge-off$_l$	0	0	0.006	0	0.255
Charge-off/Loan$_l$	0	0	0.001	0	0.076
Collateral: Fixed assets and real estate	0	0	0.243	0	0.429
Collateral: Cash and marketable sec	0	0	0.024	0	0.152
Collateral: Act. receiv. and inventory	0	0	0.284	1	0.451
Collateral: Blanket lien and other	0	0	0.304	1	0.46
Collateralized	1	1	0.854	1	0.353
Maturity	0	2	3.079	4	3.977
Collateral (restricted)	2.885	8.424	26.732	26.803	85.667
Collateral/Loan (restricted)	0.92	1.375	4.413	2.908	22.165

Panel B: Private Firms

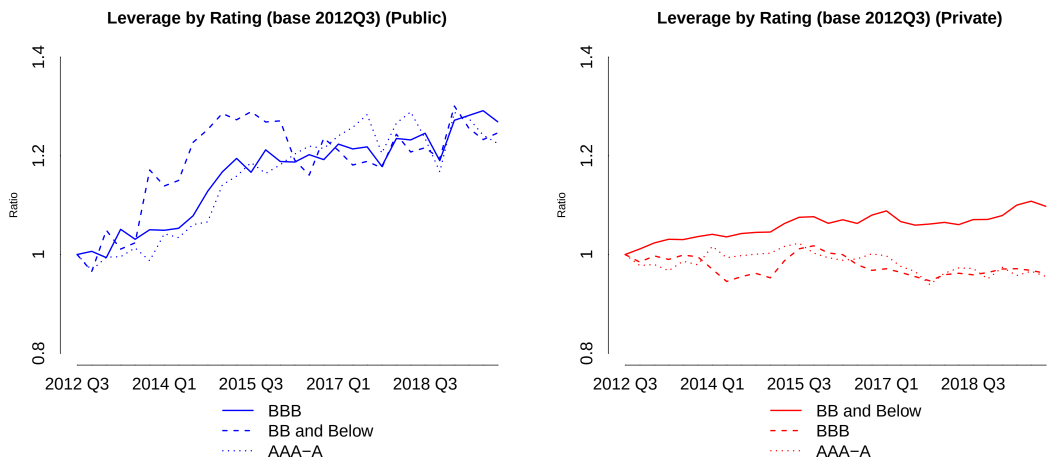
	1st Qu.	Median	Mean	3rd Qu	SD
Loans	1.5	3	8.91	8	20.195
Interest Rate	0.018	0.032	0.03	0.043	0.021
Charge-off$_l$	0	0	0.006	0	0.261
Charge-off/Loan$_l$	0	0	0.002	0	0.075
Collateral: Fixed assets and real estate	0	0	0.266	1	0.442
Collateral: Cash and marketable sec	0	0	0.022	0	0.145
Collateral: Act. receiv. and inventory	0	0	0.308	1	0.462
Collateral: Blanket lien and other	0	0	0.322	1	0.467
Collateralized	1	1	0.916	1	0.277
Maturity	0	2	3.1	4	4.296
Collateral (restricted)	2.835	7.53	11.76	24.922	10.11
Collateral/Loan (restricted)	0.948	1.402	2.765	2.805	3.848

Panel C: Public Firms

	1st Qu.	Median	Mean	3rd Qu	SD
Loans	5.688	21.6	42.723	50	89.049
Interest Rate	0	0.017	0.019	0.032	0.022
Charge-off$_l$	0	0	0.003	0	0.226
Charge-off/Loan$_l$	0	0	0.001	0	0.083
Collateral: Fixed assets and real estate	0	0	0.14	0	0.347
Collateral: Cash and marketable sec	0	0	0.034	0	0.181
Collateral: Act. receiv. and inventory	0	0	0.172	0	0.377
Collateral: Blanket lien and other	0	0	0.224	0	0.417
Collateralized	0	1	0.567	1	0.495
Maturity	2	3	2.994	4	2.243
Collateral (restricted)	3.829	27.989	123	113	207
Collateral/Loan (restricted)	0.728	1.112	14.957	3.98	58.41

This table reports summary statistics of loan level variables used in the paper. The sample includes 155,598 U.S. firms for the period 2013-2019, excluding financial institutions and utilities. Loans data are from Schedule H1 in FR Y-14 report. All dollar amounts in the table are expressed in millions. Refer to Table A.1 in the Appendix for variable definition.

Figure 8: Leverage Growth



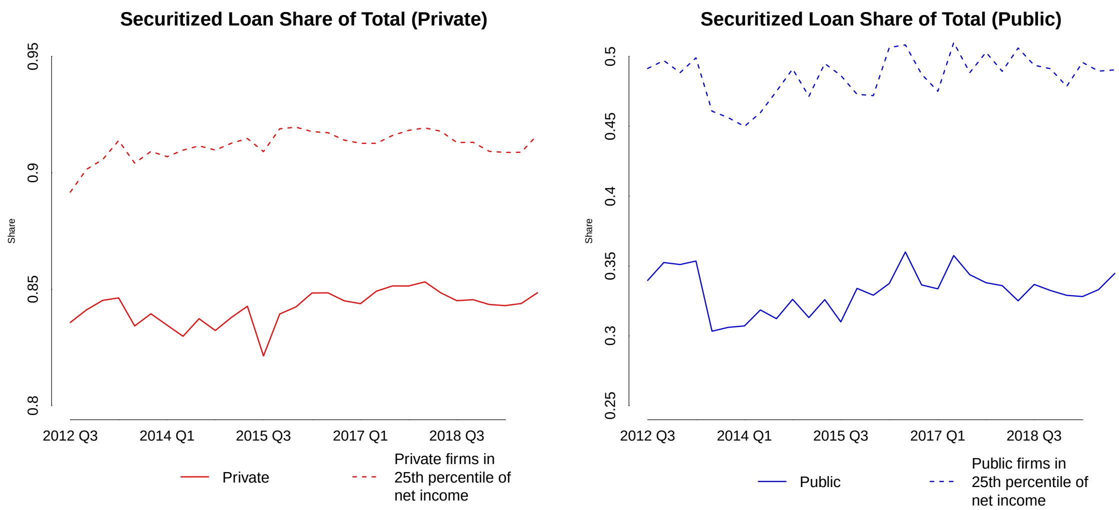
The figures plot leverage ratio–defined at the sum of short- and long-term debt over total assets– normalized to 1 the 2012Q3. The left (right) panel are the leverage ratios for public (private)borrowers. Each line is the median leverage ratio for among borrowers with the specified bank provided risk-rating. Source: FR Y-14Q H.1

rate, for 2 years compared to $21.6 million at 1.7 percent for 3 year for the median public borrower. Figure 9 plots the share of loans with some form of security or collateral broken out by private and public borrowers. Around 85% of all private loans are collateralized (red, dashed line), compared to roughly 30% for public borrowers (blue dashed line). This breakdown is consistent with the Benmelech et al. (2019) claim that only a small fraction of large public firm loans are collateralized. However, our broad-based loan data show that for smaller private firms without access to public capital markets, collateral remains an extremely prominent and important feature of borrowing arrangements. In fact, for small private firms—firms in the bottom 25th percentile of the revenue distribution, almost all loans are collateralized.

Banks also report the dollar value of collateral reported for loans that require ongoing or periodic valuation of the collateral beginning in 2015. These loans represent 11.5 percent of all loans in the data. Among these loans, the collateral-to-loan ratio for the median private borrower is 1.4 compared to 1.2 for the median public borrower, which means that private firms/SMEs have to post much more collateral than public firms for the same size loan (see Figure 10). Taken together, banks generally require private firms put down collateral to access credit, but the firms do not have access to large amounts of collateral to obtain larger loans compared to larger public borrowers. Hence, private borrowers are also collateral constrained relative to public borrowers.

The FR-Y14Q data contain detailed information about the type of collateral used to

Figure 9: Collateral–Extensive Margin: Public vs. Private

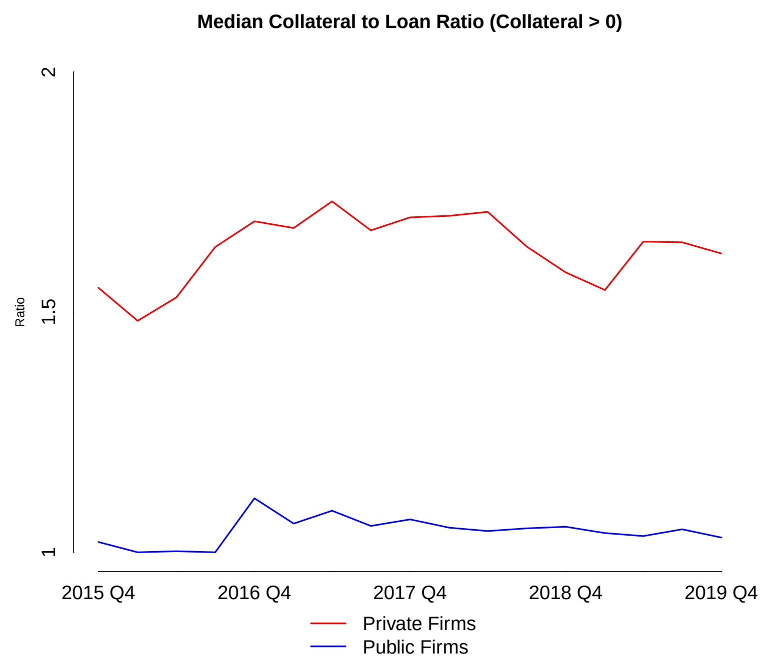


The figure reports the share of total loans that are collateralized, for private (left panel) and public (right panel) borrowers. The dashed line represents the share of total loans that are collateralized for firms in the 25th percentile of the net income distribution, for both the private and public firm sample. The solid line is the share of loans collateralized at the median of firm net-income distribution. Source: FR Y-14Q H.1

secure a loan. The different types of collateral in the data are the following: real estate and fixed assets; cash and marketable securities; accounts receivable, inventory, blanket lien, and other. Figure 11 reveals several novel insights. Quite clearly, both private and public companies rely most on accounts receivable, inventory, and blanket liens, known as cash-flow based or going concern collateral, not real estate or fixed assets. However, the propensity to secure financing through accounts receivable, inventory and blank liens falls precipitously across the public firm size distribution from about 50% for the bottom quartile to 10% in the upper quartile. Hence, although the ability to borrow unsecured increases as firm size increases, this trend is much more visible for large public firms as opposed to SMEs. Taken together, the going concern value of the firm measured by accounts, inventory, and blanket liens is by far the most important way to secure loans for SMEs. In sum, both the role that collateral plays in financing arrangements and the type of collateral pledged are different across firm types and size.

