Monetary Policy, Debt Structure, and Credit Reallocation *

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November 8, 2023

Abstract

Monetary tightening is associated with an expansion in business loans. Using microdata, I show that this expansion is driven by the *countercyclical demands* for loan financing among large unconstrained firms: they rebalance toward bank loans and away from corporate bonds as the spread of bonds over loans increases, while small firms raise more equity. To rationalize these findings, I estimate a heterogeneous-agent New Keynesian model where bank loans are senior and safer (collateralized) than defaultable bonds but issued at a greater intermediation cost. It implies that small risky firms disproportionately reduce their investment in response to interest rate hike.

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1 Introduction

Much of the literature investigating the monetary transmission mechanism predicts that an increase in interest rates is associated with a contraction in the bank loan volume. Several channels are often suggested to explain this association. The first is the interest rate channel, which focuses on the idea that the short rate affects long-term rates through investors' expectations and therefore affects the costs of borrowing and aggregate demand. The second is the bank lending channel, which emphasizes that bank balance sheet conditions matter in order for short rates to affect loan provision. The third is firms' balance sheet channel, which shows that interest rate hikes worsen firms' liquidity conditions by raising interest payments and hence suppress the demand for loans. Note that all these channels predict a reduction in loans after tight money raises credit spreads.

This paper investigates a novel channel for the transmission of monetary policy involving shifts in firms' debt structures, the credit substitution channel. At the aggregate level, interest rate hikes are associated with a contraction in corporate bonds, as expected. However, in contrast to the conventional view, I find a *short-run* (but not transitory) expansion in business loans.[1] At the firm level, I find that large firms substitute loans for bonds. These findings imply that credit substitution is an important channel of monetary policy transmission. In particular, I show that the short-run increase in aggregate business loans is not surprising if we realize that the demand for loan financing by large, safe borrowers (firms) is countercyclical, rising in bad times when the spread between corporate bonds and business loans widens. However, this crowds out loan lending to small firms, forcing them to issue more equity. By shifting the allocation of credit from the small constrained firms to the large unconstrained firms, the credit substitution amplifies the negative effects of tight money and worsens the drop in aggregate investment, as small constrained firms cut down investment more aggressively.

Empirically I start by investigating the relationship between firms' debt borrowing costs, external financing choices, and interest rates using firm-level debt issuance data. Following the interest rate hikes, I find that bond financing becomes relatively more expensive, as bond spreads increase more than loan spreads. Large, unconstrained firms with lower default risk substitute cheaper loans for corporate bonds as the probability of

[1] I use the debt series of the nonfinancial corporate sector from Flow of Funds L.103. The expansion in bank loans at the aggregate level was first documented in Gertler and Gilchrist (1993) over a sample of earlier periods from 1958 to 1993. They use the federal funds rate minus the 10-year government bond rate FF-GB10 as an indicator of monetary policy, and they show a positive cross correlation between FF-GB10 and the growth rate of bank loans around periods of tight money.

borrowing from banks instead of borrowing from the market increases. Small, low-rated firms that are considered "financially constrained" have a higher propensity to issue new equity. Lastly, the impact of tight money on the debt compositional shift is persistent, even after controlling for the supply side effect. These results hold up to a number of robustness tests.

To understand the driving forces for the empirical findings, I develop a heterogeneous-agent New Keynesian (HANK) model that features debt heterogeneity and credit market frictions. Credit market frictions are characterized by bankruptcy costs, tax benefits, debt and equity issuance costs, and collateral constraints on loan borrowing. The total costs of debt include the exogenous issuance costs and the endogenous interest rates charged by the lenders. In the model, the key difference between loans and bonds is that loans are modeled as senior debt secured by physical capital, and bonds are modeled as riskier defaultable debt. Under the assumption of seniority, loan lenders have lower exposure to interest rate risk, so there is a nonnegative spread between bonds and loans. Firms trade off the lower intermediation (issuance) costs of loans against the lower charged interest rates of bonds. Costly loan issuance leads large firms to avoid using up all the collateral when interest rate is relatively low in order to preserve their borrowing capacity for future economic downturns.

I estimate the model by the Simulated Method of Moments (SMM). The model generates steady-state cross-sectional implications for a firm's choice of debt composition, which depends on a firm's default risk. In the model, firms prefer debt to equity financing because of the tax benefit. The credit spread is close to zero for large firms with low default risks, and therefore, they choose to have only bond financing to avoid high loan intermediation costs. Note that for each unit of debt, firms are charged a higher interest rate as they choose a higher bond share, but a lower intermediation cost. Therefore, firms with a median degree of default risk choose an optimal bond share such that they are indifferent between loan and bond financing. The cost of taking bonds exceeds the cost of taking loans for small firms with high default risk. They choose to have a mix of loan and equity financing to avoid high-interest rates, and they exhaust all collateral before going to the equity market.

The economic mechanism emphasizes that firms' preserved debt financing flexibility is an important determinant of firms' adjustments in financing and investment to interest rate risk. The dynamic effects of monetary policy are evaluated by the perfect foresight transition dynamics of positive innovation to the Taylor rule. The shock raises the nominal interest rate and also lowers the inflation rate because of sticky prices, elevating the real rate. Aggregate demand drops in response to the interest rate hike, which leads to a lower output price. These dampen investment demand through both cash flow and discount rate channels. Lower output price, higher credit spreads and higher real debt payment reduce firms' cash flow. The lower cash flow and the higher default risk raise the total expected loss. The credit spread between bonds and loans increases as senior loan lenders have a lower level of risk exposure. Investment adjustment is slow and costly, which generates a demand for external financing despite being more expensive. Ultimately, large firms with unbinding collateral constraint switch from bond issuance toward relatively cheaper loan issuance, while small, constrained firms with high leverage tend to issue more equity. What this implies is that small, bank-dependent firms with a high loan share cut down their investment more aggressively after tight money.

Next, I quantify the redistributive effects of credit substitution. Following a tightening of monetary policy, credit flows away from the bond market to the loan market. Moreover, credit is "misallocated", as there is a rise in the flow of liquidity to large, unconstrained firms but not to small, constrained firms. This suggests that small firms typically suffer a disproportionately greater drop in investment, as in the data. In aggregate, the impulse responses show that a 25 basis point increase in the innovation of the Taylor rule reduces consumption by 0.37%, output by 1.4%, capital by 0.32%, and total debt by 1.55% quarterly. In addition, this model quantitatively *reverses* the traditional bank lending channel by generating a short-run expansion in bank loans (5% in five quarters), accompanied by a contraction in corporate bonds (1.9% in five quarters). The frictions in the flow of liquidity to small firms suggest a role of credit substitution in propagating downturns.

In the counterfactual analysis, I show that credit market frictions are quantitatively important to determine the loan-bond tradeoff and evaluate the impact of monetary policy. First, when intermediation costs are set the same for both loans and bonds, firms always prefer loans until they are constrained. This preference creates a counterfactually low bond ratio of 7% in the model, compared to that of 76% in the data. The elasticity of substitution (the coefficient of the interaction term between monetary shocks and firm size) declined by one-third of that in the baseline model due to less loan financing flexibility. Second, a 10% increase in the production fixed cost raises the default probability and bond spread by 60% and 37%. The economy has a low leverage of 9%, compared to that of 21% in the data sample. The low leverage raises the substitution elasticity by one-half due to more financing flexibility. Third, a one-half reduction in equity issuance costs leads to a 10% drop in the leverage and a 3% drop in the bond share as well as a 20% rise in equity financing. The elasticity of substitution becomes insignificant and close to zero since firms rely more on equity financing.

In summary, this paper points out that the degree of firms' financing flexibility is crucial in understanding the transmission of monetary policy, and it generates important policy implications: to mitigate credit misallocation after tight money, the optimal regulation policy is to provide easier bank credit access to small firms at a lower cost and, at the same time, prevent credit from being overdrawn among large firms.

Related Literature This paper primarily contributes to four strands of literature.

The first strand of literature discusses the monetary policy and bank loan provision. The traditional "bank lending channel" of monetary policy argues that the transmission of monetary policy works through both the asset (loan) and liability (deposit) sides of the bank balance sheet. Early studies include Bernanke and Blinder (1988), Kashyap and Stein (1995), Kashyap and Stein (2000), Bernanke and Gertler (1995), and Thakor (1996). Recent studies include Drechsler et al. (2017), Xiao (2020), Greenwald et al. (2020), Wang et al. (2022), Begenau and Stafford (2022), and Supera (2021). The "deposit channel of monetary policy" by Drechsler et al. (2017) finds that the deposit spread increases as the interest rate goes up. Banks reduce loan lending because the cost of loan provision increases. However, the deposit channel of monetary policy is not well identified, nor does it aggregate. Several recent studies find conflicting evidence. Wang et al. (2022) show that bank market power interacts with capital regulation to *reverse* the effect of monetary policy when the federal funds rate is very low. Specifically, they estimate that, when the federal funds rate is below 0.9%, further cuts in the policy rate can be contractionary. Begenau and Stafford (2022) point out that networked branches and bank concentration are important to consider when examining the deposit channel. They argue that the deposit channel fails to aggregate because of the extreme bank size distribution and the differential behavior of small and large banks. Supera (2021) shows that the shift in banks' funding mix from time deposits (CDs) to savings deposits can explain a long-term decrease in the nominal rate and a decline in banks' supply of business loans, firm investment, and new firm creation. The "credit line channel" proposed in Greenwald et al. (2020) argue that the expansion of bank lending occurs during COVID periods because large firms draw down the credit line of their existing debt, which crowds out banks' provision of term loans to smaller firms, and that exacerbates the fall in aggregate investment.

These papers add new insights to the "bank lending channel" literature by emphasizing the importance of bank balance sheets and bank structure in determining loan supply and the transmission of monetary policy. This paper differs from the existing research by proposing a novel, *complementary* channel for the transmission mechanism of monetary policy. It emphasizes that the frictions in the borrowers' balance sheet helps to reconcile the difference between the micro and macro evidence. The *countercyclical demands* for loan financing among large unconstrained firms lead to the *short-run* expansion in aggregate business loans.

Second, this paper speaks to the literature that discusses other channels for the transmission of monetary policy to the real economy and asset prices in a heterogeneous-agent setup. This includes the investment (firm balance sheet) channel,[2] consumption channel,[3] asset prices channel,[4] mortgage refinancing channel, inflation expectations channel, exchange rate channel, and so on.[5] I build on the model developed in Ottonello and Winberry (2020) and contribute to this literature by studying the heterogeneous responses in firms' financing decisions to monetary shocks. This paper differs from the other research in several perspectives. The "floating rate channel" proposed in Ippolito et al. (2018) operates through existing debt, but I focus on the new debt issuance in the primary market. The "bond lending channel" proposed in Darmouni et al. (2022) and the "credit disintermediation" proposed in Crouzet (2021) studies suggest that debt structure is important in explaining heterogeneous investment sensitivities to interest rate risk. I study how firms' balance sheet condition drives the heterogeneous responses in their external financing decisions to interest rate risk as the relative cost of debt changes.[6]

Third, this paper is also related to the large literature that studies the corporate capital and debt structure. Debt structure is a central element in a firm's capital structure. Empirical studies about the cross-sectional debt structure find that asymmetric information, liquidation efficiency, access to the capital market, transaction costs, and firm characteristics such as credit quality, size, leverage, profitability, growth opportunities, and prior

[2]Papers that study the investment channel include Kashyap et al. (1994), Gertler and Gilchrist (1994), Ippolito et al. (2018), Darmouni et al. (2022), Ottonello and Winberry (2020), Crouzet (2021), and Morlacco and Zeke (2021). They find that firm characteristics such as liquidity, age, default risk, and debt composition drive the differential response in firms' investments.

[3]This includes Kaplan et al. (2018), Auclert (2019), etc.

[4]This includes Bernanke et al. (1999), Bernanke and Gertler (2001), Gilchrist and Leahy (2002), Bhamra et al. (2011), Daniel et al. (2021), and Corhay and Tong (2021).

[5]Dou et al. (2020) provide a critical review of macroeconomic models used for monetary policy at central banks from a finance perspective.

[6]Schwert (2020) estimates the pricing of bank loans relative to corporate bonds in a novel sample of loans matched with bonds with similar lengths of maturities from the same firm on the same date.

financing decisions are important determinants of the corporate debt structure (Johnson (1997), Denis and Mihov (2003), Rauh and Sufi (2010), and Colla et al. (2013)). Closely related papers are Adrian et al. (2013), Becker and Ivashina (2014), who study the time variation in the corporate debt structure. They find evidence of substitution between loans and bonds during a financial crisis and when credit conditions tighten. My paper differs in that I show that the substitution between loans and bonds is driven by changes in the relative borrowing costs over the monetary cycle. In terms of the theoretical modeling of debt heterogeneity, the most relevant work is Crouzet (2018), in which he quantifies the transmission of financial shocks through the corporate debt structure on aggregate investment, following the seminal contributions of Diamond (1991), Rajan (1992), and Bolton and Scharfstein (1996). I contribute to the theoretical modeling by further incorporating debt heterogeneity into a HANK model and provides an algorithm to solve for the nonlinear global solution with occasionally binding constraints.

Fourth, this paper also builds on a large macro-finance literature that studies the (amplification) effect of financial frictions and agency frictions through the lens of dynamic models with endogenous investment. An incomplete list includes Carlstrom and Fuerst (1997), Kiyotaki and Moore (1997), Gomes (2001), Hennessy and Whited (2005), Hennessy and Whited (2007), Rampini and Viswanathan (2013), Rampini and Viswanathan (2020), Kuehn and Schmid (2014), Li et al. (2016), Alfaro et al. (2018), Belo et al. (2019), and Ai et al. (2020b). Macroeconomic shocks are important determinants of firms' capital structure choices. Financial frictions amplify the effect of exogenous shocks on corporate investment through the changes in asset prices and the external financing premium. Hackbarth et al. (2006) develop a quantitative model of firms' capital structure in which financing decisions vary over the business cycle through its effect on default policies. Jermann and Quadrini (2012) propose a quantitative theory to show that credit market shocks are necessary to rationalize cyclical external financing choices. Begenau and Salomao (2019) further quantitatively examine the heterogeneous effects of macroeconomic shocks. This paper adds to this literature by allowing for an endogenous debt structure and emphasizing the importance of credit substitution in propagating economic downturns.

The remainder of the paper is organized as follows. Section 2 provides the main empirical results, which include data construction, aggregate time series, and firm-level panel analysis. Section 3 outlines a dynamic heterogeneous-agent New Keynesian model to interpret the main empirical evidence, where a theoretical characterization of model mechanisms through which monetary policy affects firms' financing decisions is included. Section 4 characterizes firms' optimal decisions, details the estimation strategies, and presents model solutions. The quantitative analysis, which includes cross-sectional model validation and firms' differential adjustments, as well as model implications, is included in section 5. Section 6 discusses the findings, and section 7 concludes.

2 Empirical Evidence

In this section, I explore how monetary policy affects firms' financing decisions. I first examine aggregate patterns before analyzing the response across a panel of firms.

2.1 Data

The sample spans the first quarter of 1990 to the last quarter of 2018. It includes monetary policy shocks, aggregate time-series data from the flow of funds accounts and the Federal Reserve Bank of St. Louis Fed, firm-level accounting variables from Compustat, (syndicated) loan facilities origination from Loan Pricing Corporation's DealScan, as well as corporate bonds issuance from Mergent Fixed Income Securities Database (FISD).

Monetary Policy Shocks

I use the same measurement of unexpected monetary policy shocks as Gürkaynak et al. (2005) and Gorodnichenko and Weber (2016) in the baseline analysis.[7] Specifically, I measure monetary shocks as the changes in the current month's federal funds futures rate in a 30-minute narrow window around Federal Open Market Committee (FOMC) announcements. Daily monetary shock ϵ_t^m is defined as

$$\epsilon_t^m = \tau(t) \times (ffr_{t+\Delta_+} - ffr_{t-\Delta_-}), \tag{1}$$

where t is the time of the monetary announcement and ffr_t is the implied fed funds rate from a current-month federal funds futures contract at time t. I focus on a window of $\Delta_- = 10$ minutes before the announcement and $\Delta_+ = 20$ minutes after the announcement.

[7] They measure monetary shocks using the high-frequency, even-study approach, pioneered by Rudebusch (1998), Kuttner (2001), Cochrane and Piazzesi (2002), and Bernanke and Kuttner (2005).

The term $\tau(t)$ is an adjustment for the timing of the announcement within the month.[8] There are 225 high-frequency shocks in my sample. I aggregate the high-frequency shocks to a quarterly frequency following Ottonello and Winberry (2020) by weighting shocks by the amount of time firms have had to react to them. The quarterly monetary shock has a mean of approximately zero and a standard deviation of 9.1 basis points. It has a negative correlation of -0.30 with real GDP growth.[9] Figure 1 plots the measured monetary shocks at the daily and quarterly frequency.

[Figure 1 and Table 1 Here]

Aggregate-level Variables

I obtain the quarterly time series of aggregate U.S. nonfinancial corporate debt from Flow of Funds L.103. Their debt consists primarily of debt securities and loans. Within these two categories, corporate bonds (defined as market debt) account for around 84% of total debt securities, while "depository institution loans not elsewhere classified (defined as bank debt)" and "other loans and advances" together account for around 77% of total loans over the period. The average quarterly changes in corporate bonds and bank loans are 0.93% and -0.08%, respectively. Their correlation with real GDP growth is -0.06 and 0.1, and with the measured monetary shocks, the correlation is -0.12 and 0.15.[10]

Debt Variables

Loan origination data are from DealScan, and corporate bond issuance data are from FISD, which includes information about issuance date, maturity, borrowing amount, and issuer credit rating.[11] Merging debt issuance data with Compustat gives a sample of public firms that have loan financing, bond financing, or both. This sample consists of 25,476

[8] This adjustment accounts for the fact that the fed funds futures payout is based on the average effective rate over the month. It is defined as $\tau(t) = \frac{\tau_m^n(t)}{\tau_m^n(t) - \tau_m^d(t)}$, where $\tau_m^d(t)$ denotes the day of meeting in the month and $\tau_m^n(t)$ the number of days in the month.

[9] It contains 37 monetary tightening and 76 monetary easing over the sample.

[10] Nonfinancial corporate bonds outstanding in the U.S. grew from approximately $1 trillion in 1990 to approximately $3 trillion in 2008 and to approximately $5.5 trillion at year-end 2018. Similarly, the sum of depository institution loans and other loans together in the U.S. grew from approximately $1.1 trillion in 1990 to approximately $2.2 trillion in 2008, then to approximately $3 trillion at the year-end of 2018.

[11] Wharton Research Data Services (WRDS) has updated the DealScan dataset starting from the summer of 2021. The update is a reorganization of the entire dataset, combining all the information in a single table and changing loan identifiers. The analysis here is based on a vintage version of DealScan, which is now considered the "legacy" version of WRDS. In particular, I use data from the following tables: Facility-Legacy, Package-Legacy, Company-Legacy, Lenders-Legacy, Current Facility Pricing-Legacy, and DealScan-Compustat Linking Database.

loan facilities, with an average loan amount of $ 431 million, a maturity of 4.16 years, and a spread of 191 basis points. The sample consists of 12,468 corporate bond issuances, with an average quantity of $ 414 million, an average maturity of 11.14 years, and a spread of 183 basis points. Figure 2 plots the debt issuance distribution across borrowers' size, split according to Chodorow-Reich et al. (2022)'s classification. The panels on the left represent the new issuance to all Compustat firms, and the panels on the right are the new issuance to public firms with access to both bank loans and corporate bonds. Most of the new debt is issued to large firms. Corporate bonds typically have a longer maturity and larger credit spread relative to bank loans. The difference in maturity between bonds and loans is increasing in borrowers' size, while the difference in the spread is declining in firm size.[12]

Firm-level Variables

I obtain the net equity issuance and loan share from quarterly Compustat. Following Eisfeldt and Muir (2016), the net equity issuance is computed as the sale of common and preferred stock (SSTK) minus the purchase of common and preferred stock (PRSTKC), scaled by lagged total assets. This measure of equity issuance also includes the granting of stock options to employees as a form of compensation. I therefore follow McKeon (2015) to do the adjustment.[13]

Following Crouzet (2021), I define the firm-level loan to be the total of notes payable (NP) and other long-term debt (DLTO) and interpolate missing values of loan if the spells are less than one year.[14] Control variables include firm size, leverage, market-to-book value, tangibility, distance to default (D2D) following Gilchrist and Zakrajšek (2012), an indicator for whether firms pay out dividends, and a dummy for investment grade firms (BBB^- or higher) based on the S&P long-term debt credit rating.

[12]Following Chodorow-Reich et al. (2022), I split firms into four groups based on assets: less than $250 million, $250–$999 million, $1–$5 billion, and greater than $5 billion. I refer to all firms with less than $250 million in assets as SMEs and to firms with over $1 billion as large firms. The final sample contains 53 firms with between $50 million and $250 million in assets, 313 firms with between $250 million and $1 billion in assets, 571 firms with between $1 billion and $5 billion, and 323 firms with more than $5 billion in assets.

[13]For each firm quarter, we classify the equity raised by the firm during the quarter as firm initiated if the proceeds represent at least 2% of the firm's end-of-quarter market equity (the equity raised during a quarter is Compustat item SSTKY for Q1 and ΔSSTKY for Q2 to Q4; a firm's end-of-quarter market equity is PRCC $\times$ CSHOQ) and scale it by beginning-of-quarter total assets.

[14]Crouzet (2021): NP includes bank acceptances, bank overdrafts, and loans payable. For long-term debt, DLTO includes all revolving credit agreements, as well as all construction and equipment loans. It excludes senior nonconvertible bonds (which are included in debentures, DD), and convertible or subordinate bonds (included in DCVT and DS, respectively). The main drawback is that both NP and DLTO include outstanding commercial paper.

Summary statistics of firm variables can be found in Table 1, Panel C. Appendix A contains more detailed definitions of these variables and sample construction.

2.2 Aggregate-level Dynamics

I estimate the cumulative effects of monetary policy shocks using a Jordà (2005)-style local projection:

$$y_{t+h} - y_{t-1} = \alpha_h + \beta_h \epsilon_t^m + \Gamma_h Controls_{t-1} + \epsilon_{t+h}, \tag{2}$$

where $h = 0, 1, ..., 8$ indexes the forecast horizon. Monetary shocks ϵ_t^m are standardized. The dependent variable y is the (log) real debt. The control variables include one year of lagged values of the monetary policy shock and one year of lagged values of the one-quarter change in the respective dependent variable, real GDP growth, inflation rate, unemployment, term spread, SLOOS tightening standards[15], and the forecasts of GDP growth and unemployment. Coefficient β_h measures the cumulative response of corporate debt in quarter $t + h$ to a monetary shock in quarter t. Figure 3 reports the estimates of coefficient β_h over quarter h. The effect is large and persistent across all dependent variables. A 25 basis point interest rate hike raises bank loans by 1.8 billions and reduces corporate bonds by 4.8 billions, as shown in panel (a) and (c). The peak of cumulative effects on loan growth is around 1 $\times$ 25/9 = 2.78 percentage points in Panel (d), and the peak of cumulative effects on bond growth is around -1.5 $\times$ 25/9 = -4.17 percentage points in Panel (b), which remains significant up to five quarters. The initial impact on the flow of total debt is close to zero and remains insignificant for two years.[16]

[Figure 3 Here]

2.3 Firm-level Analysis

At the aggregate level, the tightening of monetary policy leads to a contraction in corporate bonds and an expansion in bank loans. Analogous to the previous section, I now analyze firms' responses. Using microdata, I estimate the differential effects of mone-

[15] The series corresponds to the net percentage of domestic respondents tightening their standard for commercial and industrial (C&I) loans to large and medium-sized firms. A higher value indicates that more banks report tighter credit standards (contraction in bank credit).

[16] The results are robust to various sets of controls and numbers of lags. However, the long-run effect is imprecisely estimated with large standard errors, and therefore, in the rest of the paper, I only focus on the short-run impact of monetary shocks.

tary policy on debt borrowing costs and firms' external financing decisions at both the extensive and intensive margins.

2.3.1 Debt Financing Decision: Loans vs. Bonds

I first estimate how firms' choices between loans and bonds change in response to monetary shocks, with the following regression:

$$\begin{aligned} y_{i,t} =& \alpha_i + \lambda_{s,q} + \gamma \epsilon_t^m + \beta \epsilon_t^m \times (X_{i,t-1} - \mathbb{E}_i(X_{i,t-1})) + \eta \Delta GDP_t \times (X_{i,t-1} - \mathbb{E}_i(X_{i,t-1})) \\ &+ \delta (X_{i,t-1} - \mathbb{E}_i(X_{i,t-1})) + \Gamma_1' Z_{i,t-1} + \Gamma_2' Y_{t-1} + \epsilon_{i,t}. \end{aligned} \tag{3}$$

The variables in $X_{i,t-1}$ are standardized $X_{i,t-1}$ to avoid the results being driven by permanent differences across firms. The variable $Z_{i,t-1}$ is a set of firm characteristics, and the variable Y_{t-1} is a set of macroeconomic variables including four lags of GDP growth and inflation rate. α_i is a firm fixed effect, and $\lambda_{s,q}$ is a sector-quarter fixed effect. I also include the interaction between GDP growth and $X_{i,t-1}$ to control for heterogeneous cyclical sensitivities.

My central result establishes a connection between loan and bond substitution and monetary policy at the firm level, conditional on firms' raising new debt financing. By limiting the sample to new debt issuances, I can be certain that firms in the sample have a non-zero demand for credit. Specifically, I keep the firm-quarters that have either a new loan or new bond issuance. The number of firm-quarters in which firms raise both types of debt is rare (3.2% of firm-quarters with new debt) and is likely to be associated with large corporate events such as mergers. Including these observations does not affect our results. This subsample consists of 1,573 firms and 15,287 firm-quarter observations.

However, it is important to recognize this approach's limitations. The sample is restricted to firms with access to both loans and corporate bonds, so it is not representative of the universe of bank borrowers. Despite being a small fraction of the total firms, over half of the new origination are taken by firms in this group and therefore, their financing choices are important for explaining the aggregate dynamics.

Columns (1) to (4) of Table 2 report the results at the extensive margin, where the dependent variable is a dummy for debt choices and equals one if a firm chooses new loans and zero if a firm chooses new bonds in quarter t. The positively significant coefficient estimate γ in column (1) is 1.4 percentage points. Compared to a sample average of 58%, this is a $25/9 \times 1.4/58$ = 6.7% increase in the probability of borrowing from a bank.[17] To avoid the selection issue, I conduct the analysis over loan and bond issuance samples separately, which cover a larger set of firms. On average, firms have a higher (lower) probability of borrowing from bank (issuing bonds) in response to interest rate hikes. The results are included in Table A.2.

Columns (5) to (8) report the results at the intensive margin, where the dependent variable is the change in loan flow measured using Compustat data in quarter t, expressed as a percentage. This is a much larger sample and consists of 8,212 firms and 263,454 firm-quarter observations. Compared to a sample average of 2.39%, the coefficient estimate of 0.275% in column (5) suggests a significant increase, 0.275/2.39 = 11.51%, in the quarterly growth rate of the loan.

[Table 2 Here]

The substitution effect is particularly more pronounced for "financially unconstrained" firms, which are large, high-rated firms with lower default risk. The coefficient estimates β in columns (2) to (4) and columns (6) to (8) suggest an economically and statistically significant heterogeneity in the preference for loan financing across firms. A one standard deviation increase in firm size and distance to default further raises the probability of borrowing from bank by $0.7/58 \times 25/9$ = 3.35%, and $1.8/58 \times 25/9$ = 8.62%. Only investment-grade firms raise more loans as the interest rate rises. The dynamic effects of monetary policy on large, high-rated, and less risky firms are large and persistent, as shown in Figure 4.

2.3.2 Equity Financing Decision

I estimate the same regression specification as that in the previous section. This sample consists of 9,072 firms and 418,728 firm-quarter observations.

Columns (1) to (4) of Table 3 report the equity financing decisions at the extensive margin, where $y_{i,t}$ is a dummy taking a value of 100 (expressed as a percentage) if the net equity issuance of firm i in quarter t is positive and equals zero otherwise. Columns (5) to (8) report the equity financing decisions at the intensive margin, where the dependent variable is the change in the firm's equity (defined as the difference between total assets

[17] Table 2 reports the results of a linear probability model. The results of the logistic regression shown in Table A.3 give similar conclusion.

and total debt) in quarter t over lagged total assets. On average, firms have a higher probability of issuing new equity following an unanticipated interest rate hike. The coefficient estimate in column (1) is 0.22%. Compared to an average issuance rate of 6.63% and a standard deviation of 25%, this implies that a 25 basis points interest rate hike is associated with a 25/9 $\times$ 0.22/6.63 = 9.2% increase in the probability of issuing new equity. The coefficient estimate of 0.124% in column (5) suggests a 25/9 $\times$ 0.124/1.08 = 11.5% increase in the quarterly change in equity share. At first glance, this seems to be contradicted by asset price channels of monetary policy, which suggests that a policy-induced increase in the short-term nominal interest rate makes debt instruments more attractive than equities in the eyes of investors, thus causing equity prices to fall. A reasonable explanation is that the higher desire for equity financing among small firms, despite being more costly, leads to an increase in the average net equity issuance, as these firms have a limited debt-borrowing capacity and are usually financially constrained. This can be implied from the negative coefficient estimates of the interaction terms in column (2) and columns (6) to (8). A one standard deviation increase in firm size further reduces the probability of issuing new equity by 25/9 $\times$ 0.119/6.63 = 5%, and the equity share by 25/9 $\times$ 0.069/1.08=17.7%.

