Monetary Policy, Debt Structure and Credit Reallocation *

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Abstract

Unexpected monetary tightening predicts a contraction in aggregate corporate bonds but an expansion in bank loans. Using micro-data, I argue that, large, high rated firms with high collateral value rebalance towards bank loans and away from corporate bonds as the relative spread of bond over loan increases. This drives the aggregate evidence. I explain these facts in a heterogeneous agents New Keynesian model by making bank loans safer (collateralized) than defaultable bonds but issued at a greater intermediation cost. An interest rate hike raises default risk and hence the cost of bond financing. Substitution takes place within large, unconstrained firms, while constrained firms tend to issue more equity. The model implies that bank credit is "misallocated" from constrained productive to unconstrained firms. This substitution effect mitigates the negative impact on large firm investment but not enough to avoid a decline in aggregate investment. This model quantitatively reverses the traditional bank lending channel.

JEL codes:

Keywords: Monetary policy, Capital structure, Debt structure, Credit reallocation

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1 Introduction

A rapid increase in corporate indebtedness has generated a wide spread concern about firm's risk exposure to adverse macro shocks and financial stability during economic downturn. In contrast to conventional wisdom,[1] loans expand and corporate bonds contract following a tightening of monetary policy.[2] I revisit this counterintuitive fact by proposing a credit substitution channel both empirically and theoretically to account for this aggregate pattern.

This paper studies firms' differential responses in their financing decisions to interest rate risk considering debt heterogeneity, as well as its implications on credit reallocation and investment. I argue that, the rise in bank debt and the decrease in corporate bonds is driven by the substitution towards loans among large, high rated firms with high collateral value, as the relative spread of bonds over loans increases. Monetary shocks are measured using the high-frequency event-study approach, which are changes in Fed Funds rate within a narrow window around the FOMC announcements. It has a mean and median closed to zero and a standard deviation of nine basis points. The baseline empirical specification estimates the differential effects of monetary shocks by firm size, credit rating and tangibility on debt pricing and financing decisions at both the intensive and extensive margin. I control for firm and sector-quarter fixed effects to capture permanent differences across firms and differences in how sectors response to interest rate risk. Firm controls and macroeconomic conditions are included. To further rule out the effects of heterogeneous cyclical sensitivities, I also include the interaction of firm characteristics and GDP growth.

Using micro data, I find that, following a one-standard-deviation (9 basis points) increase in interest rate, 1) bond financing becomes relatively more expensive, as loan spread (over LIBOR) increases by 1.6 basis points (which is a 0.85% increase compared to an average loan spread of 188.39 basis points) while bond spread increases by 13 basis points (which is a 4.27% increase compared to an average of 304.48 basis points); 2) in terms of debt financing choices between bonds and loans, firms substitute cheaper loans for corporate bonds. Conditional on debt financing, the probability to borrow from bank instead of borrow from market increases by 2.4% at the extensive margin. At the intensive margin, the quarter change in firm-level loan share increases by one half. The substitution effect is more pronounced within large, high rated firms with high collateral value;[3] 3) in terms of equity financing and capital structure,

[1] Traditional theories such as Bernanke et al. (1999) predict a credit contraction and a rise in credit spreads during bad times.

[2] This aggregate evidence was first documented in Gertler and Gilchrist (1993).

[3] DealScan does not provide details for the usage of credit line so I use collateral value as a proxy for credit

small, low rated firms that are considered as "financially constrained" have higher propensity to issue new equity. On average, a one percentage increase in interest rate is associated with a 3.3% increase in the probability to issue new equity at the extensive margin (compare to an average equity issuance probability of 6.8%). At the intensive margin, there is a 0.194% increase in the quarter change of equity share. (This is an 20% increase compare to an average of 0.97%). The monetary policy effect on this debt compositional shift is large and persistent. These results are robust to a number of robustness tests. The robustness tests are included in the Appendix D.

Theoretically, I develop a heterogeneous agents New Keynesian model to explain these new facts. The key features of the model are: (i) firms can choose different types of debt financing where loans are modeled as risk-free debt secured by a (standard) collateral constraint and bonds are modeled as risky defaultable debt. Firms tradeoff higher intermediation costs of loans against default risk of bonds. In the steady state equilibrium, firms endogenously choose the optimal bond share to equalize the cost of loan financing and cost of bond financing; (ii) firms have access to costly equity issuance. They tradeoff between tax benefit and the average cost of loans and bonds in choosing the optimal capital structure. The macroeconomic risk together with financial frictions lead firms to optimally choose low leverage in order to preserve borrowing capacity for bad times. An unanticipated interest rate hike raises the default risk and hence the relative cost of bond financing. Large firms with unbinding collateral constraint switch towards cheaper loans issuance, while financially constrained firms with sufficiently high leverage tend to issue more equity. The model economic mechanism emphasizes that firms' preserved debt financing flexibility is an important determinant of firms' dynamic adjustments in capital and debt structure in response to interest rate risk.

I simulate a panel of firms from the calibrated model that matches the unconditional moments of loan share, leverage, investment, profitability and credit spread reasonably well. I first validate the model fit by comparing the cross-sectional debt distribution implied from the real and simulated data. The model generates a reasonable unconditional distributions of leverage and loan share, as well as their distributions by size.[4] The employment share across different age groups implied from the firm dynamic model also fits the data. The model matches the stylized facts of cross-sectional determinants of debt composition documented in the literature: bank debt borrowers are smaller, less profitable firms that have relatively

availability. Greenwald et al. (2021) documents the fact that large firms drawdown credit line during bad times

[4]The cross-sectional distribution of loan ratio is left-skewed. Leverage is increasing in firm size while loan ratio has a hump-shape pattern across firm size.

low leverage, low credit rating and higher tangibility, compared to firms that have access to market debt.

In response to an interest rate hike, inflation rate declines and the real value of debt payment rises. Firms resort to external financing due to the shortage of available internal funds. The relative spread of bonds over loans increases as the default risk and the expected loss goes up. Large, financially unconstrained firms switch to relatively cheaper loan financing and therefore, their loan share increases. Financially constrained firms that have no extra debt flexibility tend to issue more equity, which leads to an increase in their equity share.

Finally, the model has interesting implication on credit reallocation and corporate investment. Following a tightening of monetary policy, bank debt flows from small, constrained, more productive firms to large, unconstrained, less productive firms, as in the data. Therefore, credit is "misallocated". In addition, the credit substitution channel mitigates the negative effect of monetary shocks on firm investment, only among large firms. The credit substitution effect suggests that debt composition can explain part of heterogeneous investment elasticities. Firms with higher loan share are more responsive in cutting down investment. Overall, this credit substitution effect is not enough to avoid a decline in aggregate borrowing and investment.

The counterfactual analysis quantitatively evaluates the importance of debt issuance cost and liquidation value in determining the loan-bond tradeoff. Both reducing debt issuance cost and lowering liquidation value lead to higher default rate and credit spread but through different channels. Lower debt issuance cost leads to more borrowing in the future, and thus lower bond price and higher spread. Lower recovery rate leads to less borrowing but higher spread due to less debt repayment during bankruptcy. The findings in this paper are important from a policy perspective. It provides a quantitative framework for policymakers to evaluate the financial stability and bank regulation when implementing monetary policy.

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

The first literature discusses several transmission channels of monetary policy to the real economy and the heterogeneous effects of monetary policy on corporate decisions and asset prices. This includes the investment (firm balance sheet) channel,[5] consumption channel,[6]

[5]Papers study investment channel include Kashyap et al. (1994), Gertler and Gilchrist (1994), Ippolito et al. (2018), Jeenas (2019), Darmouni et al. (2020), Ottonello and Winberry (2020), Crouzet (2021), Morlacco and Zeke (2021). They find that firm characteristics such as liquidity, age, default risk and debt composition drive the differential responses in firm's investment.

[6]This includes McKay et al. (2016), Kaplan et al. (2018), Auclert (2019), Wong (2019).

bank lending (credit) channel,[7] asset prices channel,[8] mortgage refinancing channel, inflation expectations channel and exchange rate channel, etc. 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 through firm balance sheet and asset prices channel. This paper differs from the existing research in several perspective. 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. (2020) and the "credit disintermediation" proposed in Crouzet (2021) studies how debt structure affect the transmission of monetary policy while I study how firms' balance sheet condition drives the heterogeneous responses in their choices among bank debt, bonds and equity when the relative cost of borrowing changes.[9]

Second, this paper is also related to the literature that studies corporate capital and debt structure.[10] Debt structure is a central element in a firm's capital structure. Empirical studies about cross-sectional debt structure find that asymmetric information, liquidation efficiency, access to capital market, transaction costs and firm characteristics such as credit quality, size, leverage, profitability, growth opportunities, prior financing decisions are important determinants of corporate debt structure (Houston and James (1996), Johnson (1997), Denis and Mihov (2003), Sufi (2009), Rauh and Sufi (2010) and Colla et al. (2013)). Closely related papers are Adrian and Boyarchenko (2012), Becker and Ivashina (2014), Li et al. (2019) who study the time-variation in corporate debt structure. They find evidence of substitution between loans and bonds during financial crisis, and when credit conditions tighten and information asymmetry increases. My paper differs in that I estimate the changes in borrowing costs and adjustment of debt structure in response to interest rate risk. In terms of theoretical modeling of debt heterogeneity, the most relevant work is Crouzet (2018), in which he quantifies the transmission of financial shocks through corporate debt structure on aggregate investment,

[7]This includes Bernanke and Blinder (1988), Kashyap et al. (1992), Kashyap and Stein (1995), Kashyap and Stein (2000), Bernanke and Gertler (1995), Drechsler et al. (2017), Xiao (2020), Wang et al. (2020). Traditional "bank lending channel" argues that the balance sheet conditions of bank matter for the provision of bank debt and the transmission of monetary policy works through both the asset (loan) and liability (deposit) sides of bank balance sheet.

[8]This includes Bernanke et al. (1999), Bernanke and Gertler (2001), Gilchrist and Leahy (2002), Bhamra et al. (2011).

[9]Darmouni et al. (2020) uses European data. Schwert (2020) estimates the pricing of bank loans relative to capital market debt in a novel sample of loans matched with bond spreads from the same firm on the same date. The sample is restricted to firms with outstanding corporate bonds, so it is not representative of the universe of bank borrowers.

[10]For an excellent overview on the research in dynamic corporate finance and debt structure, see Roberts and Sufi (2009), Graham and Leary (2011), Strebulaev and Whited (2012), Ai et al. (2020a) and Colla et al. (2020).

following the seminal contributions of Diamond (1991), Rajan (1992) and Bolton and Scharfstein (1996). I contribute to the theoretical modeling by further studying firms' decisions in a general equilibrium setup.

Third, this paper also builds on a large macro finance literature that studies the (amplification) effect of financial frictions and agency friction through the lens of dynamic models with endogenous investment. An incomplete list includes Gertler and Bernanke (1989), Carlstrom and Fuerst (1997), Kiyotaki and Moore (1997), Gomes (2001), Hennessy and Whited (2005), Hennessy and Whited (2007), Rampini and Viswanathan (2013), Rampini and Vishwanathan (2020), Kuehn and Schmid (2014), Li et al. (2016), Ai et al. (2020b), Belo et al. (2019) and Alfaro et al. (2018). Macroeconomic shocks are important determinants of firms' capital structure choice.[11] Financial frictions amplifies the effect of exogenous shocks on corporate investment through the changes in asset prices and external financing premium. Jermann and Quadrini (2012) propose a quantitative theory to show that credit market shocks are necessary to rationalize cyclical external-financing choices. 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. Begenau and Salomao (2019) further quantitatively examines the heterogeneous effects of macroeconomic shocks. This paper adds to this literature by allowing endogenous debt choices and emphasize the importance of debt financing flexibility and credit reallocation induced by the changes in relative borrowing costs in the transmission of monetary policy.

Fourth, this paper connects to a growing literature studying the impact of macroeconomic risks on bank credit supply using the FR Y-14 data. Niepmann and Schmidt-Eisenlohr (2018) studies the relationship between U.S. exchange rates and banks credit supply to foreign firms. Chodorow-Reich et al. (2020) investigates the effects of COVID on credit line draw downs stemming from the differences between small and large firms in terms of their financing. Luck and Zimmermann (2020) examines the real effects of quantitative easing. Closely related papers are Greenwald et al. (2021) and Caglio et al. (2021). Caglio et al. (2021) finds evidence of firm risk-taking behavior by documenting several facts about the composition of credit by firm size and investigate the implications for the transmission of monetary policy. The "credit line channel" proposed in Greenwald et al. (2021) shows how monetary policy transmits differently through credit lines versus terms loans. Instead of examining bank debt composition, I consider firm's choices between bank debt and market debt, as well as the real

[11] For example, Korajczyk and Levy (2003), Dittmar and Dittmar (2008), Covas and Den Haan (2011), Covas and Den Haan (2012) and so on

effects of this credit substitution channel.

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

2 Empirical Evidence

In this section, I explore the empirical relationships between monetary policy shocks and non-financial corporate firms' financing decisions. At the aggregate level, a policy rate hike, i.e, contractionary monetary policy, leads to an increase in credit spread, a contraction in corporate bonds and an expansion in loans. To understand what drives these aggregate patterns, I further explore the heterogeneous effects of monetary policy on firm's financing decisions using micro-data.

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 high collateral value and unused credit line substitute bank loans for corporate bonds, and therefore the share of loans in total debt increases. This is consistent with the aggregate evidence. Small, low rated firms have higher propensity to issue new equity. These patterns hold at both the extensive and intensive margin. 3) The impact of monetary shocks on debt compositional shift is large and persistent.

2.1 Data

The sample includes monetary policy shocks measured using high frequency Fed Funds rate, aggregate time series data from Flow of Funds and St.Louis Fed, firm-level accounting variables from quarterly 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 measure the monetary policy shocks following Gürkaynak et al. (2005) and Gorodnichenko and Weber (2016) in the baseline analysis. They measure monetary shocks using the high-frequency, even-study approach, pioneered by Rudebusch (1998), Kuttner (2001) and Cochrane and Piazzesi (2002).[12] Specifically, the monetary policy shock is measured as the changes in current month's Fed Funds futures rate in a 30-minute narrow window around FOMC announcements.[13] 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 monetary announcement. ffr_t is the implied Fed Funds Rate from a current-month Federal Funds future contract at time t, Δ_+ and Δ_- control the size of the time window around the announcement, and $\tau(t)$ is an adjustment for the timing of the announcement within the month.[14] I focus on a window of $\Delta_- =$ ten minutes before the announcement and $\Delta_+ =$ twenty minutes after the announcement. The high-frequency shock series begins in January 1990 and ends in December 2018. I then aggregate the high-frequency shocks to quarter-level following Ottonello and Winberry (2020).[15] Figure 2 plots the measured monetary shocks at the daily and quarterly frequency. Summary statistics can be found in Table 1 Panel A.

[Figure 2 and Table 1 Here]

Aggregate-level Variables

I obtain the quarter time series of aggregate U.S non-financial corporate debt from Flow of Funds (L.103), reported by the Federal Reserve Bank. Non-financial corporate debt consists primarily of debt securities and loans.[16] Within these two categories, corporate bonds account

[12] Other approaches include vector auto-regression (VAR) studies such as Christiano et al. (1999) and Bernanke et al. (2005), and narrative approach by Romer and Romer (2004).

[13] Fed Funds futures have traded at the Chicago Board of Trade exchange since October 1988. Tight window is defined as ten minutes before the announcement and twenty minutes after the announcement. Wide time window is defined as fifteen minutes before the announcement and forty five minutes after the announcement. Changes in prices are adjusted for the timing of announcements within the month, which accounts for the fact that Fed Funds futures pay out based on the average effective rate over the month.

[14] This adjustment accounts for the fact that Fed Funds Futures pay out 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.

[15] They construct a moving average of the raw shocks weighted by the number of days in the quarter after shock occurs. They weight shocks by the amount of time firms have had to react to them.

[16] Non-financial corporate bonds outstanding in the U.S. grew from approximately $1 trillion in 1990 to ap-

for around 84% of total debt securities, while "depository institution loans not elsewhere classified" and "other loans and advances" together account for around 77% of total loans in the periods between 1980 to 2018. I define bank debt as the Depository Institution Loans Not Elsewhere Classified and market debt as Corporate Bonds.[17] Other macroeconomic and financial variables I consider in the regression analysis include real GDP growth (deflated by Consumer Price Index for All Urban Consumers (All Items), and thus "CPI"), unemployment rate, inflation rate, term spread, price-dividend ratio, credit spread and intermediary implied leverage rate from He et al. (2017) (Therefore "HKM"). To address the concern about information channel of FOMC announcements, I also control for central bank's information set using the Greenbook forecast revisions of real output growth, inflation rate and unemployment rate between concurrent FOMC announcements.[18] All the time series data are from January 1990 to December 2018.

Firm-level Variables

Loans origination and corporate bonds issuance data are from DealScan and FISD, respectively, including issuance date, maturity, borrowing amount, credit rating and a secured debt dummy. I obtain firm-level accounting variables from quarterly Compustat, a panel of publicly listed U.S firms, and stock return from CRSP. The variables of interest include net equity issuance and loan share. Following Eisfeldt and Muir (2014), the net equity issuance is computed as sale of common and preferred stock (SSTK) minus purchase of common and preferred stock (PRSTKC), scaled by lagged total asset (When cash dividend is missing, I replace it with zero). This measure of equity issuance also includes granting of stock options to employees as a form of compensation. I therefore follow McKeon (2015) to do the adjustment.[19] Following Crouzet (2021), I define firm-level loan share to be the ratio of sum of notes payable (NP) and other long-term debt (DLTO) to total debt, which is the sum of

proximately $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 year-end 2018.

[17] In the rest of the paper, I use bank debt and loans, market debt and bonds interchangeably.

[18] The Greenbook is produced before each meeting of the Federal Open Market Committee. It is produced by the research staff at the Board of Governors. The staff makes projections about future quarters in our economy. The revised forecast for variable x_t between two consecutive meetings is defined as $F_t x_t - F_{t-1} x_t$, where $F_{t-1} x_t$ denotes Greenbook forecasts for quarter t made at time $t-1$, and x_t includes real output growth, inflation rate and unemployment rate.

[19] For each firm quarter, we classify the equity raised by the firm during 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 × CSHOQ.) and scale it by beginning-of-quarter total assets.

short-term debt (DLC) and long-term debt (DLTT).[20] Firm control variables include firm size, leverage, market-to-book value, past sales growth, tangibility, quarter dummies, an indicator for whether firms pay out dividend or not in the current period and a dummy for investment grade firms (BBB^- or higher) based on S&P long-term debt credit rating. Summary statistics of corporate debt and firm variables can be found in Table 1 Panel B and C. The Appendix A contains more detailed definitions of these variables and sample construction.

2.2 Aggregate-level Dynamics

This section performs time series analysis using aggregate data from Flow of Funds and St. Louis Fed. Contractionary monetary policy is associated with a decline in bond and an increase in loan at both the level and the share. The impact of monetary policy shocks on corporate debt compositional shift is large and persistent, for up to three years, with the peak of cumulative effect showing up in five quarters after the shocks occur.

2.2.1 Descriptive Statistics

Before turning to firm-level data, I first examine the aggregate stock of non-financial corporate debt and its growth rate. Figure 1 plots the time series of debt ratio: bank debt/total debt and market debt/total debt from 1980Q1 to 2018Q4.[21] There are several striking patterns. First, there is a shift from bank debt to market debt over time. Second, bank debt shrinks dramatically during recessions, especially during periods of 2008 financial crisis, while market debt is more stable and less affected. Table 1 shows the descriptive statistics of monetary policy shocks and corporate debt in the sample period (from 1990Q2 to 2018Q4). During this time there are 225 high frequency shocks with a mean of approximately zero and a standard deviation of 7.6 basis points. Quarterly monetary policy shocks is negatively correlated with real GDP growth, with a relatively low correlation coefficient around -0.30. The average quarter changes in market and bank debt are 0.93% and -0.08%, respectively. Their correlation with the real GDP growth are -0.06 and 0.1. Their correlation with the measured monetary shocks are -0.12 and 0.15.