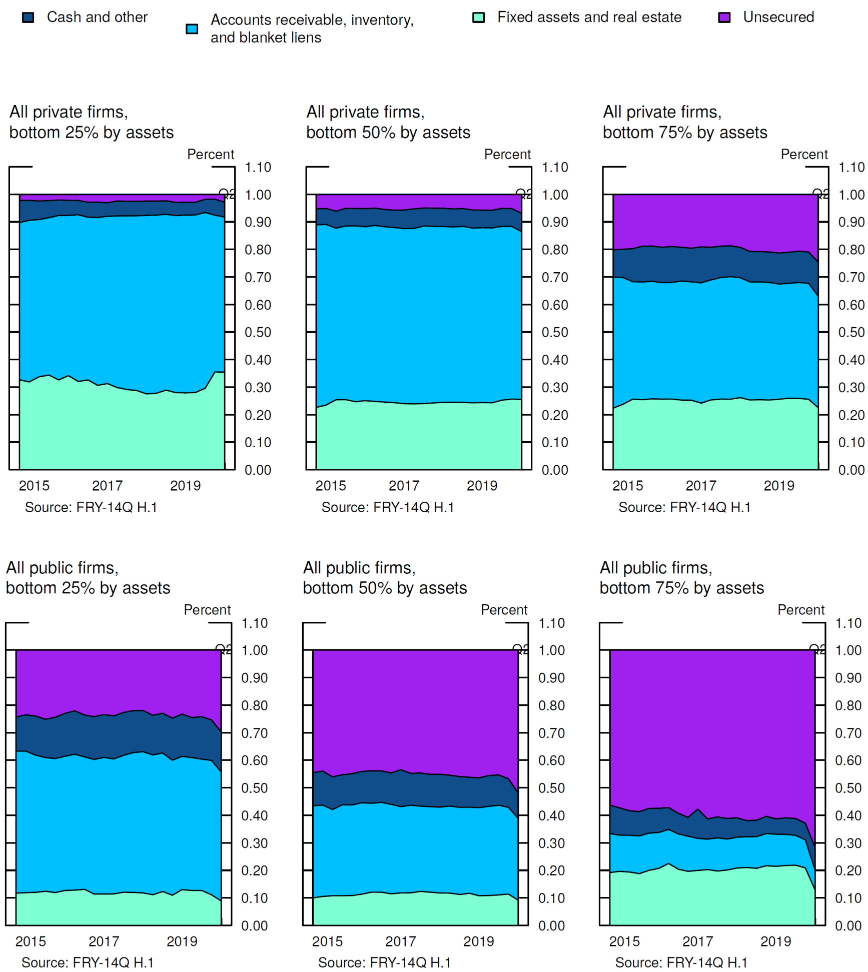
Figure 12 breaks down the aggregate share of loans by dollar amount into different maturity bins for both public and private firms. The major difference between the two sets of firms is that loan maturities between 5-10 years–generally term loans–are a much larger fraction of committed amount to public borrowers (around 80%) than private borrowers (about 60%). In addition, short-term loans less than 1 year-credit lines–are relatively more important for private borrowers; almost 40% versus about 20% for public borrowers. These facts imply

Figure 10: Collateral–Intensive Margin (Amount): Private vs. Public



The figure plots median collateral-to-loan ratio for private borrowers (in red) and public borrowers (in blue). The dollar value of collateral is reported by banks at the loan level. The collateral-to-loan ratios are computed for loans in which the dollar value of collateral is non-zero. Source: FR Y-14Q H.1

Figure 11: Collateral Type: Public vs. Private



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 dark blue); accounts receivable, inventory, and blanket liens in light blue; fixed assets and real estate in turquoise; and unsecured loans in purple. 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, below the median of assets, and below the top quartile of assets. The broom three panels present the same information for public borrowers. Source: FR Y14-Q H.1.

public borrowers obtain the bulk of their funds long-term compared to private firms; SMEs are not only collateral constrained, they are maturity constrained as well in terms of limited access to long-term financing.

Figure 13 plots the average interest rate for different loan types–fixed and floating–for both public and private borrowers by firm size. In general, public firms borrow at lower interest rates irrespective of loan type. Specifically, the median interest rate for public firms on fixed (floating) rate loans is 2.55% (2.69%). The same median interest rates for SMEs (less than or equal to the median of the asset distribution) are 4.49% and 3.80% respectively.[21]

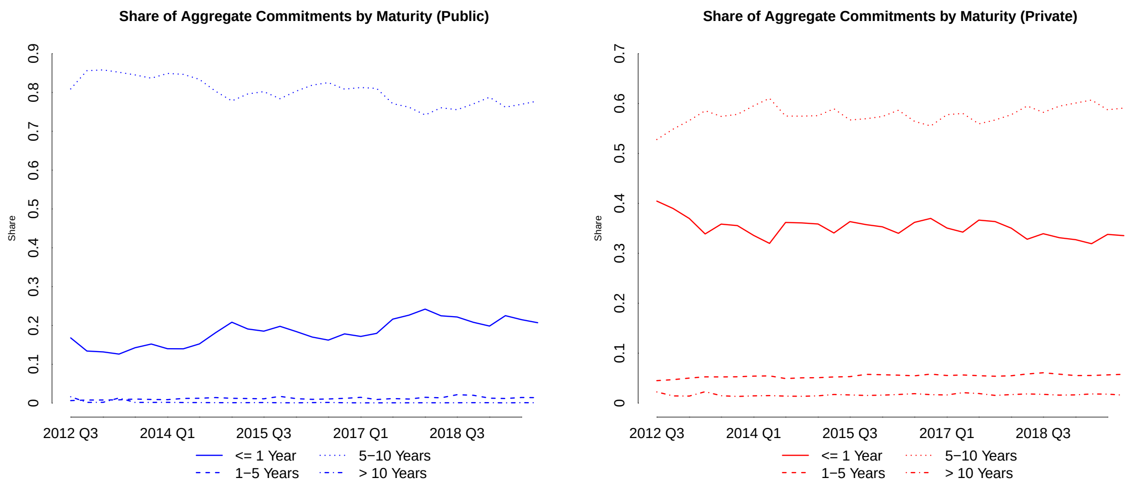
In terms of trend movements, the difference between the rate on fixed and floating products is much smaller for public than private borrowers; typically around 50 bps for public borrowers around 100 bps for private borrowers. However, that gap closed as the FED began increasing the federal funds rate in 2016, and both rates were equivalent by 2018. The mean floating rate follows the same pattern across firm groups; trending down from 2013 through 2016 and then increasing during the lift-off period. By contrast, mean rates among fixed rate loans have declined only for private firms (solid red line) for most of the sample period but were flat before moving upward for public borrowers (solid blue line). Finally, smaller private firms pay significantly higher rates for both fixed rate (solid orange line) and floating rate (dashed orange line) loans than larger private or public firms. In the light of the collateral figures, the declining fixed rates for private borrowers suggests room for more risk taking by private firms.

Figure 14 plots borrower default probabilities (PD) for public and private firms broken down by firm size.[22] As expected, the average default probability for public firms is generally lower than private firms. The smallest size bin for private firms have the highest default probability, whereas, for public borrowers, the series are similar across quartiles with the top and bottom quartiles showing slightly upward trends. Overall, these measures show relatively benign default probability movements for most borrowers. This is an important finding since these measures are the standard risk taking measures used in the previous literature, and our data show that they might miss the leverage build-up and potential risk taking among different sized borrowers.

[21] The media interest rate among large private firms–those in the top quartile of the asset distribution–for fixed (floating) rate loans is 3.29% (3.15%.)

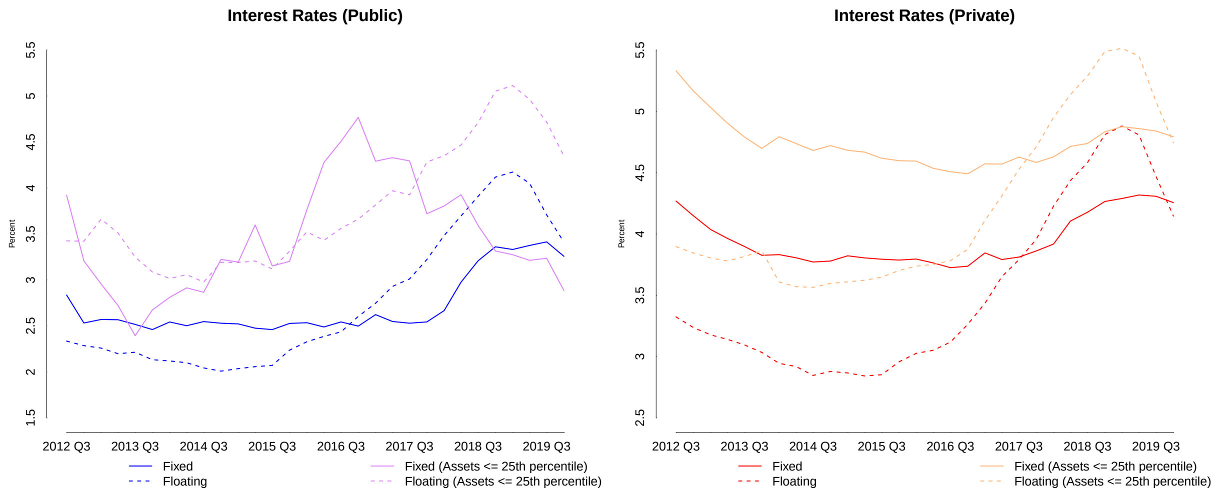
[22] For each borrower, the BHCs provide a bank-level internal probability that the firm will default within one year. We standardize the probability of default for each borrower by computing a weighted average of the probability of default across banks, where the weight is the share of committed amount of loan over total loan amount in each quarter.