[Table 3 Here]

2.3.3 Debt Pricing

Another way to infer a countercyclical demand for loan financing among large, unconstrained firms is to compare the relative prices. I estimate the monetary policy effects on the cost of security j by borrower i at year t following a panel regression:

$$\begin{aligned} Credit\ Spread_{j,i,t} =& \alpha_i + \lambda_{s,q} + \gamma\epsilon_t^m + \beta\epsilon_t^m \times (X_{i,t-1} - \mathbb{E}_i(X_{i,t-1})) + \eta\Delta GDP_t \times (X_{i,t-1} - \mathbb{E}_i(X_{i,t-1})) \\ &+ \delta(X_{i,t-1} - \mathbb{E}_i(X_{i,t-1})) + \Gamma_1' Z_{i,t-1} + \Gamma_2' W_{j,i,t-1} + \Gamma_3' Y_{t-1} + \epsilon_{j,i,t} \end{aligned} \tag{4}$$

where loan spread refers to the variable "All-in-drawn"in DealScan, which is the difference between the loan rate and the three-month LIBOR plus an annual fee. The corporate bond spread is measured as the difference between the offering yield and the three-month LIBOR in columns (5) to (8) (maturity-matched interest rate swaps in columns (9) to (12)).[18] Debt characteristics $W_{j,i,t-1}$ include the maturity length and borrowing amount.

[18]Prior literature has found swap rates to be closer to the "true" risk-free rate than Treasury rates, which contain a convenience yield. For instance, see Feldhütter and Lando (2008). Results using the Treasury

The results are summarized in Table 4. The coefficient estimate of 0.039 in column (1) indicates that a 25 basis points interest rate hike raises the average loan spread by $3.9 \times 25/9 = 10.83$ basis points, which is a 5.66% increase compared to the sample average. Column (5) suggests a $18.8 \times 25/9 = 52.22$ basis points increase in the average bond spread when using the three-month LIBOR as the base rate. This is a 28.54% increase compared to the sample average. The magnitude remains significantly larger, $7.7 \times 25/9 = 21.39$ basis points, even after adjusting for maturity difference in column (9). The increase in the loan spread is more significant among less risky firms, which is justified by an increase in firm demand for loan financing. However, we do not observe a significant heterogeneity in bond pricing.

[Table 4 Here]

Loans and bonds are different in several dimensions. Compared to corporate bonds, loans on average have collateral, shorter maturities, lower information sensitivity, higher seniority, and a renegotiation benefit.[19] What leads to a lower pass-through from interest rate risk to loan spreads? First, seniority explains why loan lenders have lower risk exposure. Loan lenders have the priority of getting debt payments and hence lower expected loss when firm borrowers declare bankruptcy, as documented by Rauh and Sufi (2010).[20]Loans are safe debt as they are usually negotiable, collateralized, and have less asymmetric information. Second, bond yields, on average, are more sensitive to interest rate changes because of the longer maturity. However, we still see a higher pass-through to bond spreads even after adjusting for maturity differences using swaps as the base rate. To isolate the duration channel, I perform a subsample analysis of new issuance with maturities between 3 and 8 years. By construction, the maturity of loans has a mean of 4.9 years and a median of 5 years, while the maturity of bonds has a mean of 5.5 years and a median of 5 years. The significant estimates in Table A.4 indicate that the heterogeneous pass-through are not completely driven by the duration difference. Third, a stronger lender-borrower relationship is associated with a lower interest rate sensitivity

yield curve are available upon request.

[19]In the DealScan sample, loans are mostly taken by firms for corporate purpose instead of being taken by households for real estate purchases. Unlike mortgages, business loans have low prepayment risk and they are less likely used for refinancing. Moreover, we do not observe an increase in the mortgages at the aggregate level.

[20]According to Moody's recovery database for nonfinancial corporations, the median (mean) recovery rate for bank loans was 100% (82%) in the 20 years prior to the financial crisis. In contrast, the median recovery rates for corporate bonds ranged from 67% to 2%, depending on the seniority structure of the particular debt contract (see Figure A.5).

(see Table A.5).

Loans mostly have floating rates, whereas bonds mostly have fixed rates. However, the rate difference itself cannot explain the rising demand for loan financing as floating-rate debt gives higher interest payments when rate goes up, as suggested in the firm's balance sheet channel. This makes loans less attractive. Different from Greenwald et al. (2020) where large firms draw down *existing* credit lines at a *predetermined* rate during COVID periods, I focus on the loan origination in the primary market. Over half of the new issuances are credit lines with a corporate purpose. However, we cannot observe how much credit line the borrowers draw down when issued in DealScan.

2.4 Summary and Robustness Check

I document the following new facts. 1) Bond financing becomes relatively more expensive as bond spreads increase more than loan spreads. 2) As a result, large, high-rated firms with low default risk substitute bank loans for corporate bonds, and therefore loan borrowing increases. This is consistent with the aggregate evidence. Small, low-rated, risky firms have a higher propensity to issue new equity. These patterns hold at both the extensive and intensive margins. The online Appendix contains several sets of additional empirical results.

The first set of additional results contains two robustness checks of the aggregate analysis. Columns (1) to (4) of Table A.6 decompose the aggregate loans by maturity, showing that monetary shocks have a large and significant impact on short-term loans relative to long-term loans, mostly mortgages. Columns (5) to (8) decompose the measured monetary shocks, suggesting that it is the changes in the short rate ("target" component) rather than the changes in the long rate ("path" component) that drive the results.

The second set of additional results distinguish "financially constrained" firms from "unconstrained" firms using "Whited-Wu" (Whited and Wu (2006)) and the Size & Age index (Hadlock and Pierce (2010), hereafter, the "HP" index). The results in Table A.7 confirm the robustness of differential adjustments in financing decisions in response to monetary shocks.

The third set of robustness checks discuss the measures of monetary shocks. The high-frequency identification method assumes that no other news is systematically released within the narrow windows around the FOMC announcement. However, the literature on the Fed information effect have called this assumption into question: they posits that the Federal Reserve systematically reveals new information about other economic fundamentals in its meeting announcements, in addition to the pure monetary policy news. Therefore, it is important to differentiate between the two effects. This is not likely to be an issue for two reasons. First, the Fed information effect became dominant after 2007 with the adoption of unconventional monetary policy. The significant results of the pre-crisis (1990-2007) sample analysis included in Table A.8 imply that the results are more likely to be driven by the changes in the short rate. Second, Jarociński and Karadi (2020) exploit the negative and positive co-movement between interest rates and stock prices to disentangle the pure monetary policy effect from the Fed information effect. The correlation between S&P 500 stock return and the pure monetary shocks, information shocks are -0.45 and 0.23, respectively. I employ the pure monetary policy shocks constructed in Jarociński and Karadi (2020) and the results are presented in Figure A.4. Policy news shocks from Nakamura and Steinsson (2018) give similar conclusions, as shown in Table A.9.

Business cycle and monetary cycle are overlapped. The correlation between GDP growth and monetary shocks is reasonably low in this sample. To rule out the business cycle effect, I also control for a set of macroeconomic variables. In addition, Table A.10 shows the asymmetric effects of monetary policy, and it suggests that most of the results are driven by expansionary periods. The effects of monetary policy on firm-level borrowing costs, cash holding, trade credit, dividend payout decision, and excess stock return are presented in Table A.11 and Table A.12.[21]

3 Model

To explain the above empirical patterns, I introduce a New Keynesian general equilibrium model with firm heterogeneity and financial frictions to help understand the economic mechanism that drives the empirical results. Firms use internal funds, costly external debt, and equity issuance to finance their production activities. Motivated by the empirical facts, I distinguish loans from bonds by modeling loans as senior collateralized debt but issued at a higher intermediation cost and bonds as riskier defaultable debt. Credit substitution is determined by the changes in the relative prices of these two risky securities and the preserved debt financing flexibility.

[21] Jarociński and Karadi (2020) find that a surprise policy tightening raises interest rates and reduces stock prices, while a complementary positive central bank information shock raises both. The decrease in stock prices and, therefore, stock returns in Table A.12 further confirms this.

Time is discrete and infinite. The model consists of four building blocks: a representative household, a continuum of production firms that make financing and investment decisions, a financial intermediary that prices debt, and a New Keynesian block that consists of a final good producer, a continuum of intermediate retailers, and a monetary authority.

3.1 Heterogeneous Firm Producers

3.1.1 Technology and Investment

Firms use physical capital (k) and labor (l) in period t to produce goods (y) using a decreasing returns to scale technology. The production function of firm i at time t is given by

$$y_{i,t} = z_{i,t} k_{i,t}^{\alpha} l_{i,t}^{\nu}, \tag{5}$$

where $0 < \alpha + \nu < 1$. Firm-specific productivity $z_{i,t}$ follows a log AR(1) process

$$log(z_{i,t+1}) = \rho_z log(z_{i,t}) + \sigma_z \epsilon_{i,t+1}, \tag{6}$$

where $\epsilon_{i,t+1}$ is an $i.i.d.$ standard normal shock that is uncorrelated across all firms in the economy. ρ_z and σ_z are the autocorrelation and conditional volatility of firm-specific productivity, respectively. The production process incurs a fixed cost of c_f if the firm decides to undertake the production.

Firms make investment decisions every period. Physical capital accumulation is given by

$$k_{i,t+1} = (1-\delta) k_{i,t} + i_{i,t}, \tag{7}$$

where $i_{i,t}$ represents investment and δ denotes the capital depreciation rate.

When installing new capital or selling old capital, the firm has to incur a quadratic capital adjustment cost with functional form convex adjustment costs $AC(i_{i,t}, k_{i,t})$, given by

$$AC(i_{i,t}, k_{i,t}) = \frac{\phi}{2} \left(\frac{i_{i,t}}{k_{i,t}} \right)^2 k_{i,t}. \tag{8}$$

With these capital adjustment costs, I capture in a simple way that capital is illiquid. This form of capital adjustment costs is common in the investment literature, and it is widely used in the corporate finance literature—for example, in Bolton et al. (2013) and

Eisfeldt and Muir (2016). Here, I assume an asymmetric adjustment cost: $\phi^+ < \phi^-$: ϕ^+ is the adjustment cost when investment is positive, and ϕ^- is the adjustment cost when investment is negative (disinvestment).

3.1.2 Debt Financing

The firm can borrow via a bank loan, a corporate bond, or both. Every period the firm owner chooses the total amount of debt borrowing $B_{i,t+1}$ and share of bond debt $s_{i,t+1}$. Therefore, the bond amount is $B_{i,t+1}s_{i,t+1}$ and the bank loan amount is $B_{i,t+1}(1 - s_{i,t+1})$. The firm owner needs to make the debt payment $(1 + c)B_{i,t+1}$ at the beginning of the next period, where c is the proportional coupon for both types of debt that provides a tax advantage. Bonds and loans are different in many dimensions: maturities, seniority, intermediation cost, information sensitivity, floating/fixed rate, and so on. Below I discuss the model assumptions to distinguish bonds from loans.

Assumption 1. (Liquidation and bankruptcy cost)

Liquidation involves deadweight losses. This assumption is common to many models in which the underlying financial friction is limited liability. The creditors receive full payment per unit of debt if the firm does not default. If the firm decides to default on the outstanding debt, the liquidation value is χ fraction of undepreciated capital stock $(0 \leq \chi \leq 1)$: $\chi(1 - \delta)k_{i,t+1}$.

Assumption 2. (Debt seniority)

In most cases, bank lenders are more senior than bond lenders. Previous studies have provided empirical support for the assumption.[22] To capture this predetermined seniority structure in the model, the recovery value per unit of bank loans and corporate bonds is

$$R^l_{i,t+1} = min\left\{\frac{\chi(1-\delta)k_{i,t+1}}{B_{i,t+1}(1-s_{i,t+1})/\Pi_{t+1}}, 1+c\right\}, \tag{9}$$

[22] Loans—either credit lines or term loans—tend to be either fully secured or senior to all other credit obligations, whereas bonds tend to be unsecured, subordinated, or both. For instance, Diamond (1993) suggests that the seniority and collateralization of short-term debt can serve as compensation for the monitoring cost of short-term creditors. Rauh and Sufi (2010) document that, in a sample of rated firms, 53.9% of all secured debt consists of credit lines or term loans, and a further 31.8% consists of mortgage and equipment debt. Subordinated debt, on the other hand, entirely comprises (either convertible or nonconvertible) debt. Crouzet (2018) finds that a very large portion of short-term debt (on average, 95%) constitutes loans. To the extent that these loans are extended by banks, they are almost always senior, as discussed in Welch (1997).

and

$$R^b_{i,t+1} = min\left\{\frac{\chi(1-\delta)k_{i,t+1} - (1+c)B_{i,t+1}(1-s_{i,t+1})/\Pi_{t+1}}{B_{i,t+1}s_{i,t+1}/\Pi_{t+1}}, 1+c\right\}. \tag{10}$$

This assumption is crucial to generate lower risk exposure for loan lenders and, therefore, a rise in the credit spread of bonds over loans in response to an interest rate hike.

[Figure A.5 Here]

Assumption 3. (Collateralized loans)

In the model, the collateral constraint a firm faces on loan borrowing is

$$(1+c)B_{i,t+1}(1-s_{i,t+1}) \leq \theta(1-\delta)k_{i,t+1}. \tag{11}$$

Here, only θ fraction of undepreciated capital can be used as collateral, which affects the tightness of the collateral constraint and determines the borrowing capacity. I further assume $0 < \theta < \chi$, which means that bank lenders cannot always get full payment during bankruptcy even though the loan is secured. This generates a time-varying loan spread.

Assumption 4. (Loan issuance is more costly)

Debt issuance is costly.[23] For simplicity, I assume that there is a linear issuance cost ξ_0 and ξ_1 per unit of loans and bonds, respectively. The debt issuance cost is higher for an intermediated bank loan: $\xi_0 > \xi_1$, because of costly intermediation.[24] The functional form for debt issuance cost is given by

$$DIC(B_{i,t+1}, s_{i,t+1}) = \xi_0 B_{i,t+1}(1-s_{i,t+1}) + \xi_1 B_{i,t+1}s_{i,t+1} = \xi_0 B_{i,t+1} + (\xi_1 - \xi_0)B_{i,t+1}s_{i,t+1}, \tag{12}$$

Assumption 5. (Short-term debt)

On average, bonds have a longer maturity than loans. Both loans and bonds take the form of a one-period contract in the model for simplicity. This assumption can be relaxed to short-term loans and long-term bonds to include the duration channel.

[23] Fang (2005) finds that bond issuance in the U.S. has an average underwriting fee of 0.95%. Philippon (2015) estimates the overall intermediation costs in the U.S. financial sector to be approximately 2% between 1870 and 2012.

[24] Bank borrowing requires active relationship management (firm owners need to share private information with their bank lenders to verify loan covenants), and banks do monitoring to overcome the problem of asymmetric information between lenders and borrowers. This assumption can be relaxed to allow procyclical and heterogeneous issuance costs: the process of loan intermediation is more costly for riskier firms. The average intermediation costs are higher in bad times.

3.1.3 Equity Financing

Taxable corporate profits are equal to output less capital depreciation and interest expenses: $y_{i,t} - \delta k_{i,t} - cB_{i,t}/\Pi_t$. A firm's internal funds in period t is defined as after-tax profit (output minus labor expense) plus the value of undepreciated capital and the tax benefit net of debt payment and fixed production cost:

$$\begin{aligned} n_{i,t} = & \max_{l_{i,t}} \ (1-\tau)(p_t z_{i,t} k_{i,t}^{\alpha} l_{i,t}^{\nu} - w_t l_{i,t}) + \tau(\delta k_{i,t} + cB_{i,t}/\Pi_t) \\ & + (1-\delta)k_{i,t} - c_f - (1+c)B_{i,t}/\Pi_t \\ & = (1-\tau) w_t^{\frac{\nu}{\nu-1}} \left[\nu^{\frac{\nu}{1-\nu}} - \nu^{\frac{1}{1-\nu}}\right] \left(p_t z_{i,t} k_{i,t}^{\alpha}\right)^{\frac{1}{1-\nu}} + \tau(\delta k_{i,t} + cB_{i,t}/\Pi_t) \\ & + (1-\delta)k_{i,t} - c_f - (1+c)B_{i,t}/\Pi_t. \end{aligned} \tag{13}$$

It follows that a firm's budget constraint can be written as

$$d_{i,t} + k_{i,t+1} = n_{i,t} + Q_{i,t}^{l} B_{i,t+1}(1-s_{i,t+1})(1+c) + Q_{i,t}^{b} B_{i,t+1} s_{i,t+1} - DIC(B_{i,t+1}, s_{i,t+1}) - AC(i_{i,t}, k_{i,t}), \tag{14}$$

in which τ is the corporate tax and $d_{i,t}$ is the dividend payout. Firms do not incur costs when paying dividends or repurchasing shares. Besides internal funds and debt, firms can also finance their investment via equity issuance, modeled as a negative dividend. External equity issuance is costly and consists of a fixed and proportional cost: $EIC(d_{i,t}) = (\lambda_0 + \lambda_1 |d_{i,t}|)\mathbb{1}(d_{i,t} < 0)$. The effective cash flow distributed to shareholders is given by

$$d_{i,t} - EIC(d_{i,t}). \tag{15}$$

3.1.4 New Entrants

Every period, new entrants enter the economy with initial capital k_0 from households and have zero debt. The mass of new entrants is equal to the mass of firms that exit the economy so that the total mass of production firms is fixed in each period. Each of these new entrants draws idiosyncratic productivity $z_{i,t}$ from the time-invariant distribution $\mu^{ent}(z) \sim logN\left(-m\frac{\sigma}{\sqrt{1-\rho^2}}, \frac{\sigma}{\sqrt{1-\rho^2}}\right)$. They then proceed as incumbent firms.

3.1.5 Timing

The timing of events within a period is as follows:

(i) **Default decision** All firms (include the new entrants) enter into each period with productivity, capital, and total debt $(z_{i,t}, k_{i,t}, B_{i,t})$. At the beginning of period t, the firm decides whether to continue or default: $D_{i,t}$ based on firm equity value $V_{i,t}$:

$$\begin{cases} D_{i,t} = 0 & \text{if } V_{i,t} \geq 0 \\ D_{i,t} = 1 & \text{if } V_{i,t} < 0. \end{cases}$$

If the firm defaults, it immediately and permanently exits the economy. In the event of default, lenders recover a fraction of the firm's undepreciated capital stock $\chi(1-\delta)k_{i,t}$ as debt payment. To continue, the firm must pay back the face value of outstanding debt: $(1+c)B_{i,t}$ and pay a fixed operating cost c_f.

(ii) **Production** Continuing firms produce. They hire labor $l_{i,t}$ from a competitive labor market with wage rate w_t. The firm's net worth in period t is defined above.

(iii) **Investment** Firms have three sources for financing their investment $k_{i,t+1}$. First, firms can use internal financing by lowering dividend payments. Second, firms can issue corporate debt—both loans and bonds—which incur an issuance and bankruptcy cost. Lenders offer a price schedule $Q^l(z_{i,t}, k_{i,t+1}, B_{i,t+1}, s_{i,t+1})$ for loans and $Q^b(z_{i,t}, k_{i,t+1}, B_{i,t+1}, s_{i,t+1})$ for bonds. Third, firms can issue equity with a variable and fixed cost.

3.1.6 Recursive Formulation

A firm's optimization problem can be written recursively. Conditional on continuing, firms make decisions on labor hiring, investment, and borrowing: (l, k', B', s'). The state variables of a firm are productivity, capital, and total debt (z, k, B). Conditional on continuing, the equity value $V_t(z, k, B)$ solves the following Bellman equation:

$$\begin{aligned} V_t(z,k,B) &= \max_{l,k',B',s'} d - EIC(d) + \mathbb{E}_t[\Lambda_{t,t+1} \max_{D'(z',k',B')\in\{0,1\}} V_{t+1}(z',k',B')] \\ s.t \quad n &= (1-\tau)(p_t z k^\alpha l^\nu - w_t l) + (1-\delta)k + \tau(\delta k + cB/\Pi_t) - c_f - (1+c)B/\Pi_t \\ d + k' &= n + Q^l_{i,t}B'(1-s') + Q^b_{i,t}B's' - DIC(B',s') - AC(i,k) \\ B'(1-s')(1+c) &\leq \theta(1-\delta)k' \\ k' &= (1-\delta)k + i, \end{aligned}$$

where $D'_{t+1}(z', k', B')$ is an indicator variable taking the value of one when the firm defaults and $0 \leq s' \leq 1$. $\Lambda_{t,t+1} = \beta \frac{U'(C_{t+1})}{U'(C_t)}$ is the discount factor that equals β at the steady state. The capital adjustment cost $AC(i, k)$, debt issuance cost $DIC(B', s')$, and equity issuance cost $EIC(d)$ are defined in the above section.

3.2 Financial Intermediary

The financial intermediary takes the household's savings deposit and lends it to firm producers in the form of risky debt. The debt contract specifies the debt prices from intermediary's break-even condition at the steady state:[25]

$$Q_t^j(z_{i,t}, k_{i,t+1}, B_{i,t+1}, s_{i,t+1}) = \mathbb{E}_t \left[\frac{\Lambda_{t,t+1}}{\Pi_{t+1}} \Big((1 - D_{i,t+1})(1 + c) + D_{i,t+1} \max\{R_{i,t+1}^j, 0\} \Big) \right], \tag{16}$$

where $j = l, b$. The yield on the defaultable debt is defined as $\frac{1+c}{Q_{i,t}^j}$. Therefore, the yield spread between bonds and loans can be computed as

$$\frac{1+c}{Q_{i,t}^b} - \frac{1+c}{Q_{i,t}^l}, \tag{17}$$

The properties of debt prices are discussed in the next section.

3.3 Household

There is a representative household with preferences over consumption C_t and labor supply L_t represented by the expected utility function

$$\mathbb{E}_0 \sum_t^{\infty} \beta^t (logC_t - \Psi L_t),$$

where β is the discount factor and Ψ controls for the disutility of labor supply. The household owns all firms in the economy so they earn a profit share from the producers. The household can also save on risk-free bonds. The consumption-saving decision gives the Euler equation that links the discount factor and the nominal interest rate: $\Lambda_{t,t+1} = \frac{1}{R_t^{nom}/\Pi_{t+1}}$.

[25]Frictions in the intermediary are not discussed in the model for computation simplicity. Differences between bond and loan lenders are reflected in the structure of debt contract. The inclusion of supply-side frictions will further amply the quantitative results.

3.4 The New Keynesian Block

The New Keynesian block of the model consists of a final good producer, intermediate retailers who introduce price rigidity, and a monetary authority who sets the interest rate rule. It generates 1) a New Keynesian Phillips curve relating nominal variables to the real economy and 2) a Taylor rule, which links the monetary policy shock and inflation to the nominal interest rate.

Final good producer There is a representative final good producer who produces the final good Y_t using intermediate goods from all retailers with the production function:

$$Y_t = \left(\int \tilde{y}_{i,t}^{\frac{\gamma-1}{\gamma}} \right)^{\frac{\gamma}{\gamma-1}},$$

where γ is the elasticity of substitution between intermediate goods. The final good producer's profit maximization problem gives the demand curve $\tilde{y}_{i,t} = \left(\frac{\tilde{p}_{i,t}}{P_t}\right)^{-\gamma} Y_t$ where the price index is $P_t = \left(\tilde{p}_{i,t}^{1-\gamma} di\right)^{\frac{1}{1-\gamma}}$. The final good serves as the numeraire in the model.

Intermediate retailers There is a fixed mass of retailers $i \in (0,1)$. Each retailer i produces a differentiated variety $\tilde{y}_{i,t}$ using the undifferentiated good $y_{i,t}$ from heterogeneous firm producers as its only input: $\tilde{y}_{i,t} = y_{i,t}$.

The retailers are monopolistic competitors who set their prices $\tilde{p}_{i,t}$ subject to the demand curve generated by the final good producer and the wholesale price of the input P_t. Retailers pay a quadratic menu cost in terms of final good $\frac{\psi}{2}\left(\frac{\tilde{p}_{i,t}}{\tilde{p}_{i,t-1}} - 1\right)^2 P_t Y_t$ in order to adjust their prices, as in Rotemberg (1982), where Y_t is the final good. The resulting price stickiness comes from the price-setting decisions made by retailers maximizing profits.

$$\pi_{i,t} = (\tilde{p}_{i,t} - p_t)\tilde{y}_{i,t} - \frac{\psi}{2}\left(\frac{\tilde{p}_{i,t}}{\tilde{p}_{i,t-1}} - 1\right)^2 P_t Y_t,$$

The retailer's profit maximization gives the following **New Keynesian Phillips curve**:

$$log\Pi_t = \frac{\gamma - 1}{\psi} log\frac{p_t}{p*} + \beta \mathbb{E}_t log\Pi_{t+1}, \tag{18}$$

where $p* = \frac{\gamma-1}{\gamma}$ is the steady-state wholesale price, or in other words, the marginal cost for retailer firms.

The Phillips curve links the New Keynesian block to the production block through the real wholesale price $p*$ for production firms. If the expectation of future inflation is unchanged, when aggregate demand for the final good Y_t increases, retailers must increase the production of their differentiated goods because of the nominal rigidity. This in turn increases demand for the production goods $y_{i,t}$, which raises the real wholesale price p_t and generates inflation through the Phillips curve.[26]

Inflation dynamics follows[27]

$$\Pi_t = exp\left(\frac{1}{\psi_\pi}\left[log\left(\Pi_{t+1}\frac{U'(C_t)}{U'(C_{t+1})}\right) - \epsilon_t^m\right]\right). \tag{19}$$

Monetary authority The monetary authority sets the nominal risk-free R_t^{nom} according to the log version of a Taylor rule:

$$log(R_t^{nom}) = log\frac{1}{\beta} + \psi_\pi log\Pi_t + \epsilon_t^m, \tag{20}$$

where $\epsilon_t^m \sim N(0, \sigma_m^2)$, Π_t is gross inflation in the final good price, ψ_π is the weight on inflation in the reaction function, and ϵ_t^m is the monetary policy shock.

3.5 Model Equilibrium

The steady-state equilibrium for this economy is given by a set of value functions $V_t(z_{i,t}, k_{i,t}, B_{i,t})$; decision rules $\{k_{i,t+1}, B_{i,t+1}, s_{i,t+1}, l_{i,t}\}$ for capital, total debt, bond share, and labor hiring; a default policy $D_{t+1}(z_{i,t+1}, k_{i,t+1}, B_{i,t+1})$ and a measure of firms $\mu_t(z_t, k_t, B_t)$; a loan and bond price schedule $Q_{i,t}^j(z_{i,t}, k_{i,t+1}, B_{i,t+1}, s_{i,t+1})$; and a set of prices w_t for the wage rate, p_t for the firm output price and $\Lambda_{t,t+1}$ for the discount factor, such that

(i) Given prices, the policy functions $\{k_{i,t+1}, B_{i,t+1}, s_{i,t+1}, l_{i,t}\}$, default policy $D_{t+1}(z_{i,t+1}, k_{i,t+1}, B_{i,t+1})$, and the value function $V_t(z_{i,t}, k_{i,t}, B_{i,t})$ solve the firm's optimization problem;

(ii) Given prices, the household optimizes;

(iii) Lenders price default risk competitively;

(iv) The stationary distribution of firms is consistent with decision rules;

[26] The aggregate demand channel helps to match the credit spread of bonds over loans in equilibrium as a drop in the real wholesale price p_t further reduces firm producers' cash flow.

[27] Following an interest rate hike, wholesale price p_t declines and deflation takes place. It amplifies the short rate effects quantitatively as deflation raises the real debt payment and thus lowers firm cash flow.

(v) The consumption good market, labor market, and corporate debt markets all clear.

4 Model Solution

4.1 Optimal Decisions

In this section, I explore a firm's optimal decisions and their related properties.

4.1.1 Optimal Capital Structure

The price of a risky bond is lower than a senior collateralized loan as compensation for higher expected bankruptcy loss: $Q^b_{i,t}(z_{i,t}, k_{i,t+1}, B_{i,t+1}, s_{i,t+1}) \leq Q^l_{i,t}(z_{i,t}, k_{i,t+1}, B_{i,t+1}, s_{i,t+1})$. This can be easily inferred from the repayment policy. The prices of debt securities are increasing in capital investment and decreasing in the borrowing of risky debt: $\frac{Q^j_{i,t}}{k_{i,t+1}} > 0$, $\frac{Q^j_{i,t}}{B_{i,t+1}} < 0$ and $\frac{Q^j_{i,t}}{s_{i,t+1}} < 0$, where $j = l, b$. Higher current investment leads to higher output and more internal funds, which reduces the firm's default probability and expected bankruptcy loss in the next period. Carrying more (riskier) debt that are less valuable today leads to higher future debt payment. It raises the default probability and expected bankruptcy loss.