[20] 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), convertible or subordinate bonds (included in DCVT and DS, respectively). The main drawback is that both NP and DLTO include commercial paper outstanding.

[21] Bank debt is defined as the Depository Institution Loans Not Elsewhere Classified, while market debt is defined as Corporate Bonds. Total debt is the sum of debt securities and loans.

[Figure 1 Here]

2.2.2 Dynamic Effects on Corporate Debt

Are the effects of monetary policy shocks on corporate debt large and persistent? To answer this question, I estimate the cumulative effect of monetary policy shocks using Jordà (2005)-style local projection:

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

where $h \in [0, 16]$ indexes the forecast horizon. The dependent variable is either changes in debt $\Delta log(Debt)$ or changes in debt share (loan and bond share) over h quarters. A lag of monetary shock and forecasts revisions are also included as control variables. Coefficient β_h measures the cumulative response of corporate debt share in quarter $t+h$ to a monetary shock in quarter t. Figure 3 reports the estimates of coefficient β_h over quarters h. The effect is large and persistent. Panel (a) and (b) show that the peak of cumulative impact on bonds and loans share, which has a magnitude of around -0.4% and 0.3%, occurs about five quarters after one standard deviation increase in interest rate and it remains significant up to three years. Panel (c) (d) and (e) show that, the dollar amounts of loans increase while the dollar amounts of bonds decrease. The initial impact on total dollar amounts of loans and bonds is closed to zero, while it becomes significantly negative (around -1.5%) in three years. This suggests that firms deleverage in the long run.[22]

[Figure 3 Here]

2.3 Firm-level Analysis

Analogous to the previous section, using micro-data, I estimate the impact of monetary policy shocks on debt borrowing costs and firms' external financing decisions at both the extensive and intensive margin.

2.3.1 Debt Financing Decision: Loan vs Bond

How does firm's debt composition change in response to interest rate risk? How does this change vary across firms? I first estimate how firms' choices between loans and bonds change

[22] However, the long-run effect is imprecisely estimated with large standard errors and therefore, in the rest of paper, I only focus on the short-term impact of monetary shocks.

in response to interest rate risk:[23]

$$y_{i,t} = \alpha_i + \lambda_{s,q} + \gamma\epsilon_t^m + \beta\epsilon_t^m \times X_{i,t-1} + \eta\Delta GDP_t \times X_{i,t-1} + \delta X_{i,t-1} + \Gamma_1' Z_{i,t-1} + \Gamma_2' Y_{t-1} + \epsilon_{i,t} \quad (3)$$

where $X_{i,t-1}$ is firm size, tangibility or a dummy for investment grade (based on S&P long-term debt rating) in the previous quarter. $Z_{i,t-1}$ is a set of firm characteristics including market-to-book ratio, liquidity, leverage and a dummy for dividend payout. Y_{t-1} is a set of macroeconomic variables including four lags of GDP growth, inflation rate and unemployment rate. α_i is firm fixed effect and $\lambda_{s,q}$ is sector-quarter fixed effect. To control for the heterogeneous cyclical sensitivities, I also include the interaction of GDP growth and $X_{i,t-1}$. Column (1) to (5) of Table 2 reports debt financing decisions at the extensive margin, where the dependent variable is a dummy for debt financing decision equaling to one if firm chooses loans instead of bonds in quarter t.[24] Column (6) to (10) reports debt financing decisions at the intensive margin, where the dependent variable is the change of loan share in quarter t expressed in percentage. The sample covers periods from 1990Q2 to 2018Q4.

[Table 2 Here]

The coefficient γ estimates in column (1) and (6) are positively significant. Column (2) shows that, on average, a one-standard-deviation increase in interest rate is associated with a 2.4% increase in the probability to borrow from bank, which is 4% increase from the average probability of loan financing (0.59). At the intensive margin, 0.03 in column (7) implies that a one-standard-deviation increase in interest rate is associated with a 0.03% increase in the quarter change of loan share, compared to an average of 0.06% and a standard deviation of 6%. The substitution effect is particularly more pronounced for "financially unconstrained" firms, which are large, high rated firms with high tangibility and unused credit line. The coefficient β estimates in column (3) (4) (5) (8) (9) and (10) suggest an economically and statistically significant heterogeneity in the mix of debt across firms.[25] A one-standard-deviation increase in firm size or tangibility raises the probability to borrow from bank by over one-

[23] The full sample consists of 70% credit lines and 30% term loans. In the Appendix Table A.4, I show the results over sub-sample of credit lines and term loans

[24] The number of firm-quarters where firms raise both types of debt are rare (3.2% of firm-quarters with new debt) and are likely to be associated with large corporate events such as mergers. Including these observations does not affect our results.

[25] Becker and Ivashina (2014) performs a similar study on firms' debt financing decisions but they focus more on the cyclicality of credit supply. They interpret firm's switching from loans to bonds as a contraction in bank credit supply characterized by various measurements of credit provisions. They also examine the impact of monetary policy measured as the deviation from Taylor rule, but get to different conclusion. I attribute it to the measure of monetary policy shocks.

half, and raises the loan share by over 100%. Only investment-grade firms raise more loans as interest rate goes up.

2.3.2 Equity Financing Decision

Net equity issuance is defined as sale of common and preferred stock minus purchase of common and preferred stock, scaled by lagged total asset. Only equity issuance amount that exceeds 2% of the end-of-quarter market equity is considered as new equity issuance. I estimate the same regression specification as that in the last section.

Column (1) to (5) of Table 3 reports equity financing decisions at the extensive margin, where $y_{i,t}$ is a dummy taking value one if net equity issuance of firm i in quarter t is positive and equals to zero otherwise. Column (6) to (10) reports equity financing decisions at the intensive margin, where the dependent variable is the change in firm's equity (defined as the difference between total asset and total debt) in quarter t over lagged total asset. On average, firms have a higher probability to issue new equity following an unanticipated interest rate hike. Column (2) implies that a one-standard-deviation increase in interest rate is associated with a 0.3% increase in the probability to issue new equity, compare to an average issuance rate of 6.8% and a standard deviation of 25.2% (or equivalently, an one-percentage increase in interest rate raises the probability of new equity issuance by $100/9.1\times$ 0.3% $\approx$ 3.3%). The coefficient estimate of 0.194 in column (7) indicates that an one-standard-deviation increase in the interest rate leads to a 0.194% increase in the quarter change of equity share, compared to an average of 0.97% and a standard deviation of 10.7%. The probability of switching to equity financing is lower for "financially unconstrained" firms since they can make use of their preserved debt financing flexibility to avoid costly equity issuance. This can be implied from the negative coefficient estimates of the interaction terms in column (3) (4) (5) (8) (9) and (10). A one-standard-deviation increase in firm size or tangibility reduces the probability to issue new equity by over one-third and two-third, respectively, and the equity share deceases by 37% and 163%.

[Table 3 Here]

2.3.3 Debt Pricing

How do borrowing costs of securities of different risks changes with respect to monetary policy shocks? I estimate the following panel regression

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

where loan spread refers to the variable "All-in-drawn"in DealScan, which is the difference between loan rate and three-month LIBOR plus some annual fee.[26] Corporate bond spread is measured as the difference between offering yield in FISD and three-month LIBOR.[27] $Z_{i,t-1}$ is a vector of firm-level controls and Y_{t-1} is a set of macroeconomic variables, same as the above specification. $W_{i,t-1}$ is a vector of debt characteristics including maturity, borrowing amount, credit rating and a secured loan dummy.

The results are summarized in Table 4. Column (1) to (5) are changes in loan spreads, where the coefficient estimate of 0.016 in column (1) indicates that, a one-standard-deviation increase in interest rate raises loan spread by 1.6 basis points on average (Or equivalently, a 25 basis points increase in interest rate raises the loan spread by 4.4 basis points. This is a 2.3% increase in loan spread). Column (6) to (10) are results about bond spreads. The coefficient estimate of 0.13 in column (7) suggests that, a one standard deviation increase in interest rate leads to a 13 basis points increase in bond spread (Or equivalently, a 25 basis points increase in interest rate raises the bond spread by 36.1 basis points. This is a 11.9% increase in bond spread). The coefficient estimates of the interaction term are statistically insignificant.

[Table 4 Here]

2.4 Robustness Check

Online Appendix contain several sets of additional empirical results.

The first set of additional results contains two robustness checks of the aggregate analysis. Column (1) to (4) of Table A.2 decompose the aggregate loans by maturity and it shows that monetary shocks have large and significant impact on short-term loan instead of long-term loan. Column (5) to (8) decompose the measured monetary shocks and it suggests that, it is

[26] I only consider "All-in-drawn"that uses LIBOR as the base rate.

[27] To make sure that loans and bonds have the same base rate, I use LIBOR as the base rate instead of treasury yield to compute the bond spread. I do not use LIBOR swap to adjust the maturity effect.

the changes in short rate ("target" component) rather than the changes in long rate ("path" component) that drives the results.

Second, I investigate how much "target" and "path" component affects firm's choices between loans and bonds. Table A.3 shows that both target and path components are statistically significant in most of cases, while results from the target component are more pronounced and consistent. Table A.4 presents the results of main analysis in two split samples. The coefficient estimates of "credit line" sample are not only positively significant, but also larger in economic magnitude.

The third set of additional results distinguish "financially constrained" firms from "unconstrained" firms using "Whited-Wu" (Whited and Wu (2006)) and Size & Age index (Hadlock and Pierce (2010) and hence "HP" index). The results in Table A.5 confirm the robustness of differential adjustments in financing decisions in response to monetary shocks. Fourth, I repeat the baseline analysis using policy news shocks from Nakamura and Steinsson (2018), measures from Gertler and Karadi (2015) ("FF4"), which lead to similar conclusions (Table A.6 and A.7). A robustness check using post-1994 sample periods is also included in Table A.8.

To have a more accurate measure of firm-level loan share, I use detailed debt structure data from S&P Capital IQ data. Table A.9 shows the changes in both debt (loan/bond) amount and share in response to interest rate hike. The results suggest that an increase in interest rate not just raises the loan share but also the loan amount. In contrast, it reduces the bond amount and therefore the bond share. Table A.10 further presents the effects of interest rate hike on the share of various types of debt: secured debt, unsecured debt, floating rate debt, fixed rate debt and undrawn credit line. The coefficient estimates imply that firms tend to use more secured debt while less unsecured debt, more floating rate debt but less fixed rate debt. Firms not only issue more new loans, but also draw their unused credit line, as the fraction of undrawn credit line decreases. Both lead to an expansion in bank loans at the aggregate level. This is consistent with the results found in Greenwald et al. (2021).

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 collateralized risk-free debt and bonds as risky defaultable debt. The main mechanism that generates this substitution is the changes in relative prices of safe and risky securities, and the unused credit line.

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 risk neutral financial intermediary that prices corporate bonds and a New Keynesian Block which 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 good (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 $0 < \alpha + \nu < 1$ and τ is the corporate tax. 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. $\bar{z}$, ρ_z and σ_z are the mean, auto-correlation, and conditional volatility of firm-specific productivity, respectively. The production process incurs a fixed cost c_f if the firm decides to do 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 (2014). Here I assume 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

Firm can borrow via bank loan modeled as risk-free debt secured by collateral and issue corporate bond modeled as risky defaultable debt. Every period the firm owner chooses total amount of debt borrowing $B_{i,t+1}$ and share of bond debt $s_{i,t+1}$. Therefore, the amount of bond firm borrows is $B_{i,t+1}s_{i,t+1}$ and the amount of bank loan is $B_{i,t+1}(1 - s_{i,t+1})$. Firm owner need to make the debt payment $(1 + c)B_{i,t+1}$ at the beginning of 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, floating/fixed rate, etc. Below I discuss the model assumptions to distinguish bonds from loans.

Assumption 1. (Short-term debt)

On average, bonds have longer maturity than loans. Both loan and bond take the form of a one-period contract in the model for simplicity since the tradeoff does not depend on maturity. This assumption can be relaxed to short-term loans and long-term bonds.[28]

Assumption 2. (Seniority of bank lenders)

Bank lenders are more senior than market lenders so they have the priority to get debt payment when firm borrowers declare bankruptcy. Most senior debt have strong covenants so they have higher recovery value. Empirically, bank loans tend to be either senior or secured by liens on assets, as documented by Rauh and Sufi (2010). This assumption is crucial to generate changes in relative prices of bonds and loans in response to monetary shocks.

Assumption 3. (Liquidation and bankruptcy cost)

Liquidation involves dead-weight losses. This assumption is common to many models in which the underlying financial friction is limited liability. It embodies the notion that bankruptcy and liquidation are costly processes, and is supported by evidence on changes in asset values of firms that go through bankruptcy proceedings.

[28]The monetary policy effect would be stronger if we allow long-term bonds.

The short-term creditors receive full payment per unit of bond 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 ($0 \leq \chi \leq 1$). The recovery value per unit of corporate bond is therefore

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

Assumption 4. (Loan issuance is more costly)

Debt issuance is costly. For simplicity, I assume that there is a linear issuance cost ξ_0 and ξ_1 per unit of loans and bonds, respectively. Debt issuance cost is higher for intermediated bank loan: $\xi_0 > \xi_1$, due to costly intermediation.[29] Philippon (2015) estimates the overall intermediation costs in the U.S. financial sector to be approximately 2% between 1870 and 2012. Fang (2005) finds that bond issuance in the U.S. has an average underwriting fee of 0.95%. The functional form for debt issuance cost is given by

$$DIC(B_{i,t+1}, s_{i,t+1}) = \xi_0 B_{i,t+1}(1-s_{i,t+1}) + \xi_1 B_{i,t+1}s_{i,t+1} = \xi_0 B_{i,t+1} + (\xi_1 - \xi_0)B_{i,t+1}s_{i,t+1}, \tag{10}$$

Assumption 5. (Secured loan and defaultable bond)

Loan is assumed to be secured and fully collateralized, while bond is assumed to be a risky debt.[30]

The collateral constraint firm faces 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 collateral constraint and determines the borrowing capacity of the firms. I assume $0 < \theta \leq \chi$, which guarantees that bank lenders always get full payment even in the bankruptcy. Therefore price for loan is $\beta(1+c)$.

Previous studies have provided empirical support for this assumption. Loans, either

[29] Bank borrowing requires active relationship management (Firm owners need to share private information with their bank lenders to verify loan covenants) and bank do monitoring to overcome the problem of asymmetric information between lenders and borrowers.

[30] While "risk-free" loans is a strong assumption to reduce computational burden, it is not crucial to the loan-bond tradeoff, as long as bank lenders have the seniority in bankruptcy repayment. This assumption can be relaxed to allow defaultable loans.

credit lines or term loans, tend to be either fully secured, or senior to all other credit obligations, bonds tend to be unsecured and/or subordinated.[31] According to Moody's recovery database for non-financial corporations, the median recovery rate for bank loans was 100% in the twenty 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 4). In addition, the robustness check of aggregate analysis shows that, it is the short-term component of loans that is most responsive to monetary shocks and drives the results, which provides further support for this assumption.

[Figure 4 Here]

In addition, most bank loans have floating rates mechanically tied to monetary policy rates while most corporate bonds have fixed rate. Ippolito et al. (2018) documents a "floating-rate channel" through which monetary shocks affect firms' balance sheet liquidity condition by changing their interest rate payment. While they focus on the *existing loans* and this channel disappears when policy rates are at the zero lower bound, this paper mainly focus on the *new debt* issuance in the primary market.

3.1.3 Equity Financing

Taxable corporate profits are equal to output less capital depreciation and interest expenses: $y_{i,t} - \delta k_{i,t} - cB_{i,t}/\Pi_t$. Firm's net worth in period t is defined as output plus value of undepreciated capital and tax benefit net of labor expense, debt payment and fix production cost:

$$
\begin{aligned}
n_{i,t} &= Max_{l_{i,t}} \ (1-\tau)(p_t z_{i,t} k_{i,t}^{\alpha} l_{i,t}^{\nu} - w_t l_{i,t}) + \tau(\delta k_{i,t} + cB_{i,t}/\Pi_t) \\
&\quad + (1-\delta)k_{i,t} - c_f - (1+c)B_{i,t}/\Pi_t \\
&= (1-\tau) w_t^{\frac{\nu}{\nu-1}} \left[\nu^{\frac{\nu}{1-\nu}} - \nu^{\frac{1}{1-\nu}}\right] \left(p_t z_{i,t} k_{i,t}^{\alpha}\right)^{\frac{1}{1-\nu}} + \tau(\delta k_{i,t} + cB_{i,t}/\Pi_t) \\
&\quad + (1-\delta)k_{i,t} - c_f - (1+c)B_{i,t}/\Pi_t,
\end{aligned}
\tag{12}
$$

[31] For instance, Diamond (1993) suggests that the seniority and collateralization of short-term debt can serve as compensation for monitoring costs 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 terms loans, and a further 31.8% consists of mortgage and equipment debt. Subordinated debt, on the other hand, is entirely comprised of (either convertible or non-convertible) debt. Crouzet (2018) finds that a very large portion of short-term debt (on average, 95%) constitute of loans. To the extent these loans are extended by banks they are almost always senior, as discussed in Welch (1997).

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

$$d_{i,t} + k_{i,t+1} = n_{i,t} + \frac{B_{i,t+1}(1-s_{i,t+1})(1+c)}{1+r_t} + Q_{i,t}B_{i,t+1}s_{i,t+1} - DIC(B_{i,t+1}, s_{i,t+1}) - AC(i_{i,t}, k_{i,t}), \tag{13}$$

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 fund and debt, firms can also finance their investment via equity issuance, modeled as negative dividend. External equity issuance is costly, which 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

$$d_{i,t} - EIC(d_{i,t}). \tag{14}$$

3.1.4 New Entrants

Every period, new entrants enter into the economy with initial capital k_0 from household and have no 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 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, firm decides whether to continue or default: $D_{i,t}$:

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

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 $\chi(1-\delta)k_{i,t}$. To continue, the firm must pay back the face value of outstanding bank debt and bond: $(1+c)B_{i,t}$ 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. Firm's net worth in period t is defined above.

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

3.1.6 Recursive Formulation

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:

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

where $D'_{t+1}(z', k', B')$ is an indicator variable taking value zero when firm defaults and $0 \leq s' \leq 1$. $\Lambda_{t,t+1}$ is the discount factor that equals to β at the steady state. 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 take household's saving deposit and lend to firm producers in the form of risk-free and risky debt. The bond contract specifies the bond price at the steady state:

$$Q_t(z_{i,t}, k_{i,t+1}, B_{i,t+1}, s_{i,t+1}) = \mathbb{E}_t\left[\frac{\beta}{\Pi_{t+1}}\left((1-D_{i,t+1})(1+c) + D_{i,t+1} max\{R_{i,t+1}, 0\}\right)\right], \tag{15}$$

The properties of bond price is 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 the disutility of labor supply. The household owns all firms in the economy so they earn profit share from the producers. The household can also save in risk-free bond. The consumption-saving decision gives the Euler equation that links the discount factor and nominal interest rate $\Lambda_{t,t+1} = \beta = \frac{1}{R_t^{nom}/\Pi_{t+1}}$: the discount factor equals to β at the steady state.

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 term of final good $\frac{\psi}{2}\left(\frac{\tilde{p}_{i,t}}{\tilde{p}_{i,t-1}}-1\right)^2 P_tY_t$, 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 maximizing profits.

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

Proposition 1. *The retailer's profit maximization gives the following* ***New Keynesian Phillips curve****:*

$$log\Pi_t = \frac{\gamma - 1}{\psi} log\frac{p_t}{p*} + \beta\mathbb{E}_t log\Pi_{t+1}, \tag{16}$$

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 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.