Figure 12: Loan shares by maturity



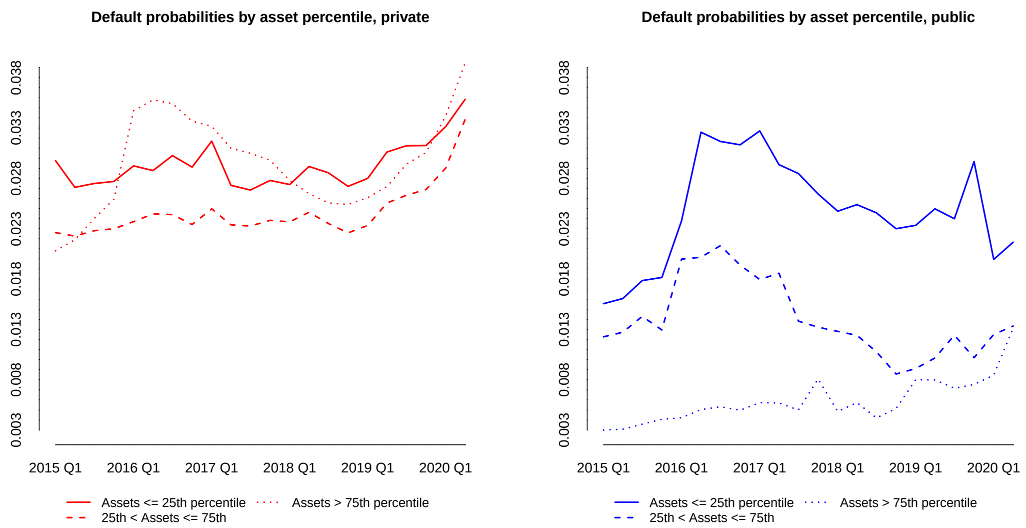
The figure plots the share of loan commitments (in dollars) by different maturities. The left (right) panel are the maturities shares for public (private) borrowers: Source FR Y-14Q H.1.

Figure 13: Interest rates: Fixed versus floating



The figure plots the median interest rate (in percent) for fixed versus floating rate loans for public borrowers on the left and private borrowers on the right. Each panel plots four series. The blue and red line are the median interest rate among all fixed rate loans by borrower type. The dashed blue and red lines are the median interest rate for all fixed floating rate loans by borrower type. The solid purple and orange lines are the median interest rate on fixed rate loans to borrowers in the bottom quartile of the respective asset distribution for public and private borrowers. The dashed purple and orange lines are the median interest rate on floating rate loans to borrowers in the bottom quartile of the respective asset distribution for public and private borrowers. Source: FR Y-14Q H.1.

Figure 14: Average borrower default probability



The figure plots the bank provided default (PD) probabilities for private (left panel) public (right panel) borrowers. The PDs are reported in basis points and represent the likelihood that a borrower defaults on a loan in the next 12 months. The solid line in each figure is the median firm PD among firms in the bottom quartile of the asset distribution, the medium sized dash line is the median firm PD among firms in the inner-quartile range of the asset distribution, and the thin-dashed line is the median firm PD among firms in the top quartile of the firm asset distribution. Source FR Y-14Q H.1.

5 Empirical Analysis

Having shown a great deal of heterogeneity among SMEs and large firms, private and public borrowers in terms of collateral posted, loan rate, maturity and amount of loans, we now turn to the transmission of monetary policy.

5.1 Risk-Taking for Ex-Ante Leveraged Firms and Banks

We begin by disentangling the effect of monetary policy shocks on the demand for credit from the supply of credit (loans). We regress the outstanding committed loan amount, ($Loan$), and the nominal loan interest rate, (i), on measures of bank and firm risk interacted with a measure of monetary policy shocks, MP, estimated from the high frequency methodology.[23]:

$$MP_t^m = \gamma_t \times \left(\text{ffr}_t^m - \text{ffr}_{t-\Delta t}^m\right) \tag{1}$$

where m denotes the month and ffr denotes the fed funds rate and the adjustment factor $\gamma_t \equiv \frac{\tau^n}{\tau^n - \tau^d}$, τ^n is the number of days in the month of the FOMC meeting, and τ^d is the day

[23] The same high frequency methodology is also used in Ottonello and Winberry (2020) and Wong (2019).

of the FOMC meeting.[24] In particular, we use the surprise component of the fed futures contract that contains the next FOMC meeting from current FOMC announcement at time t, MP2, which is usually the 3-month contract.[25] The surprise component is taken around a 30 minute window of the FOMC announcement. Following Coibion (2012), we convert the monthly shock into a quarterly level measure by taking the cumulative sum of shocks with in quarter, and de-mean. For robustness, we consider the surprise component of the 6-month fed futures contract and the results are qualitatively unchanged. Figure 15 plots the raw monetary policy shock, MP2, estimated from (1), used for our main analysis. The figure also plots the shock implied by the 6-mo feds future contract, MP4, that we use for robustness. As expected, at the ZLB, the volatility of the MP shock implied from the 3-mo contract is lower than the volatility of the shock implied from using the longer-term 6-mo contract.

We investigate the response of credit quantities a prices to a monetary policy shock in time t, within the same period. However we will lag the "risk" measures for firms and banks with the idea that ex-ante "risky" firms and banks will respond differently to monetary policy surprises. Hence, we run:

$$\log \mathrm{Y}_{f,b,q} = \alpha_{f,b} + \alpha_{f,q} + \kappa(\textbf{Bank Leverage}_{b,q-1} \times \log \mathrm{MP}_q) + \vartheta_{f,b,q} \tag{2}$$

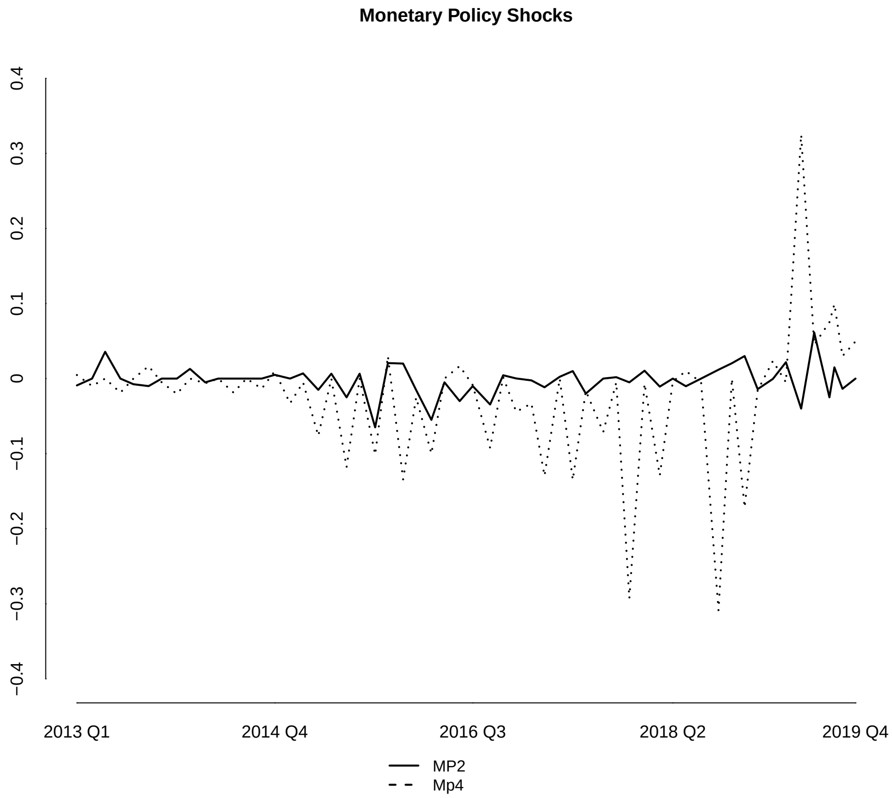
$$\log \mathrm{Y}_{f,b,q} = \alpha_{f,b} + \alpha_{b,q} + \kappa(\textbf{Firm Leverage}_{f,q-1} \times \log \mathrm{MP}_q) + \vartheta_{f,b,q} \tag{3}$$

where $\log \mathrm{Y}_{f,b,q}$, is either the loan amount or one plus the loan interest rate, $(1 + i_{f,b,q})$ for a given bank-firm pair, (b, f) and quarter (q). The coefficient $\alpha_{f,b}$ is the bank×firm fixed effect, which controls for unobserved firm- and bank-level time-invariant heterogeneity and so addresses time-invariant selection arising from different bank-firm relationships. Therefore, identification comes from within bank-firm variation for each pair over time. The loan interest rates are value-weighted interest rates as there might be several loans between a given bank-firm pair. All leverage ratios are lagged and de-meaned, hence the interpretation of κ is the effect of a monetary policy shock for more risky firms or banks than the average

[24] 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 Gürkaynak et al. (2005) and replace the adjustment factor with the rate change in the following month federal futures contract without a multiplier.

[25] The results are robust to using the surprise component of the 1-month contract. Moreover, one could argue that a longer-term term contract is required because the short-term federal funds rate was expected to be close to the ZLB for much of our sample period. We also use the surprise component of a 6-month contract, and the main results continue to hold.

Figure 15: Surprise Monetary Policy Shocks



The figure plots two different estimates of the raw monetary policy (MP) shock series from (1) following the methodology of Gürkaynak et al. (2005). The MP2 series plots the MP shock using the fed funds future contract that corresponds to the time of the second future FOMC meeting–usually the 3-mo futures contract. The MP4 series plots the MP shock using the fed funds future contract that corresponds to the time of the fourth future FOMC meeting–usually the 6-mo futures contract. Following the literature, all of our results are based on using the MP2 series, but are robust to using the MP4 series. Source: Authors' calculations.

firm or bank.

The first regression controls for firm×time fixed effects, $(\alpha_{f,q})$, which means this regression will identify κ from firms that borrow from multiple banks in a given quarter. This methodology was popularized by Khwaja and Mian (2008), so that the researcher can solely focus on the credit supply provided by banks controlling all that varies at firm-time level including firm credit demand and firm credit risk. Hence, we interact our monetary policy shocks with a measure of bank riskiness, that is bank leverage, where we define this measure before the shock.

The second regression, does the opposite and controls for bank×time fixed effects, $(\alpha_{b,q})$. This means that now we condition on bank-time varying variables including bank credit supply and bank riskiness and interact our monetary policy shocks with a measure of firm riskiness, that is firm leverage, again measuring it before the shock. Hence, results of this regression will be driven by firm credit demand.

Table 5 shows the baseline results. Columns (1) and (3) show the credit demand regressions for quantities and prices respectively, and columns (2) and (4) present credit supply regressions. For the demand regressions, the interaction-term coefficient on loan quantity is **-0.731** and statistically significant at 0.1 percent. The interpretation is that an unexpected decrease in the federal funds rate, or monetary policy easing, increases borrowing among highly-levered firms relative to the average firm. In terms of magnitude, a monetary surprise easing from the 75th to 25th percentile of the distribution leads to a 1 percent increase in loan demand among highly levered firms relative to the low-levered firms (-1.374bps - (-0.004bps) = -1.37 bps $\times$-.7303 = 1.001), which amounts to around $150,000 in additional borrowing. This result is consistent with the firm balance sheet channel of monetary policy transmission in which a decrease in firm borrowing rates due to lower policy rates decreases the external finance premium, and expands borrowing, especially for risky firms. However, column (3) shows that loan pricing is moving in the opposite direction of this channel. The coefficient of **-0.0405** implies that highly levered firms borrower at higher rates, relative to low levered firms, when monetary policy eases. Here, we need to be careful about the *relative* interpretation of a DID regression. Even though, a reduction in the external finance premium implies lower borrowing costs for everyone, these "riskier" firms still pay higher rates than "less -risky" firms, where we use ex-ante leverage to measure riskiness. The reduction in external finance premium implies that these firms should pay less. Given the fact that bank credit supply is controlled in these regressions, if lower rates induce overall more demand for credit, then loan prices should be higher in equilibrium, meaning "risky firms" end up paying relatively more. In sum, having data both on loan *amounts* and *prices* allows us to pin down the risk-taking channel: even though "risky" firms borrow more, they also pay more, and hence even though there is risk-taking, firm-specific interest rates reflect that.