Let η_t be the Lagrangian multiplier associated with the collateral constraint. The first-order condition with respect to $k_{i,t+1}$ and $B_{i,t+1}$ are, respectively,

$$
\begin{aligned}
&\left(1 + \lambda_1 \mathbb{1}(d_{i,t} < 0)\right) \left(1 + \frac{\partial AC_{i,t}}{\partial k_{i,t+1}} - \frac{\partial Q^b_{i,t}}{\partial k_{i,t+1}} B_{i,t+1} s_{i,t+1} - \frac{\partial Q^l_{i,t}}{\partial k_{i,t+1}} B_{i,t+1}(1 - s_{i,t+1})\right) - \eta_t \theta (1-\delta) \\
=&\mathbb{E}_t \left[\Lambda_{t,t+1} \left(\alpha(1-\tau) p_{t+1} z_{i,t+1} k^{\alpha-1}_{i,t+1} l^{\nu}_{i,t+1} + \tau\delta + (1-\delta) - \frac{\partial AC_{i,t+1}}{\partial k_{i,t+1}}\right) \left(1 + \lambda_1 \mathbb{1}(d_{i,t+1} < 0)\right) (1 - D_{i,t+1})\right],
\end{aligned}
\tag{21}
$$

and

$$
\begin{aligned}
&\left(1 + \lambda_1 \mathbb{1}(d_{i,t} < 0)\right) \left(\frac{\partial Q^l_{i,t}}{\partial B_{i,t+1}} B_{i,t+1}(1 - s_{i,t+1}) + Q^l_{i,t}(1 - s_{i,t+1}) + \frac{\partial Q^b_{i,t}}{\partial B_{i,t+1}} B_{i,t+1} s_{i,t+1} + Q^b_{i,t} s_{i,t+1} \right. \\
&\left. - \left(\xi_0 + (\xi_1 - \xi_0) s_{i,t+1}\right)\right) - \eta_t (1 - s_{i,t+1})(1 + c) = \mathbb{E}_t \left[\Lambda_{t,t+1} \left(1 + \lambda_1 \mathbb{1}(d_{i,t+1} < 0)\right) \left(\frac{1 + c - \tau c}{\Pi_{t+1}}\right) (1 - D_{i,t+1})\right].
\end{aligned}
\tag{22}
$$

The left-hand side of the equation (21) is the marginal cost of investment, and the right-hand side is the marginal benefit. The marginal capital adjustment cost $\left(1 + \frac{\partial AC_{i,t}}{\partial k_{i,t+1}}\right)$ is augmented by the marginal cost of issuance $(1 + \lambda_1 \mathbb{1}(d_{i,t} < 0))$. More important, one additional unit of capital $k_{i,t+1}$ will reduce the marginal cost through (1) relaxing the collateral constraint $-\eta_t\theta(1-\delta)$ and (2) the price effect $\frac{\partial Q^j_{i,t}}{\partial k_{i,t+1}}$: more investment leads to higher output in the next period and, therefore, a lower default probability. The next-period marginal benefit of this additional unit of capital depends on the marginal benefit of investing in real technology and the reduction in the future marginal cost of equity issuance and default probability due to an increase in retained earnings.

Equation (22) equates the marginal cost of one additional unit of debt with its marginal benefit. The marginal benefit of debt financing is the tax benefit, while the marginal cost is the weighted average of debt borrowing costs (including their issuance costs $\xi_0 + (\xi_1 - \xi_0)s_{i,t+1}$), interest rates charged by the lenders, and constraint risk $\eta_t(1-s_{i,t+1})(1+c)$. The marginal cost is increasing in the marginal issuance cost of equity because firms may need to take on costly external equity financing to repay the debt due next period. The above two equations pin down a firm's optimal capital structure.

4.1.2 Optimal Debt Structure

Firms trade off between the higher intermediation cost of loans and the higher charged interest rate of bonds when choosing the optimal debt composition. Within each period, given $(z_{i,t}, k_{i,t+1}, B_{i,t+1})$, firms choose their optimal debt composition $s_{i,t+1}(z_{i,t}, k_{i,t+1}, B_{i,t+1})$ to maximize the total debt value, subject to a collateral constraint on loan borrowing. The objective function is

$$\begin{aligned} F = &\max_{s_{i,t+1}} \quad Q^l_{i,t}B_{i,t+1}(1-s_{i,t+1}) + Q^b_{i,t}B_{i,t+1}s_{i,t+1} - DIC(B_{i,t+1}, s_{i,t+1}), \\ &s.t \;\; 1 - \frac{\theta(1-\delta)k_{i,t+1}}{B_{i,t+1}(1+c)} \le s_{i,t+1} \le 1. \end{aligned} \tag{23}$$

The lower bound of $s_{i,t+1}$ comes from the collateral constraint. The first-order condition with respect to bond share $s_{i,t+1}$ is

$$\frac{\partial F}{\partial s_{i,t+1}} = \xi_0 - \xi_1 + \left(Q^b_{i,t} - Q^l_{i,t}\right) + \frac{\partial Q^b_{i,t}}{\partial s_{i,t+1}}s_{i,t+1} - \frac{\partial Q^l_{i,t}}{\partial s_{i,t+1}}s_{i,t+1}. \tag{24}$$

Let $s^\star_{i,t+1}$ denote the optimal bond share and $\hat{s}_{t+1}$ be the solution for $\frac{\partial F}{\partial s_{i,t+1}} = 0$.

Proposition 1. *For* $\forall\,(z_{i,t}, k_{i,t+1}, B_{i,t+1})$ *such that* $Q^b_{i,t} \approx Q^l_{i,t}$ *for* $\forall s_{i,t+1}$*, and* $\frac{\partial F}{\partial s_{i,t+1}}|_{s_{i,t+1}=1} > 0$*, then* $s^*_{i,t+1} = 1$

i.e, when firms are charged the similar rates from bond and loan lenders (or the spread between bonds and loans is small enough), firms choose bond debt only.

Proof. See Appendix B. □

Proposition 2. *For* $\forall\,(z_{i,t}, k_{i,t+1}, B_{i,t+1})$ *such that* $Q^b_{i,t} < Q^l_{i,t}$ *for* $\forall s_{i,t+1}$*, and* $\frac{\partial F}{\partial s_{i,t+1}}|_{s_{i,t+1}=1} \leq 0$*,*

$$s^*_{i,t+1} = max\left\{\hat{s}_{t+1}, 1 - \frac{\theta(1-\delta)k_{i,t+1}}{B_{i,t+1}(1+c)}\right\} \leq 1,$$

where $\hat{s}_{t+1} = \frac{(\xi_0-\xi_1)+(Q^b_{i,t}-Q^l_{i,t})}{\frac{\partial Q^l_{i,t}}{\partial \hat{s}_{i,t+1}} - \frac{\partial Q^b_{i,t}}{\partial \hat{s}_{i,t+1}}}$ *such that* $\frac{\partial F}{\partial s_{i,t+1}}|_{s_{i,t+1}=\hat{s}_{t+1}} = 0$*.*

That is, when there is a certain degree of spread between bonds and loans: $\frac{1+c}{Q^b_{i,t}} - \frac{1+c}{Q^l_{i,t}} > 0$*, they choose debt mix financing. The optimal debt composition is*

$$s^*_{i,t+1} = \frac{(\xi_0-\xi_1)+(Q^b_{i,t}-Q^l_{i,t})}{\frac{\partial Q^l_{i,t}}{\partial s^*_{i,t+1}} - \frac{\partial Q^b_{i,t}}{\partial s^*_{i,t+1}}},$$

for financially unconstrained firms (i.e, the collateral constraint is not binding) and

$$s^*_{i,t+1} = 1 - \frac{\theta(1-\delta)k_{i,t+1}}{B_{i,t+1}(1+c)},$$

for financially constrained firms.

Proof. See Appendix B. □

Firms' leverage $\frac{B_{i,t+1}}{k_{i,t+1}}$ and default risk together determine the cross-sectional distribution of debt composition in the steady-state equilibrium. The model predicts that firms prefer debt to equity financing because of the tax benefit and lower issuance costs. Suppose the corporation would like to raise additional funds for investment beyond internal funds in the steady state; in this case, it will use debt first. The total costs of debt include exogenous issuance costs and endogenous interest rates charged by the lenders. In the cross-section, large firms with little default risk always prefer bond financing to avoid costly bank intermediation, as bonds and loans are charged similar interest rates: $\frac{1+c}{Q^b_{i,t}} - \frac{1+c}{Q^l_{i,t}} \approx 0$ (see Proposition 1). They also have an incentive to keep financing flexibility for future economic downturns and stay away from binding constraints because of costly debt issuance. As they take on more debt, they incur a higher interest payment, which lowers retained earnings and leads to higher default risk and a higher credit spread. Firms with a median degree of default risk choose a mix of bonds and loans. Note that for each unit of debt, the higher the bond share, the higher the endogenous interest rate charged but the lower the exogenous intermediation cost paid. The optimal bond share they choose equals the cost of loans to the cost of bonds before they reach the borrowing limit (see Proposition 2). After that, firms seek bond financing again if they need extra funds. Small firms with high default risk resort to equity financing when the credit spread is high enough. They switch to equity financing after they run out of collateral.

4.2 Calibration and Estimation

I study the model solutions and perform a quantitative analysis by means of calibration and estimation. I start with an explanation of the *quarterly* calibration and estimation, followed by discussions on model mechanisms and policy functions. I solve for the steady-state equilibrium via a value function iteration and do transition dynamics following a one-time interest rate shock. Details on the numerical algorithm are included in Appendix C. The quarterly parameter predetermination (calibration) is summarized in Table 5, and the parameter estimation is summarized in Table 7. I take parameter values reported in the literature whenever possible and choose the rest of them to match the data moments from the empirical sample. Estimation of the parameters is achieved by the simulated method of moments (SMM), which minimizes a distance criterion between key moments from the real data and the simulated data. The model is computationally intensive, and therefore only five parameters are estimated, while the remaining parameters are predetermined. Predetermined parameters can be divided into four groups: incumbent (technology, financing, and productivity), new entrant, household's preference, and New Keynesian block.

4.2.1 Calibration

Firm's technology The first block of the table reports the production parameters of the model. I set the capital share $\alpha = 0.21$ to match the average profits, and the labor share $\nu = 0.64$, which gives $\frac{\alpha}{1-\nu} = 0.58$, in line with the evidence in Cooper and Ejarque (2003) and close to the estimate in Li et al. (2016). This implies a total return to scale of 85%. Capital depreciates at a rate $\delta = 10\%$ per year, which is a standard assumption. The capital adjustment parameters ϕ^+ and ϕ^- are calibrated to match the cross-sectional dispersion of investment.

Firm's productivity Persistence ρ_z and conditional volatility σ_z of the idiosyncratic productivity shock are calibrated to match the autocorrelation and cross-sectional dispersion of profitability and leverage.

Firm's financing Firms can issue debt and equity. I set the effective corporate tax rate τ to be 0.3, the same as in Nikolov and Whited (2014). Upon default, bond investors can recover part of the asset value. The senior unsecured bond recovery rate from 1983 to 2017 was 37.74%, as reported in Exhibit 7 of Moody's report. I set the recovery rate to $\chi = 0.38$. The collateral parameter θ is set to be 0.5, following Li et al. (2016).

New entrants (firm life cycle) I assume that new entrants draw their productivity from distribution $N(-m\frac{\sigma^2}{\sqrt{1-\rho^2}}, \frac{\sigma^2}{\sqrt{1-\rho^2}})$, and with an initial level of capital k_0 to be 1 and zero debt. The number of new entrants is chosen to have a constant measure of firms. I set the mean shift of entrants' productivity to $m = 1.2$. k_0, which is set to match the employment share of young firms.

Household's preference The discount factor β is set to be 0.99, which implies a 4% annual real rate. I choose the disutility of labor supply Ψ to generate a steady-state employment rate of 60%.

New Keynesian Block Following Ottonello and Winberry (2020), I set the elasticity of substitution over intermediate goods γ to be 10, implying a steady-state markup of 11%. I set the Rotemberg (1982) price adjustment cost $\varphi = 90$ to generate a Phillips curve slope equal to 0.1 and φ_π, the weight on inflation in the reaction function, to be 1.25, which is in the middle of the range commonly considered in the literature.

[Table 5 Here]

4.2.2 Simulated Method of Moments

The SMM proceeds as follows: a set of data moments Ψ^A is selected for the model to match. For an arbitrary value of θ, the dynamic program is solved and the policy functions are generated. These policy functions are used to compute a simulated data panel. The simulated moments $\Psi^S(\theta)$ are then calculated from the simulated data panel, along with an associated criterion function $\Gamma(\theta)$, where $\Gamma(\theta) = (\Psi^A - \Psi^S(\theta))'W(\Psi^A - \Psi^S(\theta))$, which is a weighted distance between the simulated moments $\Psi^S(\theta)$ and the data moments Ψ^A. The optimal parameter estimate $\hat{\theta}$ is obtained by searching over the parameter space using the annealing algorithm (see Appendix C for more details). The value $\hat{\theta}$ minimizes the criterion function:

$$\hat{\theta} = \text{arg min}_{\theta \in \Theta} (\Psi^A - \Psi^S(\theta))' W (\Psi^A - \Psi^S(\theta)). \tag{25}$$

Here, θ is a vector of five parameters: equity fixed and variable issuance costs λ_0 and λ_1, to match the average frequency of equity issuance and the ratio of new equity issuance to lagged total assets; unit loan issuance cost ξ_0 and unit bond issuance cost ξ_1, to match the average leverage and bond share; and fixed production cost c_f to match the annualized default rate and the credit spread of 10-year Baa corporate bonds.

4.2.3 Simulation

The empirical targets are based on the sample set I use for the empirical evidence above: quarterly Compustat data from 1990Q2 to 2018Q4. To compute the corresponding firm-level moments from the model, I simulate a panel of 10,000 firms for 200 quarters in total, including a 100-quarter burn-in period. The mass of firms is constant over time. I exclude defaulting firms when I calculate the moments.[28] I simulate 50 artificial samples and report the cross-sample average results as model moments in Table 6 and 7. The tables show the cross-simulation averages of the mean and standard deviation of the investment rate, profitability, and leverage, autocorrelation of leverage, frequency of new equity issuance, ratio of average equity issuance to total assets, credit spreads, and average bond ratio.

[Table 6 and 7 Here]

4.3 Value and policy functions

Figure 5 shows the optimal value and policies of firms with average productivity and debt under high rate and low rate economies.[29] It plots the value of equity (top left panel), investment rate (top right panel), (total) debt issuance rate (bottom left panel), and the price of the (defaultable) bond (bottom right panel). Each line in the figure corresponds to the economy with a specific interest rate. The solid blue line refers to the economy in a

[28] I also exclude firms that are less than two years old when I calculate the sample autocorrelation of leverage.

[29] Figure 5 shows the optimal value and policy functions of a partial equilibrium model in which the discount factor follows an AR(1) process, and therefore the interest rate is a state variable. The details of the partial equilibrium model can be found in Appendix B.

good state (low rate), and the dashed red line refers to the economy in a bad state (high rate).

The equity value is increasing in its capital stock while the investment rate declines. Conditional on capital, firms in a good state have a higher firm value and investment rate relative to firms in a bad state. The total debt issuance rate increases in the capital stock when the firm is small and lacks internal funds. Firms issue more debt when the interest rate is high. The total debt issuance decreases in the capital stock when a firm is large. Firms issue more debt in a good state because debt becomes more valuable as a result of lower default risk and, therefore, higher prices. Conditional on firms' idiosyncratic state, the overall cost of investment is lower, and investment opportunities become more profitable in a good state.

5 Quantitative Analysis

5.1 Cross-sectional Debt Composition

To begin, I provide steady-state cross-sectional evidence to validate the model. I show that the cross-sectional unconditional distribution of leverage, the distribution of loan share across firm size, and the life-cycle dynamics of firms implied from this model are in line with the key features of the data emphasized by the firm dynamics literature.

Unconditional distribution. Panel A in Table 8 shows the unconditional distributions of leverage in the model and the data. I report the mean and the 5^{th}, 25^{th}, 75^{th}, and 95^{th} percentiles across firms. The model generates a reasonable cross-sectional leverage distribution with estimated percentiles close to those in the data, even though the model generates a relatively lower leverage ratio, 0.571 at the 95^{th} percentile, compared to 0.645 in the data.

Size. Size is a key dimension of firm heterogeneity. Figure 6 shows how the loan ratio covaries with firm size in the data and the model. Size is measured as lagged total assets. I sort loan shares by size quintiles. The data are shown in the red bars. The black bars show the corresponding values implied from the model. As in the data, the model is able to generate a hump-shaped distribution in the loan ratio.

Life-cycle dynamics. The initial value of capital that new entrants carry is calibrated to match the employment share of young firms (firms less than 1 year old) in the data. Panel B in Table 8 shows the untargeted employment share of firms in different age groups. In the data, the share of employment in firms less than 1 year old, between 1 and 10 years, and over 10 years are 0.02, 0.21, and 0.76, respectively.[30] Since the data sample covers 115 quarters in total, I only consider firms that are no older than 30 years in the simulated sample. The corresponding moments implied from the model are 0.015, 0.268, and 0.717.

Cross-sectional determinants of debt structure. The previous literature has established some stylized facts about the cross-sectional determinants of choice between loans and bonds. Johnson (1997) find that reliance on bank borrowing is decreasing in firm size and overall leverage. Denis and Mihov (2003) show that the primary determinant of firms' choice of debt instruments is their credit quality. Public borrowers are larger and more profitable, have a higher proportion of fixed assets to total assets, and have higher credit ratings relative to firms that borrow from either banks or non-bank private lenders. Table 9 examines the model-implied cross-sectional distribution of debt structure in the following regression test:

$$\text{Loan Share}_{i,t} = \alpha_i + \Gamma' X_{i,t} + \epsilon_{i,t}, \tag{26}$$

where Loan Share is defined as the ratio of loans over the total of loans and bonds. The expression $X_{i,t}$ is a set of firm characteristics, including leverage, a dummy for credit rating, profitability, size, tangibility, and market-to-book value. The dummy for credit rating takes the value of one if the credit spread is zero and takes the value of zero if the credit spread is positive. The correlation between leverage and size, leverage, and tangibility are -0.23 and -0.89. Columns (1) to (5) report the univariate regression where the firm-level loan share is decreasing in firm leverage, credit rating, market-to-book value, and profitability but increasing in tangibility, consistent with the facts documented from the data.

5.2 Capital, Debt Structure Dynamics, and Interest Rate Risk

As documented in the empirical part of the paper, large firms switch towards loan financing, while small firms raise more equity after the tightening of monetary policy. The objective of this subsection is to show how the model can reproduce these empirical patterns with credit market frictions and risk prices of aggregate shocks.

I now quantitatively analyze the effect of monetary shock ϵ_t^m. The economy is initially at the steady state and unexpectedly receives a $\epsilon_0^m = 0.0025$ innovation to the Taylor rule,

[30]Data are from Ottonello and Winberry (2020).

which reverts to 0 according to $\epsilon^m_{t+1} = \rho_m \epsilon^m_t$ with $\rho_m = 0.5$. I compute the perfect foresight transition path of the economy as it converges back to the steady state. To compare our model to the data, I simulate a panel of 10,000 firms in response to a monetary shock and estimate the baseline empirical specification using simulated data.[31] I assume that the high-frequency shocks ϵ^m_t that we measure in the data are innovations to the Taylor rule in the model. I estimate the regressions using data from 1 year before the shock to 12 years after the shock.

Model predictions are generally consistent with what we observe in the data. The panel regression results are shown in Table 10, which reports the average effect on the credit spread and the heterogeneous effects on the loan share and equity share. Column (3) of Table 10 shows that the spread between bonds and loans widens as the interest rate increases. This is because loan lenders have lower risk exposure due to seniority and collateral requirement. The expected loss of bond lenders increases more. It is costly to cut down investment, which generates countercyclical demands for external financing despite higher interest rates. As a result, large, less risky firms with ample unused collateral substitute loans for bonds. Firms with a median degree of default risk choose a higher loan share. Small, constrained firms have to raise more equity as they run out of collateral. The positive estimate of the loan share elasticity in column (1) and the negative estimate of the equity share elasticity in column (2) confirm the heterogeneous financing patterns.

5.3 Inspecting the Mechanism

This section performs the counterfactual analysis of key parameters that determine the loan-bond trade-off and substitution elasticity. I use simulated data as a laboratory to examine how the production fixed cost, debt, and equity issuance costs quantitatively affect the substitution between loans and bonds. Table 11 shows the key model moments from various model specifications. I compare the baseline model with (1) a model with an equal debt issuance cost for loans and bonds, (2) a model with the production fixed cost increased by 10%, and (3) a model with the variable equity issuance cost reduced by one-half.

In model (1) when intermediation costs are set the same for both loans and bonds,

[31] In the model, I use a time fixed effect rather than a sector-time fixed effect because the model does not contain multiple sectors. In addition, I do not include the subset of control variables $Z_{i,t-1}$, which are outside the model.

firms always prefer loans until they are constrained. This leads to a counterfactually very low bond share of 7% in the economy, compared to 76% in the data. The sensitivity of substitution (the coefficient of the interaction term between monetary shocks and firm size) declined by one-third, compared to the baseline model, due to less loan financing flexibility. In model (2), a 10% increase in the production fixed cost raises the default probability and bond spread by 60% and 37%, compared to the baseline model. The economy has lower leverage of 9%, compared to 21% in the data sample. The low leverage raises the substitution elasticity by one-half due to more financing flexibility. In model (3), a one-half reduction in equity issuance costs leads to a 10% drop in the leverage, a 3% drop in the bond share, as well as a 20% rise in equity financing. The elasticity of substitution becomes insignificant and close to zero since firms rely more on equity financing.

5.4 Model Implications

This section studies the model implications on credit flows and corporate investment. First, I document a heterogeneous effect of monetary shocks on firm investment. Second, I investigate the responses of key aggregate variables to monetary shocks.

5.4.1 Real Effect: Investment

In the model, the expanding demands for loan financing among large firms crowd out the bank credit to small, bank-dependent firms as a result of the finite debt supply. Therefore, constrained, bank-dependent firms have to disproportionately reduce investment after tight money. This suggests that debt composition is an important factor in determining investment elasticity: the firm with a higher loan share (less unused collateral) is more responsive. Here, I revisit this finding in the real and simulated data following the regression specification:

$$\Delta log k_{i,t+1} = \alpha_i + \lambda_{s,q} + \gamma\epsilon_t^m + \beta\epsilon_t^m \times \text{Loan Share}_{i,t-1} + \delta \text{Loan Share}_{i,t-1} + \Gamma_1' Z_{i,t-1} + \Gamma_2' Y_{t-1} + \epsilon_{i,t}. \tag{27}$$

The results are shown in Table 12. In column (1), -0.137 indicates that a 25 basis points interest rate hike reduces the average investment rate by 0.38%, compared to an average quarterly change in capital of 1.46%. The coefficient estimate of the interaction term is negatively significant at -0.130, which means that small, bank-dependent firms are more responsive to monetary shocks, as they are lack of unused collateral to hedge against interest rate risk. Column (2) shows consistent results using simulated data from the model.

5.4.2 Aggregate Implications

To understand the role of credit substitution in the transmission mechanism of monetary policy, Figure 7 plots the impulse responses of key aggregate variables to a 25 basis points interest rate hike. A positive shock to the nominal rate lowers the inflation rate as a result of sticky prices and therefore generates a larger increase in the real rate. The high rate depresses the investment demand by raising the cost of capital. It also depresses consumption demand from the household as a result of the standard intertemporal substitution. Overall, it reduces consumption by 0.37%, output by 1.4%, capital by 0.32%, and total debt by 1.55%. In addition, this model quantitatively reverses the traditional bank lending channel by generating a short-run expansion, 5% in five quarters, in bank loans, accompanied by a contraction, 1.9% in five quarters, in corporate bonds. A 25 basis points nominal rate hike leads to a 2.25% decline in the bond share.

6 Discussion

6.1 Revolver Lines of Credit versus Term Loans

I now inquire how revolvers or term loans change in response to interest rate risk. I follow Berg et al. (2016) in classifying loan facilities as term loans or revolver lines of credit.[32] The full sample consists of 71% revolving credit facilities and 29% term loans. Figure A.6 plots the credit distribution across firm size for credit lines and term loans separately. Most of the loan credit is issued to large firms with total assets over 1 billion. On average, term loans have a longer maturity than credit lines, which is independent of borrowers' size. In Table A.13, I perform the subsample analysis of credit lines or term loans. In panel A, firms switch to credit lines more than term loans, which is both statistically and economically more significant. In panel B, a significant increase in the average loan spread

[32] I only include credit lines and term loans in the final sample. Term loans are defined as all loans with type "Term Loan," "Term Loan A"-,"Term Loan H," or "Delay Draw Term Loan," as indicated in the facility table in DealScan. Revolving loans are defined as all loans with type "Revolver/Line $<$ 1 Yr.," "Revolver/Line $\geq$ 1 Yr.," "364-Day Facility," "Limited Line," or "Revolver/Term Loan," as indicated in the facility table in DealScan.

for credit lines suggests an increase in demand for credit lines, which is consistent with the results in panel A.

6.2 Supply-side effects

Financial frictions, market power, and bank regulation affect transmission of monetary policy. The bank reserve channel argues that a high federal funds rate raises the opportunity cost of holding reserves, thus contracting deposit creation. The bank capital channel shows that a high federal funds rate reduces bank capital because of a balance-sheet maturity mismatch and thus constrains banks' capacity to lend. The effects of bank market power are different in the deposit and loan markets. In a high rate environment, the deposit market power channel predicts that banks charge higher markups on deposits, thus leading to a further contraction in deposits and loans, while the loan market power channel predicts the opposite: banks reduce markups on loan rates to mitigate the effects of monetary tightening on loan demand (Scharfstein and Sunderam (2016)).

To control for the supply-side effect, I merge the final sample with lenders' balance sheet variables from FR Y9-C.[33] Bank characteristics, such as size, capital ratio, cost of funding, return to equity and ratio of non-performing loan, and bank-time fixed effect, are included to control for the supply-side effect. Errors are clustered over bank k, firm i, and time t. The estimates of the following test are reported in Table A.14:

$$\begin{aligned} y_{j,i,k,t} =& \alpha_{k,t} + \gamma\epsilon_t^m + \beta\epsilon_t^m \times (X_{i,t-1} - \mathbb{E}_i(X_{i,t-1})) + \delta(X_{i,t-1} - \mathbb{E}_i(X_{i,t-1})) \\ &+ \Gamma_1' Z_{i,t-1} + \Gamma_2' W_{j,i,k,t-1} + \Gamma_3' Y_{k,t-1} + \epsilon_{j,i,k,t}, \end{aligned} \tag{28}$$

where $Z_{i,t-1}$ is a set of firm controls, $W_{j,i,k,t-1}$ is a set of security controls, and $Y_{k,t-1}$ is a set of bank controls. The term $y_{j,i,k,t}$ is the total issuance amount from lender j to borrower i in quarter t, adjusted by banks' lagged total business loan in columns (1) to (3) or log(Loan Spread) in columns (4) to (6). It shows similar results: the increase in loan lending and loan spreads is more significant among large, high-rated firms with lower default risk.

[33] I only consider bank holding companies (BHCs) of U.S. banks that have issued over 50 loans in the sample periods.

6.3 Related to trade-off theory and MM theorem

The interest rate implications of the trade-off theory are often ignored in the literature. Graham and Leary (2011), Strebulaev et al. (2012), Ai et al. (2020a), and Colla et al. (2020) provide good surveys of the capital structure and trade-off theory. This model discusses the trade-offs among a number of securities that can be used to finance endogenous investment. In the stationary equilibrium, beyond operating cash flows generated from production, the firm has the opportunity each period to take on new loans and bonds, as well as equity issuance. How does this model break the irrelevance theorem stated in Modigliani and Miller (1959)? The tax advantage of debt creates an incentive for leverage. As in the literature, bankruptcy incurs a liquidation cost, so full payment is not guaranteed for debt lenders. Firms face a borrowing limit on loans imposed by the collateral constraint. Finally, external financing incurs issuance costs for both debt and equity. All of these features create a deviation from the capital structure irrelevance.

7 Conclusion

In this paper, I argue that the countercyclical demand for loan financing among large firms is crucial in understanding the transmission of monetary policy. Using cross-sectional data, I document the new facts that large, unconstrained firms substitute away from corporate bonds and toward bank loans as interest rate hikes widen the credit spread between bonds and loans. This crowds out bank lending to small, constrained firms. As a result, small firms have to issue more new equity while disproportionally reducing their investment. Moreover, this cross-sectional pattern has important aggregate implications, worsening the drop in capital investment and consumption following tight money, despite increasing the aggregate flow of business loans.