Proposition 2. ***Inflation dynamics*** *follows*

$$\Pi_t = exp\left(\frac{1}{\psi_\pi}\left[log\left(\Pi_{t+1}\frac{U'(C_t)}{U'(C_{t+1})}\right) - \epsilon_t^m\right]\right), \tag{17}$$

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

$$log(R_t^{nom}) = log\frac{1}{\beta} + \psi_\pi log\Pi_t + \epsilon_t^m, \tag{18}$$

where $\epsilon_t^m \sim N(0, \sigma_m^2)$, Π_t is gross inflation in the final good price and ψ_π is the weight on inflation in the reaction function. 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 function $V_t(z_{i,t}, k_{i,t}, B_{i,t})$; 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 $D_{t+1}(z_{i,t+1}, k_{i,t+1}, B_{i,t+1})$, measure of firms $\mu_t(z_t, k_t, B_t)$; bond price schedule $Q_{i,t}(z_{i,t}, k_{i,t+1}, B_{i,t+1}, s_{i,t+1})$; and a set of prices w_t for wage rate, p_t for firm output price and $\Lambda_{t,t+1}$ for 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 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;

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

4 Model Solution

4.1 Optimal Decisions

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

4.1.1 Optimal Capital Structure

Proposition 3. *The price of risky bond is lower than risk-free loan as a compensation for bankruptcy loss: $Q_{i,t}(z_{i,t}, k_{i,t+1}, B_{i,t+1}, s_{i,t+1}) \leq \frac{1+c}{1+r_t}$. This can be easily inferred from the repayment policy.*

Proposition 4. *The price of risky bond is increasing in capital investment and decreasing in the borrowing of risky bond: $\frac{Q_{i,t}}{k_{i,t+1}} > 0$, $\frac{Q_{i,t}}{B_{i,t+1}} < 0$ and $\frac{Q_{i,t}}{s_{i,t+1}} < 0$.*

Higher current investment leads to higher output and therefore higher net worth in the next period, which reduces firm's default probability and bankruptcy loss in the next period. Carrying more risky bond today increases the debt payment and therefore raises the default probability and bankruptcy loss.

Proposition 5. *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,*

$$
\begin{aligned}
&(1+\lambda \mathbb{1}(d_{i,t}<0))\left(1+\frac{\partial AC_{i,t}}{\partial k_{i,t+1}}-\frac{\partial Q_{i,t}}{\partial k_{i,t+1}}B_{i,t+1}s_{i,t+1}\right)-\eta_t\theta(1-\delta)\\
=&\beta E\left[\left(\alpha(1-\tau)p_{t+1}z_{i,t+1}k_{i,t+1}^{\alpha-1}l_{i,t+1}^{\nu}+\tau\delta+(1-\delta)-\frac{\partial AC_{i,t+1}}{\partial k_{i,t+1}}\right)(1+\lambda\mathbb{1}(d_{i,t+1}<0))(1-D_{i,t+1})\right],
\end{aligned}
\tag{19}
$$

and

$$
\begin{aligned}
&(1+\lambda \mathbb{1}(d_{i,t}<0))\left(\frac{(1+c)(1-s_{i,t+1})}{1+r_t}+\frac{\partial Q_{i,t}}{\partial B_{i,t+1}}B_{i,t+1}s_{i,t+1}+Q_{i,t}s_{i,t+1}-(\xi_0+(\xi_1-\xi_0)s_{i,t+1})\right)\\
&-\eta_t(1-s_{i,t+1})(1+c)=\beta E\left[(1+\lambda\mathbb{1}(d_{i,t+1}<0))\left(\frac{1+c-\tau c}{\pi_{t+1}}\right)(1-D_{i,t+1})\right].
\end{aligned}
\tag{20}
$$

The left hand side of equation (19) 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 $(1+\lambda\mathbb{1}(d_{i,t}<0))$. More important, one additional unit capital $k_{i,t+1}$ will reduce the marginal cost through (1) relaxing the collateral constraint $-\eta_t\theta(1-\delta)$ and (2) price effect $\frac{\partial Q_{i,t}}{\partial k_{i,t+1}}$: more investment leads to higher output in the next period and therefore, 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 future marginal cost of issuance due to the increase in retained earnings caused by one additional unit of capital.

Equation (20) equates 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 default risk $\frac{\partial Q_{i,t}}{\partial B_{i,t+1}}B_{i,t+1}s_{i,t+1}$ from bond and constraint risk $\eta_t(1-s_{i,t+1})(1+c)$ from loan, as well as their issuance costs $\xi_0+(\xi_1-\xi_0)s_{i,t+1}$. 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 firm's optimal capital structure.

4.1.2 Optimal Debt Structure

Firms trade-off between high intermediation cost, constraint risk of loans and default risk of bonds when choosing optimal debt composition. Within each period, given $(z_{i,t}, k_{i,t+1}, B_{i,t+1})$, firms choose their optimal debt composition $s_{i,t+1}(z_{i,t}, k_{i,t+1}, B_{i,t+1})$ by solving a static tradeoff problem with a collateral constraint. The objective function is

$$\begin{aligned} F =& Max_{s_{i,t+1}} \quad \frac{B_{i,t+1}(1-s_{i,t+1})}{1+r_t} + Q_{i,t}B_{i,t+1}s_{i,t+1} - DIC(B_{i,t+1}, s_{i,t+1}) \\ s.t \;\; & 1 - \frac{\theta(1-\delta)k_{i,t+1}}{B_{i,t+1}(1+c)} \leq s_{i,t+1} \leq 1, \end{aligned} \tag{21}$$

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

$$\frac{\partial F}{\partial s_{i,t+1}} = \xi_0 - \xi_1 + \left(Q_{i,t} - \frac{1+c}{1+r_t}\right) + \frac{\partial Q_{i,t}}{\partial s_{i,t+1}} s_{i,t+1}, \tag{22}$$

Firm's leverage $\frac{B_{i,t+1}}{k_{i,t+1}}$ and default risk $Q_{i,t}$ together determine the optimal debt structure. The optimal debt composition is nonlinear in firm's leverage. Bond share is a non-linear function of leverage: it is increasing in leverage when firms have default risk. Firms with very low leverage and hence no default risk have the highest bond share.

Let $s^{\star}_{i,t+1}$ denotes the optimal bond share and $\hat{s}_{t+1}$ be the solution for equation (22).

Proposition 6. *For* $\forall\ (z_{i,t}, k_{i,t+1}, B_{i,t+1})$ *such that* $Q_{i,t} = \frac{1+c}{1+r_t}$ *for* $\forall s_{i,t+1}$*:* $s^{*}_{i,t+1} = 1$*,*
i.e, when firms have no default risk, they choose bond debt only.

Proof. See Appendix B. □

Proposition 7. *For* $\forall\ (z_{i,t}, k_{i,t+1}, B_{i,t+1})$ *such that* $Q_{i,t} < \frac{1+c}{1+r_t}$

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

where $\hat{s}_{t+1} = \frac{(\xi_0-\xi_1)+(Q_{i,t}-\frac{1+c}{1+r_t})}{-\frac{\partial Q_{i,t}}{\partial s_{i,t+1}}}$ *such that* $\frac{\partial F}{\partial s_{i,t+1}}|_{s_{i,t+1}=\hat{s}_{t+1}} = 0$*. i.e, when firms have default risk, they choose debt mix financing.*

The optimal debt composition is

$$s^*_{i,t+1} = \frac{(\xi_0 - \xi_1) + (Q_{i,t} - \frac{1+c}{1+r_t})}{-\frac{\partial Q_{i,t}}{\partial s_{i,t+1}}},$$

for financially unconstrained firms, i.e, 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. □

4.2 Calibration and Simulation

I study the model solutions and perform quantitative analysis by means of calibration and simulation. I start with an explanation of the quarterly calibration and simulation, followed by discussions on model mechanisms and policy functions. I solve for the steady state equilibrium via value function iteration and do transition dynamics following a one-time interest rate shock before simulation. Details on numerical algorithm are included in Appendix C.

[Table 5 Here]

The quarterly calibration is summarized in Table 5. 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. Parameters can be divided into four groups: incumbent (technology, financing and productivity), new entrant, household's preference and New Keynesian block.

Firm's technology The first block of the table relate to 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 returns to scale of 85%. Capital depreciates at rate $\delta = 10\%$ per year, which is a standard assumption. The capital adjustment parameter ϕ_0 and ϕ_1 are calibrated to match the cross-sectional dispersion of investment. I also calibrate the fixed production cost c_f to match the annualized default rate of 10-year Baa corporate bond.

Firm's productivity Persistence ρ_z and conditional volatility σ_z of the idiosyncratic productivity shock are calibrated to match the auto-correlation 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 0.3, same as Nikolov and Whited (2014). Upon default, bond investors can recover part of the asset value. I calibrate the recovery rate $\chi = 0.5$, same as the collateral parameter θ, to match the credit spread of 10-year Baa corporate bond.[32] Firms face a linear proportional cost when issuing debt and equity. I calibrate the equity fixed and variable issuance costs λ_0 and λ_1 to match the average frequency of equity issuance and new equity issuance-to-lagged total asset ratio. Loan issuance cost ξ_0 and bond issuance cost ξ_1 are set, respectively, to match the average leverage and bond share. In general, my parameter choices are consistent with Hennessy and Whited (2007).

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 0.18 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 3.12. k_0 is set to match young firms' employment share.

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, in the middle of the range commonly considered in the literature.

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 calibrated 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.[33] I simulate 50 artificial samples

[32] As reported in Exhibit 7 of Moody's report: the senior unsecured bond recovery rate from 1983 to 2017 was 37.74%.

[33] I also exclude firms with age less than 2 year when I calculate the sample auto-correlation of leverage and profitability.

and report the cross-sample average results as model moments in Table 6. It shows cross-simulation averages of mean and standard deviation of investment rate, profitability and leverage, auto-correlation of leverage and profitability, new equity issuance frequency, average equity issuance-to-total asset ratio, credit spread and average bond ratio.

[Table 6 Here]

4.3 Value and policy functions

Figure 5 shows optimal value and policies of firms with average productivity and debt under high rate and low rate.[34] 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 (defaultable) bond (bottom right panel). Each line in the figure corresponds to the economy with a specific interest rate. The blue solid line refers to an economy under low rate and therefore good state, and the red dashed line refers to an economy under high rate and therefore bad state.

The equity value is increasing in its capital stock while investment rate declines. Conditional on capital, firms in good state has higher firm value and investment rate than firms in bad state. The total debt issuance rate is increasing in capital when firm is small and lack of internal funds. They issue more debt when interest rate is high (the red dashed line lies above the blue solid line). The total debt issuance is decreasing in capital when firm is large and they issue more debt in good state because debt becomes more valuable due to lower default risk and therefore higher price (the red dashed line lies below the blue solid line). The overall cost of investment is lower in good state and investment opportunities become more profitable for firms conditional on their idiosyncratic state. Figure 6 shows more details about debt financing for firms with average productivity: decomposing issue of total debt into bond and loan issuance. Issue of bond has a similar pattern as issue of total debt. Interestingly, loan issuance is higher in bad state when interest rate is high due to the substitution effect between loan and bond.

[Figure 5 and 6 Here]

[34] 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, interest rate is a state variable. The details of partial equilibrium model can be found in Appendix B.

5 Quantitative Analysis

5.1 Cross-sectional Debt Composition

To begin with, I provide steady state cross-sectional evidence to validate the model. I show that the cross-sectional unconditional distribution of leverage and loan share, 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. Table 7 Panel A shows the unconditional distributions of leverage and loan ratio in the model and in the data. I report the mean and the 5^{th}, 25^{th}, 75^{th}, and 95^{th} percentiles across firms. The model generates reasonable cross-sectional leverage distribution with estimated percentiles closed to those in the data, despite the fact that model generates a relatively lower leverage ratio, 0.564 at the 95^{th} percentile, compared to 0.642 in the data. The cross-sectional distribution of loan ratio is left-skewed, where firms below 25^{th} percentile have no loan. The loan ratio distribution implied from the model is more left-skewed, with the 75^{th} percentile much lower compared to the data. I also include the percentiles of loan ratio based on an alternative measure where I set all the missing values of firm-level loan ratio to zero. The summary statistics implied from the model is more closed to those in the data using the alternative measure.

Life-cycle dynamics. The initial value of capital that new entrants carry is calibrated to match the employment share of young firms (firms of age less than one year) in the data. Table 7 Panel B shows the untarget employment share of firms in different age groups. In the data, share of employment in firms of age less than one year, between one and ten years, and over ten years are 0.02, 0.21 and 0.76, respectively.[35] Since the data sample covers 115 quarters in total, I only consider firms no older than 30 years in the simulated sample. The corresponding moments implied from the model are 0.016, 0.271 and 0.731.

Cross-sectional determinants of debt structure. Previous literature has established some stylized facts about the cross-sectional determinants of the choice between loans and bonds (private vs public). Houston and James (1996) and Johnson (1997) find that reliance on bank borrowing is decreasing in firm size and overall leverage. Denis and Mihov (2003) find 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 than firms borrowing from either banks or non-bank private

[35] Data is from Ottonello and Winberry (2020).

lenders. Table 8 examines the model implied cross-sectional distribution of debt structure following the regression test:

$$Loan\ Share_{i,t} = \alpha_i + \Gamma' X_{i,t} + \epsilon_{i,t} \tag{23}$$

where loan share is defined as the ratio of loans over the sum of loans and bonds. $X_{i,t}$ is a set of firm characteristics including leverage, a dummy for credit rating, profitability, size and tangibility. The dummy for credit rating takes value one if the credit spread is zero, and takes value zero if the credit spread is one. The correlation between leverage and size, leverage and tangibility are -0.07 and -0.7. Column (1) to (5) reports the univariate regression where firm-level loan share is decreasing in firm size, leverage, credit rating and profitability but is increasing in tangibility, consistent with the facts documented from the data. Column (6) and (7) reports the multivariate regression.

5.2 Capital, Debt Structure Dynamics and Interest Rate Risk

I now quantitatively analyze the effect of a monetary shock ϵ_t^m. The heterogeneous effects of monetary policy on firms' financing behaviors are consistent with the empirical results from the baseline analysis. The economy is initially at the steady state and unexpectedly receives a $\epsilon_0^m = 0.0025$ innovation to the Taylor rule which reverts to 0 according to $\epsilon_{t+1}^m = \rho_m \epsilon_t^m$ 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 5,000 firms in response to a monetary shock and estimate the baseline empirical specification using simulated data.[36] I assume that the high-frequency shocks ϵ_t^m that we measure in the data are innovations to the Taylor rule in the model. I estimate the regressions using data from one year before the shock to twenty quarters after the shock.

The panel regression results for both debt and equity financing are shown in Table 9. It shows the effect of interest rate hike on the changes in loan share and frequency of new equity issuance. Financially constrained firms measured by the tightness of collateral constraint or firm size tend to issue more equity while financially unconstrained firms borrowed more bank loans. Column (1) to (5) show the results for changes in loan share and column (6) to (10) show the results for the frequency of new equity issuance, where I define a dummy for new

[36] In the model, I use time fixed effect rather than 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.

equity issuance taking value one when the dividend payout is negative in the model. The indicator for "constrained" takes value one when the collateral constraint is binding in the model. Model predictions are generally consistent with what we observe in the data, except that the coefficient estimate of equity issuance is negative because we have a large fraction of unconstrained firms in the simulated sample. Firms have incentive to stay away from binding constraint due to high equity issuance cost. This type of firm raises their leverage in response to adverse shocks.

5.3 Model Implications

In this section, I study both the cross-sectional and aggregate implications of the model. I first show the effect of monetary shocks on credit reallocation across firms. In the second subsection, I study the investment effect of monetary shocks through the credit substitution channel.

5.3.1 Cross-sectional Credit Reallocation

Due to the substitution effects among large firms with debt financing flexibility, the model implies a bank credit reallocation from small productive but constrained firms to large unconstrained firms. I verify this implication both in the data and in the model by studying how share of bank loan held by large firms changes in response to an interest rate hike.

Using DealScan dataset, in each quarter, I calculate the ratio of total dollars of new loans issued to large firms in the top tercile, to the total dollars of new loans issued to all the firms in U.S:

$$\$ \text{ ratio} = \frac{\text{Total \$ New Loans to Large Firm (Top tercile)}}{\text{Total \$ New Loans to All Firms}},$$

I also compute the ratio of total numbers of new facilities issued to large firms, to the total numbers of new facilities issued to all firms.

$$\# \text{ ratio} = \frac{\text{Total \# New Facilities to Large Firms (Top tercile)}}{\text{Total \# New Facilities to All Firms}},$$

In the time series test, I then regress the change of the ratio on monetary shocks, GDP growth and their first two lags using both the real and simulated data.[37] Table 10 shows the

[37]In the simulated data, I can only calculate the ratio of dollars amount.

coefficient estimates of $\beta_{0,h}$ for $h = 0$ and $h = 4$:

$$\Delta ratio_{t+h} = \alpha_h + \sum_{j=0}^{2} \beta_{j,h}\epsilon^m_{t-j} + \sum_{j=0}^{2} \eta_{j,h}\Delta GDP_{t-j} + \epsilon_{t+h}, \tag{24}$$

The estimated $\beta_{0,h}$ is statistically insignificant over the full sample of credit lines and term loans but becomes positively significant over the sub-sample of credit lines, which suggests that credit reallocation is mainly driven by firm credit line drawdowns.[38] Specifically, an one percent increase in interest rate raises the credit ratio by dollar amounts by 7.9 percent in a quarter and 18.8 percent in a year (compared to an average of 72.2 percent). It raises the credit ratio by numbers of new issuance by around 3.9 percent (compared to an average of 31.7 percent). The model implies that interest rate hike leads to persistent bank credit reallocation from small constrained firms to large, less productive firms. Therefore, credit is "misallocated".

5.3.2 Real Effect: Investment

What's the real effect of this credit substitution channel? Carey et al. (2007) finds that the pre-bankruptcy share of bank debt has large influence on recovery than all other variables take together.[39] Crouzet (2021) explores the implications of "disintermediation" for the transmission of monetary policy shocks, where he finds that investment among firms with high loan shares is significantly more responsive to monetary policy shocks. Here I revisit this finding in the real data and model following the regression specification:

$$\Delta logk_{i,t+1} = \alpha_i + \lambda_{s,q} + \gamma\epsilon^m_t + \beta\epsilon^m_t \times LoanRatio_{i,t-1} + \delta LoanRatio_{i,t-1} + \Gamma'_1 Z_{i,t-1} + \Gamma'_2 Y_{t-1} + \epsilon_{i,t} \tag{25}$$

The results are shown in Table 11. Column (1) and (2) show the results for the alternative measure and the main measure of loan ratio. -0.07 in column (2) indicates that, on average, a one-standard-deviation increase in interest rate reduces the investment rate by 0.07 percent, compared to an average quarter investment rate of 0.53 percent. The coefficient estimate of the interaction term is negatively significant: -0.14, which means that firms with higher loan

[38] Greenwald et al. (2021) provides a comprehensive analysis of firm credit line drawdowns following several adverse macroeconomic shocks. They are able to document the details about firm credit lines usage and the structure of corporate credit using FR Y-14Q data set (Y14).

[39] They find that a marginal one percentage point increase in bank debt share improves recovery by about one-quarter percentage point.

shares are more responsive to the monetary shocks. Specifically, a 10 percent increase in firm-level loan share leads to an approximately 10 percent further reduction in capital investment, compared to firms on average. Column (3) shows the results using simulated data from the model.

5.3.3 Counterfactual Analysis

This section performs the counterfactual analysis of key financial frictions that determine the loan-bond tradeoff. I use simulated data as a laboratory to examine how debt issuance costs and liquidation value (relative to the collateral value) quantitatively affect the substitution between loans and bonds. In particular, I present the estimated coefficients of the heterogeneous responses in firm-level loan share, equity share and investment in Table 12, as well as relevant key model moments, in data simulated from various specifications nested in the benchmark model. I compare the benchmark model (1) with (2), a model with debt issuance cost reduced by one half, and (3) model in which loan is no longer risk-free since liquidation value is lower than collateral value.

In model (2), firms take much higher leverage when it is cheaper to borrow and therefore, it features a higher default probability and bond spread. In model (3), lower recovery rate leads to higher loan and bond spreads. Firms take lower leverage since it is riskier to borrow and hence, lower default probability. Reducing issuance cost amplifies the borrowing and investment sensitivities to monetary shocks, as the magnitudes of the estimated coefficients increase by four times for loan share and two times for equity share and investment. Reducing liquidation value makes debt financing, especially bond financing, very costly. The estimated coefficient for loan share is close to that in the benchmark model, while the estimated coefficient for equity share becomes positive: large firms would prefer equity financing than bond financing. Firms with higher loan share cut down investment more aggressively, as the magnitudes of the estimated coefficient increase by four times.

