Monetary Policy and Corporate Investment: The Equity Financing Channel*

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Abstract

We study the effects of monetary policy shocks on corporate investment and financing. Using the Federal Reserve FR Y-14Q data, we find a stark difference between the responses of public and private firms to these shocks. Following an unexpected rise in the policy interest rate, private firms decrease their debt, equity, and real assets. Public firms decrease their debt, but raise equity to offset the impact, resulting in no change in their real assets. Thus, the difference in the use of equity leads to diverging real responses to monetary policy shocks. We develop a structural model to explain the differences in the policy impacts. The model suggests that the combination of higher equity issuance costs at private firms and greater investment adjustment costs at public firms drives the differences in monetary policy responses.

Key Words: corporate investment, debt, equity, monetary policy, FOMC.
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1 Introduction

Considerable research has studied the transmission channels of monetary policy to firms' economic activity. The prevailing view is the credit channel, suggesting that changes in the cost of capital have limited direct impact on corporate investment, while credit market frictions amplify the effects (Kashyap, Stein, and Wilcox, 1993; Gertler and Gilchrist, 1994; Bernanke and Gertler, 1995). The focus on the role of debt financing in the policy transmission reflects the received wisdom that equity financing is unimportant for understanding corporate investment (Eisfeldt and Shi, 2018). However, recent evidence suggests that equity financing plays a critical role in driving corporate investment (Frank and Sanati, 2021) and that monetary policy strongly affects equity markets (Bernanke and Kuttner, 2005). Does equity financing play an important role in the reactions to monetary policy shocks? Since private firms may not have as easy access to external equity, do their reactions differ from those of public firms?

In this paper, we provide a comprehensive view of the effects of monetary policy shocks on firms' investments, debt, and equity financing. In the first part, using the Federal Reserve's supervisory data, we examine the impact of the policy shocks and provide novel evidence on the responses of both private and public firms. Private firms react differently to shocks and they are not just smaller versions of public firms. In the second part of the paper, we develop a dynamic general equilibrium model that provides a unified interpretation of the main facts in the data. The model indicates that the differing policy responses are driven by heterogeneities in equity issuance costs and investment adjustment costs across firms. Since the model fits the data well, we use it to quantify the impact of counter-cyclical monetary policy.

Our data on firms are primarily from the FR Y-14Q data, which contain detailed accounting information on all private and public firms that have a bank loan of over $1 million. The Federal Reserve collects these data for bank stress tests since 2011. The data cover around 77% of U.S. corporate lending. Our final sample has 167,297 unique private U.S. firms and 5,070 unique public U.S. firms from 2011 to 2019. Our data on monetary policy surprises are compiled following the high-frequency event study approach of Kuttner

(2001), Gurkaynak, Sack, and Swanson (2005), and Bernanke and Kuttner (2005). In the baseline case, we use the improved approach of Bauer and Swanson (2023) to compute the shocks. We also use the decomposition of monetary policy surprises into current policy and forward guidance components following Gurkaynak, Karasoy-Can, and Lee (2022). Our analyses control for firm characteristics, macroeconomic conditions, firm fixed effects, and bank fixed effects.

In the data, we find a stark difference between the responses of public and private firms to monetary policy shocks. Consider reactions to a tightening shock. Public firms reduce debt financing as interest rates increase. Simultaneously, they raise external equity to offset the decline in debt. This allows them to maintain the level of total financing and investment, and keep their real assets unchanged. Private firms reduce their total debt, but at a slower rate than public firms. The reduction in their total debt is the combination of a large decline in new term loans and a rapid drawdown on existing lines of credit (prior commitments by banks with prespecified rates and limits) to buffer the impact. Private firms also reduce their equity, consistent with having less easy access to equity financing. This decline in total financing coincides with a decrease in their real investments. Overall, monetary policy shocks have a significantly stronger impact on the real operations of private firms compared to public firms.