The findings in this paper generate important policy implications, as a strong demand-side effect overturns the supply-side channel, as emphasized in the traditional bank lending channel. This paper suggests that to mitigate credit misallocation after tight money, the optimal regulation policy is to provide easier bank credit access to small firms at a lower cost and, at the same time, prevent credit from being overdrawn among large firms. It sheds light on the intermediated debt market regulations that the central bank should implement when conducting monetary policy. Moreover, the discussions about firms' financing flexibility and the relevant policy interventions can be extended to other severe crises, such as the COVID-19 crisis, in future academic and policy research.

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Table 1: Summary Statistics

Table 1 reports the summary statistics of key variables. Panel A presents the summary statistics of monetary policy shocks and aggregate corporate debt series from 1990Q2 to 2018Q4. Monetary policy shocks are estimated using an event study strategy. There are 76 daily contractionary shocks and 112 expansionary shocks in the sample. Aggregate nonfinancial corporate debt series are obtained from the Flow of Funds L.103. Panel B presents the summary statistics of loan origination data from DealScan and bond issuance data from FISD. Key variables of firm borrowers by their debt compositions are shown in panel C.

Variable	Mean	Median	Std Dev	Min	Max	N
Panel A: Aggregate Time Series of Monetary Policy Shocks and Corporate Debt						
Fed Funds Rate (High Freq; %)	-0.0155	0	0.0759	-0.467	0.163	255
Policy News Shocks (High Freq; %)	0.0004	0.0068	0.0403	-0.243	0.0986	200
Fed Funds Rate (Quarterly; %)	-0.0346	-0.0061	0.0906	-0.428	0.237	115
Policy News Shocks (Quarterly; %)	0.0002	0.0105	0.0503	-0.292	0.0873	95
Target Component (Quarterly; %)	-0.0003	0.0152	0.0574	- 0.239	0.101	59
Path Component (Quarterly; %)	0.00001	0.0007	0.006	-0.015	0.014	59
Loan/Total Debt	0.148	0.121	0.046	0.075	0.236	115
Bond/Total Debt	0.518	0.502	0.056	0.386	0.611	115
Loan Growth (%)	-0.078	0.381	3.583	-11.999	8.795	115
Bond Growth (%)	0.925	0.864	1.275	-1.803	4.328	115

To be continued

Variable	Mean	Median	Std Dev	25%	75%	N
Panel B: Corporate Debt						
Bank Loan from Dealscan (All Compustat firms)						
Loan Rate (bp)	489.12	469.00	231.20	290.78	668.75	24,686
"All-in-drawn" (bp)	191.37	175	127.16	100	250	25,479
Facility Amount (Million)	430.95	180	841.41	58.40	500	25,479
Maturity (Year)	4.16	5	1.80	3	5	24,866
Corporate Bond from FISD (All Compustat firms)						
Offering Yield (bp)	652.89	665.00	242.54	495.26	803.50	12,468
Spread (bp)	182.91	116.31	189.28	43.97	272.84	12,456
Offering Amount (Million)	414.04	300	454.67	100	500	12,468
Maturity (Year)	11.14	10.01	7.65	7.01	10.11	12,468
Bank Loan from Dealscan (Firms have access to both debt markets)						
Loan Rate (bp)	468.59	440.26	228.71	273.43	637.50	14,854
"All-in-drawn" (bp)	180.03	160	127.87	87.50	250	15,322
Facility Amount (Million)	584.60	290.23	1015.98	100	650	15,322
Maturity (Year)	4.25	5.00	1.85	3	5	14,977
Corporate Bond from FISD (Firms have access to both debt markets)						
Offering Yield (bp)	653.06	665.00	240.49	498.32	802	12,168
Spread (bp)	181.11	115.59	187.63	43.70	266.70	12,157
Offering Amount (Million)	411.50	300	452.56	100	500	12,168
Maturity (Year)	11.17	10.01	7.67	7.01	10.12	12,168

To be continued

Variable	Mean	Median	Std Dev	25%	75%	N
Panel C: Firm Variables						
Dependent Variables						
Prob(New Loan Issuance) (%)	4.91	0	0.22	0	0	418,728
∆Loan Share (%)	5.79	0	5.94	-0.99	1.03	260,175
Prob(New Equity Issuance) (%)	6.63	0	24.88	0	0	418,728
∆Equity Share (%)	1.08	0.70	10.18	-1.33	2.47	410,582
Control Variables						
Bank Debt =“No”, Public Debt =“No”; 4,358 Firms						
Size	3.84	3.76	1.50	2.75	4.83	146,223
Market-to-Book	2.24	1.44	2.26	0.88	2.68	136,452
Leverage	0.18	0.08	0.23	0.00	0.27	144,241
Investment Rate	0.05	0.02	0.13	-0.00	0.06	143,825
Sales Growth	0.02	0.02	0.40	-0.10	0.14	142,142
Liquidity	0.30	0.22	0.27	0.06	0.49	146,084
Tangibility	0.37	0.35	0.22	0.19	0.52	143,414
Dividend (dummy)	0.09	0.00	0.28	0.00	0.00	150,443
Bank Debt = “No”, Public Debt = “Yes”; 200 Firms						
Size	6.68	6.64	1.89	5.25	7.86	7,305
Market-to-Book	1.77	1.20	1.53	0.85	2.08	6,630
Leverage	0.35	0.31	0.28	0.15	0.51	7,196
Investment Rate	0.05	0.03	0.11	0.01	0.06	7,170
Sales Growth	0.02	0.02	0.24	-0.06	0.10	7,165
Liquidity	0.19	0.11	0.21	0.03	0.29	7,301
Tangibility	0.40	0.42	0.20	0.25	0.54	7,081
Dividend (dummy)	0.16	0.00	0.36	0.00	0.00	7,454
Bank Debt = “Yes”, Public Debt =“No”; 2,862 Firms						
Size	5.29	5.28	1.52	4.23	6.30	146,727
Market-to-Book	1.58	1.16	1.28	0.80	1.87	138,477
Leverage	0.21	0.17	0.21	0.04	0.33	144,505
Investment Rate	0.05	0.03	0.10	0.01	0.06	145,105
Sales Growth	0.02	0.02	0.23	-0.06	0.10	144,306
Liquidity	0.14	0.07	0.17	0.02	0.21	146,659
Tangibility	0.47	0.47	0.21	0.32	0.60	143,763
Dividend (dummy)	0.07	0.00	0.26	0.00	0.00	149,207
Bank Debt = “Yes”, Public Debt = “Yes”; 1,651 Firms						
Size	7.45	7.42	1.66	6.38	8.52	110,380
Market-to-Book	1.46	1.15	1.00	0.85	1.70	104,359
Leverage	0.32	0.29	0.22	0.17	0.43	108,859
Investment Rate	0.05	0.03	0.08	0.02	0.06	109,239
Sales Growth	0.02	0.02	0.18	-0.05	0.09	109,146
Liquidity	0.10	0.05	0.12	0.02	0.12	110,250
Tangibility	0.45	0.45	0.20	0.32	0.56	107,131
Dividend (dummy)	0.12	0.00	0.33	0.00	0.00	111,624

Table 2: Debt Financing Decision to Monetary Shocks

This table reports firms' differential debt financing decisions in response to monetary shocks in quarter t. Coefficients are estimated from the following regressions.

$$\begin{aligned} y_{i,t} =& \alpha_i + \lambda_{s,q} + \gamma\epsilon_t^m + \beta\epsilon_t^m \times (X_{i,t-1} - \mathbb{E}_i(X_{i,t-1})) + \eta\Delta GDP_t \times (X_{i,t-1} - \mathbb{E}_i(X_{i,t-1})) \\ &+ \delta(X_{i,t-1} - \mathbb{E}_i(X_{i,t-1})) + \Gamma_1' Z_{i,t-1} + \Gamma_2' Y_{t-1} + \epsilon_{i,t}. \end{aligned}$$

Columns (1) to (4) report debt financing decisions on the extensive margin, where the *dependent variable* is a dummy equal to one if the firm chooses bank loans over corporate bonds in quarter t. Columns (5) to (8) report debt financing decisions on the intensive margin, where the *dependent variable* is the change in flow of loans: Δlog(Loan) in quarter t. ϵ_t^m is the monetary shock, and $X_{i,t-1}$ is firm size, credit rating, or distance to default (D2D) in the previous quarter. $Z_{i,t-1}$ is a set of additional firm control variables including market-to-book ratio, liquidity, tangibility, leverage, and a dummy for dividend payout. Y_{t-1} is a set of macroeconomic variables including four lags of GDP growth and inflation rate. Monetary shocks and firm control variables are standardized. The sample covers periods from 1990Q2 to 2018Q4 (excluding the financial crisis from 2008Q3 to 2009Q2). The firm and sector-quarter fixed effects are indicated in the table. Standard errors are heteroskedasticity-robust and clustered at the firm level, and *t*-statistics are in parentheses. All firm-level variables are winsorized at the 1% level. $^*p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Prob(Borrow from bank) (Extensive)				Δlog(Loan) (Intensive)			
ϵ_t^m	0.014***	0.014***	-0.007	0.018***	0.275***	0.236***	0.148*	0.259***
	(3.130)	(3.189)	(-0.965)	(3.953)	(3.332)	(2.804)	(1.672)	(3.058)
$\epsilon_t^m \times$ Size		0.007*				0.164**		
		(1.699)				(2.211)		
$\epsilon_t^m \times \mathbb{1}$(Invest. Grade)			0.034***				0.426**	
			(3.681)				(2.036)	
$\epsilon_t^m \times$ D2D				0.018***				0.244***
				(3.726)				(2.936)
Observations	11850	11850	11850	11850	184939	184939	184939	184939
R^2	0.400	0.400	0.401	0.401	0.094	0.094	0.094	0.095
Firm & Aggregate controls	Y	Y	Y	Y	Y	Y	Y	Y
Firm FE	Y	Y	Y	Y	Y	Y	Y	Y
Sector-Quarter FE	Y	Y	Y	Y	Y	Y	Y	Y

Table 3: Equity Financing Decision to Monetary Shocks

This table reports firms' differential equity financing decisions in response to monetary shocks in quarter t. Coefficients are estimated from the following regressions:

$$
\begin{aligned}
y_{i,t} =&\alpha_i + \lambda_{s,q} + \gamma\epsilon_t^m + \beta\epsilon_t^m \times (X_{i,t-1} - \mathbb{E}_i(X_{i,t-1})) + \eta\Delta GDP_t \times (X_{i,t-1} - \mathbb{E}_i(X_{i,t-1})) \\
&+\delta(X_{i,t-1} - \mathbb{E}_i(X_{i,t-1})) + \Gamma_1' Z_{i,t-1} + \Gamma_2' Y_{t-1} + \epsilon_{i,t}.
\end{aligned}
$$

Columns (1) to (4) report equity financing decisions on the extensive margin, where the *dependent variable* is a dummy equal to one if the firm issues new equity in quarter t. Columns (5) to (8) report equity financing decisions on the intensive margin, where the *dependent variable* is the change of equity in quarter t over lagged total asset. ϵ_t^m is the monetary shock, and $X_{i,t-1}$ is firm size, credit rating, or distance to default (D2D) in the previous quarter. $Z_{i,t-1}$ is a set of additional firm control variables including market-to-book ratio, liquidity, tangibility, leverage, and a dummy for dividend payout. Y_{t-1} is a set of macroeconomic variables including four lags of GDP growth and inflation rate. Monetary shocks and firm control variables are standardized. The sample covers periods from 1990Q2 to 2018Q4 (excluding the financial crisis from 2008Q3 to 2009Q2). The firm and sector-quarter fixed effects are indicated in the table. Standard errors are heteroskedasticity-robust and clustered at the firm level, and *t*-statistics are in parentheses. All firm-level variables are winsorized at the 1% level. $^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Prob(Net new issuance) (Extensive)				ΔEquity share (Intensive)			
ϵ_t^m	0.215***	0.213***	0.203***	0.160***	0.124***	0.108***	0.111***	0.087***
	(4.469)	(4.393)	(3.785)	(3.014)	(6.322)	(5.386)	(4.976)	(4.420)
$\epsilon_t^m \times$ Size		-0.119**				-0.069***		
		(-2.307)				(-3.144)		
$\epsilon_t^m \times \mathbb{1}$(Invest. Grade)			0.105				-0.045	
			(0.955)				(-1.371)	
$\epsilon_t^m \times$ D2D				0.001				-0.125***
				(0.031)				(-6.520)
Observations	298562	298562	298562	241825	241814	241814	241814	241814
R^2	0.141	0.141	0.141	0.149	0.133	0.134	0.133	0.134
Firm & Aggregate controls	Y	Y	Y	Y	Y	Y	Y	Y
Firm FE	Y	Y	Y	Y	Y	Y	Y	Y
Sector-Quarter FE	Y	Y	Y	Y	Y	Y	Y	Y

Table 4: The Effect of Monetary Shocks on Credit Spreads

This table reports the impact of monetary shocks on debt prices. Coefficients are estimated from the following regressions:

$$\begin{aligned} Credit\ Spread_{j,i,t} =& \alpha_i + \lambda_{s,q} + \gamma\epsilon_t^m + \beta\epsilon_t^m \times (X_{i,t-1} - \mathbb{E}_i(X_{i,t-1})) + \eta\Delta GDP_t \times (X_{i,t-1} - \mathbb{E}_i(X_{i,t-1})) \\ &+ \delta(X_{i,t-1} - \mathbb{E}_i(X_{i,t-1})) + \Gamma_1' Z_{i,t-1} + \Gamma_2' W_{j,i,t-1} + \Gamma_3' Y_{t-1} + \epsilon_{j,i,t}. \end{aligned}$$

Columns (1) to (4) report the results of loan spreads ("All-In-Drawn"), which is defined as the difference between the loan rate and the three-month LIBOR. Columns (5) to (8) (columns (9) to (12)) report the results of bond spreads, which is defined as the difference between the offering yield and three-month LIBOR (maturity-matched interest rate swaps). Column (13) report the results of the pooled sample of loans and bonds. ϵ_t^m is the monetary shock, and $X_{i,t-1}$ is the firm size, credit rating, or distance to default in the previous quarter. $Z_{i,t-1}$ is a set of additional firm control variables including market-to-book ratio, liquidity, tangibility, leverage, and a dummy for dividend payout. $W_{j,t-1}$ is a set of debt characteristics including the logarithm of borrowing amount and maturity. Y_{t-1} is a set of macroeconomic variables including four lags of GDP growth. Monetary shocks and firm control variables are standardized. The sample covers periods from 1990Q2 to 2018Q4 (excluding the financial crisis from 2008Q3 to 2009Q2). The firm and sector-quarter fixed effects are indicated in the table. Standard errors are heteroskedasticity-robust and clustered at the firm level, and t-statistics are in parentheses. All firm-level variables are winsorized at the 1% level. $^*p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
	Separated Sample												Pooled Sample
	Loan Spread				Bond Spread (3M LIBOR)				Bond Spread (Swaps)				Credit Spread
ϵ_t^m	0.039***	0.044***	0.041***	0.048***	0.188***	0.197***	0.188**	0.199***	0.077***	0.086***	0.055	0.086***	0.035***
	(4.898)	(5.332)	(3.538)	(6.014)	(6.758)	(6.651)	(2.199)	(7.096)	(4.031)	(4.325)	(0.942)	(4.576)	(3.042)
$\epsilon_t^m \times$ Size		-0.003				-0.005				-0.006			
		(-0.374)				(-0.217)				(-0.376)			
$\epsilon_t^m \times \mathbb{1}$(Invest. Grade)			0.008				-0.019				0.005		
			(0.562)				(-0.217)				(0.089)		
$\epsilon_t^m \times$ D2D				0.020*				0.029				0.012	
				(1.940)				(1.198)				(0.649)	
$\epsilon_t^m \times \mathbb{1}$(Bond)													0.096***
													(3.982)
Observations	17429	17429	17429	17429	9982	9982	9854	9982	10078	10078	9949	10078	27616
R^2	0.711	0.712	0.712	0.712	0.595	0.596	0.607	0.597	0.697	0.699	0.713	0.698	0.600
Firm & Aggregate controls	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Firm FE	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Sector-Quarter FE	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y

Table 5: Predetermined (Calibrated) Parameters for Baseline Model (Quarterly)

This table summarizes the predetermined calibrated parameters used to solve and simulate the model. All values are quarterly.

Description	Parameter	Value	Target Moment/Source
Panel A: Household			
Discount factor	β	0.99	Annual interest rate (4%)
Labor disutility	Ψ	1.148	Steady state employment rate (60%)
Panel B: Firm Producer			
Technology			
Capital coefficient	α	0.21	Predetermined calibrated
Labor coefficient	ν	0.64	Total returns to scale of 85%
Depreciation	δ	0.025	10% annual depreciation rate (BEA)
Capital adjustment cost	ϕ (ϕ^+/ϕ^-)	0.1/6	Predetermined calibrated
Productivity			
Productivity persistency	ρ_z	0.90	Predetermined calibrated
Productivity volatility	σ_z	0.12	Predetermined calibrated
Financing			
Corporate income tax	τ	0.3	Nikolov and Whited (2014)
Collateralized value	θ	0.5	Li et al. (2016)
Coupon payment	c	0.01	Standard
Liquidation recovery value	χ	0.38	Moody's Recovery Database
Panel C: New Entrants			
Initial capital	k_0	1	Predetermined calibrated
Initial debt	b_0	0	Standard
Initial productivity mean	m	-1.2	Predetermined calibrated
Panel D: New Keynesian Block			
Demand elasticity	γ	10	Steady state markup (11%); labor share (58%)
Taylor rule coefficient	φ_π	1.25	Ottonello and Winberry (2020)
Price adjustment cost	φ	90	Phillips Curve slope (0.1)
Persistence of monetary shock	ρ_m	0.5	Ottonello and Winberry (2020)

Table 6: Predetermined (Calibrated) Parameters and Model Fit

This table reports moments generated by the model. I simulate 50 economies for 100 quarters. Each sample consists of 10,000 firms. This table shows cross-simulation averages. The data are from quarterly CRSP-Compustat files covering periods from 1990Q2 to 2018Q4.

Description	Parameter	Value	Target Moments	Data	Model
Capital depreciation rate	δ	0.025	Mean of investment rate	0.045	0.028
Capital adjustment cost	$\phi\ (\phi^{+}/\phi^{-})$	0.1/6	Stdev of investment rate	0.083	0.088
Capital coefficient	α	0.21	Mean of profitability	0.018	0.019
Productivity volatility	σ_z	0.12	Stdev of profitability	0.051	0.033
Productivity persistency	ρ_z	0.90	Autocorrelation of leverage	0.896	0.908

Table 7: Estimated Parameters θ and Moments

This table reports the parameter estimates by simulated method of moments and the matched moments from both the data and the model. I simulate 50 economies for 100 quarters. Each sample consists of 10,000 firms. This table shows cross-simulation averages. The data are from the quarterly CRSP-Compustat file covering periods from 1990Q2 to 2018Q4. Data for the bond share are measured using the aggregate corporate debt data of the nonfinancial corporate sector from Flow of Funds L.103. Data for bond spreads are from FISD.

Parameters	Value	Std Error
ξ_0	0.00711	(0.0005)
ξ_1	0.00662	(0.0002)
λ_0	0.3021	(0.0256)
λ_1	0.1000	(0.0281)
c_f	0.0971	(0.0005)

Moments	$\mathbb{E}\left(\text{Leverage}\right)$	$\mathbb{E}\left(\frac{\text{Bond}}{\text{Total Debt}}\right)$	$\mathbb{E}\left(\frac{\text{Equity}}{\text{Asset}}\right)$	Prob(Equity)	Credit Spread	Prob(default)
Model	0.204	0.789	0.075	0.113	1.60%	3.08%
Data	0.222	0.760	0.094	0.067	1.78%	3.00%

Table 8: Cross-sectional Leverage Distribution and Firm Life-cycle Patterns

This table reports the cross-sectional and life-cycle patterns of firms in the data and the model. Panel A reports the unconditional distribution of leverage: the 5^{th}, 25^{th}, mean, 75^{th}, and 95^{th} percentiles. Panel B reports the employment share of firms: less than 1 year old, between 1 and 10 years, and over 10 years.

Panel A: Unconditional Leverage Distribution

	5^{th}	25^{th}	Mean	75^{th}	95^{th}
Data	0	0.029	0.223	0.348	0.645
Model	0	0.006	0.204	0.365	0.571

Panel B: Life-cycle Pattern (Employment share)

	N_1	N_{1-10}	N_{10}
Data	0.02	0.21	0.76
Model	0.015	0.268	0.717

Table 9: Cross-sectional determinants of debt structure (Simulation)

This table reports the cross-sectional determinants of the debt structure using the simulated data of 10,000 firms from the estimated model. The coefficient estimates are obtained from the following regression:

$$\text{Loan Share}_{i,t} = \alpha_i + \Gamma' X_{i,t} + \epsilon_{i,t},$$

where loan share is defined as the ratio of loans over the total amount of loans and bonds. $X_{i,t}$ is a set of firm characteristics including leverage, a dummy for credit rating, profitability, and tangibility. The dummy for credit rating takes the value of one if the credit spread is zero and takes the value of zero if the credit spread is positive. The firm fixed effect is indicated in the table. Standard errors are heteroskedasticity-robust and clustered at the firm level, and t-statistics are in parentheses. All firm-level variables are winsorized at the 1% level. $^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$.

	(1)	(2)	(3)	(4)	(5)
			Loan Share		
Leverage	-0.599***				
	(-86.76)				
Tangibility		0.691***			
		(89.14)			
Credit Rating			-0.278***		
			(-87.50)		
Profitability				-3.437***	
				(-122.32)	
Market-to-Book					-0.181***
					(-57.49)
Observations	986908	972901	986908	972901	986908
R^2	0.227	0.218	0.191	0.241	0.174
Firm FE	Y	Y	Y	Y	Y

Table 10: Dynamic Responses of Capital and Debt Structure to Interest Rate Risk

This table reports the dynamic responses of firms' financing decisions in response to interest rate shocks using the simulated data. Columns (1) and (2) show the heterogeneous responses in the loan and equity share, and column (3) shows the average effect on the credit spread. Firm and quarter fixed effects are indicated in the table. Standard errors are heteroskedasticity-robust and clustered at the firm level. ΔLoan Share is winsorized at the 5% level, and other variables are winsorized at the 1% level. $^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$.

	(1) ΔLoan Share	(2) Δ(Equity Share)	(3) Relative Spread
ϵ_t^m			0.11
$\epsilon_t^m \times \text{Size}_{i,t-1}$	0.179	-0.066	
Observations	487,151	524,734	520,740
R^2	0.065	0.687	0.749
Firm & quarter FEs	Y	Y	Y

Table 11: Counterfactual Analysis

This table reports the key estimated parameters (panel A), the matched moments (panel B), and the elasticity of debt substitution (the coefficient of $\epsilon_t^m \times$ Size in panel C) from four model specifications. "Baseline" is the benchmark model; model (1) sets equal intermediation costs for loans and bonds; model (2) raises the production fixed cost by 10%; and model (3) reduces the debt issuance costs by one-half.

	(1) Data	(2) Baseline	(3) Model (1)	(4) Model (2)	(5) Model (3)
Panel A: SMM estimated parameters					
λ_0		0.3021	0.3066	0.1446	0.15
		(0.0256)	(0.0662)	(0.0151)	(0.0575)
λ_1		0.1	0.0477	0.0468	0.05
		(0.0281)	(0.6326)	(0.0006)	(0.0137)
ξ_0		0.0071	0.0070	0.0099	0.0064
		(0.0005)	(0.0085)	(0.0003)	(0.0094)
ξ_1		0.0066	0.0070	0.0094	0.0060
		(0.0002)	(0.0085)	(0.0004)	(0.0003)
c_f		0.0971	0.0990	0.1068	0.1013
		(0.0005)	(0.0441)	(0.0006)	(0.0071)
Criterion		0.0029	0.4757	0.0678	0.0051
Panel B: SMM estimated moments					
Avg. leverage	0.222	0.204	0.1874	0.0904	0.1837
Avg. bond ratio	0.76	0.789	0.0692	0.6765	0.7689
Avg. equity/asset	0.094	0.075	0.076	0.134	0.092
Prob(equity)	0.067	0.113	0.098	0.0703	0.0979
Bond spread	1.78%	1.60%	1.86%	2.25%	1.53%
Prob(default)	3%	3.08%	2.89%	5.12%	3.23%
Panel C: Elasticity of debt substitution					
$\epsilon_t^m \times$ Size	0.077	0.122	0.088	0.187	-0.011

Table 12: Real Effects: Investment

This table reports the heterogeneous effects of monetary policy on firm investment using both real and simulated data from the model. Coefficients are estimated from the following regressions:

$$\Delta logk_{i,t+1} = \alpha_i + \lambda_{s,q} + \gamma\epsilon_t^m + \beta\epsilon_t^m \times \text{Loan Share}_{i,t-1} + \delta\text{Loan Share}_{i,t-1} + \Gamma_1' Z_{i,t-1} + \Gamma_2' Y_{t-1} + \epsilon_{i,t+1},$$

where ϵ_t^m is the monetary shocks and $Z_{i,t-1}$ is a set of firm control variables including market-to-book ratio, liquidity, tangibility, leverage, a dummy for dividend payout, and a dummy for investment grade (long-term credit rating). Y_{t-1} is a set of macroeconomic variables including four lags of GDP growth and the inflation rate. Monetary shocks and firm control variables are standardized. The sample covers periods from 1990Q2 to 2018Q4, excluding the financial crisis from 2008Q3 to 2009Q2. The firm and sector-quarter fixed effects are indicated in the table. Standard errors are heteroskedasticity-robust and clustered at the firm level, and *t*-statistics are in parentheses. $^*p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$.

	(1)	(2)
	$\Delta logk_{i,t+1}$	
	Data	Model
ϵ_t^m	-0.137*	-0.129*
$\epsilon_t^m \times$ Loan Share$_{i,t-1}$	-0.130*	-0.280***
Observations	222,336	520,740
R^2	0.131	0.749
Firm & Quarter FEs	Y	Y

Figure 1: Monetary Shocks

This figure plots the monetary shocks at the daily and quarterly frequency. The dashed red line represents the main measure of monetary shocks used in the baseline analysis: changes in fed funds futures prices around FOMC announcements. The solid blue line represents the policy news shocks from Nakamura and Steinsson (2018). The sample covers the periods from 1990Q2 to 2018Q4.

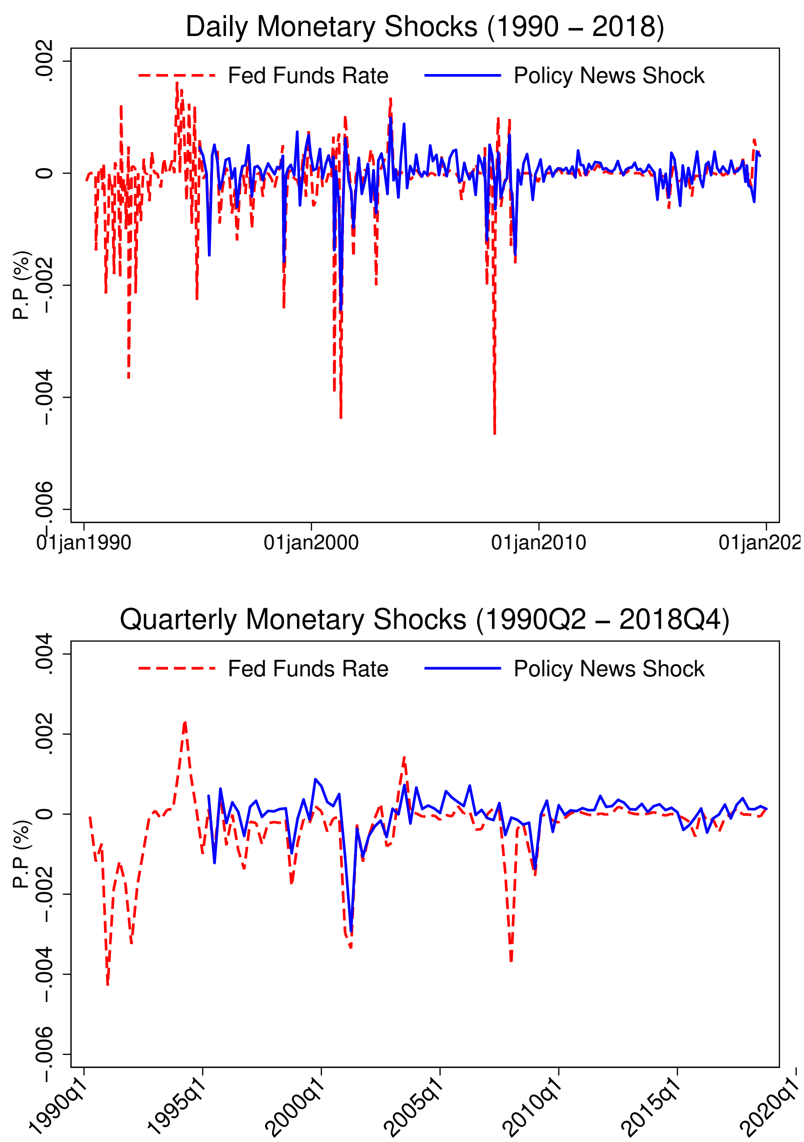
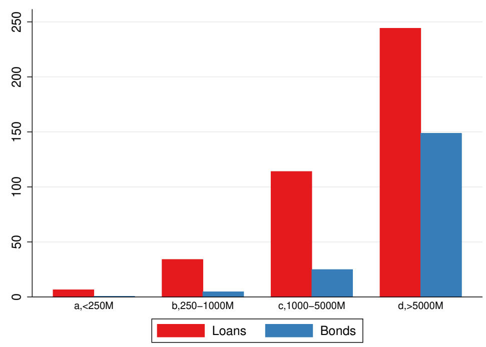


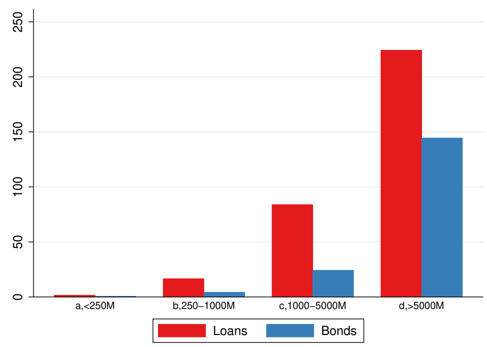
Figure 2: Debt Distribution across Firm Size: Loans and Bonds

The figures show the distributions of loan and bond new issuance across public firm size from 1990Q1 to 2018Q4. The top figures show the annual total dollar amount of debt issued to all public firms (left column) and firms with access to both markets (right column). The figures in the middle show the average debt maturities, and the bottom figures show the average credit spreads of debt issued to all public firms (left column) and firms with access to both markets (right column).