6 Discussion

Demand or supply-driven explanations The aggregate and firm-level evidence of bank credits expansion is hard to be explained by the traditional "bank lending channel" of monetary policy transmission, which predicts a decline in bank credits supply due to an increase in the cost of taking deposit. The "floating rate channel" proposed in Ippolito et al. (2018) also can-not explain this fact since it predicts a decline in loan demand due to an increase in interest payment and thus a worse liquidity condition of firm balance sheet.

This pattern is consistent with firm demand as the driver. Theory of asymmetric information predicts that intermediated debt, which is less information-sensitive, is more attractive to borrowers in bad times since bank is more flexible and it brings superior monitoring. It can also be explained by the shift in bond supply. The relative cost of bonds increases following an interest rate hike and therefore, bond supply (or investor's demand) drops. It is necessary to look at firm's choices of other securities, such as convertibles and private debt, to understand the extent to which the findings are driven by asymmetric information or quality or both.

Related to trade-off theory Strebulaev and Whited (2012), Ai et al. (2020a) provide good survey of capital structure and trade-off theory. This model discusses the tradeoffs among a number of securities that can be used to finance endogenous investment. Beyond operating cash flows generated from production, firm has the opportunity each period to take upon 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. Different from the traditional literature, default risk is not the only cost of taking debt. The overall risk of taking debt is the weighted average of default risk and constraint risk. This will also create a deviation from capital structure irrelevance. Finally, the model features issuance costs in both debt and equity issuance, while equity issuance is more costly.

This model also predicts that firms prefer debt financing to equity financing because of the tax benefit. Suppose the corporation would like to raise additional funds for investment beyond internal funds, it will choose debt first due to lower issuance cost. Firms without default risk prefer to issue bond. As they take more debt, they have to pay a higher interest expense, which lowers the available cash flow and raises the default probability (therefore, cost of bond financing). Once the cost of taking bonds exceeds the cost of taking loans, firms switch to loan financing until it gets enough external funds or the collateral constraint binds. After that, firms seek for bonds financing again if they need extra funds. Firms resort to equity financing only when the cost of debt financing is high enough. This happens to high leverage, low rated firms with very high default risk.

7 Conclusion

The interest rate implications of the trade-off theory are often ignored in the literature. This paper studies the changes in relative prices of corporate bonds and loans, as well as firms' differential responses in external financing decisions in response to monetary policy. Add to the literature, I incorporate debt heterogeneity into capital structure and argue that firm's ability to substitute between different marginal sources of external financing against interest rate risk is an important determinant of firms' capital and debt structure.

I empirically document the new facts that, relative spread of bond over loan increases following an interest rate hike. Large, high rated firms with high collateral value and unused credit lines substitute loans for corporate bonds at both intensive and extensive margin. Small, low rated firms that are considered as "financially constrained" tend to issue new equity. The monetary policy effects on this debt compositional shift and therefore, observed bank credit expansion at the aggregate level, is large and persistent.

To understand these empirical patterns, I build a dynamic, heterogeneous agents New Keynesian model that is quantitatively consistent with the empirical results. In addition to the classical trade-off theory, firms also trade off between higher intermediation cost for loans and default risk for bonds when determining the optimal debt structure. An unanticipated interest rate hike raises default risk and hence the cost of bond financing. Firms with low default risk and unused credit lines substitute loans for bonds, while firms with high default risk and binding collateral constraint have to seek for new equity issuance. To go further, the model implies a credit "misallocation" as bank credit flows from constrained, more productive firms to unconstrained firms.

Overall, the main findings in this paper can potentially be helpful to policymakers who are concerned about the redistribution effect of monetary policy on different types of debt markets and financial stability. An often-discussed goal of monetary policy is to provide resources to credit constrained firms. The model outlined in this paper provides a useful framework to quantitatively evaluate the policy effects on debt markets, which can be studied in the future research. Our results sheds light on the intermediated debt market regulations that central bank should implement when conducting monetary policy.

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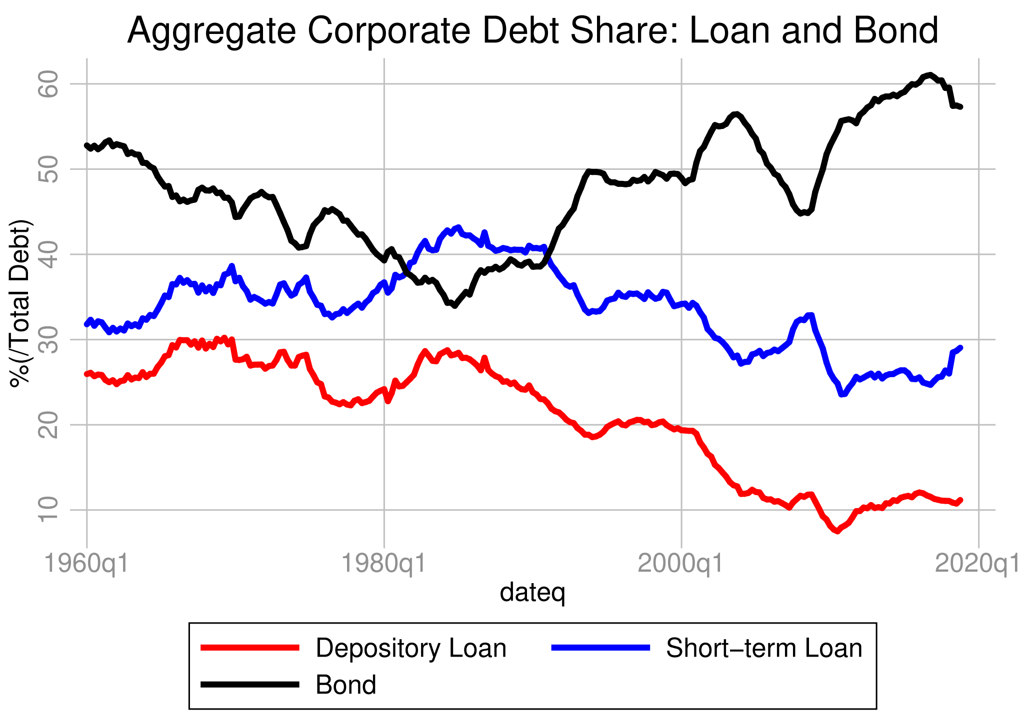
Figures

Figure 1: Aggregate Time Series of Corporate Debt

This figure plots the time series of debt ratio: loan/total debt and bond/total debt of non-financial corporate sector from 1980Q1 to 2018Q4. Total debt is defined as the sum of debt securities and loans. Short-term loan is defined as the sum of depository institution loans and other loans and advances. Data is obtained from the Flow of Funds L.103. Corporate bonds and loans are negatively correlated. There is a shrift from bank debt to market debt over time.



Non-financial 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 2: Monetary Shocks

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

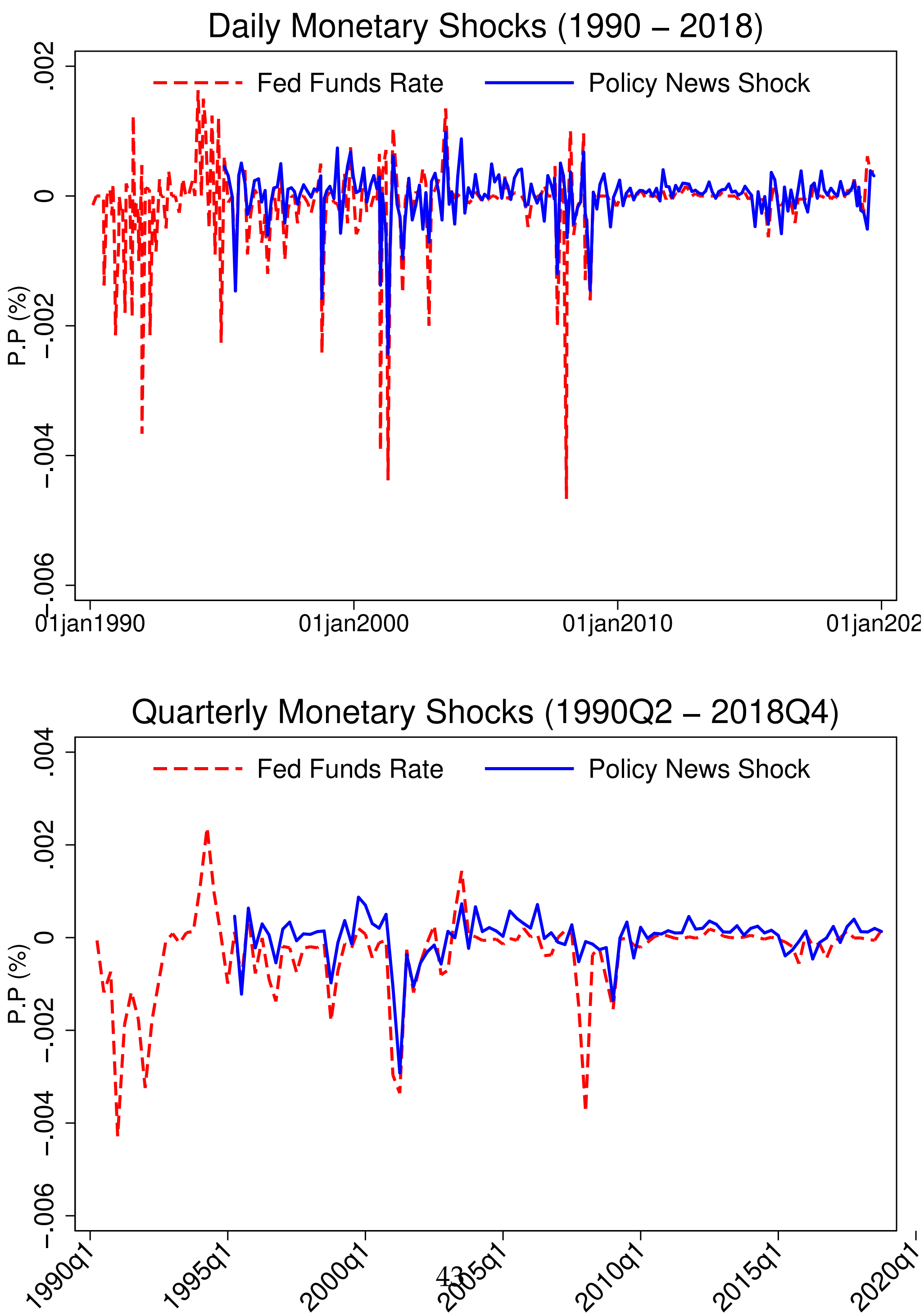


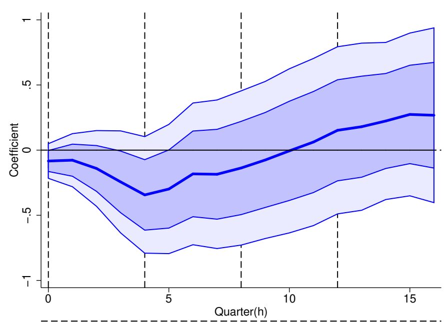
Figure 3: Dynamic Effects of Monetary Shocks on Debt Composition

This figure plots the dynamic effects of monetary shocks on corporate debt compositional shift using aggregate time series data from the Flow of Funds. Coefficient β_h estimates from the following regressions are plotted over time horizon h:

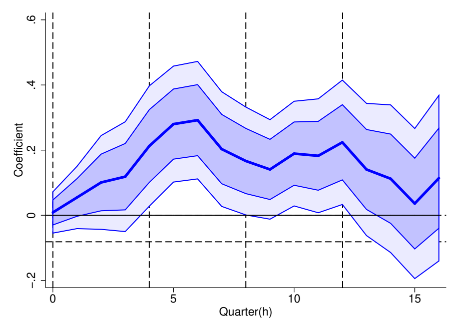
$$\Delta y_{t+h} = \alpha_h + \beta_h \epsilon_t^m + \gamma_h \epsilon_{t-1}^m + \Gamma_h Controls_t + \epsilon_{t+h}$$

where $h \in [0, 16]$. The control variables include the current and lagged values of real GDP growth, inflation rate, unemployment and their forecast revisions, credit spread, term spread, price-dividend ratio and financial sector leverage. The shaded area are 68% and 90% error bands. Panel (a) and (b) (where $y = \Delta Debt\ Share$) show the long-run cumulative effect of monetary shocks on market debt share (bonds/total debt) and bank debt share (loans/total debt); Panel (c) (d) and (e) (where $y = \Delta log(Debt)$) show the effect on bond amount, loan amount and total debt amount defined as the sum of debt securities and loans, respectively. The sample covers periods from 1990Q2 to 2018Q4.

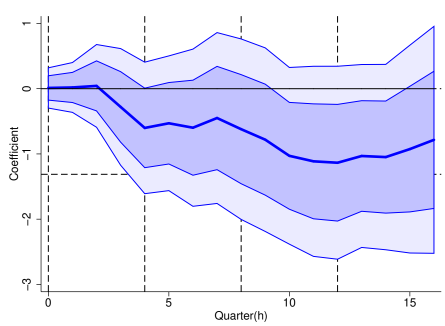
(a) Changes in Bonds Share



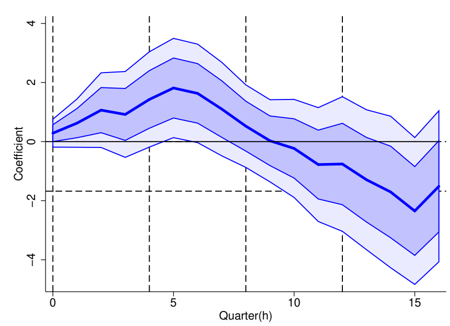
(b) Changes in Loans Share



(c) Changes in Bonds Amount



(d) Changes in Loans Amount



(e) Changes in Total Amount of Bonds and Loans

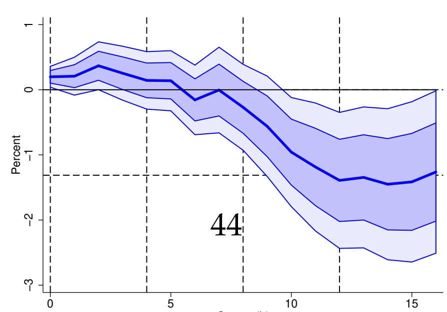
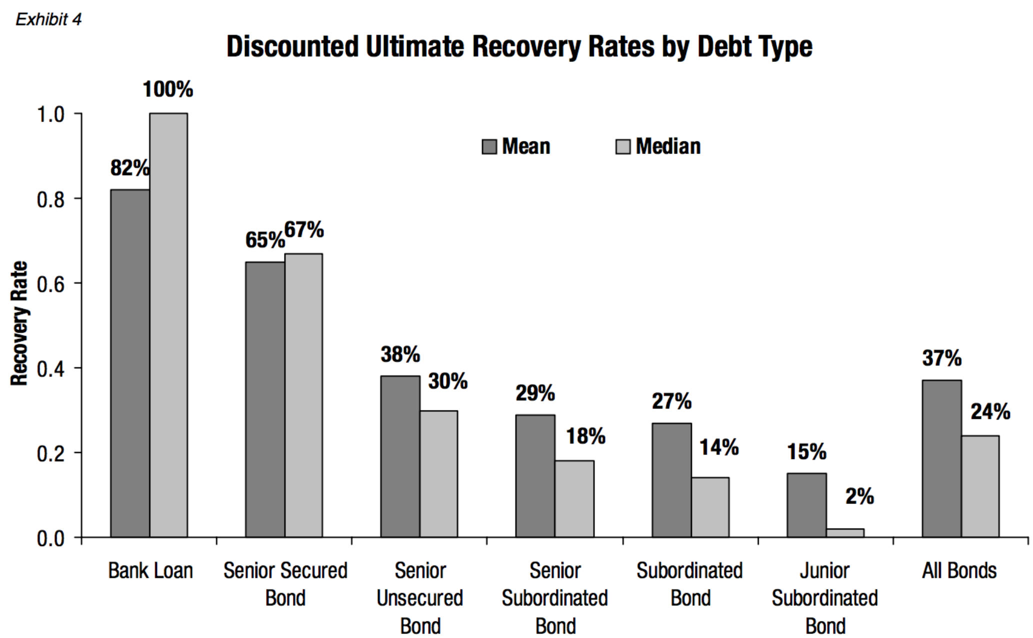


Figure 4: Moody's Recovery by Debt Type

As can be seen in Exhibit 4, bank loans recover an average of 82 percent at 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 an average of 38 percent for senior unsecured bonds down 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**



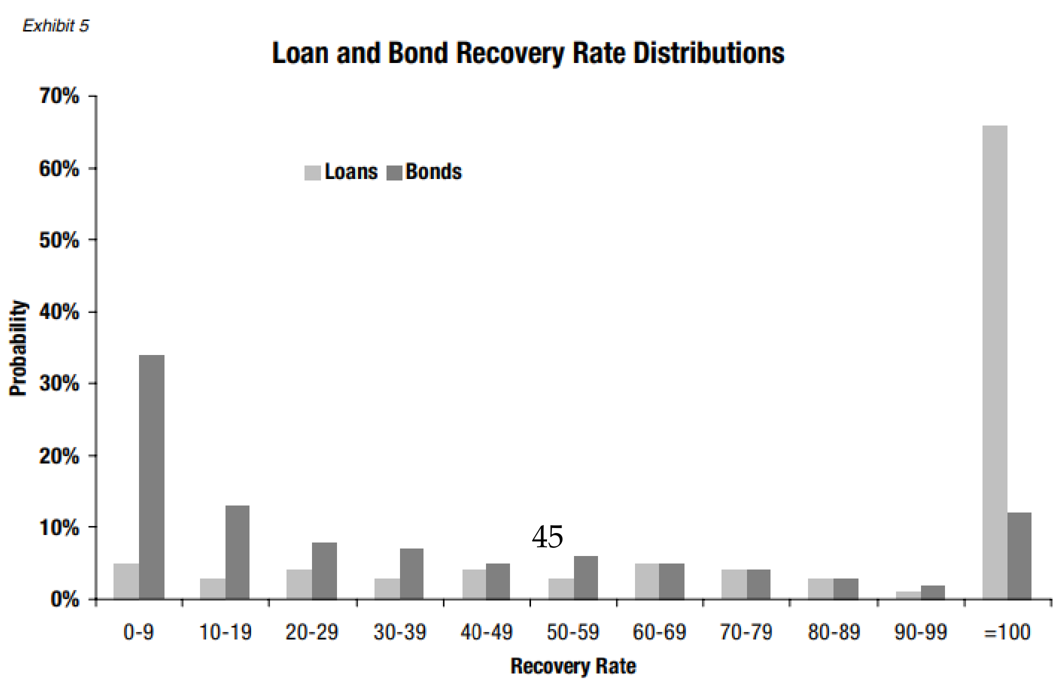


Figure 5: Optimal Value and Policy Functions

This figure plots the value of equity (top left panel), the policy for the investment-to-capital ratio (top right panel), the policy for new (total) debt issuance-to-capital ratio (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 the economy with different level of interest rates. The blue solid line refers to an economy in good state (low rate), and the red dashed line refers to an economy in bad state (high rate).