Zooming in results in columns (2) and (4) further support our conclusion. Banks with higher leverage than average do not provide different loan amounts nor do they charge different prices when policy rates ease. Table 6 shows the results for the same regressions for two separate firm samples: private versus public-held borrowers. All of the aggregate effects in Table 5 in the firm demand regressions operate through *private* firms, that is SMEs. The magnitude of the effect is higher among private borrowers than in the overall sample; a monetary surprise easing from the 75th to 25th percentile of the distribution leads to a 1.40 percent (-1.374bps - (-0.004bps) = -1.37 bps $\times$-1.0196 = 1.396) increase in loan demand among highly levered private firms relative to the average private firm, which amounts to around \$125,000 in additional credit demand.

Table 5: Response of Credit to Monetary Policy Shocks: Firm-Bank Level—All Firms

	Log (Loan)	Log (Loan)	Log $(1+i)$	Log $(1+i)$
Firm Leverage$_{t-1}$	0.0371^{+}		0.0004	
	(0.0196)		(0.0008)	
Firm Leverage$_{t-1}$ × MP Shock$_t$	-0.7307***		-0.0405***	
	(0.0863)		(0.0056)	
Bank Leverage$_{t-1}$		0.3435***		-0.0085***
		(0.0791)		(0.0018)
Bank Leverage$_{t-1}$ × MP Shock$_t$		0.3271		0.0068
		(0.2414)		(0.0040)
Observations	2199353	633771	2210232	639054
Adjusted R^2	0.946	0.911	0.772	0.854
Bank×Firm f.e.	Yes	Yes	Yes	Yes
Bank×Time f.e.	Yes	No	Yes	No
Firm×Time f.e.	No	Yes	No	Yes

$^{+}$ $p < 0.1$ * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

This table presents the results of OLS regressions for bank-firm pairs at a quarterly frequency. Interest rates are weighted by the loan shares for a given firm-bank. *Log Collateral* is the log of the market value of the collateral as of the reporting date, lagged and demeaned. Firm Leverage and Bank Leverage are lagged and demeaned. They are both based on short-term debt. MP shock is the contemporaneous Gürkaynak et al. (2005) monetary policy shock mp1 (estimated from surprises in 3-month Fed fund futures). Double-clustered standard errors by firm and time are reported in parentheses.

Turning to the regressions that investigate the role of bank's leverage on private firm borrowing in columns (2) and (4), we find that highly levered banks supply fewer loans at lower prices to private borrowers. These results are the opposite of a supply-side risk taking channel among smaller and less transparent private borrowers. The results for public borrowers in columns (6) and (8) mirror those from the aggregate sample. Mainly, highly levered banks do no supply more loans at different rates to publicly held borrowers when monetary policy rates ease. Hence, for public firms, there is no differential credit supply effect based on leverage of banks.

5.2 Risk-Taking as Ex-Post Loan Losses on Banks' Balance Sheets

We explore risk-taking further through an alternative measure, actual loan-losses. In FR Y-14 form, each bank reports the cumulative net charge-off amount on each loan that it makes. Net charge-offs are the dollar value of the loans banks determine they will not recover in default, that is non performing loans that are expected to be written down. The advantage of net charge-off relative to default probability or simple delinquency that is commonly used in the literature is that charge-offs take into account the fact that recovery rates are on average 80 percent of the face value. Moreover, the losses associated with defaulted loans

Table 6: Response of Credit to Monetary Policy Shocks: Firm-Bank Level—Private vs. Public Firms

	Private Firms				Public Firms			
	Log (Loan)	Log (Loan)	Log $(1+i)$	Log $(1+i)$	Log (Loan)	Log (Loan)	Log $(1+i)$	Log $(1+i)$
Firm Leverage$_{t-1}$	0.0154		0.0003		0.0588		0.0007	
	(0.0226)		(0.0008)		(0.0566)		(0.0014)	
Firm Leverage$_{t-1}$ × MP Shock$_t$	-1.0196***		-0.0435***		-0.0018		0.0008	
	(0.1083)		(0.0055)		(0.4843)		(0.0122)	
Bank Leverage$_{t-1}$		0.3010**		-0.0050^{+}		0.3733**		-0.0110***
		(0.1025)		(0.0025)		(0.1043)		(0.0019)
Bank Leverage$_{t-1}$ × MP Shock$_t$		1.0758**		0.0138^{+}		0.0822		0.0041
		(0.3359)		(0.0069)		(0.2942)		(0.0042)
Observations	1935430	337330	1944550	340486	263915	296120	265674	298156
Adjusted R^2	0.94	0.93	0.773	0.86	0.839	0.864	0.674	0.820
Bank×Firm f.e	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Bank×Time f.e	Yes	No	Yes	No	Yes	No	Yes	No
Firm×Time f.e	No	Yes	No	Yes	No	Yes	No	Yes

$^{+}$ $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

This table presents the results of OLS regressions for bank-firm pairs at a quarterly frequency, for private (columns 1 to 4) and public firms (columns 5 to 8). The dependent variable in columns (1)-(2) and (5)-(6) is the natural logarithm of the total committed loan amount for a bank-firm pair; the dependent variable in columns (3)-(4) and (7)-(8) is the natural logarithm of one plus the nominal interest rate weighted for loan shares for a given bank-firm pair. Firm Leverage and Bank Leverage are lagged and demeaned. They are both based on short-term debt. MP shock is the contemporaneous Gürkaynak et al. (2005) monetary policy shock mp1 (estimated from surprises in 3-month Fed fund futures). Double-clustered standard errors by firm and time are reported in parentheses.

that are highly collateralized are generally much smaller than uncollateralized loans and net charge-off amounts capture this difference.

Research suggests that, under limited liability, when agents face losses they take more risk and gamble on the upside as the downside is born by creditors. Charge-offs, or the dollar amount of already delinquent loans banks do not expect to recover net of collateral, may therefore capture gambling for resurrection by either banks (Freixas et al., 2004; Acharya and Steffen, 2015) or firms (Jensen and Meckling, 1976; Admati et al., 2018). Since charge-offs represent dollar amounts that bank expect not to recover on an already delinquent loan, higher charge-off amounts may be associated with more risky activity and gambling on the upside going forward.

To capture this gambling incentive at the relationship level, we aggregate the cumulative net charge-offs to the bank-firm level and normalize by the total committed loan amount for each borrower. The charge-off ratio is then demeaned to aid in interpretation. As charge-off ratio varies by bank-firm-quarter, these regressions identify risk-taking from same set of bank-firm pairs.

The charge-off results are reported in tables 7 and show a clear difference in the way that monetary policy easing impacts private SMEs versus large public firms. Column (2) in Panel A, in addition to bank×firm fixed effects, includes firm×time fixed effects to control for demand factors. The results in column (2) show that private borrowers with higher charge-off rates on outstanding loans receive less credit when policy rates fall (**0.6488** and significant at 10 percent). This implies that a surprise fall in the policy rate from the 75th to the 25th percentile of the distribution lowers the amount of credit extended to more risky private borrowers by 0.88 percent relative to the average-risk private borrower (a dollar value of nearly \$80,000). By contrast, column (2) in Panel B shows that the loan response to rate easing among risky public borrowers is not statistically different than zero.

Taken together, the results are inconsistent with the risk-taking hypothesis in the literature that banks take more risk when interest rates fall, and that banks evergreen their existing risky loan portfolio to avoid realizing balance sheet losses. Our results show that banks do not lend more to the risky borrowers in the first place.

Table 7: Alternative Measure of Bank Risk—Charge-Offs, Firm–Bank Level

Panel A: Private Firms

	Log (Loan)	Log (Loan)	Log (Loan)	Log (Loan)	Log $(1+i)$	Log $(1+i)$	Log $(1+i)$	Log $(1+i)$
$(\text{CCO/Loan})_{t-1}$	-0.3263***	-0.1928***	-0.3337***	-0.1980***	0.0023**	-0.0004	0.0023**	-0.0002
	(0.0572)	(0.0361)	(0.0564)	(0.0379)	(0.0008)	(0.0017)	(0.0008)	(0.0017)
$(\text{CCO/Loan})_{t-1}$ × MP Shock$_t$	1.1755**	0.6488+	1.0819**	0.6762+	-0.0055	0.0191	-0.0019	0.0183
	(0.3377)	(0.3294)	(0.3377)	(0.3493)	(0.0069)	(0.0145)	(0.0066)	(0.0147)
Observations	1961976	310023	1961973	310005	1916224	297044	1916221	297026
Adjusted R^2	0.94	0.933	0.941	0.934	0.747	0.874	0.771	0.876
Bank×Firm f.e	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Bank×Time f.e	No	No	Yes	Yes	No	No	Yes	Yes
Firm×Time f.e	No	Yes	No	Yes	No	Yes	No	Yes

Panel B: Public Firms

	Log (Loan)	Log (Loan)	Log (Loan)	Log $(1+i)$	Log (Loan)	Log $(1+i)$	Log $(1+i)$	Log $(1+i)$
$(\text{CCO/Loan})_{t-1}$	-0.1028**	-0.2458	-0.1032**	-0.2454	0.0006	-0.0052	0.0006	-0.0051
	(0.0336)	(0.1879)	(0.0335)	(0.1889)	(0.0004)	(0.0041)	(0.0004)	(0.0040)
$(\text{CCO/Loan})_{t-1}$ × MP Shock$_t$	0.5983**	-0.9638	0.5966**	-0.9417	0.0046	-0.0267	0.005	-0.0266
	(0.2159)	(1.0418)	(0.2116)	(1.0488)	(0.0032)	(0.0229)	(0.0034)	(0.0227)
Observations	298209	285175	298205	285171	291004	277986	291000	277982
Adjusted R^2	0.839	0.868	0.843	0.871	0.671	0.835	0.691	0.838
Bank×Firm f.e	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Bank×Time f.e	No	No	Yes	Yes	No	No	Yes	Yes
Firm×Time f.e	No	Yes	No	Yes	No	Yes	No	Yes

$^{+}$ $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

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 dependent variable in columns (5)-(8) is the natural logarithm of one plus the nominal interest rate weighted for loan shares for a given 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. MP Shock is the contemporaneous surprise component of the 3-month ahead monthly fed futures contract estimated from a high frequency event study from GSS (2005). Each column sequentially adds different fixed effects. Standard errors are double clustered at the firm and quarter levels, and *** indicates significance at the 0.1% level, ** at the 1% level, and * at the 5% level.