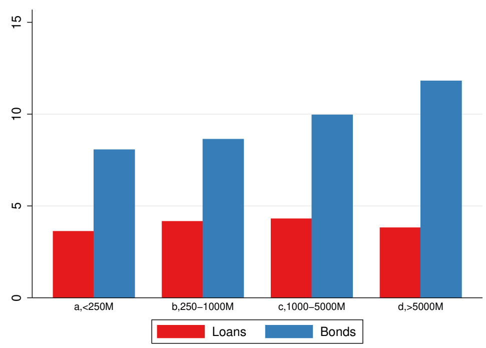
(a) Debt Amount to All Firms ($ Billion)



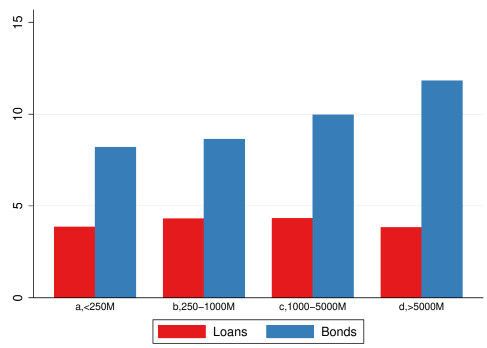
(b) Debt Amount to Firms with Access to Both Markets ($ Billion)



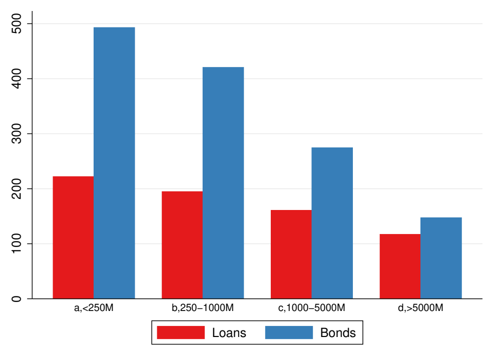
(c) Maturity to All Firms (Year)



(d) Maturity to Firms with Access to Both Markets (Year)



(e) Credit Spread to All Firms (bps)



(f) Credit Spread to Firms with Access to Both Markets (bps)

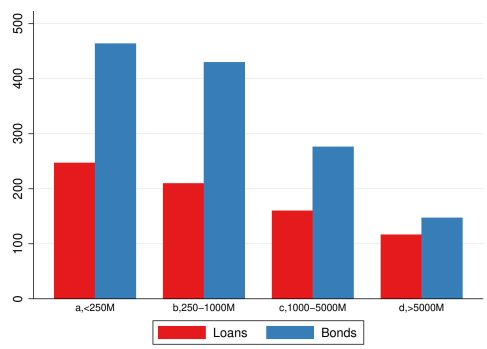


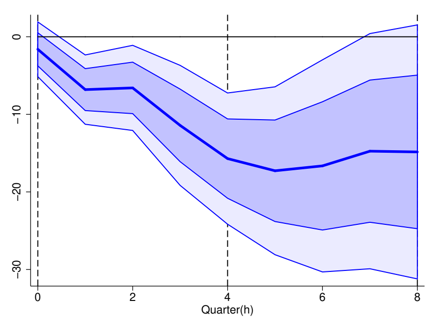
Figure 3: Dynamic Effects of Monetary Shocks on Aggregate Debt Composition

These figures plot the impulse response of aggregate corporate debt to a one standard deviation monetary shock ϵ_t^m based on the identification approach by Gürkaynak et al. (2005) and Gorodnichenko and Weber (2016) at a quarterly frequency and the local projection specification. Coefficient estimates β_h from the following regressions are plotted over time horizon h:

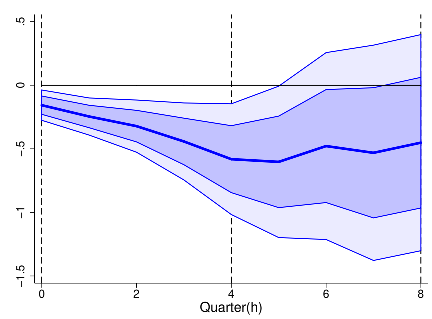
$$y_{t+h} - y_{t-1} = \alpha_h + \beta_h \epsilon_t^m + \Gamma_h Controls_{t-1} + \epsilon_{t+h},$$

where $h = 0, 1, 2, ..., 8$, and y is the (log) real credit (Billions of 1982 U.S. Dollars). The control variables include one year of lagged values of the monetary policy shock and one year of lagged values of the one-quarter change in the respective dependent variable, real GDP growth, inflation rate, unemployment, term spread, SLOOS tightening standards, and the forecasts of GDP growth and unemployment. The shaded areas are 68% and 90% error bands. Panels (a), (c) and (e) show the cumulative effects on bonds, loans, and total debt. Panels (b) and (d) show the cumulative effects on the growth rates. The debt series are obtained from the Flow of Funds L.103. The sample covers the periods from 1990Q2 to 2018Q4.

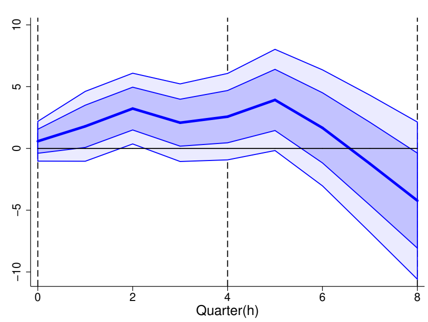
(a) β_h for ΔBond



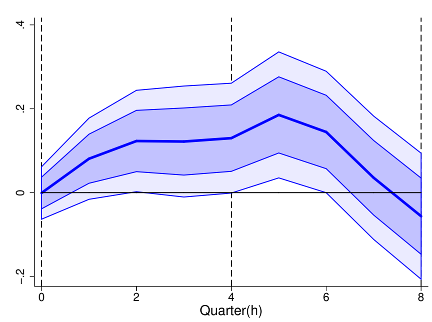
(b) β_h for Δlog(Bond) (%)



(c) β_h for ΔLoan



(d) β_h for Δlog(Loan) (%)



(e) β_h for Δ Total Debt

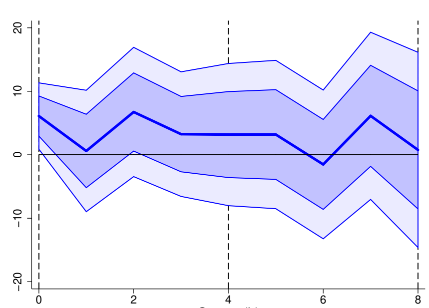


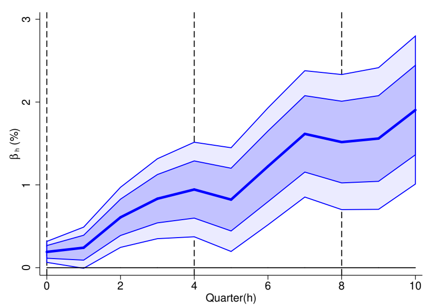
Figure 4: Dynamic Heterogeneous Effects of Monetary Shocks on Debt Composition

These figures plot the heterogeneous impulse responses of the firm-level loan flow and equity share to a one standard deviation monetary shock ϵ_t^m based on the identification approach by Gürkaynak et al. (2005) and Gorodnichenko and Weber (2016) at a quarterly frequency and the local projection specification using data from Compustat. Coefficient estimates β_h from the following regressions are plotted over time horizon h:

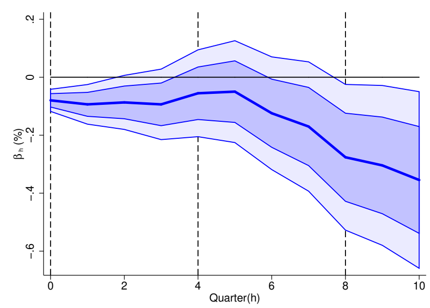
$$\Delta y_{t+h} = \alpha_i + \lambda_{s,t} + \beta_h \epsilon_t^m \times X_{i,t-1} + \delta_h X_{i,t-1} + \Gamma_h' Z_{i,t-1} + \epsilon_{t+h}$$

, where $h \in [0, 10]$. $X_{i,t-1}$ is firm size, credit rating, or distance to default (D2D). Additional control variables $Z_{i,t-1}$ include market-to-book ratio, liquidity, leverage, and a dummy for dividend payout. The shaded area are 68% and 90% error bands. Figures in the left (right) column show the cumulative effects of monetary shocks by firm size, credit rating, or distance to default on loan flow: $y = \Delta$ log(Loan) (equity share: $y = \Delta$Equity share). The sample covers periods from 1990Q2 to 2018Q4 (excluding the financial crisis from 2008Q3 to 2009Q2).

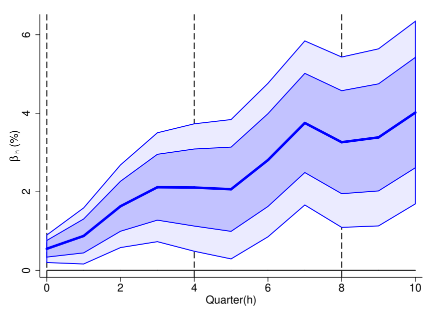
(a) β_h for Δ log(Loan) by Size (%)



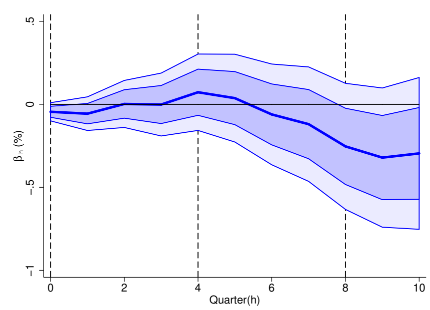
(b) β_h for ΔEquity Share by Size



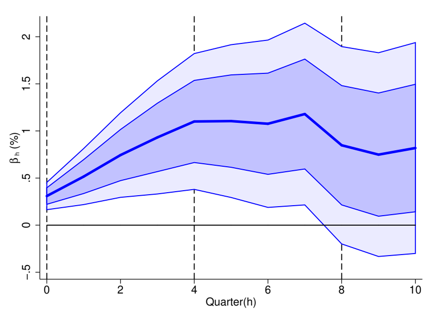
(c) β_h for Δ log(Loan) by Credit Rating (%)



(d) β_h for ΔEquity Share by Credit Rating



(e) β_h for Δ log(Loan) by D2D (%)



(f) β_h for ΔEquity Share by D2D

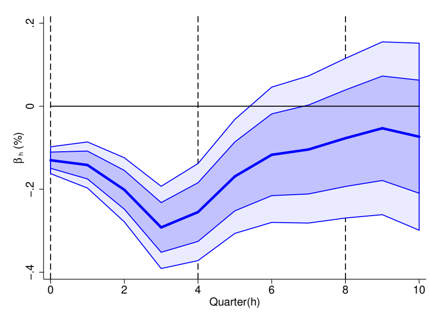


Figure 5: Optimal Value and Policy Functions

This figure plots the value of equity (top left panel), the policy for the investment-to-capital ratio (top right panel), the policy for the ratio of new (total) debt issuance to capital (bottom left panel), and the price of bond debt (bottom right panel) as functions of capital. The two lines correspond to firms with identical average idiosyncratic productivity and total debt levels, but in an economy with different interest rate levels. The solid blue line refers to an economy in a good state (low rate), and the dashed red line refers to an economy in a bad state (high rate).

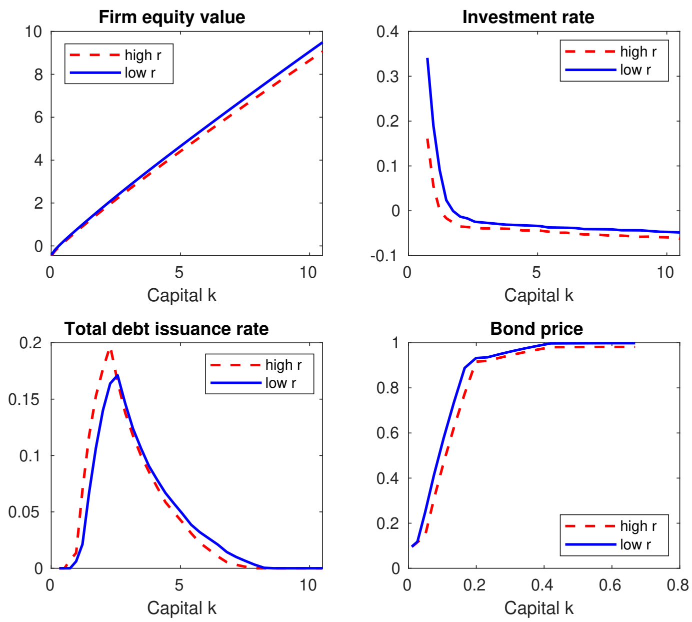


Figure 6: Firm Debt Conditional on Size

This figure shows the average loan ratio by size quintile. The data are shown by the red bars, and the black bars show the corresponding values implied from the model.

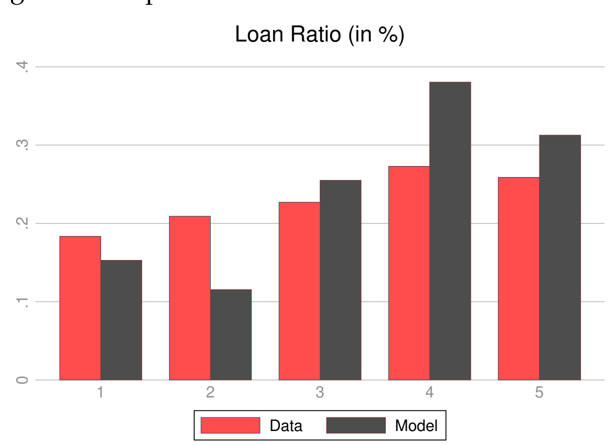
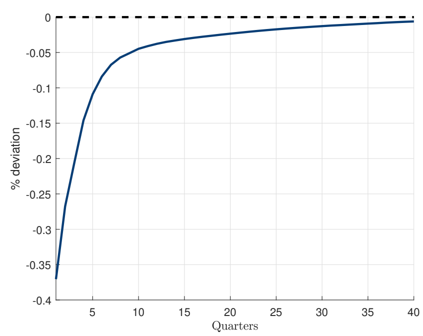


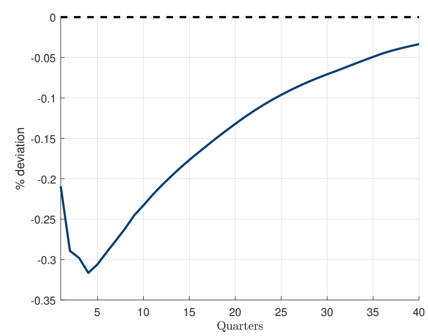
Figure 7: Aggregate Effects of Monetary Shocks

This figure plots the impulse responses of consumption, capital, total debt, bank loans, corporate bonds, and bond share to a 25 basis point innovation to the Taylor rule, which decays at rate $\rho_m = 0.5$ implied from the transition dynamics of the calibrated model.

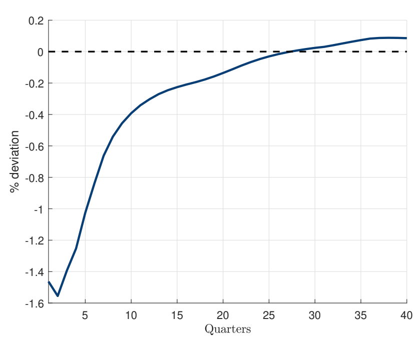
(a) IRF of Consumption



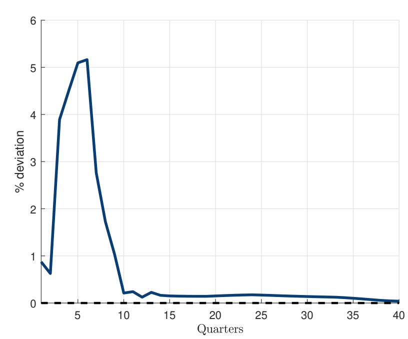
(b) IRF of Capital



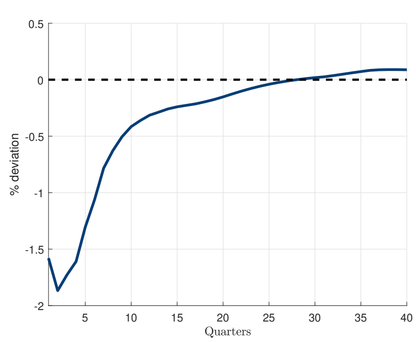
(c) IRF of Debt



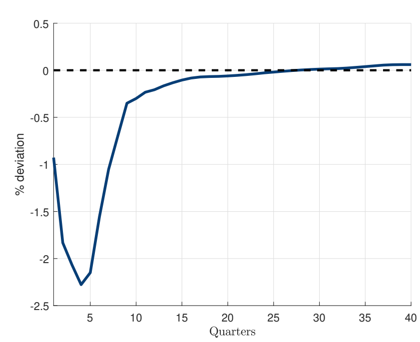
(d) IRF of Bank Loans



(e) IRF of Corporate Bonds



(f) IRF of Bond Share



Internet Appendix

A Details on Data Construction

A.1 Monetary Shocks

I use the daily measures of monetary policy shocks from Gürkaynak et al. (2005) and Gorodnichenko and Weber (2016) (hereafter, GSS and GW) as the baseline measures in the main analysis, and the measures from Nakamura and Steinsson (2018) in the robustness test.

GSS and GW measure monetary shocks as the changes in the current month's federal fund futures rate in a 30-minute narrow window around the FOMC announcement. I exclude unscheduled meetings and conference calls, which helps to mitigate the problem that monetary surprises may contain private central bank information about the state of the economy. I further exclude the apex of the financial crisis from 2008Q3 to 2009Q2. The sample runs from 1990 to 2018. I also use the policy news shock from Nakamura and Steinsson (2018) as a robustness check. The sample runs from 1995 to 2018.

I follow Ottonello and Winberry (2020) to aggregate the shocks to the quarterly frequency. I assign daily shocks fully to the current quarter if they occur on the first day of the quarter. If they occur within the quarter, I partially assign the shock to the subsequent quarter. This procedure weighs shocks across quarters corresponding to the amount of time agents have to respond.

Results based on Nakamura and Steinsson (2018)'s policy news shock can be found in Tables A.9.

A.2 Aggregate Variables

The aggregate variables used in the empirical test include nonfinancial corporate debt (debt securities and loans) from flow of funds and other variables such as price deflator (IPD: Nonfarm business sector: implicit price deflator), real GDP growth (GDPC1: Real Gross Domestic Product), the inflation rate (CPIAUCSL: Consumer Price Index for All Urban Consumers: All Items), the unemployment rate (UNRATE: Unemployment Rate), credit spread (the spread between BAA and AAA), term spread (the spread between 10-year Treasury rate and 1-year Treasury rate), loans and leases (TOTLL: Loans and Leases in Bank Credit, All Commercial Banks), commercial paper (CPLBSNNCB: Nonfinancial Corporate Business; Commercial Paper), commercial & industrial loans (TOTCI: Commercial and Industrial Loans, All Commercial Banks) and real estate loans (RELACBW027SBOG: Real Estate Loans, All Commercial Banks) available from the Federal Reserve Bank of St. Louis, as well as the Greenbook forecasts and forecast revisions available from the Federal Reserve Bank of Philadelphia. The price-dividend ratio (PD) is obtained from Shiller's website, and intermediary financial leverage (HKM) is obtained from Asaf Manela's website. Interest rate swaps and LIBOR are available on Bloomberg.

A.3 Firm Variables

Debt Data

New loan issuance data are obtained from DealScan, and new bond issuance data are obtained from FISD. I obtain the firm-level loan share from Compustat. A limitation of Compustat's balance sheets is that they do not report loans separately from the rest of the outstanding debt. Following Crouzet (2021), I approximate the firm-level loan share using the sum of two variables: a short-term debt variable, notes payable (NP), and long-term debt variables, other long-term debt (DLTO). The advantage of this definition is that it provides a comprehensive long-run measure of the loan share at the firm level.[34] For short-term debt, NP includes bank acceptances, bank overdrafts, and loans payable. For long-term debt, DLTO includes all revolving credit agreements, as well as all construction and equipment loans. It excludes senior nonconvertible bonds (which are included in debentures, DD) and convertible or subordinate bonds (included in DCVT and DS, respectively). The main drawback is that both NP and DLTO include outstanding commercial papers. Crouzet (2021) provides evidence for the fact that this measure of the loan share indeed captures the ratio of total debt outstanding. Since other long-term debt (DLTO) is not available at the quarterly frequency, I construct it as: $\text{DLTOQ}_{i,t} = \frac{\text{DLTO}_{i,\tau(t)}}{\text{DLTT}_{i,\tau(t)}}\text{DLTTQ}_{i,t}$ or zero if $\text{DLTT}_{i,\tau(t)} = 0$, where $\text{DLTO}_{i,\tau(t)}$ and $\text{DLTT}_{i,\tau(t)}$ are the balance sheet values from the firm's annual report at the annual reporting date $\tau(t)$ that immediately precedes quarter t.

Equity Data

Firm-level net equity issuance is defined as the sale of common and preferred stock minus the purchase of common and preferred stock, scaled by the lagged total asset. Equity

[34]Notes payable are not reported as a separate item before 1970Q1.

issuances are all funds received from the issuance of common and preferred stock. They include the exercise of stock options or warrants for employee compensation. Therefore, this measure may overstate equity issuances for financing reasons. I address this concern following McKeon (2015) by considering only equity issuances that are larger than 2% of end-of-quarter market equity, defined as PRCCQ $\times$ CSHOQ.

Firm-level equity stock is measured as the difference between the total asset (ATQ) and total debt (DLTTQ + DLCQ). The change in equity share every period is therefore changed in equity stock, scaled by the lagged total asset.

Distance to Default

Following Merton (1974) and Gilchrist and Zakrajšek (2012), the distance to default is defined as

$$D2D = \frac{log(V/D) + (\mu_V - 0.5\sigma_V^2)}{\sigma_V}, \tag{29}$$

where V is the total value of a firm, μ_V is the annual expected return on V, σ_V is the annual volatility of the firm's value, and D is the firm's debt. Firm value V is estimated following an iterative procedure:

1. Set an initial value for the firm value equal to the sum of firm debt and equity: $V = E + D$, where $E =$ PRC $\times$ SHROUT (daily stock price times the number of shares outstanding from CRSP).

2. Estimate μ_V and σ_V over a 250-day moving window. The return on firm value is defined as the daily log return on assets, $\Delta logV$.

3. Get a new estimate of V for every day of the 250-day moving window based on the Black-Scholes-Merton option-pricing framework

$$E = V\Phi(\delta_1) - e^{-rT}D\Phi(\delta_2) \tag{30}$$

, where $\delta_1 = \frac{log(V/D)+(r+0.5\sigma_V^2)T}{\sigma_V^2\sqrt{T}}$ and $\delta_2 = \delta_1 - \sigma_V\sqrt{T}$ where r is the daily one-year constant maturity Treasury yield from the St. Louis Fed.

4. Iterate on steps 2 and 3 until convergence.

Measures of Financial Constraints

Existing proxies aim to infer financial constraints from firms' statements about their funding situation, their actions (such as not paying a dividend), or their characteristics (such as being young or small, having low leverage, or having no credit rating). I use the Whited-Wu index (WW), Size & Age index (SA), firm size, credit rating, and distance to default as proxies for financial constraints. The SA index is constructed following Hadlock and Pierce (2010) as SA Index $= -0.737\text{Size} + 0.043\text{Size}^2 - 0.040\text{Age}$. The WW index is constructed following Whited and Wu (2006) and Hennessy and Whited (2007) as WW Index $= -0.091\text{CF} - 0.062\text{DIVPOS} + 0.021\text{TLTD} - 0.044\text{LNTA} + 0.102\text{ISG} - 0.035\text{SG}$.[35] Firms are sorted into terciles based on their index values in the previous period. Firms in the top tercile are coded as constrained, and those in the bottom tercile are coded as unconstrained. The definition and source of all variables are shown in Table A.1.

Sectoral dummies

1. Agriculture, forestry, and fishing: SIC < 999;
2. Mining: SIC $\in$ [1000, 1499];
3. Construction: SIC $\in$ [1500, 1799];
4. Manufacturing: SIC $\in$ [2000, 3999];
5. Transportation, communications, electric, gas, and sanitary services: SIC $\in$ [4000, 4999];
6. Wholesale trade: SIC $\in$ [5000, 5199];
7. Retail trade: SIC $\in$ [5200, 5999];
8. Services: SIC $\in$ [7000, 8999].

A.4 Bank Variables

Bank holding company balance sheet variables are obtained from FR Y-9C.

Bank size is defined as the log of total assets (BHCK2170), and the capital ratio is defined as the ratio of Tier 1 capital (BHCK3210) to total assets. Return of equity is the ratio of net income (BHCK4340) to bank capital (BHCK3210). Total deposits are given by (BHDM6631 + BHDM6636 + BHFN6631 + BHFN6636), and cost of funding is measured as interest expense (BHCK4073)/(total deposit + other borrowing (BHCK3190)). Total non-performing loans are given by (BHCK5524+BHCK5525+BHCK5526+BHCK4635), while total loans are the sum of BHCK2122 and BHCK2123. The non-performing loan share is calculated as total non-performing loans divided by total loans.

[35] CF is cash flow to total assets, DIVPOS is a dummy for positive dividend payout, TLTD is long-term debt to total assets, LNTA is logarithm of total assets, ISG is firm's three-digit industry sales growth, and SG is firm-level sales growth.

A.5 Sample Construction

Compustat

I apply the following filters to my Compustat sample:

- I drop firms in finance, insurance, and real estate sectors (SIC $\in$ [6000, 6799]), utilities (SIC $\in$ [4900, 4999]), non-operating establishments (SIC = 9995), and industrial conglomerates (SIC = 9997);
- I drop firms not incorporated in the United States;
- I drop observations with negative or missing sales or assets;
- I drop observations with negative liquidity, short-term/long-term debt, property, plant, and equipment (negative CHEQ, DLCQ, DLTTQ, and PPENTQ);
- I drop observations with missing acquisitions or quarterly acquisitions (AQCY) that are greater than 5% of total assets;
- I drop firms with observations less than three years in the final sample (1990-2018).

DealScan

Loan Issuance

I apply the following filters to my DealScan sample:

- I keep facilities measured in U.S. dollars;
- I keep facilities with borrowers and lenders in the USA;
- I keep facilities using "LIBOR" as the base rate;
- I keep facilities with loan types in the following categories: "364-Day Facility," "Revolver/Line < 1 Yr," "Revolver/Line >= 1 Yr," "Revolver/Term Loan," "Limited Line," "Term Loan (A-H)," and "Delay Draw Term Loan," which accounts for 96.7% of the whole sample;
- I keep facilities that are senior;
- I keep facilities that are distributed as "Syndication" or "Sole Lender";
- I drop facilities with negative or missing "All-in-Drawn."

Lead Agent

Syndicated loans are usually associated with multiple lenders. To determine the lead lender for each facility, I use the text variable "LenderRole" that defines the lender role and a Yes/No lead arranger credit variable "LeadArrangerCredit." I further follow Chakraborty et al. (2018) to rank the lenders:

1. LenderRole == "Admin Agent";
2. LenderRole == "Lead Bank";
3. LenderRole == "Lead Arranger";
4. LenderRole == "Mandated Lead Arranger";
5. LenderRole == "Mandated Arranger";
6. LenderRole == "Arranger" or "Agent" and LeadArrangerCredit == "Yes".