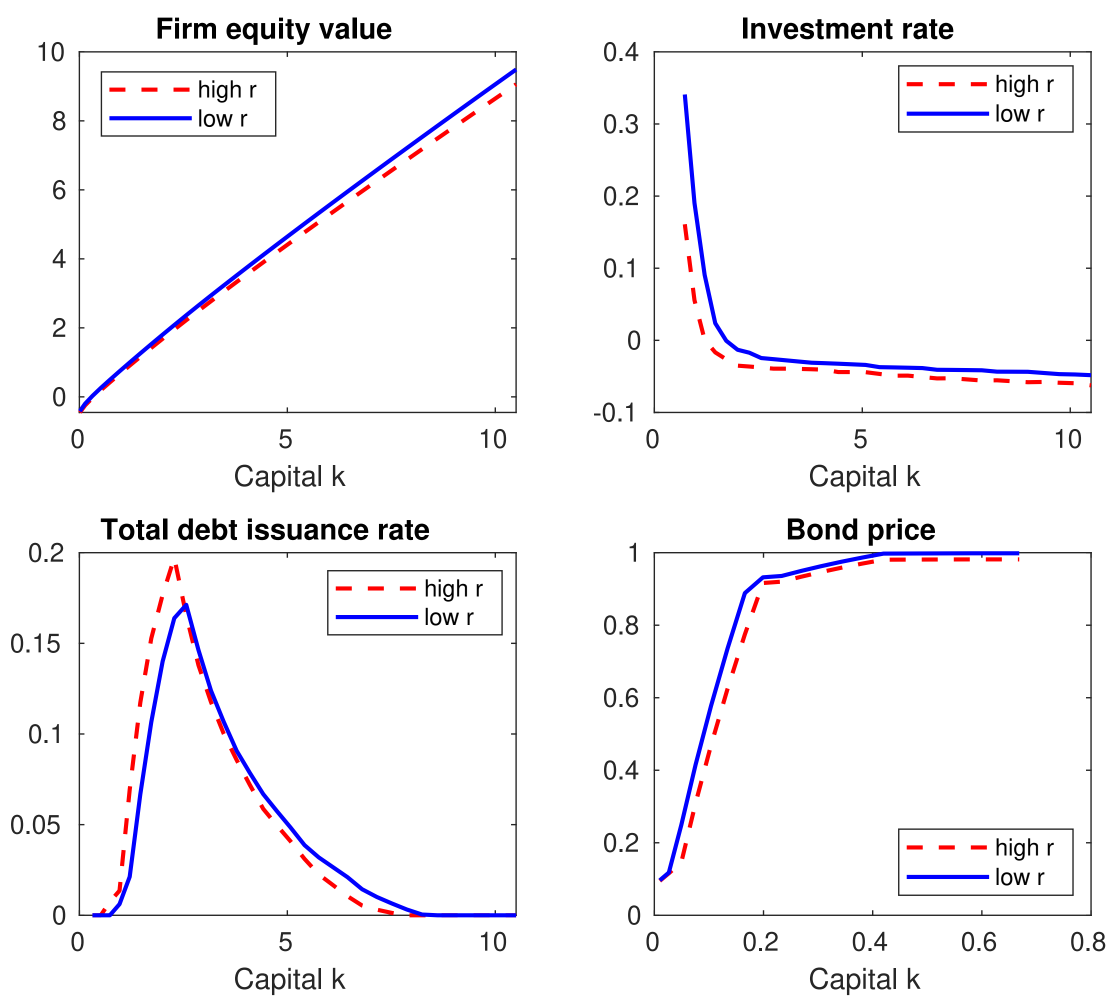


Figure 6: Bond and Loan Issuance

This figure shows more details about bond and loan financing for firms with average productivity. Figure on the top of the panel plots the total debt issuance. Bond and loan issuance are plotted on the bottom left and right of the panel , separately.

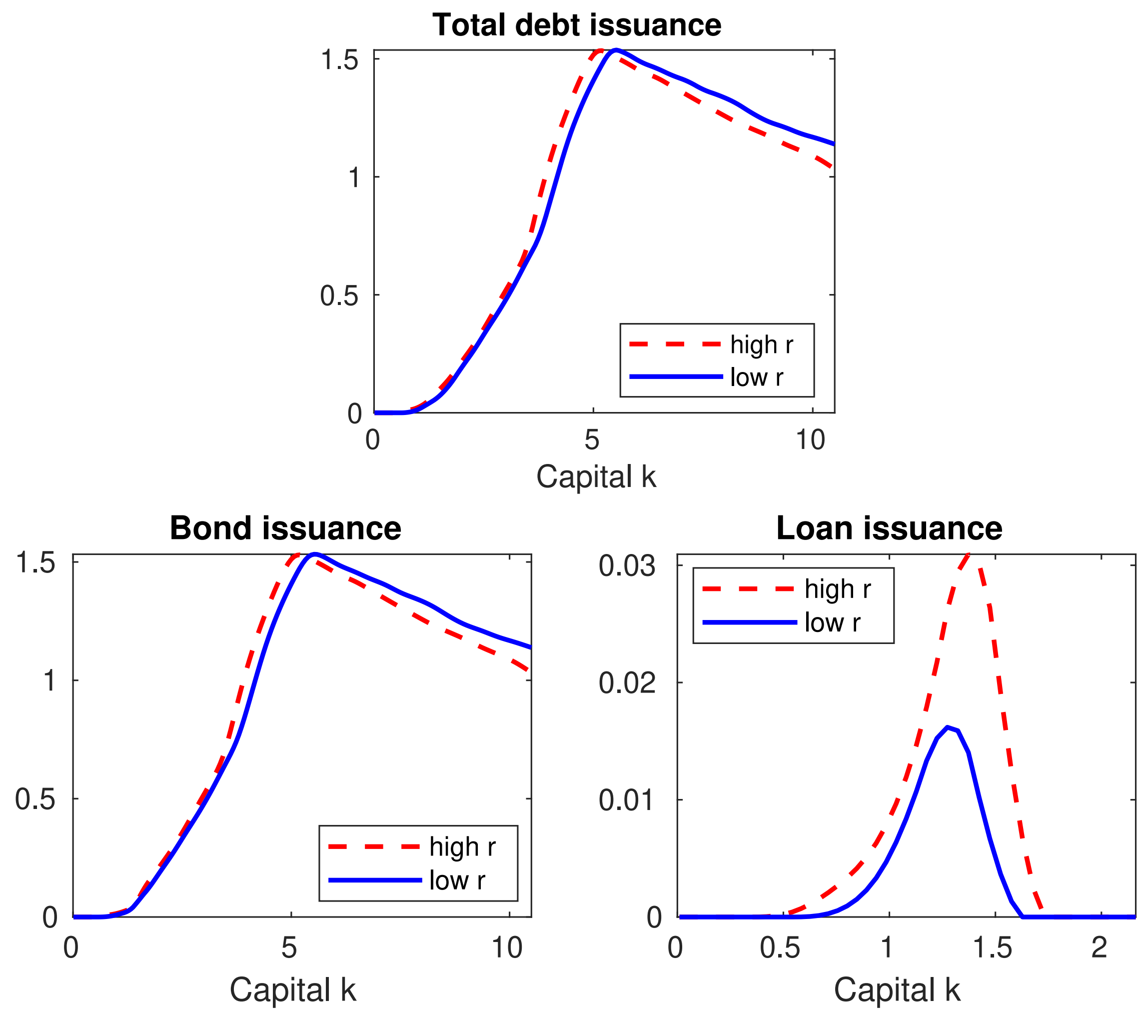
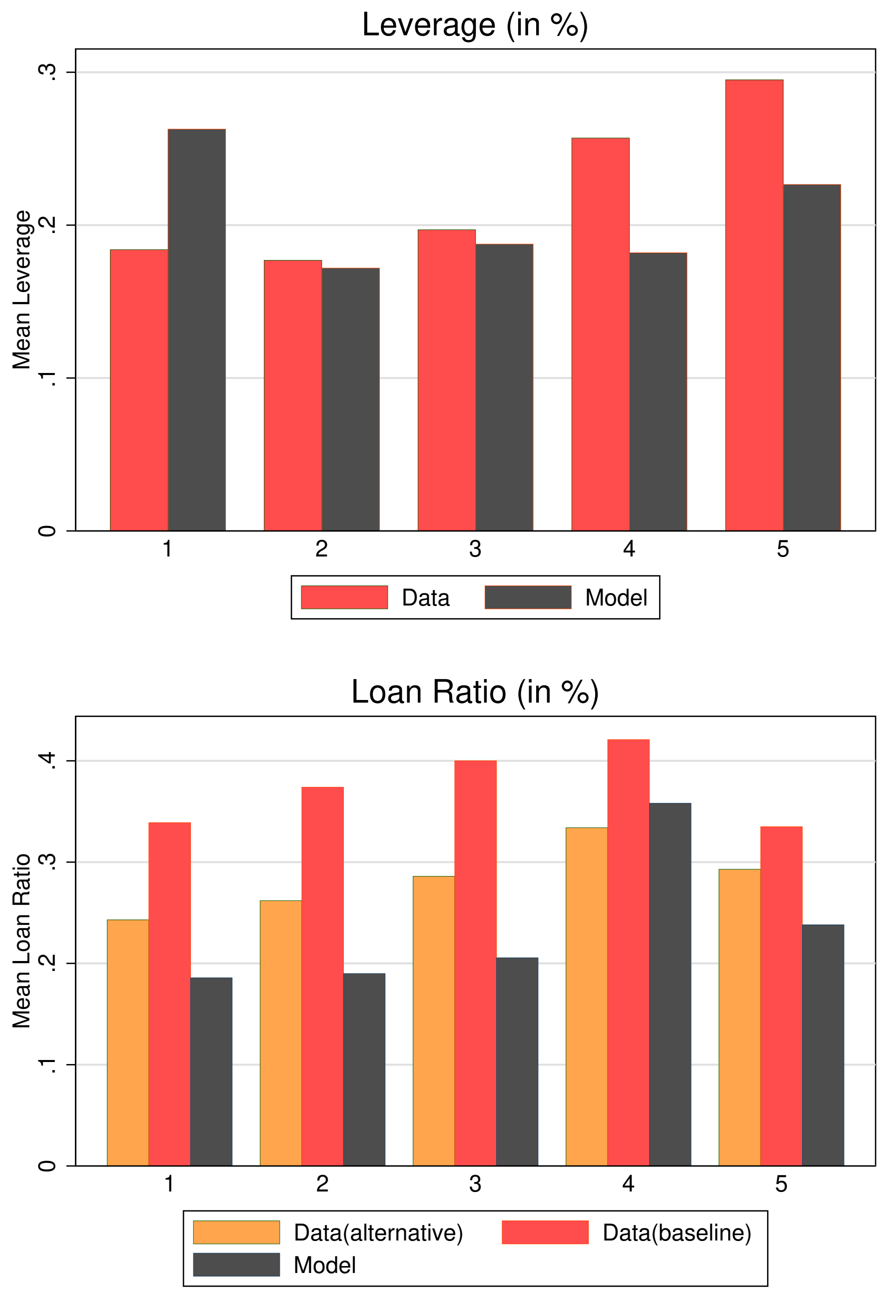


Figure 7: Firm Debt Conditional on Size

This figure shows the mean values of leverage and loan ratio by size quintile. The data is shown as the red bars and the black bars show the corresponding values implied from the model.



Tables

Table 1: Summary Statistics

Table 1 report the summary statistics of key variables. Panel A presents the summary statistics of monetary policy shocks and corporate debt from 1990Q2 to 2018Q4. Monetary policy shocks are estimated using event study strategy and aggregated using weighted average of daily changes in Fed Funds future prices and aggregate non-financial corporate debt data is from Flow of Funds. Panel B presents the summary statistics of firm-level loans data from DealScan and bonds data from FISD. Key variables of firms 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	0.149	0.121	0.047	0.075	0.238	116
Bond/Total Debt	0.517	0.501	0.057	0.385	0.611	116
Loan Growth (%)	-0.078	0.381	3.583	-12.000	8.795	115
Bond Growth (%)	0.925	0.864	1.275	-1.803	4.328	115
Variable	Mean	Median	Std Dev	25%	75%	N
Panel B: Corporate Debt						
Bank Loan from DealScan						
Loan Rate (bp)	534.30	560.89	226.82	337.74	714.91	29954
"All-in-drawn" (bp)	188.39	175	112.19	100	250	30025
Facility Amount (Million)	315.11	150	460.02	50	375	30003
Maturity (Year)	4.17	5	1.71	3	5	30276
Corporate Bond from FISD						
Offering Yield (bp)	562.67	553.20	278.17	335.11	750	8309
Spread (bp)	304.48	276.62	242.80	139.97	449.76	8309
Offering Amount (Million)	459.95	300	417.68	200	575	8310
Maturity (Year)	8.90	9.61	4.07	5.49	10.04	8307

To be continued

Variable	Mean	Median	Std Dev	25%	75%	N
Panel C: Firm Variables						
Bank Debt ="No", Public Debt ="No"; 5986 Firms						
Size	3.55	3.49	1.45	2.50	4.50	130188
Market-to-Book	2.29	1.45	2.37	0.88	2.73	120390
Leverage	0.17	0.07	0.22	0.00	0.25	128560
Investment Rate	0.05	0.02	0.14	-0.00	0.06	127602
Sales Growth	0.02	0.02	0.43	-0.11	0.15	124663
Liquidity	0.30	0.22	0.27	0.06	0.50	130104
Tangibility	0.36	0.34	0.22	0.18	0.52	127758
Dividend (dummy)	0.09	0.00	0.29	0.00	0.00	135813
Bank Debt = "No", Public Debt = "Yes"; 463 Firms						
Size	5.43	5.28	1.69	4.30	6.42	15038
Market-to-Book	2.66	1.88	2.32	1.10	3.38	13886
Leverage	0.28	0.18	0.33	0.02	0.43	14650
Investment Rate	0.06	0.03	0.15	0.00	0.08	14811
Sales Growth	0.04	0.04	0.43	-0.07	0.14	14600
Liquidity	0.38	0.35	0.28	0.13	0.61	15033
Tangibility	0.27	0.22	0.20	0.12	0.40	14617
Dividend (dummy)	0.10	0.00	0.30	0.00	0.00	15511
Bank Debt = "Yes", Public Debt ="No"; 3590 Firms						
Size	5.28	5.20	1.62	4.14	6.31	156812
Market-to-Book	1.53	1.14	1.22	0.79	1.80	146139
Leverage	0.23	0.18	0.22	0.04	0.34	154527
Investment Rate	0.05	0.03	0.09	0.01	0.06	155224
Sales Growth	0.02	0.02	0.23	-0.06	0.10	153675
Liquidity	0.14	0.07	0.17	0.02	0.20	156693
Tangibility	0.48	0.48	0.21	0.33	0.61	153748
Dividend (dummy)	0.08	0.00	0.27	0.00	0.00	159937
Bank Debt = "Yes", Public Debt = "Yes"; 2141 Firms						
Size	7.14	7.12	1.73	6.01	8.27	126039
Market-to-Book	1.54	1.19	1.13	0.86	1.79	120398
Leverage	0.30	0.27	0.22	0.15	0.41	124301
Investment Rate	0.05	0.03	0.09	0.02	0.06	125134
Sales Growth	0.02	0.02	0.19	-0.05	0.09	124432
Liquidity	0.12	0.06	0.15	0.02	0.15	125923
Tangibility	0.44	0.44	0.20	0.30	0.55	122859
Dividend (dummy)	0.12	0.00	0.32	0.00	0.00	127664

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.

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

Column (1) to (4) reports debt financing decisions on the extensive margin, where the *dependent variable* is a dummy variable for debt financing decision equaling to one if the firm chooses bank debt instead of market debt in quarter t. Column (5) to (8) reports debt financing decisions on the intensive margin, where the *dependent variable* is the change of loan share in quarter t. ϵ_t^m is the monetary shock and $X_{i,t-1}$ is firm's size, tangibility or credit rating in the previous quarter. $Z_{i,t-1}$ is a set of firm control variables including size, 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, inflation rate and unemployment rate. Monetary shocks and firm control variables are standardized. The sample covers periods from 1990Q2 to 2018Q4 and financial crisis (2008Q3 to 2009Q2) is excluded. The firm and sector-quarter fixed effect are indicated in the table. Standard errors are heteroskedasticity-robust and clustered at the firm level, and t statistics 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)	(9)	(10)
ϵ_t^m	0.017***	0.024***	0.024***	0.022***	-0.020***	0.089***	0.030	0.032	0.024	-0.003
	(4.215)	(5.120)	(5.252)	(4.613)	(-2.837)	(4.724)	(1.526)	(1.635)	(1.218)	(-0.124)
ϵ_t^m × Size			0.014***					0.061***		
			(3.282)					(3.169)		
ϵ_t^m × Tangibility				0.016***					0.029	
				(3.883)					(1.430)	
$\epsilon_t^m \times \mathbb{1}$(Invest. Grade)					0.056***					0.103***
					(6.750)					(2.925)
Firm controls	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Aggregate controls	N	Y	Y	Y	Y	N	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
Observations	14405	14405	14405	14405	14405	189284	189284	189284	189284	189284
R^2	0.258	0.271	0.273	0.272	0.274	0.080	0.082	0.082	0.082	0.082

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.

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

Column (1) to (4) reports equity financing decisions on the extensive margin, where the *dependent variable* is a dummy variable equaling to one if the firm issues new equity in quarter t. Column (5) to (8) reports 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's size, tangibility and credit rating in the previous quarter. $Z_{i,t-1}$ is a set of firm control variables including size, 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, inflation rate and unemployment rate. Monetary shocks and firm control variables are standardized. The sample covers periods from 1990Q2 to 2018Q4 and financial crisis (2008Q3 to 2009Q2) is excluded. The firm and sector-quarter fixed effect are indicated in the table. Standard errors are heteroskedasticity-robust and clustered at the firm level, and t statistics 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)	(9)	(10)
ϵ_t^m	0.003***	0.003***	0.003***	0.003***	0.003***	0.307***	0.194***	0.170***	0.193***	0.183***
	(7.706)	(5.893)	(6.137)	(6.157)	(5.921)	(16.817)	(9.551)	(8.416)	(8.745)	(7.483)
$\epsilon_t^m \times$ Size			-0.001*					-0.063***		
			(-1.691)					(-2.728)		
$\epsilon_t^m \times$ Tangibility				-0.002*					-0.314***	
				(-1.936)					(-7.801)	
$\epsilon_t^m \times \mathbb{1}$(Invest. Grade)					-0.001					-0.052
					(-1.412)					(-1.613)
Firm controls	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Aggregate controls	N	Y	Y	Y	Y	N	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
Observations	297466	297466	297466	297466	297466	297425	297425	297425	297425	297425
R^2	0.146	0.147	0.147	0.147	0.147	0.130	0.131	0.132	0.132	0.132

Table 4: The Effect of Monetary Shocks on Debt Issuance Prices

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

$$Spread_{i,t} = \alpha_i + \lambda_{s,q} + \gamma\epsilon_t^m + \beta\epsilon_t^m \times X_{i,t-1} + \eta\Delta GDP_t \times X_{i,t-1} + \delta X_{i,t-1} + \Gamma_1' Z_{i,t-1} + \Gamma_2' W_{i,t-1} + \Gamma_3' Y_{t-1} + \epsilon_{i,t}$$

Column (1) to (4) reports the impact of monetary shocks on loan issuance prices, where the *dependent variable* is the spread between loan rate and three-month LIBOR. Column (5) to (8) reports the impact of monetary shocks on bond issuance prices, where the *dependent variable* is the spread between offering yield and three-month LIBOR. ϵ_t^m is the monetary shock and $X_{i,t-1}$ is the firm size, tangibility or credit rating in the previous quarter. $Z_{i,t-1}$ is a set of firm control variables including size, market-to-book ratio, liquidity, tangibility, leverage, a dummy for dividend payout and a dummy for investment grade (long-term credit rating). $W_{i,t-1}$ is a set of debt characteristics including 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 and financial crisis (2008Q3 to 2009Q2) is excluded. The firm and sector-quarter fixed effect are indicated in the table. Standard errors are heteroskedasticity-robust and clustered at the firm level, and t statistics in parentheses. All firm-level variables are winsorized at the 1% level. $^*p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$.