According to our estimates, in the year following a one-standard-deviation tightening shock to monetary policy, public firms on average decrease their debt by 6.0%, increase equity by 7.5%, and keep their real assets essentially unchanged. We show that public firms' total equity response is primarily driven by external stock issues. Over the same period, private firms on average decrease their debt by 1.9%, equity by 3.6%, and real assets by 1.1%. In general, we find that responses to positive and negative policy shocks are reasonably symmetric, although the negative shocks have a somewhat stronger impact.

Our findings highlight the distinct effects of monetary policy on public and private firms. Public firms are able to use equity to mitigate the impact of policy shocks on their investment plans. Private firms face greater constraints in accessing external financing, making their investments more susceptible to the effects of policy shocks. Interestingly, both public and private firms use different forms of external financing to buffer the impact of monetary policy shocks on real operations. Public firms use external equity and successfully mitigate the impacts in the long term. Private firms use existing lines of credit that only helps to buffer the impact in the short term. This dynamic explains the well-established observation that monetary policy typically affects firms' real investment with a delay.

In the second part of the paper, we develop a model that provides a unified quantitative interpretation of the evidence. The model starts with a standard neoclassical general equilibrium framework similar to Jermann and Quadrini (2012). In the model, firms make dynamic investment, hiring, and financing decisions. Firm financing is modeled following Frank and Sanati (2021). Debt financing has a tax advantage, but it requires collateral. Equity financing is subject to issuance costs. So, debt and equity are not perfect substitutes. Monetary policy shocks are the only source of uncertainty in the baseline model. Monetary policy affects the economy by changing the households' discount rates, as in standard New Keynesian models (e.g., Ottonello and Winberry, 2020).

We calibrate the model separately for public and private firms. In each case, we use moments of data that are unrelated to monetary policy responses. To help the models align well with the data, public and private firms are allowed to be different in several dimensions. Our calibrations show that the cost of issuing equity is significantly higher for private firms compared to public firms. On the other hand, public firms face higher investment adjustment costs. It is important to note that these distinctions emerge from the data during the calibration process and are not assumptions of the model.

We simulate each model and evaluate the policy responses. Model simulations show that the responses of public and private firms to monetary policy shocks mirror those in the actual data very well. To illustrate the basic economic mechanism in the model, consider the impact of a monetary policy shock that increases the policy interest rate. Such a shock increases firms' borrowing cost, reducing their optimal level of debt. It also increases the discount rate in the economy, reducing the optimal level of capital investment. However, because firms face investment adjustment costs, they try to mitigate the impact of the transitory shock on investments to minimize these costs. Ideally, firms could adjust their financing sources, for example by replacing debt with external equity, to counteract the real effects of the policy shocks. But their ability to do so depends on the financing frictions, which are different across public and private firms, leading to the differences in their reactions to the shock.

We use our framework to identify the key factors behind the heterogeneity in policy effects. We evaluate impulse response functions and compare several versions of the model, each time isolating a specific aspect that distinguishes public and private firms in the calibration results. Our analyses show that firms trade off the cost of adjusting investments against the cost of issuing equity when making joint decisions on investment and financing. Public firms, facing high costs for adjusting investments but lower costs for issuing equity, tend to raise equity to offset the decline in debt and sustain their capital investments. In contrast, private firms, facing lower investment adjustment costs but higher costs of equity issuance, cut back on investments, leading to a decline in their overall financing needs and their equity. Therefore, the model attributes the differences in policy impacts to the combination of higher equity issuance costs at private firms and greater investment adjustment costs at public firms.

Our main model has only monetary policy shocks. However, much of the literature studies productivity shocks. So, we extend the model to allow for both monetary policy shocks and productivity shocks. The main economic mechanism in the baseline model is robust to the inclusion of productivity shocks. We also use this extended model to study counterfactual monetary policy experiments in a setting where the policy shocks are correlated with productivity shocks. Some detailed features of the model are affected, but the main patterns of how public and private firms react remain robust.