For a given loan package, the lender with the highest ranking is considered the lead agent. About 97.6% of the matched facilities in our merged sample have only one lead lender. Any loan for which a single lead agent cannot be determined is excluded from the sample.

FISD

I apply the following filters to my FISD sample:[36]

- I drop new issuance with maturity over 40 years;
- I drop new issuance with missing offering date, maturity, or offering amount, new issuance with maturity date earlier than offering date, and new issuance with offering date later than the current date;
- I drop non-corporate bond issues by "BOND_TYPE";
- I drop new issuance with zero offering amount or offering price;
- I keep new issuance from the U..S issuers (COUNTRY_DOMICILE=="USA");
- I drop Canadian, Yankee, and foreign currency bonds (FOREIGN_CURRENCY=="Y"; YANKEE=="Y"; CANADIAN=="Y");
- I keep non-convertible, non-exchangeable, and non-perpetual bonds only (CONVERTIBLE=="N"; EXCHANGEABLE=="N"; PERPETUAL=="N").

[36] I apply the same filters following Boyarchenko et al. (2022). I merge FISD and Compustat by issuers' CUSIP and TICKER. I thank Nina Boyarchenko for sharing her knowledge of bond data.

Primary market issuances are priced as a spread to nearest maturity on-the-run interest rate swaps. In particular, I use the following maturity matches in computing the offering spread:

- For bonds with a less than 4.5-month maturity, spread to the 3-month LIBOR;
- For bonds with a maturity of 4.5 months or more and less than 9 months, spread to the 6-month LIBOR;
- For bonds with a maturity of 9 months or more and less than 1.5 years, spread to the 1-year swap rate;
- For bonds with a maturity of [1.5, 2.5) years, spread to the 2-year swap rate;
- For bonds with a maturity of [2.5, 3.5) years, spread to the 3-year swap rate;
- For bonds with a maturity of [3.5, 4.5) years, spread to the 4-year swap rate;
- For bonds with a maturity of [4, 6) years, spread to the 5-year swap rate;
- For bonds with a maturity of [6, 8.5) years, spread to the 7-year swap rate;
- For bonds with a maturity of [8.5, 20) years, spread to the 10-year swap rate;
- For bonds with a maturity of [20, 30) years, spread to the 20-year swap rate;
- For bonds with 30 years maturity or more, spread to the 30-year swap rate.

Bank Holding Company: FR Y-9C

I apply the following filters to my bank holding company (BHC) sample:

- I drop observations with missing or negative total assets (BHCK2170);
- I keep bank holding companies (RSSD9331==28);
- I drop lower-tier holding companies whose higher tier also files Y-9C (BHCK9802==2);
- I keep holding company (RSSD9048 ==500) and exclude securities broker or dealer; (RSSD9048 ==700), insurance broker or company (RSSD9048 ==550), a utility company; (RSSD9048 ==710), and other non-depository institutions (RSSD9048 ==720) but keep Goldman Sachs, Morgan Stanley, Ally, and American Express;
- I drop observations with negative interest expense.

Table A.1: Variable Definitions

Definition		Data sources
Aggregate Variables		
Monetary Shocks	Monetary shocks measured by changes in fed funds futures prices around FOMC announcements	Gürkaynak et al. (2005), Gorodnichenko and Weber (2016) Nakamura and Steinsson (2018)
Corporate Debt	Credit market instrument liabilities (real debt and securities) for nonfinancial business sector	Flow of Funds
Real GDP growth	Growth rate of real GDP	NIPA
IPD	Price deflator (Nonfarm business sector: implicit price deflator)	St. Louis Fed
LIBOR	3-Month London Interbank Offered Rate (U.S.dollar)	Bloomberg
Interest Rate Swaps	Par yields based on the term-structure of LIBOR rates	Bloomberg
Treasury Yield	3M, 1Y, 2Y, 3Y, 5Y, 7Y, 10Y, 20Y and 30Y Treasury Rate	Gürkaynak et al. (2007)
UNRATE	Unemployment rate	St. Louis Fed
INFLAT	Inflation rate, defined as the log difference of CPI	St. Louis Fed
CPI	Consumer Price Index for All Urban Consumers	St. Louis Fed
Credit Spread	Moody's Baa corporate bond yield in excess of Aaa corporate bond yield	St. Louis Fed
Term Spread	10-year Treasury rate minus 1-year Treasury rate	St. Louis Fed
PD	Price-dividend (PD) ratio	Shiller's webpage
Leverage	Intermediary financial leverage ("HKM")	Asaf Manela's website
Mortgages	Nonfinancial Corporate Business; Total Mortgages	Flow of Funds L.217(Q)
Trade Credit	Nonfinancial Corporate Business; Trade Credit	Flow of Funds L.230(Q)
CPLBSNNCB	Nonfinancial Corporate Business; Commercial Paper	St. Louis Fed
TOTCI	Commercial and Industrial Loans, All Commercial Banks	St. Louis Fed
RELACBW027SBOG	Real Estate Loans, All Commercial Banks	St. Louis Fed
Firm Characteristics		
Leverage	Total debt (DLCQ + DLTTQ) over total assets (ATQ)	Compustat
Size	log(ATQ)	Compustat
Distance to default	D2D, estimated following Merton (1974) and Gilchrist and Zakrajšek (2012)	Compustat and CRSP
MB	Market-to-book value: sum of market equity (PRC $\times$ SHOUT) and total debt over total assets	Compustat and CRSP
Sales Growth	Log-difference of real sales (SALEQ/IPD)	Compustat
Dividend Payer	A dummy that takes value one when firms pay dividend (DVPQ >0)	Compustat
Credit Rating	A dummy that takes value one when rating (SPLTICRM) is above BBB^{-}	Compustat
Liquidity	Liquid assets (CHEQ) over total assets (ATQ)	Compustat
Trade Credit	Accounts Receivable (RECCH) over sales (SALEQ)	Compustat
Bond Characteristics		
Offering Yield	Yield to maturity at the time of issuance, based on the coupon and any discount or premium to par value at the time of sale. Offering yield is calculated only for fixed rate issues.	Mergent FISD
Offering Spread	Offering yield minus maturity-matched interest rate swaps	Mergent FISD
Bond Rating	The S&P rating assigned to a specific issue	Mergent FISD
Maturity	Date that the issue's principal is due for repayment	Mergent FISD
Offering Amount	The par value of debt initially issued	Mergent FISD
Offering date	Date the issue was originally offered	Mergent FISD
Loan Characteristics		
Loan rate	Sum of "All-in-drawn" and LIBOR	DealScan
"All-in-drawn"	The amount borrower pays in basis points over LIBOR for each dollar drawn down	DealScan
Base Rate	Type of interest rate the company's facility is tied to	DealScan
Facility Amount	The actual facility amount committed by the facility's lender pool	DealScan
Maturity	A calculation of how long (in months) the facility will be active from signing date to expiration date	DealScan
Secured	A Y/N flag indicating whether or not the facility is secured	DealScan

B Details on Model

B.1 General Equilibrium Model

B.1.1 Representative Household

There is a unit measure continuum of identical households with preferences over consumption C_t and total labor supply L_t, whose expected utility is as follows:

$$\sum_{t=0}^{\infty} \beta^t (logC_t - \Psi L_t),$$

subject to the budget constraint:

$$P_t C_t + \frac{B_{t+1}^{f,nom}}{R_t^{nom}} \leq W_t L_t + B_t^{f,nom} + T_t^{nom},$$

where β is the discount factor of households, Ψ is the disutility of working, P_t is the price index, R_t^{nom} is the nominal rate, W_t is the nominal wage rate, $B_t^{f,nom}$ is the one-period risk-free bond in nominal terms, and T_t^{nom} is the transfer from all firms including the nominal profits. The budget constraint in the real term is

$$C_t + \frac{B_{t+1}^{f}}{R_t^{nom}} \Pi_{t+1} \leq w_t L_t + B_t^{f} + T_t. \tag{31}$$

Every period, the households make a decision on labor supply, which determines the real wage in the following optimal condition:

$$w_t = \frac{W_t}{P_t} = -\frac{U_l(C_t, L_t)}{U_c(C_t, L_t)} = \Psi C_t.$$

The decision over consumption and saving (through a risk-free bond) determines the discount factor, which is linked to nominal and inflation rates through the Euler equation:

$$\Lambda_{t,t+1} = \beta \frac{U_c(C_{t+1}, L_{t+1})}{U_c(C_t, L_t)} = \beta \frac{C_t}{C_{t+1}} = \frac{1}{R_t^{nom}/\Pi_{t+1}}.$$

B.1.2 New Keynesian Block

The New Keynesian block of the model consists of a final good producer who produces final goods, retailers who have quadratic adjustment costs when setting prices (price rigidity), and a monetary authority who sets the interest rate rule. It generates 1) a New Keynesian Phillips curve relating nominal variables to the real economy and 2) a Taylor rule, which links the monetary policy shock and inflation to the nominal interest rate.

Final Good Producer

There is a representative final good producer who produces the final good Y_t using intermediate goods from all retailers with the production function:

$$Y_t = \left(\int \tilde{y}_{i,t}^{\frac{\gamma-1}{\gamma}} \right)^{\frac{\gamma}{\gamma-1}},$$

where γ is the elasticity of substitution between intermediate goods. The final good producer solves the following profit maximization problem subject to the equation above:

$$\max_{\tilde{y}_{i,t}} \; P_t Y_t - \int_0^1 \tilde{p}_{i,t} \tilde{y}_{i,t} di.$$

The optimal decision gives the demand curve $\tilde{y}_{i,t} = \left(\frac{\tilde{p}_{i,t}}{P_t} \right)^{-\gamma} Y_t$ where the price index is $P_t = \left(\tilde{p}_{i,t}^{1-\gamma} di \right)^{\frac{1}{1-\gamma}}$. The final good serves as the numeraire in the model.

Intermediate Retailers

For each production firm j, there is a corresponding retailer i who produces a differentiated variety $\tilde{y}_{i,t}$ using homogeneous good $y_{i,t}$ from production firm i as its only input:

$$\tilde{y}_{i,t} = y_{i,t},$$

where the retailers are monopolistic competitors who set their prices $\tilde{p}_{i,t}$ subject to the demand curve generated by the final good producer and the wholesale price of the input P_t. Retailers pay a quadratic menu cost in term of final good $\frac{\psi}{2} \left(\frac{\tilde{p}_{i,t}}{\tilde{p}_{i,t-1}} - 1 \right)^2 P_t Y_t$, to adjust their prices as in Rotemberg (1982), where Y_t is the final good.

The resulting price stickiness comes from the price-setting decisions made by retailers to maximize profits. I follow Rotemberg (1982) except the marginal cost is now the wholesale price

$$\pi_{i,t} = (\tilde{p}_{i,t} - p_t)\tilde{y}_{i,t} - \frac{\psi}{2} \left(\frac{\tilde{p}_{i,t}}{\tilde{p}_{i,t-1}} - 1 \right)^2 P_t Y_t.$$

Every period, the retailers choose a price to maximize the expected present value of all the future profit:

$$\max_{\tilde{p}_{j,t}} \ \mathbb{E}_t \sum \Lambda_{t,t+j}\pi_{t+j},$$

which gives the following New Keynesian Phillips curve:

$$log\Pi_t = \frac{\gamma - 1}{\psi} log\frac{p_t}{p^\star} + \beta\mathbb{E}_t log\Pi_{t+1},$$

where $p^* = \frac{\gamma-1}{\gamma}$ is the steady-state wholesale price, or in other words, the marginal cost for retailer firms. The Phillips curve links the New Keynesian block to the production block through the relative real wholesale price p^* for production firms. If the expectation of future inflation is unchanged, when the final good Y_t increases, retailers must increase production of their differentiated goods because of the nominal rigidity. This, in turn, increases demand for the production goods $\tilde{y}_{i,t}$, which increases the real wholesale price p_t and generates inflation through the Phillips curve.

B.1.3 Market Clearing Conditions

Consumption Good

$$C_t + I_t + DIC_t + EIC_t + AC_t + c_f = Y_t \tag{32}$$

Labor

$$\int l_{i,t} d\mu_t = L_t \tag{33}$$

Debt

$$\int \left(Q_t^l b_{i,t}^l + Q_t^b b_{i,t}^b \right) d\mu_t = \frac{B_t^f}{R_t^{nom}} \Pi_{t+1} \tag{34}$$

where $b_{i,t}^l = B_{i,t}^l \left(1 - s_{i,t}\right)$ is the firm-level bank loans and $b_{i,t}^b = B_{i,t}^b s_{i,t}$ is the firm-level corporate bonds. The financial intermediary takes deposit from the household and lend it in terms of one-period bonds and loans to firms.

B.2 Proposition and Derivation

Phillips Curves The optimal condition for the price-setting rule is

$$(\gamma-1)\left(\frac{\tilde{p}_{i,t}}{P_t}\right)^{-\gamma}\frac{Y_t}{P_t}=\gamma\frac{p_t^w}{P_t}\left(\frac{\tilde{p}_{i,t}}{P_t}\right)^{-\gamma-1}\frac{Y_t}{P_t}-\psi\left(\frac{\tilde{p}_{i,t}}{\tilde{p}_{i,t-1}}-1\right)\frac{Y_t}{\tilde{p}_{i,t-1}}+\mathbb{E}_t\psi\Lambda_{t,t+1}\left[\left(\frac{\tilde{p}_{i,t+1}}{\tilde{p}_{i,t}}-1\right)\frac{\tilde{p}_{i,t+1}}{\tilde{p}_{i,t}}\frac{Y_{t+1}}{\tilde{p}_{i,t}}\right].$$

With the symmetric assumption $\tilde{p}_{i,t}=\tilde{p}_{j,t}=P_t$, the above equation can be written as

$$(\gamma-1)=\gamma\frac{p_t^w}{P_t}-\psi\Pi_t(\Pi_t-1)+\mathbb{E}_t\psi\Lambda_{t,t+1}\Pi_{t+1}(\Pi_{t+1}-1)\frac{Y_{t+1}}{Y_t},$$

which gives the Phillips curves:

$$\left(\Pi_t-\bar{\Pi}\right)\Pi_t=\frac{\gamma}{\psi}\left(p_t^w-\frac{\gamma-1}{\gamma}\right)+\mathbb{E}_t\Lambda_{t,t+1}\Pi_{t+1}(\Pi_{t+1}-\bar{\Pi})\frac{Y_{t+1}}{Y_t},$$

where $p_t=\frac{p_t^w}{P_t}$ is the real wholesale price. The log-linearized steady-state version of the Phillips curves (for computation simplicity) is

$$log\Pi_t=\frac{\gamma-1}{\psi}log\frac{p_t}{p^\star}+\beta\mathbb{E}_t log\Pi_{t+1}.$$

Inflation Dynamics Combining the Euler equation

$$logR_t+log\beta=log\Pi_{t+1}-log\frac{U'(C_{t+1})}{U'(C_t)},$$

and the Taylor rule

$$logR_t+log\beta=\psi_\pi log\Pi_t+\epsilon_t^m,$$

we get

$$\psi_\pi log\Pi_t+\epsilon_t^m=log\left(\Pi_{t+1}\frac{U'(C_t)}{U'(C_{t+1})}\right),$$

which is

$$\Pi_t=exp\left(\frac{1}{\psi_\pi}\left[log\left(\Pi_{t+1}\frac{U'(C_t)}{U'(C_{t+1})}\right)-\epsilon_t^m\right]\right).$$

Proof of Proposition 1

Proof.

$$B_{i,t+1}(1 - s_{i,t+1})(1 + c) \leq \theta(1 - \delta)k_{i,t+1},$$

which gives

$$s_{i,t+1} \in \left[1 - \frac{\theta(1-\delta)k_{i,t+1}}{B_{i,t+1}(1+c)}, 1\right].$$

When firms are charged similar price, that is, $Q^b_{i,t} \approx Q^l_{i,t}$ for $\forall s_{i,t+1}$,

$$\frac{\partial F}{\partial s_{i,t+1}} > 0, \;\; \forall s_{i,t+1} \in \left[1 - \frac{\theta(1-\delta)k_{i,t+1}}{B_{i,t+1}(1+c)}, 1\right].$$

That is, bond financing is always cheaper than loan financing. Therefore, $s^*_{i,t+1} = 1$. □

Proof of Proposition 2

Proof. Given $(k_{i,t}, B_{i,t}, z_{i,t}; \beta_t)$, if $\frac{\partial F}{\partial s_{i,t+1}}|_{s_{i,t+1}=1} \leq 0$, then set

$$\frac{\partial F}{\partial s_{i,t+1}} = 0.$$

which gives

$$\hat{s} = \frac{(\xi_0 - \xi_1) + (Q^b_{i,t} - Q^l_{i,t})}{\frac{\partial Q^l_{i,t}}{\partial \hat{s}_{i,t+1}} - \frac{\partial Q^b_{i,t}}{\partial \hat{s}_{i,t+1}}} < 1.$$

The optimal bond share is

$$s^*_{i,t+1} = argmax\ F(s_{i,t+1}; z_{i,t}, k_{i,t+1}, B_{i,t+1}) > 0.$$

a) For unconstrained firms with lower leverage: $1 - \frac{\theta(1-\delta)k_{i,t+1}}{B_{i,t+1}(1+c)} < \hat{s}$, the optimal decision is the interior solution

$$s^*_{i,t+1} = \hat{s}.$$

b) For constrained firms with higher leverage: $1 - \frac{\theta(1-\delta)k_{i,t+1}}{B_{i,t+1}(1+c)} \geq \hat{s}$, the optimal decision is

$$s^*_{i,t+1} = 1 - \frac{\theta(1-\delta)k_{i,t+1}}{B_{i,t+1}(1+c)}.$$

□

C Details on Numerical Solution

C.1 Steady-State Equilibrium

In this section, I outline the numerical algorithm I use. I solve for the steady-state equilibrium by value function iteration. The value function and the optimal decision rules are solved on a grid in a discrete state space with interpolation. I discretize the state space $\mathbb{S} = (z, k, B)$ into $n_z \times n_k \times n_B$ grid points. Specifically, I specify two grids of 30 points ($n_k = n_B = 30$) for capital k and total debt B, with upper bounds that are large enough to be nonbinding. I assign more grid points around lower bounds, where the value function has most of its curvature. For interpolation, I specify two grids of 200 points for investment k' and total borrowing B'. I also specify a grid of 151 points for bond share s' for the static optimization problem for debt structure. I then discretize the exogenous productivity according to Rowenhorst (1995). I use 5 grid points ($n_z = 5$) for the idiosyncratic productivity states. In the steady-state equilibrium, the discount factor is β, the inflation rate is $\Pi^\star = 1$, and the wholesale price is $p^\star = \frac{\gamma-1}{\gamma}$. The nominal rate and the real rate are therefore $1/\beta - 1$. The computational algorithm—following Strebulaev et al. (2012)—proceeds as follows:

Start outer loop

1. Guess a default policy $D_{t+1}(z', k', B')$ and compute the implied bond prices $Q_t(z, k', B', s')$ based on lenders' zero-profit condition.

   Start inner loop

   (a) Given the default policy and bond price, have an initial guess for the expected value $E_z V^0_{t+1}(z, k', B')$.

   (b) Given (z, k, B, k', B'), solve the static loan-bond trade-off problems and get the optimal bond share $s'(z, k', B')$.

   (c) With s', solve the maximization problem for optimal investment and borrowing decisions $k'(z, k, B)$, $B'(z, k, B)$ and value function $V_t(z, k, B)$.

2. Obtain $V^{new}_{t+1}(z', k', B')$ by interpolation and update the default decision $D^{new}_{t+1}(z', k', B')$ (here, V and D do not depend on s'), expected value function $E_z V^{new}_{t+1}(z, k', B')$, and bond price $Q^{new}_t(z, k', B', s')$.

3. Compute the ergodic distribution $\mu(z, k, B)$ implied by the firm policies for default, capital and borrowing: $D(z, k, B)$, $k'(z, k, B)$, and $B'(z, k, B)$.

4. Iterate the above procedure until the error of the expected value function and default policy is small enough:

   $\epsilon = max\left(|E_z V_{t+1}(z, k', B') - E_z V^{new}_{t+1}(z, k', B')|, |D_{t+1}(z', k', B') - D^{new}_{t+1}(z', k', B')|\right).$

After convergence, I have the stationary equilibrium aggregate prices $\{\pi^\star = 1, \Lambda^\star = \beta, p^\star = \frac{\gamma-1}{\gamma}, R^\star = 1/\beta, w^\star = w^\star\}$, aggregate quantities $\{C^\star, L^\star, Y^\star, K^\star, I^\star, B^\star\}$, firm value function $V^\star(\mathbb{S})$, policy functions $k'^\star(\mathbb{S}), B'^\star(\mathbb{S}), l^\star(\mathbb{S}), s'^\star(\mathbb{S}), D^\star(\mathbb{S})$, and stationary distribution $\mu(\mathbb{S})$.

C.2 Transition Dynamics

The key assumption of the transition dynamics is that after a sufficiently long enough time, the economy will always converge back to its initial stationary equilibrium after any temporary and unexpected (MIT) shocks.

1. Generate a one-time positive interest rate shock of 25 basis points and assume the shock follows $\epsilon^m_{t+1} = \rho^m \epsilon^m_t$ with $\rho^m = 0.5$. Fix a sufficiently long transition period from $t = 1$ to $t = T$.

2. Guess a time path for marginal utility $U'(C_t)$ for $t = 1, 2, ..., T+1$ and set $U'(C_{T+1}) = U'(C^\star)$.

3. Set all the prices p, w, R, r in period $T+1$ to be their steady-state values. Given the inflation dynamics, obtain R_t from the Taylor rule, r_t from the Fisher equation, w_t from the labor market clearing condition, and p_t from Phillips curve for $t = 1, 2, ..., T$.

4. I assume a steady-state value and policy function in period $T + 1$ and update the value and policy functions using **backward induction** given the price series for $t = 1, 2, ..., T$.

5. Given the policy functions and the steady-state distribution as the initial distribution, I use **forward simulation** with the non-stochastic simulation in Young (2010) to find the transition matrix T_t and distribution $\mu_t(\mathbb{S})$ for $t = 1, 2, ..., T$.

6. I obtain all the aggregate quantities along the time path using $\mu_t(\mathbb{S})$ and update $U'(C_t)$ using consumption good market clearing condition, as well as other price series for $t = 1, 2, ..., T$.

C.3 Simulated Method of Moments Estimation

To generate the simulated data for the SMM estimation (used to create $\Phi^S(\theta)$ in Equation (25), I simulate an economy with 10,000 firms and 250 quarters, with the first 200 quarters discarded to eliminate the effects of any assumptions on initial conditions. I use a simulated annealing algorithm for minimizing the criterion function in the estimation step in Equation (25). This starts with a predefined first guess of the parameters θ. For the second guess onward, it takes the best prior guess and randomizes from this to generate a new set of parameter guesses. That is, it takes the best-fit parameters and randomly "jumps off" from this point for its next guess. Over time, the algorithm "cools" so that the variance of the parameter jumps falls, allowing the estimator to fine-tune its parameter estimates around the global best fit. I restart the program with different initial conditions to ensure the estimator converges to the global minimum. To generate the standard errors for the parameter point estimates, we generate numerical derivatives of the simulation moments with respect to the parameters and weigh them using the optimal weighting matrix. The value of the numerical derivative is computed as $f'(x) = \frac{f(x+\epsilon)-f(x-\epsilon)}{2\epsilon}$. [37] Here, I choose $\epsilon = 0.01x$.

C.4 Simulation

Model moments

To match the simulated model moments and their corresponding data moments, I simulate a sample panel of 5,000 firms for 200 quarters in total, including a 100-quarter burn-in period from the stationary equilibrium solutions. I exclude defaulting firms when I calculate the moments, except for the credit spread. I simulate 50 artificial samples and report the cross-sample average results as model moments in Table 6.

Dynamic responses

[37] The value of the numerical derivative is sensitive to the exact value of ϵ chosen. This is a common problem with calculating numerical derivatives using simulated data with underlying discontinuities, arising, for example, from grid-point-defined value functions.

To replicate firms' differential responses in their financing decision to the interest rate shock, I simulate a panel of 5,000 firms using the updated value and policy functions along the transition path after a positive interest rate shock of 25 basis points. Specifically, I first simulate 5,000 firms for 50 quarters from initial arbitrage positions using stationary value and policy functions. Then in the 101^{th} quarter, I draw a shock of 25 basis points and simulate 5,000 firms for another 20 quarters using the updated value and policy functions along the transition path. I redo the main empirical analysis using this simulated sample. The above procedure is repeated 10 times, and the average of estimates is reported.

D Additional Results

Appendix D contains several sets of additional empirical results.

The first set of additional results contains two robustness checks of the aggregate analysis. Columns (1) to (4) of Table A.6 decompose the aggregate loans by maturity, showing that monetary shocks have a large and significant impact on short-term loans relative to long-term loans, mostly mortgages. Columns (5) to (8) decompose the measured monetary shocks, suggesting that it is the changes in the short rate ("target" component) rather than the changes in the long rate ("path" component) that drive the results.

The second set of additional results distinguish "financially constrained" firms from "unconstrained" firms using "Whited-Wu" (Whited and Wu (2006)) and the Size & Age index (Hadlock and Pierce (2010), hereafter, the "HP" index). The results in Table A.7 confirm the robustness of differential adjustments in financing decisions in response to monetary shocks.

The third set of robustness checks discuss the measures of monetary shocks. The high-frequency identification method assumes that no other news is systematically released within the narrow windows around the FOMC announcement. However, the literature on the Fed information effect have called this assumption into question: they posits that the Federal Reserve systematically reveals new information about other economic fundamentals in its meeting announcements, in addition to the pure monetary policy news. Therefore, it is important to differentiate between the two effects. This is not likely to be an issue for two reasons. First, the Fed information effect became dominant after 2007 with the adoption of unconventional monetary policy. The significant results of the pre-crisis (1990-2007) sample analysis included in Table A.8 imply that the results are more likely to be driven by the changes in the short rate. Second, Jarociński and Karadi (2020) exploit the negative and positive co-movement between interest rates and stock prices to disentangle the pure monetary policy effect from the Fed information effect. The correlation between S&P 500 stock return and the pure monetary shocks, information shocks are -0.45 and 0.23, respectively. I employ the pure monetary policy shocks constructed in Jarociński and Karadi (2020) and the results are presented in Figure A.4. Policy news shocks from Nakamura and Steinsson (2018) give similar conclusions, as shown in Table A.9.

Business cycle and monetary cycle are overlapped. The correlation between GDP growth and monetary shocks is reasonably low in this sample. To rule out the business cycle effect, I also control for a set of macroeconomic variables. In addition, Table A.10 shows the asymmetric effects of monetary policy, and it suggests that most of the results are driven by expansionary periods. The effects of monetary policy on firm-level borrowing costs, cash holding, trade credit, dividend payout decision, and excess stock return are presented in Table A.11 and Table A.12.

Table A.2: Robustness Check: Loans and Bonds Issuances

This table reports firms' loans and bonds issuance decisions in response to monetary shocks in quarter t. Coefficients are estimated from the following regressions.

$$y_{i,t} = \alpha_i + \lambda_{s,q} + \gamma\epsilon_t^m + \beta\epsilon_t^m \times (X_{i,t-1} - \mathtt{E}_i(X_{i,t})) + \eta\Delta GDP_t \times (X_{i,t-1} - \mathtt{E}_i(X_{i,t})) + \delta(X_{i,t-1} - \mathtt{E}_i(X_{i,t})) + \Gamma_1' Z_{i,t-1} + \Gamma_2' Y_{t-1} + \epsilon_{i,t}.$$

where $y_{i,t}$ is a dummy equal to one if the firm chooses to issue new loans (columns (1) to (4)) or issues new bonds (columns (5) to (8)) in quarter t. ϵ_t^m is the monetary shock, and $X_{i,t-1}$ is firm's size, credit rating or distance to default (D2D) in the previous quarter. $Z_{i,t-1}$ is a set of additional firm control variables including market-to-book ratio, liquidity, tangibility, leverage, and a dummy for dividend payout. Y_{t-1} is a set of macroeconomic variables including four lags of GDP growth and inflation rate. Monetary shocks and firm control variables are standardized. The sample covers periods from 1990Q2 to 2018Q4 (excluding the financial crisis from 2008Q3 to 2009Q2). The firm and sector-quarter fixed effects are indicated in the table. Standard errors are heteroskedasticity-robust and clustered at the firm level, and t-statistics are in parentheses. All firm-level variables are winsorized at the 1% level. $^*p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Prob(issue new loans)				Prob(issue new bonds)			
ϵ_t^m	0.006***	0.007***	0.006***	0.007***	-0.002	-0.004**	0.006***	-0.004**
	(9.402)	(9.492)	(8.498)	(10.017)	(-1.390)	(-2.367)	(3.836)	(-2.332)
$\epsilon_t^m \times$ Size		0.003***				-0.008***		
		(3.550)				(-4.024)		
$\epsilon_t^m \times \mathbb{1}$(Invest. Grade)			0.002				-0.022***	
			(1.359)				(-6.052)	
$\epsilon_t^m \times$ D2D				0.002***				-0.005***
				(2.852)				(-3.362)
Observations	158998	158998	158998	158998	53710	53710	53710	53710
R^2	0.045	0.045	0.045	0.045	0.136	0.137	0.138	0.137
Firm & Aggregate controls	Y	Y	Y	Y	Y	Y	Y	Y
Firm FE	Y	Y	Y	Y	Y	Y	Y	Y
Sector-Quarter FE	Y	Y	Y	Y	Y	Y	Y	Y

Table A.3: Robustness Check: Debt Financing Decision in Logistic Regression

This table reports firms' differential debt financing decisions in response to monetary shocks in quarter t. Coefficients are estimated from the following *logistic* regressions.

$$y_{i,t} = \alpha_i + \lambda_{s,q} + \gamma\epsilon_t^m + \beta\epsilon_t^m \times (X_{i,t-1} - \mathtt{E}_i(X_{i,t})) + \eta\Delta GDP_t \times (X_{i,t-1} - \mathtt{E}_i(X_{i,t})) \\ + \delta(X_{i,t-1} - \mathtt{E}_i(X_{i,t})) + \Gamma_1' Z_{i,t-1} + \Gamma_2' Y_{t-1} + \epsilon_{i,t}.$$

where $y_{i,t}$ is a dummy equal to one if the firm chooses bank loans over corporate bonds in quarter t. ϵ_t^m is the monetary shock, and $X_{i,t-1}$ is firm's size, credit rating or distance to default (D2D) in the previous quarter. $Z_{i,t-1}$ is a set of additional firm control variables including market-to-book ratio, liquidity, tangibility, leverage, and a dummy for dividend payout. Y_{t-1} is a set of macroeconomic variables including four lags of GDP growth and inflation rate. Monetary shocks and firm control variables are standardized. The sample covers periods from 1990Q2 to 2018Q4 (excluding the financial crisis from 2008Q3 to 2009Q2). The firm and sector-quarter fixed effects are indicated in the table. Standard errors are heteroskedasticity-robust and clustered at the firm level, and t-statistics are in parentheses. All firm-level variables are winsorized at the 1% level. $^*p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$.