	Bank Loan					Corporate Bond				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
ϵ_t^m	0.016*	0.005	0.017*	0.017*	0.018	0.181***	0.130***	0.142***	0.133***	0.045
	(1.839)	(0.581)	(1.855)	(1.814)	(1.354)	(5.541)	(3.832)	(3.883)	(3.531)	(0.260)
ϵ_t^m × Size			0.013					0.013		
			(1.453)					(0.321)		
ϵ_t^m × Tangibility				-0.008					0.037	
				(-0.842)					(1.060)	
$\epsilon_t^m \times \mathbb{1}$(Invest. Grade)					-0.005					0.104
					(-0.267)					(0.595)
Maturity	0.044***	0.059***	0.057***	0.058***	0.057***	-0.080***	-0.068***	-0.067***	-0.067***	-0.066***
	(5.036)	(6.973)	(6.723)	(6.843)	(6.808)	(-6.242)	(-5.607)	(-5.520)	(-5.521)	(-5.491)
Borrowing Amount	-0.106***	-0.098***	-0.096***	-0.097***	-0.097***	-0.045	-0.073	-0.073	-0.071	-0.073
	(-5.575)	(-5.184)	(-5.085)	(-5.125)	(-5.114)	(-0.609)	(-1.059)	(-1.064)	(-1.031)	(-1.063)
Firm controls	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Aggregate controls	N	Y	Y	Y	Y	N	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
Observations	10344	10344	10344	10344	10344	4453	4453	4453	4453	4453
R^2	0.529	0.566	0.568	0.568	0.568	0.454	0.525	0.525	0.526	0.525

Table 5: Parameters for Baseline Model (Quarterly)

This tables summarizes the external fixed and internal 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	1.59	Steady state employment rate (60%)
Panel B: Firm Producer			
Technology			
Capital coefficient	α	0.21	Internal calibrated
Labor coefficient	ν	0.64	Total returns to scale of 85%
Depreciation	δ	0.025	10% annual depreciation rate (BEA)
Production fixed cost	c_f	0.0975	Internal calibrated
Capital adjustment cost	ϕ (ϕ^+/ϕ^-)	0.1/6	Internal calibrated
Productivity			
Productivity persistency	ρ_z	0.90	Internal calibrated
Productivity volatility	σ_z	0.12	Internal calibrated
Financing			
Corporate income tax	τ	0.3	Nikolov and Whited (2013)
Collateralized value	θ	0.5	Li, Whited and Wu (2019); Ai et al. (2020)
Liquidation recovery value	χ	0.5	Internal calibrated (Moody's Recovery Database)
Loan issuance cost	ξ_0	0.0063	Internal calibrated
Bond issuance cost	ξ_1	0.006	Internal calibrated
Equity fixed issuance cost	λ_0	0.22	Internal calibrated
Equity variable issuance cost	λ_1	0.1	Internal calibrated
Panel C: New Entrants			
Initial capital	k_0	1	Internal calibrated
Initial debt	b_0	0	Standard
Initial productivity mean	m	-1.2	Internal 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 & Winberry (2020)
Price adjustment cost	φ	90	Phillips Curve slope (0.1)
Persistence of monetary shock	ρ_m	0.5	Ottonello & Winberry (2020)

Table 6: Internal 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 the quarterly CRSP-Compustat file covering periods from 1990Q2 to 2018Q4. Data of bond share is measured using the aggregate corporate debt data from Flow of Funds. Data of ten-year Baa-rated bonds credit spread and default probability is from Huang and Huang (2012).

Description	Parameter	Value	Target Moments	Data	Model
Capital depreciation rate	δ	0.025	Mean of investment rate	0.045	0.029
Capital adjustment cost	ϕ (ϕ^{+}/ϕ^{-})	0.1/6	Stdev of investment rate	0.086	0.092
Bond issuance cost	ξ_1	0.006	Mean of leverage	0.224	0.213
Capital coefficient	α	0.21	Mean of profitability	0.016	0.018
Productivity volatility	σ_z	0.12	Stdev of profitability	0.054	0.033
			Stdev of leverage	0.215	0.221
Productivity persistency	ρ_z	0.90	Autocorrelation of profitability	0.389	0.247
			Autocorrelation of leverage	0.854	0.908
Equity variable issuance cost	λ_1	0.1	Mean of equity issue-to-asset ratio	0.085	0.058
Equity fixed issuance cost	λ_0	0.22	Frequency of equity issuance	0.069	0.095
Loan issuance cost	ξ_0	0.0063	Bond share (bond/(bond+loan))	0.74	0.76
Production fixed cost	c_f	0.098	Default probability (Annualized %)	4.39	3.28
Liquidation recovery value	χ	0.5	Average credit spread (Annualized %)	1.94	1.32

Table 7: Cross-sectional Debt Distribution and Firm Life-cycle Patterns

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

Panel A: Unconditional Debt Distribution

	5^{th}	25^{th}	Mean	75^{th}	95^{th}
Data					
Leverage	0	0.030	0.224	0.348	0.642
Loan ratio (baseline)	0	0.025	0.370	0.663	1
Loan ratio (alternative)	0	0	0.284	0.541	1
Model					
Leverage	0	0.005	0.210	0.372	0.593
Loan ratio	0	0	0.240	0.438	1

Panel B: Life-cycle Pattern (Employment share)

	N_1	N_{1-10}	N_{10}
Data			
	0.02	0.21	0.76
Model			
	0.016	0.271	0.713

Table 8: Cross-sectional determinants of debt structure (Simulation)

This table reports the cross-sectional determinants of debt structure using the simulated data of 5,000 firms from the calibrated model. The coefficient estimates below are obtained from the following regression:

$$LoanShare_{i,t} = \alpha_i + \Gamma' X_{i,t} + \epsilon_{i,t}$$

where loan share is defined as the ratio of loans over the sum of loans and bonds. $X_{i,t}$ is a set of firm characteristics including leverage, a dummy for credit rating, profitability, size and tangibility. The dummy for credit rating takes value one if the credit spread is zero, and takes value zero if the credit spread is one. The firm fixed effect is indicated in the table. Standard errors are heteroskedasticity-robust and clustered at the firm level, and t statistics 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)
				Loan Share			
Leverage	-0.515***					-0.413***	-0.006
	(-69.11)					(-67.16)	(-1.30)
Size		-0.072***				-0.037***	0.278***
		(-36.55)				(-15.17)	(119.24)
Tangibility			0.749***			0.310***	1.651***
			(73.09)			(35.25)	(129.61)
Credit Rating				-0.307***			-0.537***
				(-117.82)			(-189.83)
Profitability					-4.346***		-6.827***
					(-120.84)		(-130.75)
Observations	985808	971360	971360	985808	971360	971360	971360
Adjusted R^2	0.201	0.159	0.188	0.188	0.224	0.212	0.385
Firm FE	yes	yes	yes	yes	yes	yes	yes
Firm Clustering	yes	yes	yes	yes	yes	yes	yes

Table 9: 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 shock using the simulated data from the model. Column (2) shows the results for heterogeneous changes in the loan share and column (4) shows the results for equity share. Column (6) shows the average effect on the relative change in the spread of bonds over loans. The firm fixed effect is indicated in the table. Standard errors are heteroskedasticity-robust and clustered at the firm level. ΔLoan Share are winsorized at the 5% level. $^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$.

	(1)	(2)	(3)	(4)	(5)	(6)
	ΔLoan Share		Δ(Equity Share)		Relative Spread	
	Data	Model	Data	Model	Data	Model
ϵ_t^m	0.032	0.160	0.170	0.075	0.125	0.077
$\epsilon_t^m \times$ Size	0.061	0.112	-0.063	-0.047		
R^2	0.082	0.168	0.480	0.187	0.525	0.100
Firm FE	yes	yes	yes	yes	yes	yes
Firm Clustering	yes	yes	yes	yes	yes	yes

Table 10: Credit Reallocation

This table reports the credit reallocation effect of monetary shocks using both real and simulated data from the model. Coefficients are estimated from the following regressions:

$$\Delta ratio_{t+h} = \alpha_h + \sum_{j=0}^{2} \beta_{j,h}\epsilon_{t-j}^m + \sum_{j=0}^{2} \eta_{j,h}\Delta GDP_{t-j} + \epsilon_{t+h}$$

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	Data								Model
	All Credits				Credit Lines				Loans
	$\Delta\$ratio_t$	$\Delta\#ratio_t$	$\Delta\$ratio_{t+4}$	$\Delta\#ratio_{t+4}$	$\Delta\$ratio_t$	$\Delta\#ratio_t$	$\Delta\$ratio_{t+4}$	$\Delta\#ratio_{t+4}$	$\Delta\$ratio_t$
ϵ_t^m	1.033	0.194	0.916	0.177	0.736	0.366*	1.748**	0.311	1.110***
	(1.259)	(1.120)	(1.252)	(1.113)	(0.945)	(1.937)	(2.245)	(1.301)	(6.301)
Observations	105	105	101	101	105	105	101	101	21

Table 11: Real Effects: Investment

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

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

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, 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, inflation rate and unemployment rate. Monetary shocks and firm control variables are standardized. The sample covers periods from 1990Q2 to 2018Q4 and financial crisis (2008Q3 to 2009Q2) is excluded. The firm and sector-quarter fixed effect are indicated in the table. Standard errors are heteroskedasticity-robust and clustered at the firm level, and t statistics in parentheses. $^*p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$.

	(1)	(2)	(3)
	$\Delta logk_{i,t+1}$		
	Data		Model
	Alternative	Main	
ϵ_t^m	-0.110***	-0.071**	-0.023
	(-4.087)	(-2.135)	(-0.626)
$\epsilon_t^m \times LoanRatio_{i,t-1}$	-0.165**	-0.141*	-0.132*
	(-2.244)	(-1.713)	(-1.665)
Firm controls	yes	yes	yes
Aggregate controls	yes	yes	no
Firm FE	yes	yes	yes
Sector-quarter FE	yes	yes	no
Observations	165978	111034	65000
R^2	0.116	0.140	0.736

Table 12: Counterfactual Analysis

This table reports the results of counterfactual analysis in various model specifications. Model (1) "Baseline" is the benchmark model; model (2) "ISC" reduces the debt issuance costs by half; model (3) "Liquidation" features defaultable loans and bonds (by setting $\chi < \theta$) but keeps the seniority of loan lenders. Panel A reports the key moments at the steady state from three model specifications. Panel B, C and D report the coefficient estimates of the heterogeneous effects of monetary policy on firm's financing and investment decisions using both the real data and the simulated data from three model specifications. The firm controls and firm fixed effect are included. Standard errors are heteroskedasticity-robust and clustered at the firm level, and t statistics in parentheses. ΔLoan Share are winsorized at the 5% level. $^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$.

	Panel A: Model Moments			
	Mean Leverage	Std Leverage	Prob(Equity Issue)	Mean $\frac{\text{Equity Issue}}{Asset}$
(1) Baseline	0.213	0.221	0.095	0.058
(2) ISC	0.306	0.251	0.123	0.044
(3) Liquidation	0.193	0.205	0.117	0.050
	Default Prob. (%)	Bond Spread (%)	Loan Spread (%)	Bond Share
(1) Baseline	3.28	1.32	0	0.765
(2) ISC	8.32	2.72	0	0.825
(3) Liquidation	2.84	3.12	0.24	0.773
	Panel B: ΔLoan Share			
	Data	(1) Baseline	(2) ISC	(3) Liquidation
$\epsilon_t^m \times \text{Size}_{i,t-1}$	0.061	0.112	0.427	0.136
	Panel C: ΔEquity Share			
	Data	(1) Baseline	(2) ISC	(3) Liquidation
$\epsilon_t^m \times \text{Size}_{i,t-1}$	-0.063	-0.047	-0.087	0.138
	Panel D: $\Delta log(k)$			
	Data	(1) Baseline	(2) ISC	(3) Liquidation
$\epsilon_t^m \times \text{Loan Share}_{i,t-1}$	-0.141	-0.132	-0.290	-0.557
Firm controls	yes	yes	yes	yes
Firm FE	yes	yes	yes	yes

Online 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) ("GSS" and "GW") as the baseline measures in the main analysis and the measures from Nakamura and Steinsson (2018), as well as Gertler and Karadi (2015) in the robustness test.

"GSS" and "GW" measure monetary shocks as the changes in current month's federal funds futures rate in a 30 minutes' narrow window around FOMC announcement. I excludes 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 (Reinelt and Meier (2020)). I further excludes the apex of financial crisis from 2008Q3 to 2009Q2. The sample runs from 1995 to 2018. Gertler and Karadi (2015) uses 3-months ahead federal funds futures to measure daily monetary shocks ("FF4") and the sample runs from 1990 to 2012. I also use the policy news shock from Nakamura and Steinsson (2018) as a robustness check.

I follow Ottonello and Winberry (2020) to aggregate the shocks to 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 weights shocks across quarters corresponding to the amount of time agents have to respond.

Results based on Gertler and Karadi (2015)'s shock, and Nakamura and Steinsson (2018)'s policy news shock can be found in Table A.6.

A.2 Aggregate Variables

The aggregate variables used in the empirical test include non-financial 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), treasury yield and LIBOR available from Federal Reserve Bank of St. Louis as well as their Greenbook forecasts and forecast revisions available from Federal Reserve Bank of Philadelphia.

A.3 Firm Variables

Debt Data

New loan issuance data is obtained from DealScan and new bond issuance data is obtained from FISD. I obtain firm-level loan share from Compustat. A limitation of Compustat balance sheets is that they do not report loans separately from the rest of debt outstanding. 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.[40] 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), convertible or subordinate bonds (included in DCVT and DS, respectively). The main drawback is that both NP and DLTO include commercial paper outstanding. 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 sale of common and preferred stock minus purchase of common and preferred stock, scaled by lagged total asset. Equity 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 total asset (ATQ) and total debt (DLTTQ + DLCQ). The change in equity share every period is therefore change in equity

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

stock, scaled by lagged total asset.

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 no credit rating). I use "Whited-Wu" index (WW), Size & Age index (SA), firm size, credit rating and tangibility as proxies for financial constraints. SA index is constructed following Hadlock and Pierce (2010) as SA Index $= -0.737\text{Size} + 0.043\text{Size}^2 - 0.040\text{Age}$. WW index is constructed following Whited and Wu (2006) and Hennessy and Whited (2007) as WW Index $= -0.091\text{CF} - 0.062\text{DIVPOS} + 0.021\text{TLTD} - 0.044\text{LNTA} + 0.102\text{ISG} - 0.035\text{SG}$. Following convention, 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. From Berger et al. (1996), I estimate liquidation values as Tangibility $= 0.715 \times$ Receivables $+ 0.547 \times$ Inventory $+ 0.535 \times$ Capital, scaled by total asset.

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 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 firms with negative or missing sales or assets.
- I drop firms with negative liquidity.

DealScan

I apply the following filters to my DealScan sample:

- I keep facility measured in U.S Dollars.
- I keep facility with borrowers and lenders in USA.
- I keep facility using "LIBOR" as the base rate.
- I keep facility with loan types in the following categories: "364-Day Facility", "Revolver/Line $<$ 1 Yr", "Revolver/Line $>=$ 1 Yr", "Revolver/Term Loan", "Term Loan (A,B,C)".
- I drop facility with maturity less than one year or over 30 years.
- I drop facility with negative "All-in-Drawn".

FISD

I apply the following filters to my FISD sample:

- I replace missing offering yield with the sum of treasury spread and maturity-matched treasury yield (by linear interpolation).
- I keep the new issuance with positive offering yield that is less than 3000 basis points .
- I drop new issuance with maturity less than one year or over 30 years.

Table A.1: Variable Definitions

Definition		Data sources
Aggregate Variables		
Monetary Shocks	Monetary shocks measured by changes in Fed Funds future prices around FOMC announcements	GSS(2005), GW(2016), NK (2018)
Corporate Debt	Credit market instrument liabilities (real debt and securities) for non-financial 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	1-month and 3-Month London Interbank Offered Rate (US.dollar)	St. Louis Fed
Treasury Yield	3M, 1Y, 2Y, 3Y, 5Y, 7Y, 10Y, 20Y and 30Y Treasury Constant Maturity Rate	St. Louis Fed
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
EBP	Excess bond premium	Gilchrist and Zakrajšek (2012)
Firm Characteristics		
Bank Debt	Ratio of bank debt to total debt (in percentage)	Capital IQ
Leverage	Total debt (DLCQ + DLTTQ) over total assets (ATQ)	Compustat
Size	log(ATQ)	Compustat
MB	Market-to-book value: sum of market equity (PRC $\times$ SHOUT) and total debt over total assets	CRSP and Compustat
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
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 three-month LIBOR	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
Exchange Rate	The current rate of exchange compared to $USD based on the exchange rate date	DealScan

B Details on Model

B.1 Partial Equilibrium Model

I detail a partial equilibrium model where discount factor follows an AR(1) process and therefore, discount factor is a state variable that is incorporated into debt prices. Inflation rate is fixed at its steady state value. Firm's optimization problem can be written recursively. Conditional on continuing, firms make decisions on labor hiring, investment and borrowing: (l, k', B', s') and the equity value $V_t(z, k, B; \beta)$ solves the Bellman equation:

$$\begin{aligned}
V_t(z,k,B,\beta) &= Max\ d - EIC(d) + \beta \mathbb{E}_t[Max_{D' \in \{0,1\}} V_{t+1}(z', k', B', \beta^{'})] \\
s.t \quad n = (1-\tau) z k^{\alpha} l^{\nu} &+ (1-\delta)k + \tau(\delta k + R_t B/\bar{\pi}) - w_t l - c_f - (1+c)B/\bar{\pi} \\
d + k' &= n + \frac{B'(1-s')(1+c)}{1+r_t} + Q_t B' s' - DIC(B', s') - AC(i,k) \\
B'(1-s')(1+c) &\leq \theta(1-\delta)k' \\
k' &= (1-\delta)k + i
\end{aligned}$$

where $r_t = \frac{1}{\beta} - 1$. Both productivity z and discount factor β follow an AR(1) process.

B.2 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:

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

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, $B_t^{l,nom}$ and $B_t^{b,nom}$ are the one-period loan and bond in nominal term and T_t^{nom} is the transfer from all firms including the nominal profits. The budget constraint in real term is

$$C_t + \frac{B_{t+1}^l}{R_t^{nom}}\Pi_{t+1} + \frac{B_{t+1}^b}{R_t^{nom}}\Pi_{t+1} \leq w_t L_t + B_t^l + B_t^b + T_t \tag{26}$$

Every period, the households make 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 determine the discount factor, which is linked to nominal and inflation rate 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.3 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 cost 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.

B.3.1 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 equation above:

$$\mathbb{M}\mathrm{ax}_{\tilde{y}_{i,t}} \;\; P_t Y_t - \int_0^1 \tilde{p}_{i,t}\tilde{y}_{i,t} di,$$

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.

B.3.2 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 maximizing 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:

$$\mathbb{M}\mathrm{ax}_{\tilde{p}_{j,t}} \;\; E_t \sum \Lambda_{t,t+j}\pi_{t+j},$$

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 aggregate demand for 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.3.3 Market Clearing Conditions

Consumption Good

$$C_t + I_t + DIC_t + EIC_t + AC_t + c_f = Y_t \tag{27}$$

Labor

$$\int l_{i,t} d\mu_t = L_t \tag{28}$$

Loan

$$\int b^l_{i,t}(1+c) d\mu_t = B^l_t \tag{29}$$

Bond

$$\int Q b^b_{i,t} d\mu_t = \frac{B^b_t}{1+r_t} \tag{30}$$

B.4 Propositions

Proof of Proposition 1

Proof. The optimal condition for the price-setting rule is

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

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

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

which gives the Phillips curves:

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

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

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

□

Proof of Proposition 2

Proof. 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 6

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 firm has no default risk, i.e, $Q_{i,t} = \frac{1+c}{1+r_t}$, $\forall s_{i,t+1}$,

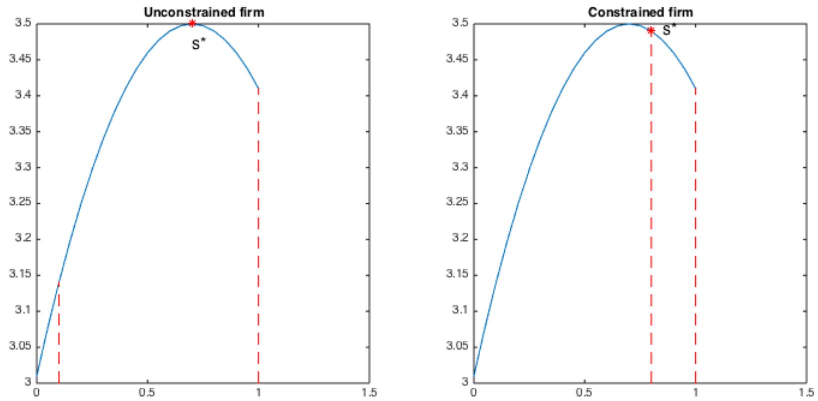
$$\frac{\partial F}{\partial s_{i,t+1}} = \xi_0 - \xi_1 > 0, \;\; \forall s_{i,t+1} \in \left[1 - \frac{\theta(1-\delta)k_{i,t+1}}{B_{i,t+1}(1+c)}, 1\right],$$

Therefore,

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

□

Proof of Proposition 7



Proof. Given $(k_{i,t}, B_{i,t}, z_{i,t}; \beta_t)$,

$$\frac{\partial obj}{\partial s_{i,t+1}}|_{s_{i,t+1}=0} = \xi_0 - \xi_1 > 0 \text{ and } s_{i,t+1} \in \left[1 - \frac{\theta(1-\delta)k_{i,t+1}}{B_{i,t+1}(1+c)}, 1\right],$$

If $\frac{\partial obj}{\partial s_{i,t+1}}|_{s_{i,t+1}=1} \geq 0$, then $s^*_{i,t+1} = 1$.