5.3 The Role of Collateral: Loan Level Analysis

In this section we explore how financial constraints impact credit growth focusing on collateral constraints. A large number of studies have proposed models in which agents borrow in order to finance projects and they are subject to collateral constraints. Following the work by Kiyotaki and Moore (1997), Bernanke and Gertler (1989), and Gertler and Gilchrist (1994), many papers show that financial frictions have substantial ability to amplify business cycle fluctuations and can affect monetary policy transmission (e.g. Khan et al. (2017) Ottonello and Winberry (2020), Greenwald (2019)). In most of these models, agents borrowing is limited by a certain fraction of their capital or earnings, that is collateral is required to obtain credit and the amount of credit is determined by the value of this collateral.

Our data allows us to test for the existence of such constraints and whether monetary policy shocks have different effects on credit growth and pricing given these constraints. We run similar regressions as in the previous section, but we exploit the loan level granularity of our data. Specifically, we regress the outstanding committed loan amount, (*Loan*), and the nominal loan interest rate, (i), on the monetary policy shock measure and a collateral variable that takes different forms. Collateral is loan specific and can vary in amount and type for a given firm-bank pair.

We first consider an indicator variable equal to 1 if the loan is collateralized and 0 otherwise. The indicator captures the extensive margin of pledging collateral in a loan contract. As before, we include bank×time fixed effects to control for unobserved time-varying differences between banks. We also control firm×time fixed effects to control for unobserved time-varying firm differences. Note that since these regressions are computed at the loan-level we can also include firm×bank×time fixed effects as denoted by $\varrho_{f,b,q}$. This most strict specification captures variation at the loan level where a firm takes out two or more loans at the same time from the same bank, with different collateral requirements. All regressions include bank-firm fixed effects with double-clustered standard errors by firm and time as before. Formally, we estimate the following equation:

$$\log \mathrm{Y}_{f,b,l,q} = \varrho_{f,b,q} + \beta_1 \mathrm{Collateral}_{f,b,l,q} + \beta_2 (\mathrm{Collateral}_{f,b,l,q} \times \log \mathrm{MP}_q) + \epsilon_{f,b,l,q} \quad (4)$$

The first set of collateral results highlight a stark difference in the way that pledging collateral interacts with access to and pricing of credit across firm types.

Table 8 shows that for private borrowers, collateralizing a loan is associated with improved access to credit and lower prices. For example, column (2) reports the results on the log of loan quantity and column (6) on the interest rate–$\log(1+i)$–and both specifications include bank×firm and firm×time fixed effects. The coefficient on the collateralized dummy is **0.3857** for loan amount and **-0.0042** on the rate, both of which are significant at 0.1 percent.

By contrast, the corresponding columns in table 9 show the exact opposite effect for public borrowers; pledging collateral is associated with restricted access to credit and higher prices. The results are not driven by supply effects as the point estimates for both sub-samples in columns (3) and (7), which add bank×time fixed effects, are virtually identical. The results suggest that small private borrowers with no access to alternative funding sources besides bank loans must post collateral to access funding. Large public borrowers have access to unsecured funding from commercial paper and bond markets and generally obtain unsecured bank loans. Therefore, posting collateral to obtain bank financing is a sign of distress for which access to capital is restricted and interest rates are higher.[26]

To assess whether the relation between collateral and credit growth changes with monetary policy shocks, we interact the collateral dummy variable with the monetary surprise shock. The supply regressions for private firms in columns (2) and (6) of table 8 show that private firms receive more credit, **-1.3968**, at higher prices, **-0.0104**, when posting collateral amid lower policy rates (both coefficients are significant at 0.1 percent). This suggests that risk taking does not operate through increased credit access via relaxed collateral constraints. Only when private firms have collateral, even when rates ease, do they obtain credit. Risk taking would imply the opposite; risky firms without collateral would receive more loans when rates falls. The total effect of collateral is the sum of the collateralized dummy and interaction term coefficients. For private borrowers, collateral always improves access to credit, especially when interest rates are low, compared to unsecured borrowing. The results in column (2) of table 9 show that public firms also obtain more credit when posting collateral when rates fall **-0.3418**. However, the estimate is not precise and different from zero. Furthermore, column (6) suggests that for public borrowers, posting collateral when rates ease results in higher interest rates, (**-0.0094**), further supporting the sorting effect of collateral where risky public borrowers post collateral to obtain credit. In sum, risk-taking does not appear to manifest through reduced collateral requirements for riskier borrowers as a result of lower policy rates raising asset values and relaxing collateral constraints.

Columns (3) and (7) in tables 8 and 9 add bank×time fixed effects to control for time varying unobserved supply factors. Among private firms, the coefficients are nearly identical showing that supply factors play almost no role in the finding that smaller private firms need to post collateral to obtain loans. However, for public borrowers, the coefficient on the interaction term becomes more negative, **-0.5304** versus **-0.3418**, and is now significant at 10 percent. This suggests that public companies that post collateral when policy rates fall receive more credit when controlling for supply factors. Hence, the total effect of posting collateral for public companies is improved access to credit when rates are low, again pointing to the sorting fact that only risky public firms post collateral.[27]

[26]In the full sample, the two opposing effects cancel out. Therefore, it is important to use rich, borrower-level information to isolate the relationship between collateral and access to credit and pricing. See appendix table 15.

[27]The FR Y-14Q data also contain the dollar value of collateral at the loan level–the intensive collateral margin–reported by each bank beginning in 2014. We run the same regressions as the extensive margin above by replacing the collateral dummy variable with the dollar value of posted collateral. The results are

Table 8: Response of Credit to Monetary Policy Shocks: Loan-Firm-Bank Level—The Extensive Margin: Private Firms

	Log (Loan)	Log (Loan)	Log (Loan)	Log (Loan)	Log $(1+i)$	Log $(1+i)$	Log $(1+i)$	Log $(1+i)$
Collateralized$_q$	0.3127***	0.3857***	0.3899***	0.4636***	-0.0022***	-0.0042***	-0.0044***	-0.0054***
	(0.0336)	(0.0464)	(0.0469)	(0.0528)	(0.0005)	(0.0009)	(0.0009)	(0.0011)
Collateralized$_q$ × MP Shock$_q$	-0.5469***	-1.3968***	-1.3896***	-1.4919***	-0.0047*	-0.0104*	-0.0108*	-0.0153*
	(0.1045)	(0.2436)	(0.2444)	(0.2857)	(0.0019)	(0.0047)	(0.0049)	(0.0068)
Observations	2650313	1362500	1362496	1192230	2781417	1365280	1365267	1199252
Adjusted R^2	0.726	0.446	0.446	0.271	0.645	0.433	0.433	0.365
Bank×Firm f.e	Yes	Yes	Yes	No	Yes	Yes	Yes	No
Bank×Time f.e	Yes	No	Yes	No	Yes	No	Yes	No
Firm×Time f.e	No	Yes	Yes	No	No	Yes	Yes	No
Bank×Firm×Time f.e	No	No	No	Yes	No	No	No	Yes

$^{+}$ $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

This table presents the results of OLS regressions for the effect of collateral using loan level data at a quarterly frequency, for private firm sample. The dependent variable in columns (1) through (4) is the natural logarithm of the total committed loan amount; the dependent variable in columns (5) through (8) is the natural logarithm of the nominal real interest rates. *Collateralized$_q$* is a dummy variable equal to one if the loan is collateralized, and zero otherwise. MP Shock is the contemporaneous surprise component of the 3-month ahead monthly fed futures contract estimated from a high frequency event study from GSS (2005). Double-clustered standard errors by firm and time are reported in parentheses.

Table 9: Response of Credit to Monetary Policy Shocks: Loan-Firm-Bank Level—The Extensive Margin: Public Firms

	Log (Loan)	Log (Loan)	Log (Loan)	Log (Loan)	Log $(1+i)$	Log $(1+i)$	Log $(1+i)$	Log $(1+i)$
Collateralized$_q$	-0.6071***	-0.6326***	-0.6748***	-0.8492***	0.0080***	0.0084***	0.0090***	0.0108***
	(0.0491)	(0.0498)	(0.0543)	(0.0738)	(0.0006)	(0.0006)	(0.0007)	(0.0009)
Collateralized$_q$ × MP Shock$_q$	-0.3794*	-0.3418	-0.5304^{+}	-1.2967*	-0.0123***	-0.0094*	-0.0079^{+}	-0.0085
	(0.1686)	(0.2506)	(0.2740)	(0.4985)	(0.0031)	(0.0038)	(0.0040)	(0.0054)
Observations	567052	557884	557874	418584	562827	553611	553601	415167
Adjusted R^2	0.509	0.492	0.494	0.278	0.488	0.522	0.525	0.383
Bank×Firm f.e	Yes	Yes	Yes	No	Yes	Yes	Yes	No
Bank×Time f.e	Yes	No	Yes	No	Yes	No	Yes	No
Firm×Time f.e	No	Yes	Yes	No	No	Yes	Yes	No
Bank×Firm×Time f.e	No	No	No	Yes	No	No	No	Yes

$^{+}$ $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

This table presents the results of OLS regressions of the effect of collateral using loan level data at a quarterly frequency, for the public firm sample. The dependent variable in columns (1) through (4) is the natural logarithm of the total committed loan amount ; the dependent variable in columns (5) through (8) is the natural logarithm of the nominal real interest rates. *Collateralized$_q$* is a dummy variable equal to one if the loan is collateralized, and zero otherwise. MP Shock is the contemporaneous surprise component of the 3-month ahead monthly fed futures contract estimated from a high frequency event study from GSS (2005). Double-clustered standard errors by firm and time are reported in parentheses.

The FR Y-14Q data contains rich collateral detail that allows us to explore the relationship between different types of collateral and access to and price of credit, as well as whether risk taking operates through collateral heterogeneity. To study these issues, we replace the binary collateral indicator with indicators specifying the type of collateral pledged. The first category groups loans secured with fixed assets and real estate, which represent physical assets, or trees in the vernacular of Kiyotaki and Moore (1997). The second group includes loans secured by cash and marketable securities, which are divorced from firm risk. The third category are loans secured by accounts receivable and inventory. The final group is loans secured by blanket liens. These latter two groups represent mostly going concern collateral or the fruit/dividend in vernacular of Kiyotaki and Moore (1997) rather than the tree. Unsecured loans is the omitted category.