	(1)	(2)	(3)	(4)
	Prob(Borrow from bank)			
ϵ_t^m	0.135***	0.140***	-0.009	0.165***
	(4.838)	(4.839)	(-0.178)	(5.682)
$\epsilon_t^m \times$ Size		0.073**		
		(2.307)		
$\epsilon_t^m \times \mathbb{1}$(Invest. Grade)			0.223***	
			(3.735)	
$\epsilon_t^m \times$ D2D				0.122***
				(3.888)
Observations	9042	9042	9042	9042
Firm & Aggregate controls	Y	Y	Y	Y
Firm FE	Y	Y	Y	Y
Sector-Quarter FE	Y	Y	Y	Y

Table A.4: Robustness Check: Maturity Basket

This table reports the impact of monetary shocks on debt financing decisions and borrowing costs over a subsample of new issuances with maturities between 3 and 8 years. Coefficients are estimated from the following regressions.

$$\begin{aligned} Credit\ Spread_{j,i,t} =& \alpha_i + \lambda_{s,q} + \gamma\epsilon_t^m + \beta\epsilon_t^m \times (X_{i,t-1} - \mathtt{E}_i(X_{i,t})) + \eta\Delta GDP_t \times (X_{i,t-1} - \mathtt{E}_i(X_{i,t})) \\ &+ \delta(X_{i,t-1} - \mathtt{E}_i(X_{i,t})) + \Gamma_1' Z_{i,t-1} + \Gamma_2' W_{j,i,t-1} + \Gamma_3' Y_{t-1} + \epsilon_{j,i,t}. \end{aligned}$$

In panel A, columns (1) to (4) report the results of loan spreads, which is the difference between the loan rate and the three-month LIBOR. Columns (5) to (8) report the results of bond spreads, which is the difference between offering yield and the three-month LIBOR. Panel B reports the results of firms' choices between loans and bonds. ϵ_t^m is the monetary shock, and $X_{i,t-1}$ is the firm size, credit rating or distance to default (D2D) in the previous quarter. $Z_{i,t-1}$ is a set of additional firm control variables including market-to-book ratio, liquidity, tangibility, leverage, and a dummy for dividend payout. $W_{j,i,t-1}$ is a set of debt characteristics including the logarithm of borrowing amount and maturity. Y_{t-1} is a set of macroeconomic variables including four lags of GDP growth and inflation rate. Monetary shocks and firm control variables are standardized. The sample covers periods from 1990Q2 to 2018Q4 (excluding the financial crisis from 2008Q3 to 2009Q2). The firm and sector-quarter fixed effects are indicated in the table. Standard errors are heteroskedasticity-robust and clustered at the firm level, and *t*-statistics are in parentheses. All firm-level variables are winsorized at the 1% level. $^*p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$.

Panel A: Credit Spread	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Loan Spread				Bond Spread			
ϵ_t^m	0.047***	0.057***	0.043***	0.063***	0.204***	0.216***	0.083	0.212***
	(4.778)	(5.580)	(3.323)	(6.228)	(4.839)	(5.014)	(0.764)	(5.151)
$\epsilon_t^m \times$ Size		0.012				-0.038		
		(1.342)				(-0.953)		
$\epsilon_t^m \times \mathbb{1}$(Invest. Grade)			0.043**				0.120	
			(2.276)				(1.037)	
$\epsilon_t^m \times$ D2D				0.025**				0.031
				(2.024)				(0.636)
Observations	13425	13425	13425	13425	2763	2763	2738	2763
R^2	0.693	0.694	0.694	0.694	0.690	0.691	0.705	0.692
Firm & Aggregate controls	Y	Y	Y	Y	Y	Y	Y	Y
Firm FE	Y	Y	Y	Y	Y	Y	Y	Y
Sector-Quarter FE	Y	Y	Y	Y	Y	Y	Y	Y

Panel B: Extensive margin	(1)	(2)	(3)	(4)
	Prob(Borrow from bank)			
ϵ_t^m	0.021***	0.023***	0.009	0.025***
	(3.764)	(3.963)	(1.130)	(4.278)
$\epsilon_t^m \times$ Size		0.011**		
		(2.437)		
$\epsilon_t^m \times \mathbb{1}$(Invest. Grade)			0.023**	
			(2.173)	
$\epsilon_t^m \times$ D2D				0.006
				(1.080)
Observations	7890	7890	7890	7890
R^2	0.418	0.419	0.419	0.418
Firm & Aggregate controls	Y	Y	Y	Y
Firm FE	Y	Y	Y	Y
Sector-Quarter FE	Y	Y	Y	Y

Table A.5: Robustness Check: Relationship Lending

This table reports the impact of monetary shocks on debt financing decisions and loan spreads. Coefficients are estimated from the following regressions.

$$
\begin{aligned}
y_{j,i,t} =& \alpha_i + \lambda_{s,q} + \gamma \epsilon_t^m + \beta \epsilon_t^m \times REL(M)_{i,k,j,t} + \eta \Delta GDP_t \times REL(M)_{i,k,j,t} \\
& + \Gamma_1' Z_{i,t-1} + \Gamma_2' W_{j,i,t-1} + \Gamma_3' Y_{t-1} + \epsilon_{j,i,t}.
\end{aligned}
$$

The relationship strength is defined as

$$
REL(Amount)_{i,k,j,t} = \frac{\text{Amount of loans by lender i to borrower j in the last 5 years(\$)}}{\text{Total amount of loans by borrower j in the last 5 years(\$)}},
$$

$$
REL(Number)_{i,k,j,t} = \frac{\text{Number of loans by lender i to borrower j in last 5 years}}{\text{Total number of loans by borrower j in last 5 years}},
$$

and $REL(Dummy)$ equals to one when $REL(Amount)_{i,k,j,t}$ is positive. Columns (1) to (4) report the results of firms' choices between loans and bonds. Columns (5) to (8) report the results of loan spreads, which is the difference between the loan rate and the three-month LIBOR. ϵ_t^m is the monetary shock, and $REL(M)_{i,k,j,t}$ is the measure of relationship strength. $Z_{i,t-1}$ is a set of firm control variables including size, distance to default, market-to-book ratio, liquidity, tangibility, leverage, a dummy for dividend payout, and a dummy for credit rating. $W_{j,i,t-1}$ is a set of debt characteristics including the logarithm of borrowing amount and maturity. Y_{t-1} is a set of macroeconomic variables including four lags of GDP growth and inflation rate. Monetary shocks and firm control variables are standardized. The sample covers periods from 1990Q2 to 2018Q4 (excluding the financial crisis from 2008Q3 to 2009Q2). The firm and sector-quarter fixed effects are indicated in the table. Standard errors are heteroskedasticity-robust and clustered at the firm level, and *t*-statistics are in parentheses. All firm-level variables are winsorized at the 1% level. $^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Prob(Borrow from bank)				Loan Spread			
ϵ_t^m	0.018***	0.016***	0.020***	0.017***	0.019**	0.048***	0.049***	0.047***
	(4.084)	(3.181)	(3.887)	(3.371)	(2.480)	(4.801)	(4.525)	(4.673)
ϵ_t^m × REL(Amount)		0.013				-0.084***		
		(1.029)				(-4.325)		
ϵ_t^m × $\mathbb{1}$(REL)			-0.005				-0.057***	
			(-0.581)				(-3.988)	
ϵ_t^m × REL(Number)				0.009				-0.085***
				(0.703)				(-4.253)
Observations	11850	11850	11850	11850	17429	17429	17429	17429
R^2	0.396	0.399	0.400	0.399	0.722	0.723	0.723	0.723
Firm & Aggregate controls	Y	Y	Y	Y	Y	Y	Y	Y
Firm FE	Y	Y	Y	Y	Y	Y	Y	Y
Sector-Quarter FE	Y	Y	Y	Y	Y	Y	Y	Y

Table A.6: Robustness Check: Aggregate Time Series Analysis

This table reports the effect of monetary shocks on aggregate debt in quarter t. Coefficients are estimated from the following regressions.

$$\Delta y_t = \alpha + \beta \epsilon_t^m + \Gamma Controls_{t-1} + \epsilon_t.$$

Columns (1) to (4) report the effects of monetary shocks ϵ_t^m on the flows of short-term and long-term loans in quarter t. Columns (5) to (8) report the separate effects of the target and path components of monetary shocks on the flows of loans and bonds. Nonfinancial corporate sector debt series are obtained from the Flow of Funds L.103. Other control variables include lagged values of the dependent variable, real GDP growth, inflation rate, unemployment, term spread, price-dividend ratio, and the forecasts of GDP growth. Monetary shocks are standardized. The sample of columns (1) to (4) covers periods from 1990Q2 to 2018Q4 (excluding the financial crisis from 2008Q3 to 2009Q2). The sample of columns (5) to (8) covers periods from 1990Q2 to 2004Q4. The t-statistics are in parentheses. All the variables are real. $^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Short-term versus Long-term Loan				Shock: Target versus Path			
					Target		Path	
	$\Delta STLoan$		$\Delta LTLoan$		$\Delta Loan$	$\Delta Bond$	$\Delta Loan$	$\Delta Bond$
ϵ_t^m	4.942***	5.516***	0.510	0.531				
	(2.985)	(3.304)	(0.611)	(0.590)				
ϵ_t^m(Target)					3.214***	-3.956**		
					(3.762)	(-2.435)		
ϵ_t^m(Path)							0.419	-0.221
							(0.348)	(-0.115)
ΔGDP_{t-1}	497.887	407.245	-57.942	-210.012	99.670	90.551	329.663*	-231.889
	(1.473)	(1.035)	(-0.279)	(-0.943)	(0.667)	(0.275)	(1.819)	(-0.681)
ΔCPI_{t-1}	900.387*	631.595	250.543	187.860	233.356	-661.484	105.047	-459.080
	(1.876)	(1.199)	(0.687)	(0.514)	(0.794)	(-1.025)	(0.308)	(-0.677)
UNEMP$_{t-1}$	-4.123**	-2.624	-3.585***	-3.319***	-1.217	11.927*	-2.777	13.544*
	(-2.134)	(-1.009)	(-4.705)	(-2.850)	(-0.306)	(1.791)	(-0.679)	(1.783)
Term Spread$_{t-1}$		-5.140**		-0.256	-1.105	-9.619**	0.698	-11.201**
		(-2.148)		(-0.184)	(-0.410)	(-2.283)	(0.238)	(-2.311)
Price-Dividend$_{t-1}$		-0.111		0.063	-0.100	0.431*	-0.139	0.476
		(-0.738)		(0.726)	(-0.552)	(1.743)	(-0.764)	(1.597)
GDP Forecast$_{t-1}$		0.764		0.729	0.317	-0.815	0.142	-0.599
		(0.795)		(1.566)	(0.656)	(-1.376)	(0.295)	(-0.942)
Observations	110	110	110	110	58	58	58	58
Adjusted R^2	0.254	0.254	0.285	0.287	0.586	0.311	0.512	0.257

Table A.7: Robustness Check: Financing Decisions and Financial Constraints

This table reports firms' differential debt and equity financing decisions in response to monetary shocks in quarter t. Coefficients are estimated from the following regressions.

$$y_{i,t} = \alpha_i + \lambda_{s,q} + \gamma\epsilon_t^m + \Gamma_1' Z_{i,t-1} + \Gamma_2' Y_{t-1} + \epsilon_{i,t}.$$

Columns (1) to (5) report financing decisions on the extensive margin, where the *dependent variable* is a dummy equal to one if the firm chooses bank loans over corporate bonds (panel A) or issues new equity (panel B) in quarter t. Columns (6) to (10) report firm financing decisions on the intensive margin, where the *dependent variable* is the growth rate of loans (panel A) or equity share (panel B) in quarter t. Financial constraints are measured by the "Whited-Wu" index or the "HP" index. Columns (2), (3), (7), and (8) show results for financially constrained firms, while columns (4), (5), (9), and (10) show results for financially unconstrained firms. ϵ_t^m is the monetary shock and $Z_{i,t-1}$ is a set of firm control variables including size, market-to-book ratio, liquidity, tangibility, leverage, distance to default, a dummy for dividend payout, and a dummy for investment grade firms. Y_{t-1} is a set of macroeconomic variables including four lags of GDP growth and inflation rate. Monetary shocks and firm control variables are standardized. The sample covers periods from 1990Q2 to 2018Q4 (excluding the financial crisis from 2008Q3 to 2009Q2). The firm and sector-quarter fixed effects are indicated in the table. Standard errors are heteroskedasticity-robust and clustered at the firm level, and t-statistics are in parentheses. All firm-level variables are winsorized at the 1% level. $^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$.

	The Extensive Margin					The Intensive Margin				
	(1) Full Sample	(2) Constrained Firms Top Tercile	(3)	(4) Unconstrained Firms Bottom Tercile	(5)	(6) Full Sample	(7) Constrained Firms Top Tercile	(8)	(9) Unconstrained Firms Bottom Tercile	(10)
		WW	HP	WW	HP		WW	HP	WW	HP
Panel A: Debt Financing	Prob(Borrow from bank)					Δlog(Loan)				
ϵ_t^m	0.014***	-0.006	-0.003	0.012*	0.031***	0.275***	0.119	0.097	0.452***	0.420***
	(3.130)	(-0.726)	(-0.353)	(1.691)	(4.383)	(3.332)	(1.022)	(0.790)	(3.158)	(3.096)
Observations	11850	3392	3357	4161	4401	184939	52769	48611	70801	73011
R^2	0.400	0.477	0.484	0.388	0.361	0.094	0.171	0.186	0.092	0.084
Panel B: Equity Financing	Prob(Net new issuance)					ΔEquity share				
ϵ_t^m	0.215***	0.516***	0.612***	-0.058	-0.016	0.124***	0.162***	0.200***	0.080***	0.075***
	(4.469)	(4.472)	(4.766)	(-0.928)	(-0.266)	(6.322)	(2.807)	(2.898)	(4.366)	(4.174)
Observations	298562	87664	81327	112169	116547	241814	63221	56969	101215	103831
R^2	0.141	0.202	0.208	0.085	0.066	0.133	0.168	0.176	0.116	0.102
Firm & Aggregate controls	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Firm FE	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Sector-Quarter FE	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y

Table A.8: Robustness Check: Pre-crisis Periods (1990-2007)

This table reports firms' differential debt and equity financing decisions in response to monetary shocks in quarter t. Coefficients are estimated from the following regressions.

$$
\begin{aligned}
y_{i,t} =& \alpha_i + \lambda_{s,q} + \gamma\epsilon_t^m + \beta\epsilon_t^m \times (X_{i,t-1} - \mathtt{E}_i(X_{i,t})) + \eta\Delta GDP_t \times (X_{i,t-1} - \mathtt{E}_i(X_{i,t})) \\
&+ \delta(X_{i,t-1} - \mathtt{E}_i(X_{i,t})) + \Gamma_1' Z_{i,t-1} + \Gamma_2' Y_{t-1} + \epsilon_{i,t}.
\end{aligned}
$$

Columns (1) to (4) report financing decisions on the extensive margin, where the *dependent variable* is a dummy equal to one if the firm chooses bank loans over corporate bonds (panel A) or issues new equity (panel B) in quarter t. Columns (5) to (8) report financing decisions on the intensive margin, where the *dependent variable* is the growth rate of loans (panel A) or equity share (panel B) in quarter t. ϵ_t^m is the monetary shock, and $X_{i,t-1}$ is firm size, credit rating or distance to default (D2D) in the previous quarter. $Z_{i,t-1}$ is a set of additional firm control variables including market-to-book ratio, liquidity, tangibility, leverage, and a dummy for dividend payout. Y_{t-1} is a set of macroeconomic variables including four lags of GDP growth and inflation rate. Monetary shocks and firm control variables are standardized. The sample covers periods from 1990Q2 to 2007Q4. The firm and sector-quarter fixed effects are indicated in the table. Standard errors are heteroskedasticity-robust and clustered at the firm level, and *t*-statistics are in parentheses. All firm-level variables are winsorized at the 1% level. $^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$.

	The Extensive Margin				The Intensive Margin			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Panel A: Debt Financing	Prob(Borrow from bank)				Δlog(Loan)			
ϵ_t^m	0.021***	0.019***	0.000	0.025***	0.387***	0.330***	0.257**	0.376***
	(4.126)	(3.687)	(0.015)	(4.651)	(3.955)	(3.436)	(2.482)	(3.826)
$\epsilon_t^m \times$ Size		0.016***				0.227***		
		(3.242)				(2.784)		
$\epsilon_t^m \times \mathbb{1}$(Invest. Grade)			0.035***				0.563**	
			(3.568)				(2.356)	
$\epsilon_t^m \times$ D2D				0.027***				0.279***
				(5.216)				(3.041)
Observations	8414	8414	8414	8414	138677	138677	138677	138677
R^2	0.466	0.467	0.467	0.468	0.113	0.113	0.114	0.114
Panel B: Equity Financing	Prob(Net new issuance)				ΔEquity share			
ϵ_t^m	0.304***	0.312***	0.301***	0.196***	0.109***	0.110***	0.106***	0.091***
	(5.061)	(5.029)	(4.608)	(2.998)	(4.407)	(4.080)	(3.855)	(3.684)
$\epsilon_t^m \times$ Size		-0.154***				-0.069***		
		(-2.607)				(-2.663)		
$\epsilon_t^m \times \mathbb{1}$(Invest. Grade)			-0.034				-0.052	
			(-0.265)				(-1.374)	
$\epsilon_t^m \times$ D2D				-0.019				-0.103***
				(-0.350)				(-4.679)
Observations	226091	226091	226091	184689	184684	184684	184684	184684
R^2	0.143	0.143	0.143	0.152	0.149	0.149	0.149	0.149
Firm & Aggregate controls	Y	Y	Y	Y	Y	Y	Y	Y
Firm FE	Y	Y	Y	Y	Y	Y	Y	Y
Sector-Quarter FE	Y	Y	Y	Y	Y	Y	Y	Y

Table A.9: Robustness Check: Financing Decisions and Policy News Shocks

This table reports firms' differential debt and equity financing decisions in response to policy news shocks from Nakamura and Steinsson (2018) in quarter t. Coefficients are estimated from the following regressions.

$$\begin{aligned} y_{i,t} =&\alpha_i + \lambda_{s,q} + \gamma\epsilon_t^m + \beta\epsilon_t^m \times (X_{i,t-1} - \mathtt{E}_i(X_{i,t})) + \eta\Delta GDP_t \times (X_{i,t-1} - \mathtt{E}_i(X_{i,t})) \\ &+\delta(X_{i,t-1} - \mathtt{E}_i(X_{i,t})) + \Gamma_1' Z_{i,t-1} + \Gamma_2' Y_{t-1} + \epsilon_{i,t}. \end{aligned}$$

Columns (1) to (4) report financing decisions on the extensive margin, where the *dependent variable* is a dummy equal to one if the firm chooses bank loans over corporate bonds (panel A) or issues new equity (panel B) in quarter t. Columns (5) to (8) report financing decisions on the intensive margin, where the *dependent variable* is the growth rate of loans (panel A) or equity share (panel B) in quarter t. ϵ_t^m is the monetary shock, and $X_{i,t-1}$ is firm's size, credit rating or distance to default (D2D) in the previous quarter. $Z_{i,t-1}$ is a set of additional firm control variables including market-to-book ratio, liquidity, tangibility, leverage, and a dummy for dividend payout. Y_{t-1} is a set of macroeconomic variables including four lags of GDP growth and inflation rate. Monetary shocks and firm control variables are standardized. The sample covers periods from 1995Q1 to 2018Q4 (excluding the financial crisis from 2008Q3 to 2009Q2). The firm and sector-quarter fixed effects are indicated in the table. Standard errors are heteroskedasticity-robust and clustered at the firm level, and t-statistics are in parentheses. All firm-level variables are winsorized at the 1% level. $^*p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$.

	The Extensive Margin				The Intensive Margin			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Panel A: Debt Financing	Prob(Borrow from bank)				Δlog(Loan)			
ϵ_t^m	0.003	0.004	0.002	0.007	0.518***	0.572***	0.283***	0.517***
	(0.703)	(0.878)	(0.382)	(1.532)	(6.533)	(6.937)	(3.391)	(6.395)
$\epsilon_t^m \times$ Size		0.001				0.535***		
		(0.360)				(6.861)		
$\epsilon_t^m \times \mathbb{1}$(Invest. Grade)			0.002				1.280***	
			(0.284)				(5.624)	
$\epsilon_t^m \times$ D2D				0.008*				0.139
				(1.748)				(1.601)
Observations	11707	11707	11707	11707	152065	152065	152065	152065
R^2	0.391	0.391	0.391	0.391	0.101	0.102	0.102	0.101
Panel B: Equity Financing	Prob(Net new issuance)				ΔEquity share			
ϵ_t^m	0.279***	0.274***	0.288***	0.213***	0.200***	0.184***	0.207***	0.136***
	(5.479)	(5.524)	(5.168)	(3.849)	(8.877)	(8.375)	(8.163)	(5.938)
$\epsilon_t^m \times$ Size		-0.130**				-0.087***		
		(-2.483)				(-3.297)		
$\epsilon_t^m \times \mathbb{1}$(Invest. Grade)			0.014				-0.137***	
			(0.130)				(-3.816)	
$\epsilon_t^m \times$ D2D				-0.028				-0.189***
				(-0.507)				(-8.127)
Observations	251505	251505	251505	201595	201585	201585	201585	201585
R^2	0.150	0.150	0.150	0.159	0.140	0.140	0.140	0.140
Firm & Aggregate controls	Y	Y	Y	Y	Y	Y	Y	Y
Firm FE	Y	Y	Y	Y	Y	Y	Y	Y
Sector-Quarter FE	Y	Y	Y	Y	Y	Y	Y	Y

Table A.10: Robustness Check: Asymmetric Effects: Expansionary versus Contractionary

This table reports firms' differential debt and equity financing decisions in response to the expansionary or contractionary monetary shocks, separately, in quarter t. Coefficients are estimated from the following regressions.

$$
\begin{aligned}
y_{i,t} =& \alpha_i + \lambda_{s,q} + \gamma_p \epsilon_t^m(\epsilon_t^m > 0) + \gamma_n \epsilon_t^m(\epsilon_t^m < 0) + \beta_p \epsilon_t^m(\epsilon_t^m > 0) \times (X_{i,t-1} - \mathtt{E}_i(X_{i,t})) \\
&+ \beta_n \epsilon_t^m(\epsilon_t^m < 0) \times (X_{i,t-1} - \mathtt{E}_i(X_{i,t})) + \eta \Delta GDP_t \times (X_{i,t-1} - \mathtt{E}_i(X_{i,t})) \\
&+ \delta(X_{i,t-1} - \mathtt{E}_i(X_{i,t})) + \Gamma_1' Z_{i,t-1} + \Gamma_2' Y_{t-1} + \epsilon_{i,t}.
\end{aligned}
$$

Columns (1) to (4) report financing decisions on the extensive margin, where the *dependent variable* is a dummy equal to one if the firm chooses bank loans over corporate bonds (panel A) or issues new equity (panel B) in quarter t. Columns (5) to (8) report financing decisions on the intensive margin, where the *dependent variable* is the growth rate of loans (panel A) or equity share (panel B) in quarter t. ϵ_t^m is the monetary shock, and $X_{i,t-1}$ is firm size, credit rating or distance to default (D2D) in the previous quarter. $Z_{i,t-1}$ is a set of additional firm control variables including market-to-book ratio, liquidity, tangibility, leverage, and a dummy for dividend payout. Y_{t-1} is a set of macroeconomic variables including four lags of GDP growth and inflation rate. Monetary shocks and firm control variables are standardized. The sample covers periods from 1990Q2 to 2018Q4 (excluding the financial crisis from 2008Q3 to 2009Q2). The firm and sector-quarter fixed effects are indicated in the table. Standard errors are heteroskedasticity-robust and clustered at the firm level, and *t*-statistics are in parentheses. All firm-level variables are winsorized at the 1% level. $^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$.