The rest of the paper is organized as follows. Section 2 highlights our contribution to the related literature. Section 3 describes the data sources and key data properties. Section 4 explains the measurement of monetary policy shocks and their impacts on firm decisions in the data. Section 5 describes the setup of our model and the basic mechanism. Section 6 solves the model and analyzes the responses of public and private firms to monetary policy shocks in the model. Section 7 examines a model extension and conducts a policy experiment using the model. Section 8 concludes.

2 Contributions to the Related Literature

Our paper contributes to the literature studying the transmission channels of monetary policy. The textbook analysis of monetary policy posits that it affects firms' investments by changing their cost of capital (Bernanke and Gertler, 1995; Frank and Shen, 2016). However, empirical evidence suggests that the impact of the cost of capital on investment is relatively weak, especially in explaining the heterogeneity in firm responses (Bernanke, Gertler, and Gilchrist, 1999). Instead, the dominant view is the 'credit channel' theory of monetary policy, which states that credit market frictions are critical in amplifying the impact of the policy changes on the real economy (Bernanke and Gertler, 1995). These frictions could take different forms. For example, the 'balance sheet channel' says that the state of a firm's balance sheet affects its borrowing behavior in response to monetary policy shocks.[1] The 'bank lending channel' evaluates the policy impact on banks' willingness to extend credit.[2] The 'bond lending channel' states that frictions in the bond markets can amplify the policy impacts.[3]

Thus, the existing literature primarily focuses on the role of debt in the transmission of monetary policy and ignores the possible role of equity financing. However, Frank and Sanati (2021) show that equity financing could be a key factor in driving firm investments in general. A few studies highlight the effects of monetary policy on equity markets. For example, Bernanke and Kuttner (2005) show that monetary policy can strongly affect equity prices. Guo, Ottonello, and Whited (2019) show that the aggregate equity and debt financing flows in the U.S. business sector in response to monetary policy shocks are similar in magnitude. They also provide a channel whereby monetary policy reduces inefficiencies from informational frictions in equity markets. Jeenas and Lagos (2024) introduce a q-monetary transmission channel, whereby monetary policy affects firms' in-

[1]See, for example, Gertler and Gilchrist (1994); Jeenas (2018); Ippolito, Ozdagli, and Perez-Orive (2018); Ottonello and Winberry (2020); Cloyne, Ferreira, Froemel, and Surico (2021); Caglio, Darst, and Kalemli-Ozcan (2022); Gurkaynak, Karasoy-Can, and Lee (2022).

[2]See, for example, Kashyap, Stein, and Wilcox (1993); Kashyap and Stein (2000); Campello (2002); Jimenez, Ongena, Peydró, and Saurina (2014); Scharfstein and Sunderam (2016); Drechsler, Savov, and Schnabl (2017); Gomez, Landier, Sraer, and Thesmar (2021); Wang, Whited, Wu, and Xiao (2022); Greenwald, Krainer, and Paul (2023b).

[3]See, for example, Darmouni, Giesecke, and Rodnyansky (2022).

vestments through stock market dynamics by affecting Tobin's q. Pazarbasi (2023) shows that monetary policy affects firms' equity payouts, where expansionary policy reduces firms' incentives to hold cash, leading cash-rich firms to increase equity payouts rather than increasing investments in an environment with low profitability.

Our study adds to this literature in several respects. We provide a comprehensive view on the impact of monetary policy shocks on firms' debt, equity, and investments. We document the active use of both debt and equity financing in response to policy shocks, and show that the interplay between the sources of external finance determines the impact of the shocks on firms' real assets. Our results offer new evidence on the role of equity financing in mitigating the real effects of monetary policy shocks. Also, we use new high-quality data to document both private and public firms' distinct financing and investment reactions to monetary policy shocks. Due to the importance of private firms in the aggregate economy, ignoring these distinctions can result in a misinterpretation of the real impact of monetary policy. Finally, we develop a structural model based on a neoclassical framework with monetary policy shocks, that can match many aspects of the data well. The model could provide a framework to study other questions related to interest rate shocks.