The results are reported in tables 10 and 11 largely buttress the collateral-sorting affect established above, and in addition, show the importance of earnings based constraints for SMEs as opposed to physical collateral. In particular, for private borrowers, collateral improves access to credit and pricing (in the top four rows, the coefficients in the quantity (price) regressions are positive (negative) and significant at 0.1 percent). Interestingly, a "collateral pecking order" emerges: the most useful form of collateral to obtain larger loans at lower prices is accounts receivable and inventory, followed by blanket liens and cash and marketable securities. The association between fixed assets and real estate and access to credit is not statistically significant, and has the opposite sign in the two-way fixed effects specifications (columns (2),(3), (6), and (7)). These results suggest that, for private borrowers, the most liquid going-concern collateral–accounts receivable, which is simply future cash, and inventory–are most advantageous. As shown by figure 11, fixed assets and real estate are most frequently used by the smallest private companies whose going concern values are typically lowest. Thus, real estate and fixed assets are used as collateral when other sources–mainly liquid securities or cash-flow based collateral– are unavailable. By contrast, for public firms, access to credit is restricted when posting any type of collateral and interest rates are higher. In addition, the same collateral pecking order is present: credit is less restricted and prices are lower when using liquid, going concern collateral such as accounts receivable and inventory, followed by blanket liens, cash and marketable securities, and lastly fixed assets and real estate.

reported in tables 15-17 in the Appendix. The results consistently show that an additional unit of collateral improves access to funding for all types of borrowers. This result reconciles extensive margin results where public borrowers have restricted access to credit when posting collateral. Hence, conditional on posting collateral, posting a marginal unit improves access to credit. Moreover, the risk-taking channel, or lack thereof, operates the same way along the intensive margin as it does on the extensive margin.

The bottom four rows in tables 10 and 11 present the results on risk-taking across collateral types and provide further evidence that risk taking does not operate through a reduction in collateral requirements of different types. The results for private borrowers are consistent with our previous extensive margin results. Columns (2) and (3) show that posting any type of collateral when the policy rate eases improves access to credit compared to not posting collateral. In terms of the collateral pecking order, accounts receivable and inventory continue to improve access and pricing more than other forms, but fixed assets and real estate are on similar footing as cash and marketable securities and blanket liens. Similarly for public borrowers, accounts receivable and inventory remain the best collateral source. Hence, going concern collateral is superior for both types of firms.

Because collateral is provided at the loan-level, we can also evaluate the impact of posting collateral using bank-firm-time fixed effects. This specification uses within-loan variation where the same borrower at the same bank in the same quarter takes out multiple loans. Columns (4) and (8) in tables 10 and 11 report the quantity and price results, respectively. The results are broadly consistent with the two-way fixed effects specifications. Mainly, private borrowers access more more credit at better rates when using accounts receivable and inventory, followed by blanket liens, and cash and marketable securities (top 4 rows of table 10). The coefficient on fixed assets and real estate is smallest, but not statistically different from zero. Among public borrowers, credit access is less restricted when posting accounts receivable and inventory, followed by blanket liens, cash and marketable securities, and finally fixed assets and real estate.

In terms of the transmission of monetary policy, lower policy rates lead to higher loan values for private collateralized loans than uncollateralized loans. Accounts receivable and inventory continue to provide the best access to credit, but fixed assets and real estate provide better access to credit than blanket liens and cash and marketable securities. One possibility is that lower interest rates encourage home buying and push up real estate prices, which small private companies use as collateral. Less effected by lower interest rates are the cash balances among smaller private firms and blanket liens. For public borrowers, going concern collateral–account receivable and inventory and blanket liens–are the best types of collateral when rates fall. The coefficients on fixed assets and real estate and cash and marketable securities have the consistent negative sign, but are imprecisely estimated and not statistically different from zero.

In sum, the best form of collateral to obtain more credit at the best price is going-concern collateral. Fixed assets and real estate are more important for large public borrowers than small private firms most likely because it is a last resort for small companies; the going

Table 10: Private Firms: Monetary Policy Shocks and Collateral Type, Loan-level Data

	Log (Loan)	Log (Loan)	Log (Loan)	Log (Loan)	Log $(1+i)$	Log $(1+i)$	Log $(1+i)$	Log $(1+i)$
Fixed assets and real estate$_q$	0.0362	-0.0298	-0.0315	0.0332	0.0015**	0.0009	0.0008	-0.0000
	(0.0324)	(0.0433)	(0.0440)	(0.0494)	(0.0005)	(0.0009)	(0.0010)	(0.0012)
Cash and marketable sec.$_q$	0.2225***	0.3331***	0.3269***	0.3270***	-0.0049***	-0.0070***	-0.0073***	-0.0093***
	(0.0361)	(0.0536)	(0.0554)	(0.0713)	(0.0006)	(0.0010)	(0.0010)	(0.0013)
Act. receiv. and inventory$_q$	0.5424***	0.7790***	0.7863***	0.8924***	-0.0046***	-0.0082***	-0.0084***	-0.0102***
	(0.0406)	(0.0509)	(0.0507)	(0.0535)	(0.0006)	(0.0010)	(0.0010)	(0.0013)
Blanket lien and other$_q$	0.3668***	0.4817***	0.4921***	0.5787***	-0.0024***	-0.0046***	-0.0046***	-0.0053***
	(0.0332)	(0.0431)	(0.0441)	(0.0514)	(0.0005)	(0.0008)	(0.0008)	(0.0010)
Fixed assets and real estate$_q$ $\times$ MP Shock$_q$	-0.0606	-1.0468***	-1.0547***	-1.1313***	-0.0008	-0.0107*	-0.0113*	-0.0178*
	(0.0811)	(0.2082)	(0.2114)	(0.2485)	(0.0017)	(0.0051)	(0.0053)	(0.0072)
Cash and marketable sec.$_q$ $\times$ MP Shock$_q$	-0.1948	-0.9140**	-0.9729**	-0.7354^{+}	0.0009	-0.0040	-0.0041	-0.0054
	(0.1258)	(0.2931)	(0.3064)	(0.4310)	(0.0026)	(0.0062)	(0.0064)	(0.0093)
Act. receiv. and inventory$_q$ $\times$ MP Shock$_q$	-1.0223***	-2.1088***	-2.0817***	-2.3031***	-0.0118***	-0.0135*	-0.0143*	-0.0227**
	(0.1391)	(0.3011)	(0.2966)	(0.3342)	(0.0026)	(0.0052)	(0.0055)	(0.0077)
Blanket lien and other$_q$ $\times$ MP Shock$_q$	-0.5070***	-0.9747***	-0.9245***	-0.6990*	-0.0018	-0.0105*	-0.0101*	-0.0120^{+}
	(0.1064)	(0.2348)	(0.2415)	(0.3015)	(0.0018)	(0.0045)	(0.0047)	(0.0065)
Observations	2650313	1362500	1362496	1192230	2781417	1365280	1365267	1199252
Adjusted R^2	0.734	0.472	0.472	0.307	0.647	0.442	0.442	0.376
Bank×Firm f.e	Yes	Yes	Yes	No	Yes	Yes	Yes	No
Bank×Time f.e	Yes	No	Yes	No	Yes	No	Yes	No
Firm×Time f.e	No	Yes	Yes	No	No	Yes	Yes	No
Bank×Firm×Time f.e	No	No	No	Yes	No	No	No	Yes

$^{+}$ $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

This table presents the results of OLS regressions of the effect of collateral type using loan level data at a quarterly frequency, for the private firm sample. The dependent variable in columns (1) through (4) is the natural logarithm of the total committed loan amount ; the dependent variable in columns (5) through (8) is the natural logarithm of the nominal real interest rates. The dependent variables are dummy variables equal to one if the loan is collateralized by specific type of collateral, zero otherwise; we drop the category "Unsecured". MP Shock is the contemporaneous surprise component of the 3-month ahead monthly fed futures contract estimated from a high frequency event study from GSS (2005). The coefficients for the collateral types are calculated but not displayed.Double-clustered standard errors by firm and time are reported in parentheses.

Table 11: Public Firms: Monetary Policy and Collateral Type, Loan-level Data

	Log (Loan)	Log (Loan)	Log (Loan)	Log (Loan)	Log $(1+i)$	Log $(1+i)$	Log $(1+i)$	Log $(1+i)$
Fixed assets and real estate$_q$	-1.4785***	-1.4690***	-1.5487***	-1.7947***	0.0174***	0.0171***	0.0181***	0.0210***
	(0.0579)	(0.0643)	(0.0601)	(0.0702)	(0.0008)	(0.0009)	(0.0009)	(0.0011)
Cash and marketable sec.$_q$	-0.5265***	-0.4966***	-0.4959***	-0.6392***	0.0036***	0.0046***	0.0044***	0.0046*
	(0.0624)	(0.0675)	(0.0708)	(0.1162)	(0.0010)	(0.0010)	(0.0010)	(0.0017)
Act. receiv. and inventory$_q$	-0.1312^{+}	-0.1665*	-0.1734*	-0.1888^{+}	0.0040***	0.0040***	0.0043***	0.0034**
	(0.0675)	(0.0715)	(0.0752)	(0.1092)	(0.0007)	(0.0008)	(0.0008)	(0.0012)
Blanket lien and other$_q$	-0.3597***	-0.3696***	-0.4021***	-0.4801***	0.0055***	0.0058***	0.0063***	0.0076***
	(0.0474)	(0.0488)	(0.0552)	(0.0825)	(0.0005)	(0.0005)	(0.0005)	(0.0008)
Fixed assets and real estate$_q$ $\times$ MP Shock$_q$	0.5348*	0.5170^{+}	0.2187	-0.1847	0.0071	0.0026	0.0064	0.0109
	(0.2296)	(0.3005)	(0.2922)	(0.4960)	(0.0052)	(0.0058)	(0.0057)	(0.0075)
Cash and marketable sec.$_q$ $\times$ MP Shock$_q$	-1.0363**	-0.9774*	-1.1418*	-1.2219	0.0032	0.0119	0.0125	0.0457**
	(0.3329)	(0.4083)	(0.4565)	(0.8786)	(0.0061)	(0.0070)	(0.0075)	(0.0158)
Act. receiv. and inventory$_q$ $\times$ MP Shock$_q$	-1.0167***	-1.7209***	-1.6796***	-3.5118***	-0.0206***	-0.0161***	-0.0171***	-0.0281***
	(0.2588)	(0.3986)	(0.4087)	(0.7459)	(0.0036)	(0.0042)	(0.0044)	(0.0076)
Blanket lien and other$_q$ $\times$ MP Shock$_q$	-0.3430^{+}	-0.5492^{+}	-0.6901*	-1.1431^{+}	-0.0187***	-0.0147***	-0.0127**	-0.0165*
	(0.1904)	(0.2852)	(0.3170)	(0.5983)	(0.0029)	(0.0034)	(0.0037)	(0.0062)
Observations	567052	557884	557874	418584	562827	553611	553601	415167
Adjusted R^2	0.541	0.525	0.528	0.333	0.500	0.533	0.538	0.403
Bank×Firm f.e	Yes	Yes	Yes	No	Yes	Yes	Yes	No
Bank×Time f.e	Yes	No	Yes	No	Yes	No	Yes	No
Firm×Time f.e	No	Yes	Yes	No	No	Yes	Yes	No
Bank×Firm×Time f.e	No	No	No	Yes	No	No	No	Yes