	The Extensive Margin				The Intensive Margin			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Panel A: Debt Financing	Prob(Borrow from bank)				Δlog(Loan)			
$\epsilon_t^m(\epsilon_t^m > 0)$	0.026***	0.030***	0.028**	0.027***	0.296	0.228	0.208	0.227
	(2.707)	(3.102)	(2.039)	(2.807)	(1.582)	(1.161)	(1.031)	(1.206)
$\epsilon_t^m(\epsilon_t^m < 0)$	0.015***	0.015***	-0.018*	0.022***	0.448***	0.422***	0.297***	0.492***
	(2.765)	(2.611)	(-1.816)	(4.010)	(4.356)	(4.142)	(2.654)	(4.701)
$\epsilon_t^m(\epsilon_t^m > 0) \times$ Size		0.001				-0.086		
		(0.140)				(-0.542)		
$\epsilon_t^m(\epsilon_t^m < 0) \times$ Size		0.012**				0.358***		
		(2.359)				(3.774)		
$\epsilon_t^m(\epsilon_t^m > 0) \times \mathbb{1}$(Invest. Grade)			0.003				0.194	
			(0.144)				(0.378)	
$\epsilon_t^m(\epsilon_t^m < 0) \times \mathbb{1}$(Invest. Grade)			0.051***				0.668***	
			(4.370)				(2.636)	
$\epsilon_t^m(\epsilon_t^m > 0) \times$ D2D				0.002				0.154
				(0.222)				(0.837)
$\epsilon_t^m(\epsilon_t^m < 0) \times$ D2D				0.025***				0.344***
				(3.796)				(3.237)
Observations	11850	11850	11850	11850	184939	184939	184939	184939
R^2	0.396	0.397	0.398	0.397	0.094	0.094	0.094	0.094
Panel B: Equity Financing	Prob(Net new issuance)				ΔEquity share			
$\epsilon_t^m(\epsilon_t^m > 0)$	0.060	0.023	0.098	-0.024	0.113***	0.078**	0.095**	0.105**
	(0.559)	(0.221)	(0.828)	(-0.202)	(2.646)	(1.989)	(1.975)	(2.473)
$\epsilon_t^m(\epsilon_t^m < 0)$	0.406***	0.428***	0.376***	0.351***	0.149***	0.152***	0.144***	0.104***
	(6.727)	(6.910)	(5.585)	(5.315)	(5.967)	(5.659)	(5.097)	(4.129)
$\epsilon_t^m(\epsilon_t^m > 0) \times$ Size		-0.271**				-0.068		
		(-2.230)				(-1.324)		
$\epsilon_t^m(\epsilon_t^m < 0) \times$ Size		-0.014				-0.059**		
		(-0.225)				(-2.023)		
$\epsilon_t^m(\epsilon_t^m > 0) \times \mathbb{1}$(Invest. Grade)			-0.189				-0.008	
			(-0.763)				(-0.109)	
$\epsilon_t^m(\epsilon_t^m < 0) \times \mathbb{1}$(Invest. Grade)			0.309**				-0.042	
			(2.220)				(-0.950)	
$\epsilon_t^m(\epsilon_t^m > 0) \times$ D2D				-0.030				-0.027
				(-0.256)				(-0.659)
$\epsilon_t^m(\epsilon_t^m < 0) \times$ D2D				0.055				-0.162***
				(0.859)				(-6.187)
Observations	298562	298562	298562	241825	241814	241814	241814	241814
R^2	0.141	0.141	0.141	0.148	0.133	0.133	0.133	0.133
Firm & Aggregate controls	Y	Y	Y	Y	Y	Y	Y	Y
Firm FE	Y	Y	Y	Y	Y	Y	Y	Y
Sector-Quarter FE	Y	Y	Y	Y	Y	Y	Y	Y

Table A.11: Robustness Check: Firm-Level Borrowing Costs

This table reports the impact of monetary shocks on firm-level borrowing costs (weighted average credit spreads by borrowing amount). Coefficients are estimated from the following regressions.

$$
\begin{aligned}
Credit\ Spread_{i,t} =& \alpha_i + \lambda_{s,q} + \gamma\epsilon_t^m + \beta\epsilon_t^m \times (X_{i,t-1} - \mathtt{E}_i(X_{i,t})) + \eta\Delta GDP_t \times (X_{i,t-1} - \mathtt{E}_i(X_{i,t})) \\
&+\delta(X_{i,t-1} - \mathtt{E}_i(X_{i,t})) + \Gamma_1' Z_{i,t-1} + \Gamma_2' W_{i,t-1} + \Gamma_3' Y_{t-1} + \epsilon_{i,t}.
\end{aligned}
$$

Columns (1) to (4) report the results of loan spreads, which is the difference between the loan rate and the three-month LIBOR. Columns (5) to (8) (columns (9) to (12)) report the results of bond spreads, which is defined as the difference between the offering yield and the three-month LIBOR (maturity-matched interest rate swaps). ϵ_t^m is the monetary shock, and $X_{i,t-1}$ is the firm size, credit rating or distance to default (D2D) in the previous quarter. $Z_{i,t-1}$ is a set of additional firm control variables including market-to-book ratio, liquidity, tangibility, leverage, and a dummy for dividend payout. $W_{i,t-1}$ is a set of debt characteristics including the logarithm of borrowing amount and maturity. Y_{t-1} is a set of macroeconomic variables including four lags of GDP growth and the inflation rate. Monetary shocks and firm control variables are standardized. The sample covers periods from 1990Q2 to 2018Q4 (excluding the financial crisis from 2008Q3 to 2009Q2). The firm and sector-quarter fixed effects are indicated in the table. Standard errors are heteroskedasticity-robust and clustered at the firm level, and t-statistics are in parentheses. All firm-level variables are winsorized at the 1% level. $^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	Loan Spread				Bond Spread (3M LIBOR)				Bond Spread (Swaps)			
ϵ_t^m	0.035***	0.041***	0.033*	0.047***	0.217***	0.227***	0.203***	0.235***	0.095***	0.108***	0.073	0.111***
	(3.467)	(3.965)	(1.851)	(4.537)	(10.375)	(10.602)	(4.150)	(11.176)	(5.382)	(6.108)	(1.629)	(6.457)
$\epsilon_t^m \times$ Size		0.013				0.005				0.003		
		(1.331)				(0.213)				(0.126)		
$\epsilon_t^m \times \mathbb{1}$(Invest. Grade)			0.011				0.005				0.004	
			(0.521)				(-0.031)				(0.095)	
$\epsilon_t^m \times$ D2D				0.031**				0.053**				0.016
				(2.403)				(2.014)				(0.715)
Observations	6525	6525	6525	6525	5370	5370	5279	5370	5409	5409	5317	5409
R^2	0.655	0.655	0.655	0.655	0.616	0.617	0.632	0.618	0.695	0.697	0.718	0.697
Firm & Aggregate controls	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Firm FE	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Sector-Quarter FE	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y

Table A.12: Robustness Check: Other (Real) Effects

This table reports the impact of monetary shocks on firm-level trade credit, cash holding, dividend payout (dummy), and stock excess return. Coefficients are estimated from the following regressions.

$$y_{i,t} = \alpha_i + \lambda_{s,q} + \gamma \epsilon_t^m + \beta \epsilon_t^m \times (X_{i,t-1} - \mathtt{E}_i(X_{i,t})) + \eta \Delta GDP_t \times (X_{i,t-1} - \mathtt{E}_i(X_{i,t})) + \delta(X_{i,t-1} - \mathtt{E}_i(X_{i,t})) + \Gamma_1' Z_{i,t-1} + \Gamma_2' Y_{t-1} + \epsilon_{i,t}.$$

ϵ_t^m is the monetary shock, and $X_{i,t-1}$ is the firm size, credit rating or distance to default (D2D) in the previous quarter. $Z_{i,t-1}$ is a set of additional firm control variables, including market-to-book ratio, liquidity, tangibility, leverage, and a dummy for dividend payout. Y_{t-1} is a set of macroeconomic variables including four lags of GDP growth and inflation rate. Monetary shocks and firm control variables are standardized. The sample covers periods from 1990Q2 to 2018Q4 (excluding the financial crisis from 2008Q3 to 2009Q2). The firm and sector-quarter fixed effects are indicated in the table. Standard errors are heteroskedasticity-robust and clustered at the firm level, and *t*-statistics are in parentheses. All firm-level variables are winsorized at the 1% level. $^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Trade Credit				Cash Holding			
ϵ_t^m	-0.054**	-0.042*	-0.054**	-0.027	0.043*	0.058**	0.039	0.058**
	(-2.298)	(-1.718)	(-1.965)	(-1.195)	(1.645)	(2.171)	(1.325)	(2.117)
$\epsilon_t^m \times$ Size		0.045*				0.130***		
		(1.743)				(4.893)		
$\epsilon_t^m \times \mathbb{1}$(Invest. Grade)			0.092***				0.148***	
			(2.793)				(2.585)	
$\epsilon_t^m \times$ D2D				0.087***				-0.029
				(3.871)				(-1.085)
Observations	241825	241825	241825	241825	241825	241825	241825	241825
R^2	0.648	0.648	0.648	0.648	0.795	0.795	0.795	0.795
	Dividend Payout (Dummy)				Stock Excess Return			
ϵ_t^m	-0.205***	-0.259***	-0.175**	-0.265***	-1.347***	-1.585***	-1.643***	-1.570***
	(-2.839)	(-3.451)	(-2.202)	(-3.567)	(-19.288)	(-22.222)	(-20.775)	(-22.962)
$\epsilon_t^m \times$ Size		-0.269***				0.165**		
		(-3.121)				(2.329)		
$\epsilon_t^m \times \mathbb{1}$(Invest. Grade)			-0.595***				0.416***	
			(-2.673)				(3.190)	
$\epsilon_t^m \times$ D2D				-0.007				0.024
				(-0.093)				(0.346)
Observations	241825	241825	241825	241825	240879	240879	240879	240879
R^2	0.559	0.560	0.559	0.559	0.134	0.137	0.137	0.137
Firm & Aggregate controls	Y	Y	Y	Y	Y	Y	Y	Y
Firm FE	Y	Y	Y	Y	Y	Y	Y	Y
Sector-Quarter FE	Y	Y	Y	Y	Y	Y	Y	Y

Table A.13: Loan Types: Credit Lines versus Term Loans

This table reports firms' differential debt choices and loan spread in response to monetary shocks in quarter t on the extensive margin, for credit lines and term loans separately. Coefficients are estimated from the following regressions:

$$y_{i,t} = \alpha_i + \lambda_{s,q} + \gamma\epsilon_t^m + \beta\epsilon_t^m \times (X_{i,t-1} - \mathbb{E}_i(X_{i,t-1})) + \eta\Delta GDP_t \times (X_{i,t-1} - \mathbb{E}_i(X_{i,t-1})) + \delta(X_{i,t-1} - \mathbb{E}_i(X_{i,t-1})) + \Gamma_1' Z_{i,t-1} + \Gamma_2' Y_{t-1} + \epsilon_{i,t}.$$

In panel A, columns (1) to (4) report debt choices between credit lines and bonds. Columns (5) to (8) report debt choices between term loans and bonds. Panel B reports the effects on the credit spread. ϵ_t^m is the monetary shock, and $X_{i,t-1}$ is firm size, credit rating, or distance to default (D2D) in the previous quarter. $Z_{i,t-1}$ is a set of additional firm control variables including market-to-book ratio, liquidity, leverage, and a dummy for the dividend payout. Y_{t-1} is a set of macroeconomic variables including four lags of GDP growth and the inflation rate. Monetary shocks and firm control variables are standardized. The sample covers periods from 1990Q2 to 2018Q4 (excluding the financial crisis from 2008Q3 to 2009Q2). The firm and sector-quarter fixed effects are indicated in the table. Standard errors are heteroskedasticity-robust and clustered at the firm level, and t-statistics are in parentheses. All firm-level variables are winsorized at the 1% level. $^*p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Credit Lines				Term Loans			
	Panel A: Prob(Borrow from bank) (Extensive)							
ϵ_t^m	0.018***	0.019***	-0.009	0.022***	0.004	0.005	0.009	0.007*
	(3.933)	(4.001)	(-1.228)	(4.831)	(1.031)	(1.293)	(0.888)	(1.754)
$\epsilon_t^m \times$ Size		0.009**				0.006		
		(2.068)				(1.288)		
$\epsilon_t^m \times \mathbb{1}$(Invest. Grade)			0.043***				-0.004	
			(4.645)				(-0.397)	
$\epsilon_t^m \times$ D2D				0.021***				0.006
				(4.267)				(1.340)
Observations	11399	11399	11399	11399	7788	7788	7788	7788
R^2	0.406	0.407	0.408	0.408	0.533	0.534	0.534	0.534
	Panel B: Loan Spread							
ϵ_t^m	0.019***	0.026***	0.030***	0.030***	0.035	0.054**	0.012	0.061**
	(2.806)	(3.645)	(2.905)	(4.126)	(1.530)	(2.268)	(0.494)	(2.535)
$\epsilon_t^m \times$ Size		-0.010				0.040*		
		(-1.587)				(1.727)		
$\epsilon_t^m \times \mathbb{1}$(Invest. Grade)			-0.011				0.192***	
			(-0.874)				(3.173)	
$\epsilon_t^m \times$ D2D				0.021**				0.030
				(2.399)				(1.053)
Observations	11988	11988	11988	11988	4502	4502	4502	4502
R^2	0.741	0.741	0.741	0.741	0.640	0.641	0.642	0.641
Firm & Aggregate controls	Y	Y	Y	Y	Y	Y	Y	Y
Firm FE	Y	Y	Y	Y	Y	Y	Y	Y
Sector-Quarter FE	Y	Y	Y	Y	Y	Y	Y	Y

Table A.14: Control for Supply-side Effects

This table reports firms' loan borrowing amount and cost in response to monetary shocks with the control of the supply-side effects. Coefficients are estimated from the following regressions:

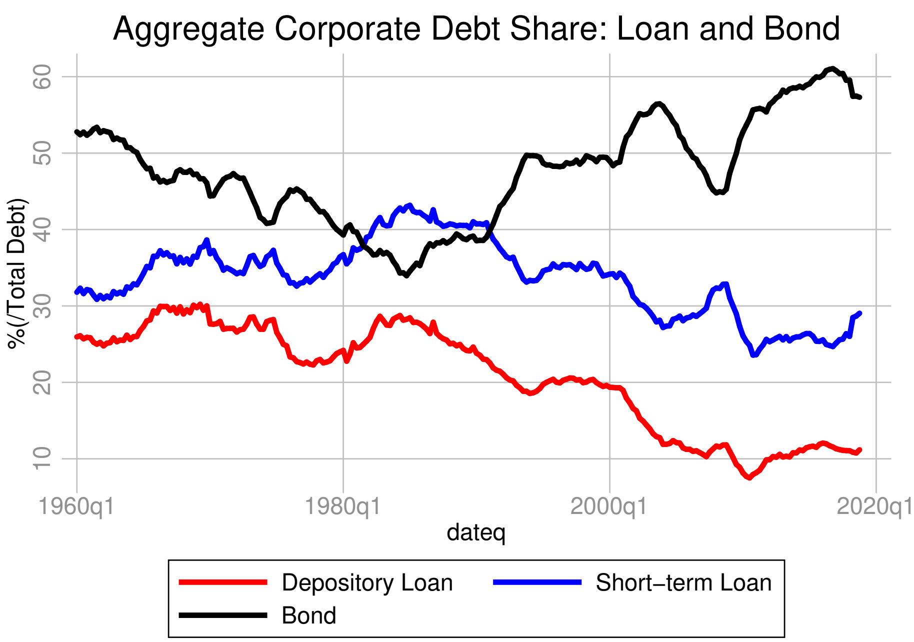
$$\begin{aligned}y_{j,i,k,t} =& \alpha_{k,t} + \gamma\epsilon_t^m + \beta\epsilon_t^m \times (X_{i,t-1} - \mathbb{E}_i(X_{i,t-1})) + \delta(X_{i,t-1} - \mathbb{E}_i(X_{i,t-1})) \\ &+ \Gamma_1' Z_{i,t-1} + \Gamma_2' W_{j,i,k,t-1} + \Gamma_3' Y_{k,t-1} + \epsilon_{j,i,k,t}.\end{aligned}$$

Panel A reports the dollar issuance share, and panel B reports the loan spread of loan j from bank k to firm i in quarter t. ϵ_t^m is the monetary shock, and $X_{i,t-1}$ is firm size, credit rating, or distance to default (D2D) in the previous quarter. $Z_{i,t-1}$ is a set of firm control variables including market-to-book ratio, liquidity, leverage, distance to default, and a dummy for the dividend payout. $W_{j,t-1}$ is a set of security control variables including maturity and a dummy for secured loans. $Y_{k,t-1}$ is a set of bank control variables including bank size, capital ratio, return to equity, and ratio of non-performing loans. Monetary shocks and firm control variables are standardized. The sample covers periods from 1990Q2 to 2018Q4 (excluding the financial crisis from 2008Q3 to 2009Q2). The bank-time fixed effect is indicated in the table. Standard errors are heteroskedasticity-robust and clustered at the bank, firm, and time level, and *t*-statistics are in parentheses. All variables are winsorized at the 1% level. $^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$.

	(1)	(2)	(3)	(4)	(5)	(6)
	$\frac{\text{Issuance}_{j,t}}{\text{Total Business Loan}_{k,t-1}}$			log(Loan Spread)$_{j,t}$		
ϵ_t^m × Size	0.364*			0.014		
	(1.897)			(1.653)		
$\epsilon_t^m \times \mathbb{1}$(Invest. Grade)		0.478*			0.043*	
		(1.752)			(1.912)	
ϵ_t^m × D2D			0.259			0.033***
			(1.687)			(3.042)
Observations	13085	13085	13085	13078	13078	13078
R^2	0.569	0.568	0.568	0.705	0.705	0.706
Firm controls	Y	Y	Y	Y	Y	Y
Bank controls	Y	Y	Y	Y	Y	Y
Debt controls	Y	Y	Y	Y	Y	Y
Bank-Time FE	Y	Y	Y	Y	Y	Y

Figure A.1: Aggregate Time Series of Corporate Debt

This figure plots the time series of debt ratio: loan/total debt and bond/total debt of the nonfinancial corporate sector from 1960Q1 to 2018Q4. Total debt is defined as the sum of debt securities and loans. Data are obtained from the Flow of Funds L.103. Corporate bonds and loans are negatively correlated. A shift from bank debt to market debt takes place over time.



Nonfinancial corporate business	1980Q1	2008Q2	2018Q4
Debt securities	412	3,499	6,310
Commercial paper	31	140	196
Municipal securities	37	404	571
Corporate bonds	344	2,955	5,542
Loans	463	3,070	3,339
Depository institution loans n.e.c.	212	759	1,003
Other loans and advances	110	1,362	1,710
Total mortgages	142	949	626

Figure A.2: Aggregate Time Series of Corporate Debt: Other Types

This figure plots the time series of other types of corporate debt from 1975Q1 to 2018Q4. It includes Commercial and Industrial (C&I) loans, commercial paper, consumer loans, and real estate loans. Data are obtained from the St. Louis Fed's FRED database.

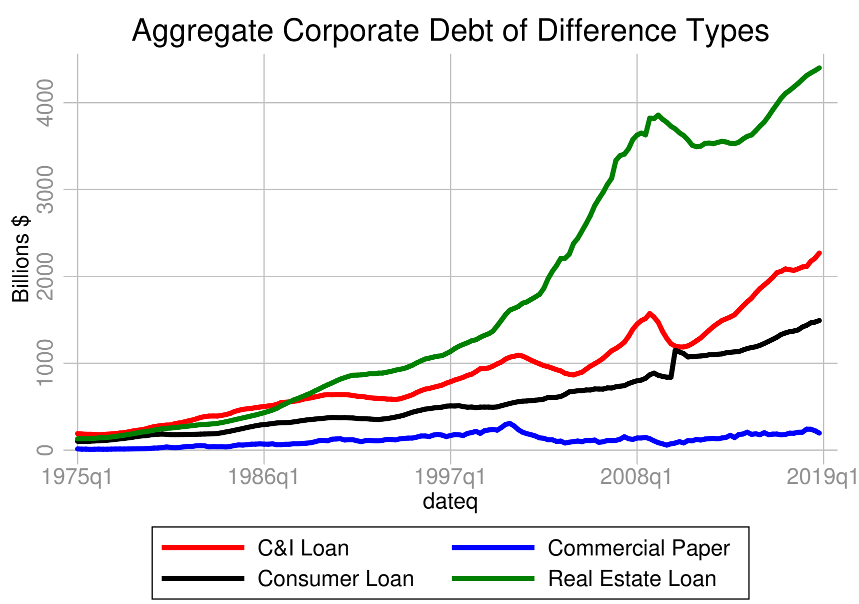


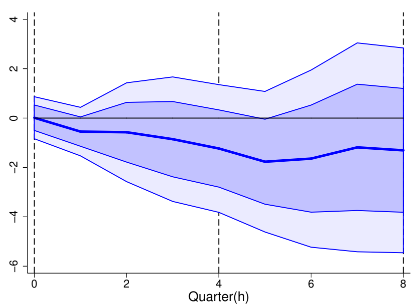
Figure A.3: Dynamic Effects of Monetary Shocks on Debt

These figures plot the impulse responses to a one-standard-deviation monetary shock ϵ_t^m based on the identification approach by Gürkaynak et al. (2005) and Gorodnichenko and Weber (2016) at a quarterly frequency and the local projection specification. Coefficient estimates β_h from the following regressions are plotted over time horizon h:

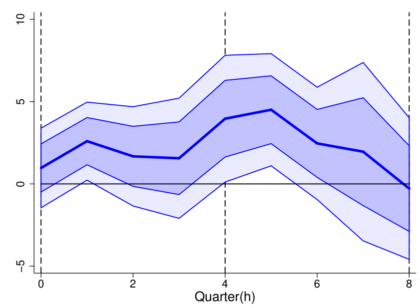
$$y_{t+h} - y_{t-1} = \alpha_h + \beta_h \epsilon_t^m + \Gamma_h Controls_{t-1} + \epsilon_{t+h},$$

where $h = 0, 1, 2, ..., 8$, and y is the log(real credit). The control variables include one year of lagged values of the monetary policy shock and one year of lagged values of the one-quarter change in the respective dependent variable, real GDP growth, inflation rate, unemployment, term spread, SLOOS tightening standards, and the forecasts of GDP growth and unemployment. The shaded areas are 68% and 90% error bands. The debt series are obtained from the Flow of Funds L.103 and the St. Louis Fed. The sample covers the periods from 1990Q2 to 2018Q4.

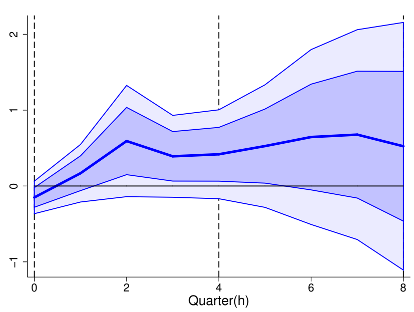
(a) β_h for Mortgages (%)



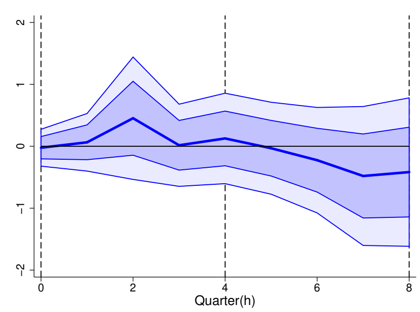
(b) β_h for Commercial Paper (%)



(c) β_h for Commercial & Industrial Loans (%)



(d) β_h for Real Estate Loans (%)



(e) β_h for Trade Credit (%)

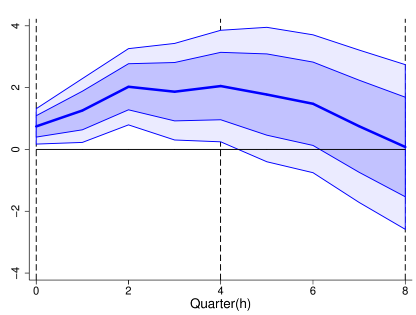


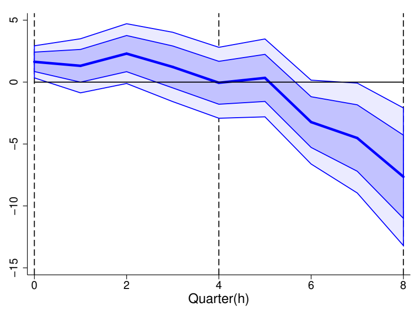
Figure A.4: Dynamic Effects of Pure Interest Rate Shocks and Information Shocks

These figures plot the impulse responses to a one-standard-deviation pure interest rate shocks and information shocks ϵ_t^m based on the identification approach by Jarociński and Karadi (2020) at a quarterly frequency and the local projection specification. Coefficient estimates β_h from the following regressions are plotted over time horizon h:

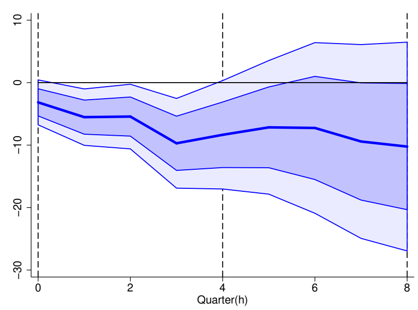
$$y_{t+h} - y_{t-1} = \alpha_h + \beta_h \epsilon_t^m + \Gamma_h Controls_{t-1} + \epsilon_{t+h},$$

where $h = 0, 1, 2, ..., 8$, and y is the real credit (Billions of 1982 U.S. Dollars). The control variables include one year of lagged values of the monetary policy shock and one year of lagged values of the one-quarter change in the respective dependent variable, real GDP growth, inflation rate, unemployment, term spread, SLOOS tightening standards, and the forecasts of GDP growth and unemployment. The shaded areas are 68% and 90% error bands. The debt series are obtained from the Flow of Funds L.103. The sample covers the periods from 1990Q2 to 2018Q4.

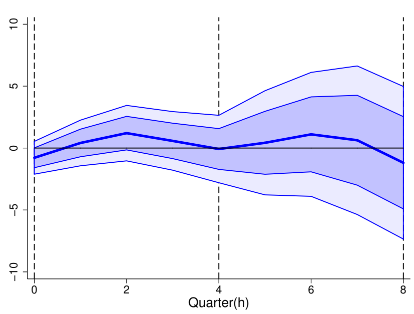
(a) Monetary policy: β_h for Bank Loans



(b) Monetary policy: β_h for Corporate Bonds



(c) CB information: β_h for Bank Loans



(d) CB information: β_h for Corporate Bonds

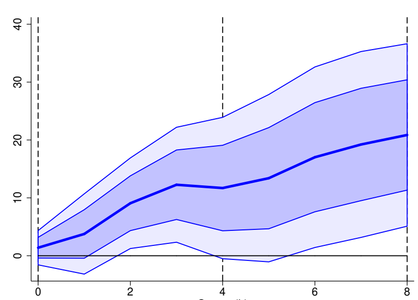


Figure A.5: Moody's Recovery by Debt Type

As can be seen in Exhibit 4, bank loans recover an average of 82 percent at a resolution on a discounted basis with a corresponding median of 100 percent. In contrast, senior secured bonds recover an average of 65 percent with a median of 67 percent. Discounted ultimate recovery rates on bonds vary from 38 percent for senior unsecured bonds to 15 percent for junior subordinated bonds. Across all bonds, the average recovery rate is 37 percent, with a median of 24 percent. Exhibit 5 shows the distributions of loan and bond recovery rates, indicating strong skewness in both distributions whereby the probability of full recovery for loans is relatively high, and the probability of low recovery for bonds is also relatively high. **Source: Moody's recovery database**

Exhibit 4

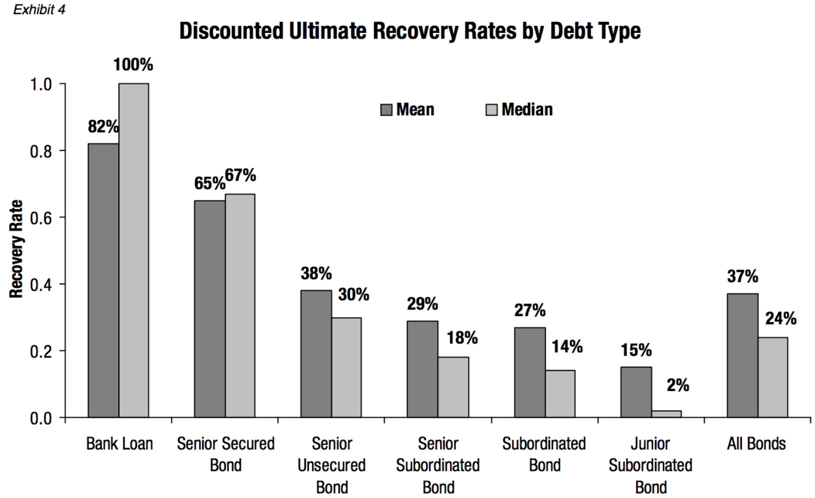


Exhibit 5

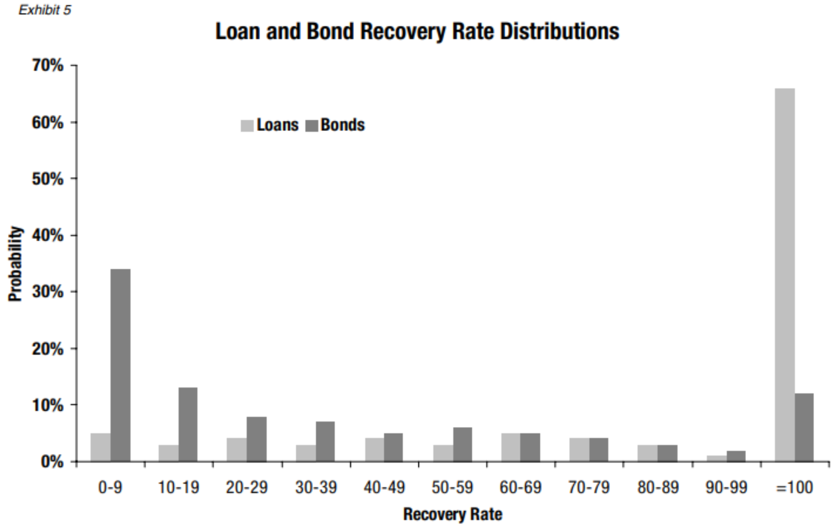
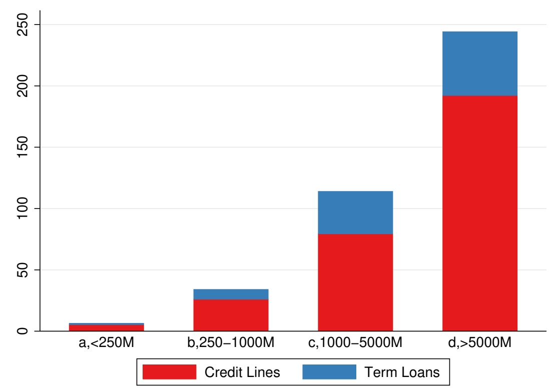


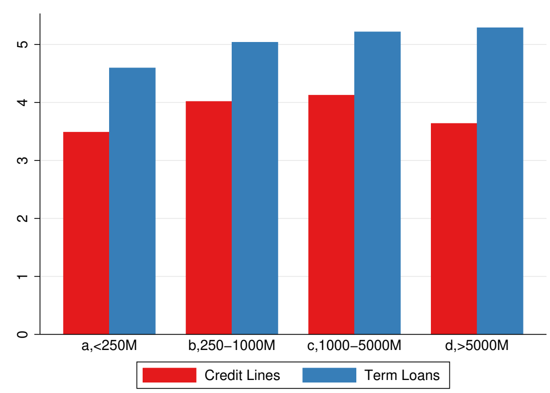
Figure A.6: Loan Distribution across Firm Size: Credit Lines and Term Loans

The figures show the distributions of credit lines and term loans from DealScan across public firm size from 1990Q1 to 2018Q4. The top figure shows the total dollar amount of issuance, and the bottom figure shows the average maturity of credit lines and term loans issued to all public firms in different size groups.

(a) Loan Amount to All Public Firms (in Billion)



(b) Loan Maturity to All Public Firms (Year)



(c) Loan Spread to All Public Firms (bps)