Our paper also relates to the literature studying the role of heterogeneities in firms' capital raising on their investment dynamics over the business cycle as well as in response to monetary policy. For example, Ottonello and Winberry (2020) study the impact of firm heterogeneity in default risk on the responses to monetary policy shocks. Caglio, Darst, and Kalemli-Ozcan (2022) show that firms' responses to monetary policy shocks depend on the type of collateral pledged when borrowing from banks. They argue that small and risky firms face earnings-based debt constraints, making them more responsive to monetary policy shocks relative to larger firms. Jungherr, Meier, Reinelt, and Schott (2022) show that firms' investments are more responsive to monetary policy when a higher fraction of their debt matures. With respect to the interplay between equity and debt financing, the closest to our paper are studies by Erel, Julio, Kim, and Weisbach (2012) and Begenau and Salomao (2019). They find that firms with easier access to external finance are better equipped to weather business cycle shocks due to their ability to raise capital and substitute debt with equity during economic downturns. Our study documents a similar mediating role for external financing in firms' responses to monetary policy shocks. In our case, public firms actively substitute debt with external equity to alleviate the impact of monetary policy shocks on their real assets. In contrast, private firms' real operations are affected by the policy shocks due to less easy access to external equity.

Finally, prior studies document that firms draw down on credit lines when faced with macroeconomic shocks, such as the Great Recession (Ivashina and Scharfstein, 2010) or the outbreak of COVID-19 (Greenwald, Krainer, and Paul, 2023a). However, this behavior is typically concentrated in large firms and crowds out credit to smaller firms. Our results document that smaller private firms use credit lines to smooth out the impact of monetary policy shocks. Larger public firms do not draw down on their credit lines and even reduce their utilization in response to monetary tightening shocks.

3 Data

3.1 Sources

Our primary data source is Schedule H.1 of the FR Y-14Q that the Federal Reserve collects as part of the Comprehensive Capital Analysis and Review (CCAR) process since 2011. The dataset is quarterly and contains granular information on the loan portfolios of the largest banks in the United States.[4] These banks originate 77% of all U.S. commercial and industrial lending.[5] Banks are required to report all corporate loans and leases inclusive of all term loans and lines of credit with a committed balance greater than or equal to $1 million, which accounts for over 97% of these banks' corporate exposures (Beyhaghi, 2022).

The dataset also contains detailed firm-level income statement and balance sheet information on borrowing firms, which gives us access to detailed financial information on

[4]These financial institutions include all bank holding companies (BHC), intermediate holding companies (IHC), and covered savings and loan holding companies (SLHCs) with at least $50 billion ($100 billion starting from 2019) in total assets. We refer to these financial instituions as banks in this paper.

[5]These banks also account for 76% of assets in the U.S. banking sector based on 2019 FR Y9-C filings, the most recent year in our sample. Also see Bidder, Krainer, and Shapiro (2021), Caglio, Darst, and Kalemli-Ozcan (2022), Ivanov, Pettit, and Whited (2022), and Beyhaghi, Fracassi, and Weitzner (2023).

a large number of U.S. private firms, and is a significant advantage of the FR Y-14Q data over other similar data. Loan information including loan interest rates and utilization rates of lines of credit are updated quarterly, however, income statement and balance sheet data items are typically updated annually.[6]

Appendix A defines all variables used in the paper. Table A.1 provides variable definitions in the FR Y-14Q data. Table A.2 shows the equivalent variable definitions in Compustat.

3.2 Cleaning

We start the data cleaning process by focusing on the sample of all domestic borrowers, excluding government entities, individual borrowers, trusts, nonprofit organizations, foreign entities, depository institutions, and firms with missing names or masked names. We also drop banks with a very small corporate lending business from the sample since their related data generally contain few observations and with several missing values. Our sample starts in 2011 and ends in 2019 to avoid the COVID-19 pandemic's impact on firms' decision making. This raw sample includes 201,671 firms with unique Taxpayer Identification Numbers (TIN).