$^{+}$ $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

This table presents the results of OLS regressions of the effect of collateral type using loan level data at a quarterly frequency, for the public firm sample. The dependent variable in columns (1) through (4) is the natural logarithm of the total committed loan amount ; the dependent variable in columns (5) through (8) is the natural logarithm of the nominal real interest rates. The dependent variables are dummy variables equal to one if the loan is collateralized by specific type of collateral, zero otherwise; we drop the category "Unsecured". MP Shock is the contemporaneous surprise component of the 3-month ahead monthly fed futures contract estimated from a high frequency event study from GSS (2005). The coefficients for the collateral types are calculated but not displayed. Double-clustered standard errors by firm and time are reported in parentheses.

Table 12: Probability of future Delinquency, Bank-firm Level

	Panel A: All Firms		Panel B: Private Firms		Panel C: Public Firms	
	Non-performing	Non-performing	Non-performing	Non-performing	Non-performing	Non-performing
High leverage bank_k × MP Shock_q	0.0057		0.0534*		-0.0232	
	(0.0146)		(0.0233)		(0.0188)	
High leverage firm_i × MP Shock_q		-0.0533***		-0.0604***		-0.0846*
		(0.0079)		(0.0085)		(0.0340)
Observations	647889	2469016	342990	2150032	304899	318976
Adjusted R^2	0.780	0.775	0.789	0.776	0.776	0.776
Observations	593131	2169482	308997	1914072	284134	255403
Adjusted R^2	0.78	0.772	0.789	0.773	0.777	0.776
Bank×Firm f.e	Yes	Yes	Yes	Yes	Yes	Yes
Bank×Time f.e	No	Yes	No	Yes	No	Yes
Firm×Time f.e	Yes	No	Yes	No	Yes	No

$^+$ $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

This table reports OLS estimates of the effect of MP shocks on the probability that loans become delinquent at any point in the future at the bank-firm level using quarterly data. Panel A uses all firms, panel B uses the private firm sample, and panel C uses the public firm sample. The dependent variable is an indicator variable that equals 1 if a firm has any loan outstanding that becomes delinquent for more than 30 days at any point in the future. *High leverage* $firm_i$ is a dummy variable equal to one if the first quarter leverage of firm i is higher than the median leverage of the firms in the sample, and zero otherwise. *High leverage* $bank_k$ is a dummy variable equal to one if the first quarter leverage of bank k is higher than the median leverage of the banks in the sample, and zero otherwise. MP Shock is the contemporaneous surprise component of the 3-month ahead monthly fed futures contract estimated from a high frequency event study from GSS (2005). Each column sequentially adds different fixed effects. Standard errors are double clustered at the firm and quarter levels, and *** indicates significance at the 0.1% level, ** at the 1% level, and * at the 5% level.

concern cash-flow is far more valuable. Going concern collateral is also most valuable when policy rates fall.

5.4 Credit Growth and Future Delinquency

Overall, our results suggest that monetary policy transmission during the low interest rate environment works mostly through firm demand for credit rather than credit supplied in the banking system. In particular, lower policy rates lead to increased demand for loans among smaller and more leveraged private companies, but no change in the supply of funds among banks as a function of bank or firm leverage. In this sense we do not find any evidence of risk-taking *by banks*. This does not mean there are no risks to financial stability. Thus, this section assesses whether the increase in firm leverage due to low rates is any evidence of risk-taking, that is, is it the case that these firms are most likely to default in the future.

We address this issue using the same specification of Jiménez et al. (2014). In particular, we use non-performing loans of more than 30 days and regress it on our measures of firm and bank leverage, separately, and interacted with the monetary policy surprise variable. Banks report whether or not a loan is non-performing past 30 days meaning that the borrower is delinquent. We compute a dummy variable equal to one if a firm has a non-performing loan at any point in the future with a given bank. Thus, the variable captures whether or not loans to risky firms or loans by risky banks (risk captured by ex-ante time invarying leverage) are more likely to become non-performing at any point in the future.

Table 12 contains the results for the different firm samples. Panel A is the full sample, while panel B are only privately-owned firms and panel C are only publicly-owned firms. As before, we do not find any risk-taking by banks, unlike Jiménez et al. (2014), as all interactions on credit supply side for bank leverage and monetary policy shocks are insignificant. On the firm credit demand side, we find that highly leveraged firms are more likely to be delinquent when monetary policy is expansionary. This result is visible in the sample of all firms and private firms but not of public firms. As a result, private SMEs are main drivers of credit growth during low interest rates and they constitute a risk to financial stability as they are more likely to default.

5.5 Robustness

In this section we use the sample for all firms, public and private, and we cut the sample on size and leverage to show the importance of both for our main result. To have a clear interpretation, we define a time-invariant dummy for high leverage firms being 1 if the leverage is above sample median, and also define a time-invariant dummy of being an SME if firms revenue is less than $50 million on average over the sample.

Table 13 shows the results based on a triple difference-in-differences regression. Our main result that high leveraged firms increase their demand for credit when monetary policy is expansionary and receive lower rates is robust to using time invariant treatment groups. However, to make sure this result is not just driven by leveraged public firms but leveraged SMEs, we run a triple interaction. The last line of the table shows that our main result is clearly driven by high leveraged SMEs as the triple interaction of being a leveraged SME during an expansionary shock now drives the result, whereas double interaction for leverage and the monetary policy shock becomes insignificant.[28] Overall these results confirm our key result on the risk taking channel of monetary policy leading to credit growth being driven by leveraged SMEs increasing their credit demand when rates are lower as they are financially constrained during normal times.

[28]Low leverage SMEs reduce their credit demand in spite of the lower rates during expansionary shock as they are financially constrained.

Table 13: Leverage and Firm Size, Bank-Firm Level

	Loan	Loan	Loan	Rate	Rate	Rate
High leverage$_i$ × MP Shock$_q$	-0.2444***		-0.0670	-0.0117***		-0.0084***
	(0.0357)		(0.0512)	(0.0018)		(0.0018)
SME$_i$ × MP Shock$_q$		0.3364***	0.6788***		0.0070***	0.0139***
		(0.0503)	(0.0801)		(0.0008)	(0.0017)
High leverage$_i$ × SME$_i$ × MP Shock$_q$			-0.4847***			-0.0092***
			(0.0636)			(0.0017)
Observations	2460475	2460475	2460475	2472261	2472261	2472261
Adjusted R^2	0.945	0.945	0.945	0.767	0.767	0.768
bankfirm	Y	Y	Y	Y	Y	Y
banktime	Y	Y	Y	Y	Y	Y

$^+$ $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

This table presents results for the OLS regressions for bank-firm pairs using quarterly data for the all sample. The dependent variable in columns (1)-(3) is the natural logarithm of the total committed loan amount for a bank-firm pair; the dependent variable in columns (4)-(6) is the natural logarithm of one plus the nominal interest rate weighted for loan shares for a given bank-firm pair. SME_i is a dummy indicating whether a firm is a SME (less than 50 millions in net sales) or non-SME. $High\ Leverage_i$ is a dummy indicating whether whether a firm is in the "low" (= 0) or "high" (= 1) bin of firms defined by their average leverage ratio over the sample period. MP shock is the contemporaneous Gürkaynak et al. (2005) monetary policy shock mp1 (estimated from surprises in 3-month Fed fund futures). Double-clustered standard errors by firm and time are reported in parentheses.

6 Conclusion

We use new confidential regulatory firm-bank-loan level data from the U.S., in order to understand monetary policy transmission and risk-taking in an economy with heterogeneous agents and contracts. Our headline results are as follows. First, SMEs are financially constrained, whereas large public firms are not. Second, low interest rates do not lead to risk-taking by banks but rather SMEs, being constrained in normal times, simply increase their borrowing due to low rates. As the SMEs who increase borrowing are more risky SMEs, measured by internal credit ratings and ex-ante leverage, these results imply a hidden financial stability risk that might be overlooked by the policy makers.

Our results build on four new facts about the credit markets in the U.S. First, small-medium enterprises (SMEs) borrow shorter maturity and pay higher interest rates relative to large publicly listed firms. Second, SMEs more frequently use future claims to their enterprise value as collateral rather than fixed assets and real estate that may be easier to liquidate upon default. Third, SMEs typically utilize all available bank credit which comprises their entire balance sheet debt, as oppose to large listed firms who can switch between corporate bonds and drawing from credit lines. Fourth, the relation between collateral and risk, at the loan level, is positive for large listed firms but negative for SMEs, where we measure risk by the loan risk premia.

Based on our new facts, we revisit monetary policy transmission in a low interest rate environment. We investigate, whether or not high leverage banks are knowingly taking risk by lending to firms who are more likely to default, that is high leverage and/or low collateral firms, or is it the case that low interest rates lead to a rise in demand for credit among small firms because lower rates increases their ability to repay debts? Our findings point to the latter mechanism.

Understanding the relation between collateral and risk is important for our monetary policy transmission results. For SMEs, collateralizing a loan is associated with improved access to credit and lower spreads, but it is the exact opposite for large public borrowers; pledging collateral is associated with restricted access to credit and higher prices. These results suggests that risk-taking does not operate through increased credit access via relaxed collateral constraints that stem from lower rates booting asset values. If that was the channel, then one should find that risky firms with collateral that would get overvalued receive more loans when rates falls. This is not the case in the data.