If $\frac{\partial obj}{\partial s_{i,t+1}}|_{s_{i,t+1}=1} \leq 0$, set $\frac{\partial obj}{\partial s_{i,t+1}} = 0$ gives

$$\hat{s} = \frac{(\xi_0 - \xi_1) + (Q_{i,t} - \frac{1+c}{1+r_t})}{-\frac{\partial Q_{i,t}}{\partial s_{i,t+1}}},$$

Then $s^*_{i,t+1} = \hat{s} < 1$. Therefore, the optimal bond share

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

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

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

.

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

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

Also see figure above. □

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 Rouwenhorst (1995). I use 5 gird 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 and the real rate is therefore $1/\beta - 1$. The computational algorithm - following Strebulaev and Whited (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 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 the 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 sufficient 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 steady state value and policy function in period $T + 1$ and update the value and policy functions using **backward induction** given the prices 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 prices series for $t = 1, 2, ..., T$.

C.3 Simulation

Model moments

To match the model simulated 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

To replicate firms' differential responses in their financing decision to interest rate shock, I simulate a panel of 5,000 firms using the updated value and policy functions along the transition path after a 25 basis points positive interest rate shock. Specifically, I first simulate 5,000 firms for 50 quarters from arbitrage initial 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 for 10 times and the average of estimates are reported.

D Additional Results

Appendix D contain several sets of additional empirical results.

The first set of additional results contains two robustness checks of the aggregate analysis. Column (1) to (4) of Table A.2 decompose the aggregate loan quantity of non-financial corporate sector by maturity. The coefficient estimates in column (2) and (4) indicate that monetary shocks have large and significant impact on short-term loan instead of long-term loan. Following Gürkaynak et al. (2005), I further decompose monetary policy shocks into a“target” component that affects the level of the yield curve and a “path” component that affects the slope of yield curve. Column (5) to (8) suggest that, it is the changes in short rate rather than the changes in long rate that affect the debt quantities.

The second set of robustness tests investigates how much “target” and “path” component affects firm’s debt financing decisions. The sample only covers from 1990Q2 to 2004Q4. Both target and path components have mean closed to zero but the target component is more volatile, with a standard deviation of 0.057, which explains most of the variation in measured monetary shocks, compared to the path component. Table A.3 shows that both target and path components are statistically significant in most of cases, while results from the target component are more pronounced and consistent. This suggests that both changes in the level and slope of yield curve matters for debt financing decisions. In this sample, bank loans consist of revolving credit facilities (70%) and term loans (30%). Which types of loans drive the results? Table A.4 presents the results of main analysis in two split samples. The coefficient estimates of “credit line” sample are not only positively significant, but also larger in economic magnitude, compared to those of “term loan” sample. High rated firms with higher collateral value are more responsive in expanding their borrowing in credit lines and term loans.

The third set of additional results distinguish “financially constrained” firms from “unconstrained” firms using “Whited-Wu” (Whited and Wu (2006)) and Size & Age index (Hadlock and Pierce (2010) and hence “HP” index). I repeat the main empirical tests over the split samples (Top 33% and bottom 33% based on the indices). The results in Table A.5 confirm the robustness of differential adjustments in financing decisions in response to monetary shocks.

The fourth set of robustness checks repeats the baseline analysis using policy news shocks from Nakamura and Steinsson (2018), measures from Gertler and Karadi (2015) (“FF4”), which lead to similar conclusions (Table A.6 and A.7). A robustness check using post-1994 sample periods is also included in Table A.8.

In the main analysis, firm-level loan share is constructed using Compustat variable, which is only a proxy. To have a more accurate measure of firm-level loan share, I use detailed debt structure data from S&P Capital IQ data. The coverage rate of Capital IQ is very low before financial crisis. Therefore, I keep the sample from 2009 to 2018. Bank debt amount is defined as the sum of revolving credit and term loans. Public bond amount is defined as the sum of senior and subordinated bonds and notes. To mitigate the impact of measurement error, I compare the difference between total debt from Capital IQ and that from Compustat. I only keep the observations with absolute difference less than 25%. I also exclude all observations for which the sum of bank loan, bond and common equity exceeds total assets. Bank loan percentage is defined as the ratio of bank debt to total assets or total debt. Public bond percentage is defined as the ratio of public bonds to total assets or total debt.

Table A.9 shows the changes in loan (bond) amount, loan (bond) percentage, and the ratio of loan to the sum of loan and bond, in response to interest rate hike. The results suggest that an increase in interest rate not just raises the loan share but also the loan amount. In contrast, it reduces the bond amount and therefore the bond share. Table A.10 further presents the effects of interest rate hike on the percentages of secured debt, unsecured debt, floating rate debt, fixed rate debt and undrawn credit line. The coefficient estimates in Panel A and B are consistent. Following a tightening of monetary policy, firms tend to use more secured debt while less unsecured debt, more floating rate debt but less fixed rate debt. Firms not only issue more new loans, but also draw their unused credit line, as the fraction of undrawn credit line decreases. Both of them lead to an expansion in bank loans at the aggregate level. This is consistent with the results found in Greenwald et al. (2021).

Figures

Figure A.1: Aggregate Time Series of Corporate Debt

This figure plots the time series of different types of corporate debt from 1975Q1 to 2018Q4. It includes Commercial and Industrial (C&I) loan, commercial paper, consumer loan and real estate loan.

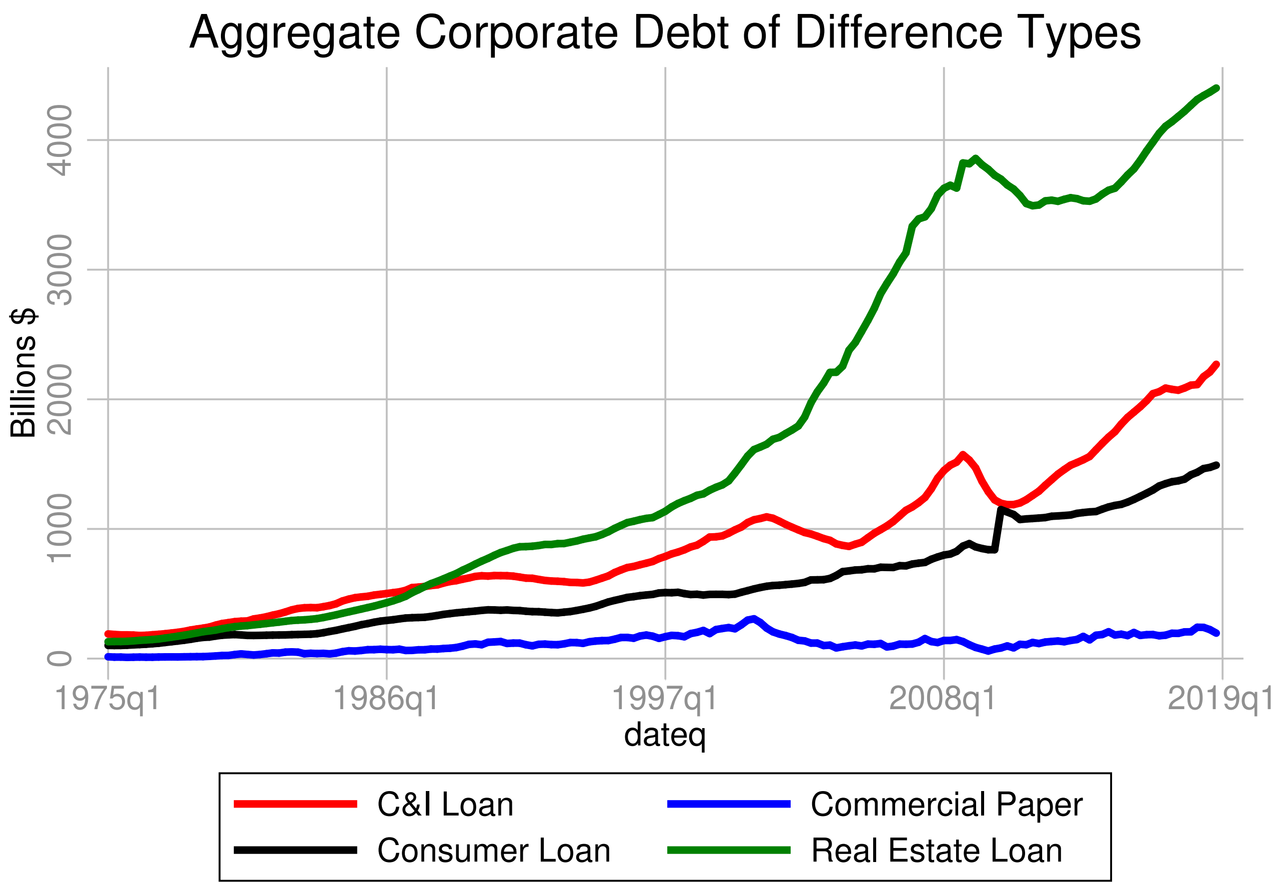
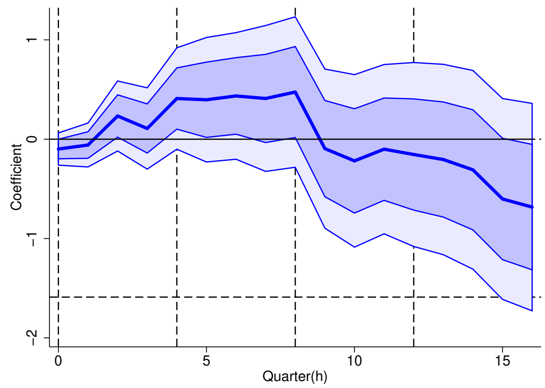


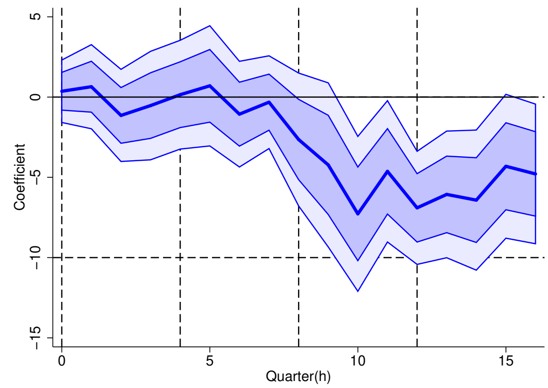
Figure A.2: Dynamic Effects of Monetary Shocks on Debt

These figures plot the impulse responses to a one-standard-deviation contractionary monetary policy shock based on the identification approach by Gürkaynak et al. (2005) and Gorodnichenko and Weber (2016) at a quarterly frequency and the local projection specification. The debt series are obtained from St. Louis Fed's FRED database. 95 and 68 percent confidence bands are shown using Newey and West (1987) standard errors.

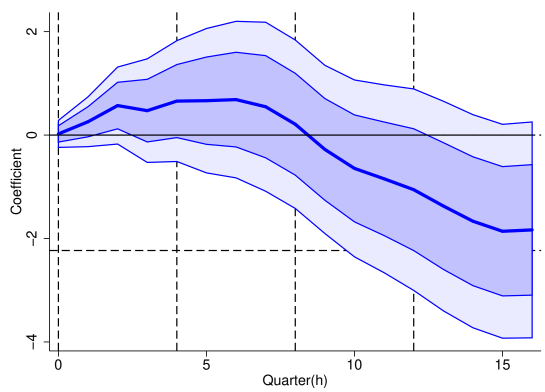
(a) Loans and Leases



(b) Commercial Paper



(c) Commercial & Industrial Loans



(d) Real Estate Loans

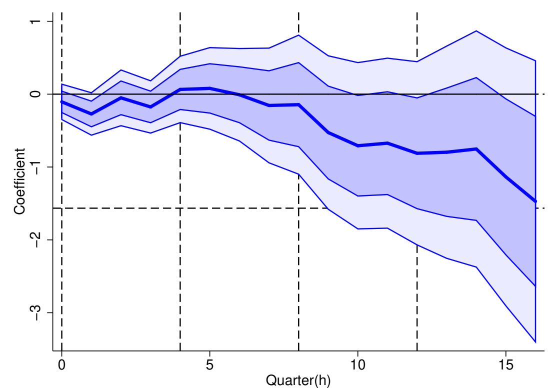
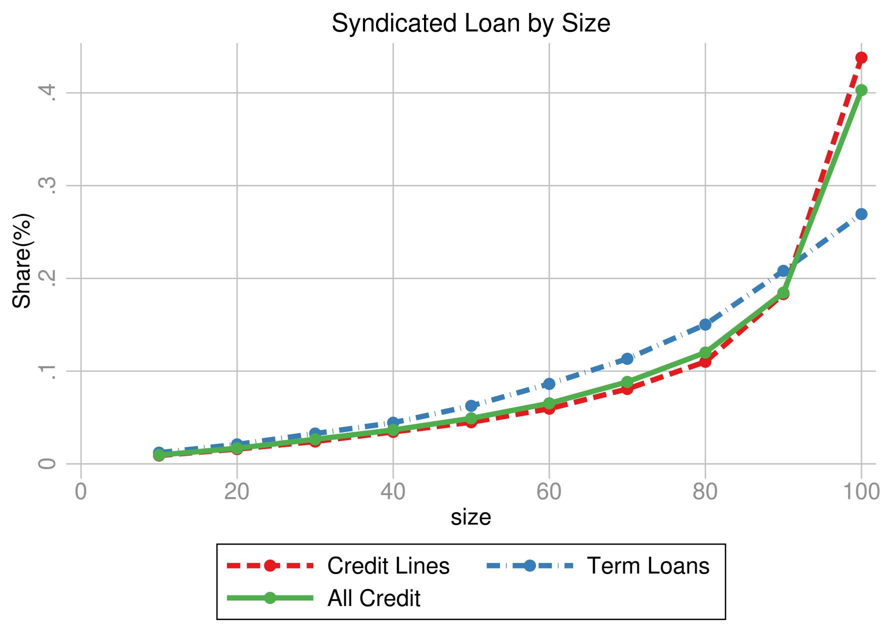


Figure A.3: Credit across Firm Size Distribution

The figures show different types of syndicated loans for percentiles across the firm size distribution in DealScan from 1990Q1 to 2018Q4. The top figure shows the share of all syndicated loans, credit lines and term loans issued to firms in different size percentile groups. The bottom figure shows the dollar amount of credit lines and term loans (in Billions) issued to firms in different size percentile groups.



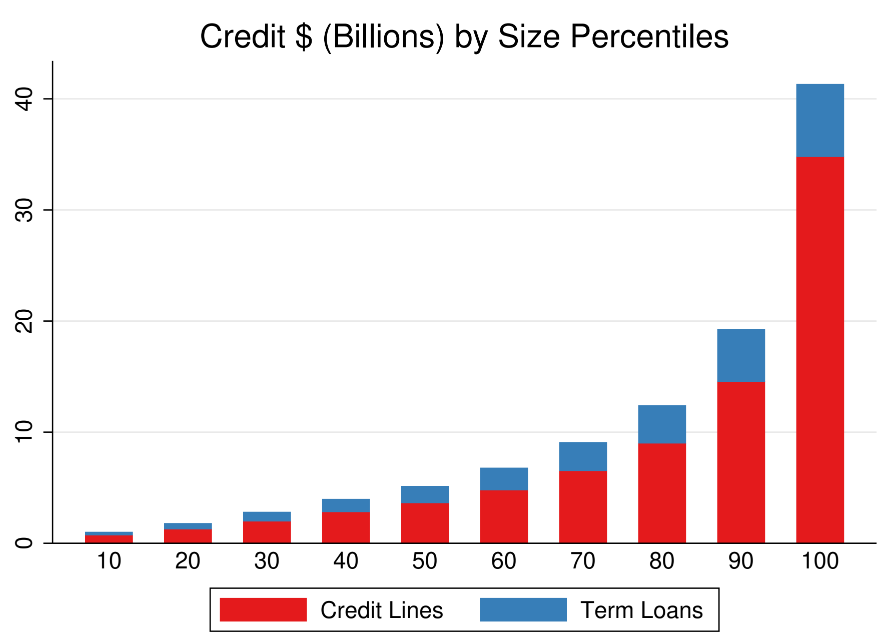


Table A.2: Robustness Check: Aggregate Time Series Analysis

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

$$y_{i,t} = \alpha + \beta\epsilon_t^m + \Gamma Controls_t + \epsilon_t$$

Column (1) to (4) reports the effect of monetary shocks on different components of loan growth by maturity in quarter t. Column (5) to (8) decomposes monetary shocks and reports the separate effect of target and path component of monetary shocks on loan and bond growth. Non-financial corporate sector debt data is from the Flow of Funds. Other macroeconomic and financial control variables include real GDP growth, inflation rate, unemployment, credit spread, term spread, price-dividend ratio and financial intermediary leverage. The sample of column (1) to (4) covers periods from 1990Q2 to 2018Q4 and financial crisis (2008Q3 to 2009Q2) is excluded. The sample of column (5) to (8) covers periods from 1990Q2 to 2004Q4. The t statistics in parentheses reported below each coefficient estimate are obtained using robust standard error. All the variables are real. $^*p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$.

	Short-term vs Long-term Loan				Shock: Target vs Path			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
					Target		Path	
	$\Delta STLoan$		$\Delta LTLoan$		$\Delta Loan$	$\Delta Bond$	$\Delta Loan$	$\Delta Bond$
ϵ_t^m	0.612***	0.544***	-0.119	0.026				
	(3.008)	(2.970)	(-0.672)	(0.127)				
ϵ_t^m(Target)					7.968**	-5.481*		
					(2.297)	(-1.778)		
ϵ_t^m(Path)							16.051	-10.290
							(0.301)	(-0.278)
Δlog(GDP)	0.017	0.429	0.506	0.329	0.946***	-0.424	1.132***	-0.551*
	(0.047)	(0.883)	(1.329)	(0.550)	(3.015)	(-1.399)	(3.816)	(-1.790)
Δlog(CPI)	-0.652	-1.132**	-0.779*	-0.548	-0.266	-1.403***	-0.189	-1.462**
	(-1.564)	(-2.384)	(-1.678)	(-0.872)	(-0.304)	(-2.987)	(-0.195)	(-2.586)
Unemployment	-0.927***	-0.985***	-0.937***	-1.036***	-0.007	0.016**	-0.009	0.018***
	(-4.459)	(-2.893)	(-6.433)	(-3.874)	(-0.979)	(2.663)	(-1.208)	(2.840)
Term Spread		-0.713**		-0.148	-0.011*	-0.010**	-0.009	-0.011**
		(-2.481)		(-0.373)	(-1.959)	(-2.577)	(-1.519)	(-2.585)
BAA-AAA		-0.037***		0.005	-0.032**	-0.011	-0.032**	-0.012
		(-3.256)		(0.425)	(-2.143)	(-1.288)	(-2.087)	(-1.087)
P/D Ratio		0.022		0.018	-0.001***	0.000**	-0.001***	0.001**
		(1.004)		(0.675)	(-2.967)	(2.064)	(-3.256)	(2.418)
Leverage (HKM)		0.359***		0.005	-0.001	-0.001	-0.001	-0.000
		(3.605)		(0.052)	(-1.013)	(-0.967)	(-1.255)	(-0.769)
Observations	115	91	115	91	59	59	59	59
Adjusted R^2	0.260	0.479	0.241	0.322	0.681	0.323	0.650	0.266

Table A.3: Decompose the Monetary Shocks: Target Factor vs Path Factor

This table reports the impact of different compositions of monetary shocks on firm financing decisions. Coefficients are estimated from the following regressions.