Next, we sequentially exclude the following firms step by step: special purpose entities, firms with potentially misreported loan amounts or financial data (following the general guidelines of Brown, Gustafson, and Ivanov (2021)), financial firms (NAICS 2-digit 52), offices of banks and intermediate holding companies (NAICS 551111), utilities (NAICS 2-DIGIT 22), and public administration and governmental firms (NAICS 2-digit 92). More details about the data cleaning steps are in Appendix B, which explains in detail each step of the cleaning process and reports the number of unique firms and observations in each step.

We then carefully identify public and private firms with three steps. First, we merge the FR Y-14Q data with Compustat using a combination of TIN, ticker, and CUSIP. TIN is a 9-digit identification assigned by the U.S. Internal Revenue Service, the standard firm

[6] Detailed data instructions are available on the Federal Reserve's website at https://www.federalreserve.gov/apps/reportingforms/Report/Index/FR_Y-14Q.

identifier of FR Y-14Q data, and thus is the primary merging variable. Ticker and CUSIP are mainly used for verification purposes.[7] Firms that are matched to Compustat are identified as public firms and those that are not matched are defined as private firms.

Next, we manually check the largest 1% of non-matched firms (989 firms) for accidental mis-classification due to missing identifiers. We use a combination of firm name, address, and other information for this exercise and successfully reclassify 34% of these firms as public. In addition, to ensure that the firms identified as private firms are true private and not domestic subsidiaries of foreign public firms, we drop all observations for which we have stock exchange information but which did not match to Compustat data. Last, to ensure that our results are not affected by any residual chances of public firms being mistakenly classified as private firms, we trim the sample of private firms on borrower size at the 99.5$^{\text{th}}$ percentile. These steps leave us with 167,262 unique private firms and 5,081 unique public firms from 2011 to 2019.

Next, we construct three separate datasets for our empirical analyses. The first dataset is an unbalanced firm-year panel of financial data that includes the main balance sheet and income statement items, with a structure similar to the Compustat annual data. Our data are not limited to public firms as they include and are dominated by private firms. We acknowledge that a caveat of our data is that the majority of the firms only appear in the data for a few years while they maintain a borrowing relationship with the reporting banks.[8]

The second dataset is also an unbalanced firm-year panel, which contains firms' borrowing balances. This dataset is constructed separately from the first one due to the timing differences between the reported financial information and loan information in each individual loan observation. For each loan observation in quarter q (i.e., all loan-based information as of quarter q), banks report firm financial information of quarter $q-1$. A

[7]Ticker and CUSIP are not used as main merging variables for two reasons. First, the reporting format for these two variables varies across and within banks due to lack of specified requirements on reporting format. Second, these two variables are not as well populated as TIN in early years in our sample. Banks also report Obligor Name, which is the legal name of the borrower. However, we observe that different banks often report the same borrower name differently. Thus, firm name is not used for merging FR Y-14Q data with other datasets, but is used for verification purpose as well.

[8]A bank only needs to report a borrower's financial information when the bank has a lending relationship with the borrower.

typical borrower might have multiple loans with a bank at the same time. Term loans are generally fully funded loans (\$utilized = \$commitment). Lines of credit can be fully or partially funded or unfunded (\$utilized ≤ \$commitment). Using loan information, we calculate the firms' total annual commitment amount, total annual utilized credit, and unutilized credit (i.e., annual commitment minus annual utilized). Then, we merge the first two datasets by firm and year.

The third dataset is a detailed loan-level data that contains information such as banks' private assessments of loan risk (loan rating), loan amount, maturity, collateral, and guarantees, among others.