During our quest of understanding the relation between collateral and risk, we uncover a pecking order for collateral. The best form of collateral to obtain more credit at the best price is going concern collateral, that is future enterprise value. Fixed assets and real estate are more important for large public borrowers, who have these assets, than small private firms as SMEs do not have them and/or use them only as last resort (their house). The most used collateral by SMEs, that is the going concern value, becomes even more valuable when policy rates fall, allowing credit growth by SMEs. As SMEs cover more than 50 percent of the real economy, our results have important implications for aggregate boom-bust cycles in terms of credit, employment and output in a low interest rate environment.

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Appendices

A Variable Definitions

Variable	Definition
Bank leverage	It is calculated both as short-term debt as a fraction of total assets and as total liabilities as a fraction of total assets.
Firm leverage	It is calculated both as short-term debt as a fraction of total assets and as total liabilities as a fraction of total assets.
Collateral amount	Market value of the collateral backing the loan.
Collateral type	Fixed assets and real estate
	Cash and marketable securities
	Accounts receivable and inventory
	Blanket lien and others
	Unsecured
Collateral to loan ratio	It is calculated as collateral value as a fraction of the committed amount by loan.
Probability of default (Percent)	The firm's estimated probability of default by quarter.
Probability of default (Weighted)	It is computed as average firm's probability of default, weighted by the committed loan amount for each firm-bank.
Probability of future default	It is dummy equal to one if the firm defaults at any point in time in the future.
Charge-offs$_b$	It is calculated as the maximum cumulative net charge-offs by bank weighted by the bank's commitments.
Charge-offs$_f$	It is calculated as the total cumulative net charge-offs by firm.
Charge-offs$_l$	It is calculated as the average cumulative net charge-offs by loan.
NPL$_4$	It is a dummy variable that takes a value of 1 if a firm had a non-performing loan in the past 4 years.
Charge-off ratio$_b$	It is calculated as bank's total net charge off amount divided by the bank's total commitments.
Charge-off ratio$_f$	It is calculated as bank-firm's total net charge off amount divided its committed loan amount for each firm.
Charge-off ratio$_b$	It is calculated as net charge off amount divided its committed loan amount for each loan.
Collateralized$_{t-1}$	It is a dummy variable equal to one if the loan is collateralized, and zero otherwise.

B Supplemental Material

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, 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 Parisbas.

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 due to 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 *e.g.* leverage are generally reasonable.

8. After re-scaling miss reporting issues, we take the max value when banks inconsistently report information for the same firm.

Internal Consistency of Balance Sheet Information

We follow Gopinath et al. (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 or current assets

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

The table below presents the results of the data quality comparison.

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

C Tables

Table 14: Response of Credit to Monetary Policy Shocks: Loan-Firm-Bank Level—The Extensive Role of Collateral: All Firms

	Log (Loan)	Log (Loan)	Log (Loan)	Log (Loan)	Log $(1+i)$	Log $(1+i)$	Log $(1+i)$	Log $(1+i)$
Collateralized$_q$	-0.0887*	-0.1994***	-0.2129***	-0.2097**	0.0030***	0.0041***	0.0043***	0.0042***
	(0.0361)	(0.0444)	(0.0463)	(0.0592)	(0.0004)	(0.0006)	(0.0006)	(0.0008)
Collateralized$_q$ × MP Shock$_q$	-0.2762**	-1.0197***	-1.1490***	-1.8582***	-0.0097***	-0.0067*	-0.0064^{+}	-0.0063
	(0.0983)	(0.2457)	(0.2549)	(0.3787)	(0.0021)	(0.0030)	(0.0031)	(0.0045)
Observations	3221734	1924237	1924236	1613869	3191807	1917471	1917470	1612565
Adjusted R^2	0.727	0.535	0.536	0.370	0.620	0.497	0.498	0.404
Bank×Firm f.e	Yes	Yes	Yes	No	Yes	Yes	Yes	No
Bank×Time f.e	Yes	No	Yes	No	Yes	No	Yes	No
Firm×Time f.e	No	Yes	Yes	No	No	Yes	Yes	No
Bank×Firm×Time f.e	No	No	No	Yes	No	No	No	Yes

$^{+}$ $p<0.1$, * $p<0.05$, ** $p<0.01$, *** $p<0.001$

This table presents the results of OLS regressions for the effect of collateral using loan level data at a quarterly frequency, for the all sample. The dependent variable in columns (1) through (4) is the natural logarithm of the total committed loan amount; the dependent variable in columns (5) through (8) is the natural logarithm of the nominal real interest rates. $Collateralized_{t-1}$ is a dummy variable equal to one if the loan is collateralized, and zero otherwise. MP Shock is the contemporaneous surprise component of the 3-month ahead monthly fed futures contract estimated from a high frequency event study from GSS (2005). Double-clustered standard errors by firm and time are reported in parentheses.

Table 15: Response of Credit to Monetary Policy Shocks: Loan-Firm-Bank Level—The Role of Collateral: Intensive Margin

	Log (Loan)	Log (Loan)	Log (Loan)	Log (Loan)	Log $(1+i)$	Log $(1+i)$	Log $(1+i)$	Log $(1+i)$
Log Collateral$_q$	0.0614***	0.1190***	0.1264***	0.1662***	-0.0001*	-0.0003*	-0.0002^{+}	-0.0004^{+}
	(0.0087)	(0.0189)	(0.0201)	(0.0382)	(0.0001)	(0.0001)	(0.0001)	(0.0002)
Log Collateral$_q$ × MP Shock$_q$	-0.1238^{+}	-0.2803*	-0.3528*	-0.6588*	-0.0007*	-0.0005	-0.0003	-0.0010
	(0.0601)	(0.1293)	(0.1522)	(0.2625)	(0.0003)	(0.0004)	(0.0006)	(0.0015)
Observations	321473	154222	154191	137963	321561	154386	154355	138153
Adjusted R^2	0.786	0.513	0.515	0.439	0.565	0.314	0.314	0.296
Bank×Firm f.e	Yes	Yes	Yes	No	Yes	Yes	Yes	No
Bank×Time f.e	Yes	No	Yes	No	Yes	No	Yes	No
Firm×Time f.e	No	Yes	Yes	No	No	Yes	Yes	No
Bank×Firm×Time f.e	No	No	No	Yes	No	No	No	Yes

$^{+}$ $p<0.1$, * $p<0.05$, ** $p<0.01$, *** $p<0.001$

This table presents the results of OLS regressions at the loan level a quarterly frequency. The dependent variable in columns (1) through (4) is the natural logarithm of the total committed loan amount; the dependent variable in columns (5) through (8) is the natural logarithm of the nominal real interest rates. *Log Collateral* is the log of the market value of the collateral as of the reporting date, lagged and demeaned. MP shock is the contemporaneous GSS(2005) monetary policy shock MP4 (estimated from surprises in 3-month Fed fund futures). Double-clustered standard errors by firm and time are reported in parentheses.

Table 16: Response of Credit to Monetary Policy Shocks: The Role of Collateral: Intensive Margin among Private Firms, Loan Level Data

	Log (Loan)	Log (Loan)	Log (Loan)	Log (Loan)	Log $(1+i)$	Log $(1+i)$	Log $(1+i)$	Log $(1+i)$
Log Collateral$_q$	0.0514***	0.1090***	0.1273***	0.1618***	-0.0002*	-0.0002	-0.0003	-0.0004
	(0.0078)	(0.0213)	(0.0201)	(0.0254)	(0.0001)	(0.0001)	(0.0002)	(0.0003)
Log Collateral$_q$ $\times$ MP Shock$_q$	-0.1724*	-0.4920*	-0.5294*	-0.7018**	-0.0010*	0.0003	-0.0001	0.0000
	(0.0635)	(0.1905)	(0.1867)	(0.2385)	(0.0004)	(0.0009)	(0.0011)	(0.0022)
Observations	277841	116623	116569	108574	277931	116777	116724	108748
Adjusted R^2	0.792	0.432	0.434	0.376	0.607	0.247	0.247	0.266
Bank×Firm f.e	Yes	Yes	Yes	No	Yes	Yes	Yes	No
Bank×Time f.e	Yes	No	Yes	No	Yes	No	Yes	No
Firm×Time f.e	No	Yes	Yes	No	No	Yes	Yes	No
Bank×Firm×Time f.e	No	No	No	Yes	No	No	No	Yes

$^{+}$ $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

This table presents the results of OLS regressions at the loan level a quarterly frequency, for the private firm sample. The dependent variable in columns (1) through (4) is the natural logarithm of the total committed loan amount; the dependent variable in columns (5) through (8) is the natural logarithm of the nominal real interest rates. *Log Collateral* is the log of the market value of the collateral as of the reporting date, lagged and demeaned. MP shock is the contemporaneous GSS(2005) monetary policy shock MP4 (estimated from surprises in 3-month Fed fund futures). Double-clustered standard errors by firm and time are reported in parentheses.

Table 17: Response of Credit to Monetary Policy Shocks: The Role of Collateral: Intensive Margin among Public Firms, Loan Level Data

	Log (Loan)	Log (Loan)	Log (Loan)	Log (Loan)	Log $(1+i)$	Log $(1+i)$	Log $(1+i)$	Log $(1+i)$
Log Collateral$_q$	0.0763***	0.1180***	0.1183***	0.1727*	-0.0000	-0.0002*	-0.0001	-0.0004
	(0.0161)	(0.0242)	(0.0263)	(0.0704)	(0.0001)	(0.0001)	(0.0001)	(0.0002)
Log Collateral$_q$ $\times$ MP Shock$_q$	-0.0730	-0.1539	-0.2437	-0.5830	0.0004	-0.0009^{+}	-0.0003	-0.0023
	(0.0725)	(0.1078)	(0.1480)	(0.4046)	(0.0010)	(0.0005)	(0.0007)	(0.0020)
Observations	42997	37181	37117	29041	43003	37191	37136	29057
Adjusted R^2	0.631	0.538	0.537	0.444	0.408	0.443	0.439	0.368
Bank×Firm f.e	Yes	Yes	Yes	No	Yes	Yes	Yes	No
Bank×Time f.e	Yes	No	Yes	No	Yes	No	Yes	No
Firm×Time f.e	No	Yes	Yes	No	No	Yes	Yes	No
Bank×Firm×Time f.e	No	No	No	Yes	No	No	No	Yes

$^{+}$ $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

This table presents the results of OLS regressions at the loan level a quarterly frequency, for the public firm sample. The dependent variable in columns (1) through (4) is the natural logarithm of the total committed loan amount; the dependent variable in columns (5) through (8) is the natural logarithm of the nominal real interest rates. *Log Collateral* is the log of the market value of the collateral as of the reporting date, lagged and demeaned. MP shock is the contemporaneous GSS(2005) monetary policy shock MP4 (estimated from surprises in 3-month Fed fund futures). Double-clustered standard errors by firm and time are reported in parentheses.