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

where ϵ_t^m is the target factor in column (1) to (6) and the path factor in column (7) to (12). The definition of *dependent variable* is consistent with that in Table 2 and 3. $X_{i,t-1}$ is the firm size, tangibility or credit rating in the previous quarter. $Z_{i,t-1}$ is a set of firm control variables including size, market-to-book ratio, liquidity, tangibility, leverage, a dummy for dividend payout and a dummy for investment grade (long-term credit rating). $W_{i,t-1}$ is a set of debt characteristics including logarithm of borrowing amount and maturity. Y_{t-1} is a set of macroeconomic variables including four lags of GDP growth, inflation rate and unemployment rate. Monetary shocks and firm control variables are standardized. The sample covers periods from 1990Q2 to 2018Q4 and financial crisis (2008Q3 to 2009Q2) is excluded. The firm and sector-quarter fixed effect are indicated in the table. Standard errors are heteroskedasticity-robust and clustered at the firm level, and t statistics 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)	(14)	(15)	(16)
	Target Factor								Path Factor							
	Extensive				Intensive				Extensive				Intensive			
Panel A: Debt Financing Decision																
ϵ_t^m	0.489***	0.399***	0.504***	-0.514***	0.988**	0.550	0.992**	-0.109	2.708**	2.771**	2.784**	3.600**	8.818***	7.541**	8.769***	4.151
	(4.119)	(3.342)	(4.248)	(-2.611)	(2.059)	(1.092)	(2.069)	(-0.187)	(2.162)	(2.250)	(2.216)	(2.171)	(2.760)	(2.283)	(2.744)	(1.065)
$\epsilon_t^m \times$ Size		0.308***				1.797***				-0.551				7.480***		
		(2.944)				(4.105)				(-0.545)				(2.621)		
$\epsilon_t^m \times$ Tangibility			0.233**				0.297				-1.389*				5.511*	
			(2.076)				(0.620)				(-1.648)				(1.660)	
$\epsilon_t^m \times \mathbb{1}$(Invest. Grade)				1.220***				3.471***				-1.217				15.793***
				(5.415)				(4.002)				(-0.680)				(2.653)
Observations	8049	8049	8049	8049	125441	125441	125441	125441	8049	8049	8049	8049	125441	125441	125441	125441
R^2	0.341	0.342	0.341	0.344	0.106	0.107	0.106	0.107	0.340	0.341	0.340	0.341	0.106	0.106	0.106	0.106
Panel B: Equity Financing Decision																
ϵ_t^m	0.059***	0.065***	0.060***	0.071***	3.341***	3.586***	3.198***	3.642***	0.238**	0.366***	0.240**	0.443***	12.485**	13.000**	10.099**	13.890**
	(4.973)	(5.168)	(5.041)	(5.312)	(6.693)	(6.393)	(6.382)	(6.185)	(1.984)	(2.920)	(1.993)	(3.356)	(2.567)	(2.467)	(2.072)	(2.487)
$\epsilon_t^m \times$ Size		-0.029***				-1.256**				-0.770***				-17.175***		
		(-2.599)				(-2.439)				(-7.865)				(-3.528)		
$\epsilon_t^m \times$ Tangibility			-0.031				-6.252***				-0.767***				-80.491***	
			(-1.266)				(-5.783)				(-3.558)				(-7.796)	
$\epsilon_t^m \times \mathbb{1}$(Invest. Grade)				-0.049**				-1.458*				-0.921***				-17.149**
				(-2.244)				(-1.960)				(-4.860)				(-2.398)
Observations	193883	193883	193883	193883	193850	193850	193850	193850	193883	193883	193883	193883	193850	193850	193850	193850
R^2	0.156	0.156	0.156	0.156	0.158	0.159	0.159	0.159	0.156	0.156	0.156	0.156	0.158	0.159	0.159	0.159
Firm controls	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Aggregate controls	Y	Y	Y	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	Y	Y	Y
Sector-Quarter FE	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y

Table A.4: Extensive Debt Financing Decision: Credit Lines vs Term Loans

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

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

Column (1) to (5) reports debt choices between credit lines and bonds in quarter t. Column (6) to (10) reports reports debt choices between term loans and bonds in quarter t. ϵ_t^m is the monetary shock and $X_{i,t-1}$ is firm's size, tangibility or a dummy for investment grade (long-term credit rating) in the previous quarter. $Z_{i,t-1}$ is a set of firm control variables including market-to-book ratio, liquidity, leverage and a dummy for dividend payout. Y_{t-1} is a set of macroeconomic variables including four lags of GDP growth, inflation rate and unemployment rate. Monetary shocks and firm control variables are standardized. The sample covers periods from 1990Q2 to 2018Q4 and financial crisis (2008Q3 to 2009Q2) is excluded. The firm and sector-quarter fixed effect are indicated in the table. Standard errors are heteroskedasticity-robust and clustered at the firm level, and t statistics 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)
	The Extensive Margin									
	Credit Lines					Term Loans				
ϵ_t^m	0.018***	0.026***	0.026***	0.024***	-0.017**	0.007	0.009*	0.009*	0.007	-0.027**
	(4.315)	(5.338)	(5.404)	(4.837)	(-2.223)	(1.564)	(1.797)	(1.800)	(1.425)	(-2.106)
ϵ_t^m × Size			0.012***					0.005		
			(2.757)					(1.113)		
ϵ_t^m × Tangibility				0.016***					0.008*	
				(3.803)					(1.825)	
ϵ_t^m × $\mathbb{1}$(Invest. Grade)					0.054***					0.042***
					(6.157)					(3.118)
Firm controls	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Aggregate controls	N	Y	Y	Y	Y	N	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
Observations	13794	13794	13794	13794	13794	8877	8877	8877	8877	8877
R^2	0.269	0.282	0.284	0.283	0.284	0.414	0.421	0.421	0.421	0.422

Table A.5: Robustness Check: Financing Decision and Financial Constraints

This table reports firms' differential debt and equity (Panel A and B) financing decisions in response to monetary shock in quarter t. Coefficients are estimated from the following regressions.

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

Column (1) to (5) reports financing decisions on the extensive margin, where the *dependent variable* is a dummy variable for financing decision equaling to one if firm chooses bank debt (Panel A) or issues new equity (Panel B) in quarter t. Column (6) to (10) reports financing decisions on the intensive margin, where the *dependent variable* is the changes in loan share (Panel A) or equity share (Panel B) in quarter t. Financial constraints are measured by "Whited-Wu" index or "HP" index. Column (2) (3) (7) (8) shows results for financially constrained firms, while column (4) (5) (9) (10) shows 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, 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, inflation rate and unemployment. The sample covers periods from 1990Q2 to 2018Q4 and financial crisis (2008Q3 to 2009Q2) is excluded. The firm and sector-quarter fixed effect are indicated in the table. Standard errors are heteroskedasticity-robust and clustered at the firm level, and t statistics 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)	(9)	(10)
	Full Sample	Constrained Firms Top Tercile		Unconstrained Firms Bottom Tercile		Full Sample	Constrained Firms Top Tercile		Unconstrained Firms Bottom Tercile	
		WW	HP	WW	HP		WW	HP	WW	HP
Panel A: Debt Financing										
ϵ_t^m	0.024***	-0.007	-0.014	0.049***	0.047***	0.030	-0.009	-0.046	0.080***	0.071***
	(5.120)	(-0.754)	(-1.573)	(6.594)	(6.200)	(1.526)	(-0.219)	(-1.009)	(2.911)	(2.598)
Observations	14405	4179	4148	4969	5106	189284	54008	51814	71781	73835
R^2	0.271	0.375	0.374	0.266	0.264	0.082	0.135	0.141	0.074	0.063
Panel B: Equity Financing										
ϵ_t^m	0.003***	0.005***	0.005***	0.001	0.001	0.194***	0.308***	0.342***	0.108***	0.100***
	(5.893)	(4.125)	(3.895)	(0.830)	(1.229)	(9.551)	(5.403)	(5.521)	(5.417)	(5.077)
Observations	297466	86814	83139	112214	115844	297425	86802	83124	112206	115839
R^2	0.147	0.209	0.208	0.088	0.068	0.131	0.153	0.154	0.130	0.114
Firm controls	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
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.6: Robustness Check: Financing Decision and Policy News Shocks

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

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

Column (1) to (4) reports financing decisions on the extensive margin, where the *dependent variable* is a dummy variable for financing decision equaling to one if firm chooses bank debt (Panel A) or issues new equity (Panel B) in quarter t. Column (5) to (8) reports financing decisions on the intensive margin, where the *dependent variable* is the changes in loan share (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, tangibility or credit rating in the previous quarter. $Z_{i,t-1}$ is a set of firm control variables including size, 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, inflation rate and unemployment. The sample covers periods from 1995Q1 to 2018Q4 and financial crisis (2008Q3 to 2009Q2) is excluded. The firm and sector-quarter fixed effect are indicated in the table. Standard errors are heteroskedasticity-robust and clustered at the firm level, and t statistics 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)	(9)	(10)
Panel A: Debt Financing										
ϵ_t^m	0.251***	0.237***	0.249***	0.225**	-0.095	2.277***	1.559***	1.912***	1.487***	0.231
	(3.268)	(2.600)	(2.702)	(2.441)	(-0.602)	(6.241)	(4.258)	(5.249)	(4.024)	(0.512)
$\epsilon_t^m \times$ Size			0.049					2.191***		
			(0.530)					(6.118)		
$\epsilon_t^m \times$ Tangibility				0.146*					0.534	
				(1.880)					(1.376)	
$\epsilon_t^m \times \mathbb{1}$(Invest. Grade)					0.415**					4.201***
					(2.276)					(5.785)
Observations	12771	12771	12771	12771	12771	154236	154236	154236	154236	154236
R^2	0.262	0.274	0.275	0.274	0.274	0.090	0.092	0.092	0.092	0.092
Panel B: Equity Financing										
ϵ_t^m	0.040***	0.050***	0.046***	0.051***	0.050***	5.958***	4.261***	3.958***	4.759***	4.535***
	(4.481)	(5.096)	(4.914)	(5.048)	(4.343)	(14.944)	(9.891)	(9.858)	(10.526)	(8.585)
$\epsilon_t^m \times$ Size			-0.006					-1.313**		
			(-0.589)					(-2.556)		
$\epsilon_t^m \times$ Tangibility				-0.007					-4.419***	
				(-0.703)					(-9.119)	
$\epsilon_t^m \times \mathbb{1}$(Invest. Grade)					-0.002					-1.312*
					(-0.124)					(-1.827)
Observations	249234	249234	249234	249234	249234	249197	249197	249197	249197	249197
R^2	0.156	0.156	0.157	0.156	0.156	0.135	0.137	0.138	0.138	0.138
Firm controls	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Aggregate controls	N	Y	Y	Y	Y	N	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.7: Robustness Check: Financing Decision and Gertler and Karadi (2015)'s Shocks

This table reports firms' differential debt and equity (Panel A and B) financing decisions in response to Gertler and Karadi (2015)'s shock in quarter t. Coefficients are estimated from the following regressions.

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

Column (1) to (4) reports financing decisions on the extensive margin, where the *dependent variable* is a dummy variable for financing decision equaling to one if firm chooses bank debt (Panel A) or issues new equity (Panel B) in quarter t. Column (5) to (8) reports financing decisions on the intensive margin, where the *dependent variable* is the changes in loan share (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, tangibility or credit rating in the previous quarter. $Z_{i,t-1}$ is a set of firm control variables including size, 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, inflation rate and unemployment. The sample covers periods from 1990Q1 to 2012Q2 and financial crisis (2008Q3 to 2009Q2) is excluded. The firm and sector-quarter fixed effect are indicated in the table. Standard errors are heteroskedasticity-robust and clustered at the firm level, and t statistics 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)	(9)	(10)
Panel A: Debt Financing										
ϵ_t^m	0.751***	0.668***	0.629***	-0.519**	0.968***	3.185***	1.771***	1.577***	1.732***	0.287
	(5.800)	(4.401)	(4.157)	(4.333)	(-2.084)	(5.987)	(3.192)	(2.806)	(3.117)	(0.419)
$\epsilon_t^m \times$ Size			0.429***					2.564***		
			(2.841)					(4.752)		
$\epsilon_t^m \times$ Tangibility				0.293**					0.480	
				(2.155)					(0.856)	
$\epsilon_t^m \times \mathbb{1}$(Invest. Grade)					1.487***					4.682***
					(5.149)					(4.540)
Observations	11954	11954	11954	11954	11954	167034	167034	167034	167034	167034
R^2	0.283	0.297	0.299	0.297	0.299	0.086	0.088	0.088	0.088	0.088
Panel B: Equity Financing										
ϵ_t^m	0.073***	0.088***	0.087***	0.087***	0.108***	7.099***	4.111***	4.044***	4.318***	3.406***
	(5.600)	(5.797)	(5.604)	(5.707)	(6.114)	(12.855)	(6.564)	(6.142)	(6.704)	(4.476)
$\epsilon_t^m \times$ Size			-0.054***					-0.855		
			(-3.488)					(-1.215)		
$\epsilon_t^m \times$ Tangibility				0.006					-5.748***	
				(0.202)					(-4.456)	
$\epsilon_t^m \times \mathbb{1}$(Invest. Grade)					-0.078***					-0.520
					(-2.673)					(-0.516)
Observations	267046	267046	267046	267046	267046	267006	267006	267006	267006	267006
R^2	0.145	0.145	0.146	0.145	0.145	0.136	0.138	0.138	0.138	0.138
Firm controls	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Aggregate controls	N	Y	Y	Y	Y	N	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: Post-1994 Periods

This table reports firms' differential debt and equity (Panel A and B) financing decisions in response to monetary shock in quarter t. Coefficients are estimated from the following regressions.

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

Column (1) to (4) reports financing decisions on the extensive margin, where the *dependent variable* is a dummy variable for financing decision equaling to one if firm chooses bank debt (Panel A) or issues new equity (Panel B) in quarter t. Column (5) to (8) reports financing decisions on the intensive margin, where the *dependent variable* is the changes in loan share (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, tangibility or credit rating in the previous quarter. $Z_{i,t-1}$ is a set of firm control variables including size, 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, inflation rate and unemployment. The sample covers periods from 1994Q1 to 2018Q4 and financial crisis (2008Q3 to 2009Q2) is excluded. The firm and sector-quarter fixed effect are indicated in the table. Standard errors are heteroskedasticity-robust and clustered at the firm level, and t statistics 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)	(9)	(10)
Panel A: Debt Financing										
ϵ_t^m	0.004	0.017***	0.017***	0.016***	-0.014*	0.079***	0.044*	0.045*	0.040*	0.005
	(0.910)	(3.317)	(3.309)	(3.156)	(-1.812)	(3.401)	(1.842)	(1.878)	(1.691)	(0.161)
$\epsilon_t^m \times$ Size			0.008					0.066***		
			(1.598)					(2.889)		
$\epsilon_t^m \times$ Tangibility				0.015***					0.058**	
				(3.252)					(2.393)	
$\epsilon_t^m \times \mathbb{1}$(Invest. Grade)					0.041***					0.124***
					(4.395)					(2.906)
Observations	13313	13313	13313	13313	13313	165933	165933	165933	165933	165933
R^2	0.263	0.274	0.276	0.275	0.275	0.088	0.090	0.090	0.090	0.090
Panel B: Equity Financing										
ϵ_t^m	0.003***	0.002***	0.003***	0.003***	0.002***	0.374***	0.210***	0.169***	0.181***	0.199***
	(5.994)	(3.785)	(4.323)	(4.353)	(3.483)	(16.644)	(8.614)	(6.826)	(7.063)	(6.653)
$\epsilon_t^m \times$ Size			0.000					-0.105***		
			(0.219)					(-3.631)		
$\epsilon_t^m \times$ Tangibility				-0.003***					-0.450***	
				(-2.581)					(-9.560)	
$\epsilon_t^m \times \mathbb{1}$(Invest. Grade)					0.001					-0.126***
					(0.613)					(-3.170)
Observations	266571	266571	266571	266571	266571	266530	266530	266530	266530	266530
R^2	0.154	0.154	0.154	0.154	0.154	0.134	0.135	0.136	0.136	0.136
Firm controls	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Aggregate controls	N	Y	Y	Y	Y	N	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.9: Robustness Check: Debt Structure from Capital IQ

This table reports the changes in both the debt (loan/bond) amount and share in response to monetary shock in quarter t. Coefficients are estimated from the following regressions.

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

ϵ_t^m is the monetary shock and $X_{i,t-1}$ is firm's size, tangibility or credit rating in the previous quarter. $Z_{i,t-1}$ is a set of firm control variables including size, 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, inflation rate and unemployment. The sample covers periods from 2009Q1 to 2018Q4 after the financial crisis. The firm and sector-quarter fixed effect are indicated in the table. Standard errors are heteroskedasticity-robust and clustered at the firm level, and t statistics 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)
	log(Loan)	$\frac{\text{Loan}}{\text{Total Assets}}$	$\frac{\text{Loan}}{\text{Total Debt}}$	log(Bond)	$\frac{\text{Bond}}{\text{Total Assets}}$	$\frac{\text{Bond}}{\text{Total Debt}}$	$\frac{\text{Loan}}{\text{Loan + Bond}}$
ϵ_t^m	0.046***	0.560***	1.139***	-0.037***	-0.577***	-0.819**	0.929***
	(2.651)	(4.258)	(3.226)	(-2.975)	(-3.914)	(-2.307)	(2.861)
Observations	27376	33141	33141	24990	25224	25224	22101
R^2	0.876	0.849	0.830	0.953	0.884	0.783	0.824

Table A.10: Robustness Check: Other Types of Debt from Capital IQ

This table reports the changes in different types of debt in response to monetary shock in quarter t. Coefficients are estimated from the following regressions.

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

ϵ_t^m is the monetary shock and $X_{i,t-1}$ is firm's size, tangibility or credit rating in the previous quarter. $Z_{i,t-1}$ is a set of firm control variables including size, 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, inflation rate and unemployment. The sample covers periods from 2009Q1 to 2018Q4 after the financial crisis. The firm and sector-quarter fixed effect are indicated in the table. Standard errors are heteroskedasticity-robust and clustered at the firm level, and t statistics 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)
			Panel A		
	$\frac{\text{Secured debt}}{\text{Total Assets}}$	$\frac{\text{Unsecured debt}}{\text{Total Assets}}$	$\frac{\text{Floating rate debt}}{\text{Total Assets}}$	$\frac{\text{Fixed rate debt}}{\text{Total Assets}}$	$\frac{\text{Undrawn credit line}}{\text{Total Assets}}$
ϵ_t^m	0.280	-0.503***	0.366***	-0.508***	-0.175
	(1.618)	(-3.576)	(2.734)	(-3.105)	(-1.472)
Observations	30027	28520	30704	29637	24728
R^2	0.884	0.859	0.831	0.867	0.696
			Panel B		
	$\frac{\text{Secured debt}}{\text{Total Debt}}$	$\frac{\text{Unsecured debt}}{\text{Total Debt}}$	$\frac{\text{Floating rate debt}}{\text{Total Debt}}$	$\frac{\text{Fixed rate debt}}{\text{Total Debt}}$	$\frac{\text{Undrawn credit line}}{\text{Total Debt}}$
ϵ_t^m	1.018***	-0.225	1.320***	-0.852**	-2.536
	(2.582)	(-0.622)	(3.516)	(-2.241)	(-1.107)
Observations	30027	28520	30704	29637	24728
R^2	0.832	0.831	0.803	0.744	0.751