Lastly, our measure of monetary policy shocks are based on the high-frequency changes in the implied Federal Funds rates around monetary policy announcements. We use the shocks that are measured and provided by Bauer and Swanson (2023) and Gurkaynak, Karasoy-Can, and Lee (2022). We discuss the measurement of the monetary policy shocks in more details in Section 4.1.

3.3 Basic Properties

We analyze a firm's budget constraint to describe investment and financing properties in our sample. Equation (1) shows the flow budget constraint at time t, setting the sources of funds on the left-hand side equal to the uses of funds on the right-hand side.

$$\underbrace{Y_t}_{\substack{\text{operating}\\ \text{income}}} + \underbrace{E_{t+1} - E_t}_{\text{net equity issuance}} + \underbrace{B_{t+1} - B_t}_{\text{net debt issuance}} = \underbrace{A_{t+1} - (1-\delta_t)A_t}_{\text{investment}} + \underbrace{D_t}_{\text{dividends}} + \underbrace{r_t B_t}_{\text{interest}} + \underbrace{T_t}_{\text{taxes}}. \quad (1)$$

Sources of funds include internally generated operating income Y_t and external financing in the form of debt and equity. The firm starts the period with total book equity E_t and ends the period with E_{t+1} after making equity issuance decisions. The net equity issuance $E_{t+1} - E_t$ can be positive (issuance) or negative (repurchase). Also, the firm starts the period with total debt liability B_t and ends the period with B_{t+1} after adjusting its debt policy. Net debt issuance $B_{t+1} - B_t$ can also be positive (issuing debt) or negative (repurchasing or maturing debt).

Uses of funds include capital investments in period t, measured as the difference between the firm's assets in the beginning of the next period A_{t+1} and depreciated assets this period $(1-\delta_t)A_t$, where δ is the depreciation rate. Throughout the paper, we refer to nonfinancial assets simply as "assets" for brevity. The firm also uses funds to pay dividends D_t to shareholders, interest $r_t B_t$ to creditors with interest rate r_t, and taxes T_t to the government. Appendix A provides detailed variable definitions.

Define period t asset growth as $\Delta A_{t+1} = A_{t+1} - A_t$, net equity issuance as $\Delta E_{t+1} = E_{t+1} - E_t$, and net debt issuance as $\Delta B_{t+1} = B_{t+1} - B_t$. We rearrange the budget constraint to have the following relation between asset growth and the sources of financing:

$$\Delta A_{t+1} = Y_t + \Delta E_{t+1} + \Delta B_{t+1} - D_t - r_t B_t - \delta_t A_t - T_t. \tag{2}$$

Table 1 shows the summary statistics for the main investment and financing variables in our sample. The average public firm has approximately \$3 billion in total assets, which is an order of magnitude larger than the average private firm with approximately \$93 million in total assets.[9] Public and private firms look more similar with respect to their capital structure. The debt-to-asset ratio of the average public firm is 0.32, which is slightly larger than the ratio of 0.29 in the average private firm. Turning to growth rates, the average public and private firms have similar asset growth rates of 5% and 6% per year, respectively. During our sample period, public firms issue more debt than equity as they have an average equity growth rate of 3% and an average debt growth rate of 6% per year. On the other hand, private firms' equity grows on average 6% per year, and their debt grows on average 1% per year. Finally, the average private firm has an operating income-to-asset ratio of 0.29, making it more profitable than the average public firm with a ratio of 0.16. We acknowledge that the income ratio could be affected by the data collection threshold of FR Y-14Q, whereby only firms with a bank loan of at least \$1 million are included in the dataset.

[Table 1 around here]

[9] Dollar figures reflect real values in 2015 USD.

3.4 Asset Growth Decomposition

We also compare the relation between asset growth and sources of financing in public and private firms using the asset growth decomposition approach of Frank and Sanati (2021). Equation (2) shows that if the firm's assets increase, other aspects of the identity must also adjust so that the identity still holds. The goal is to establish some basic patterns in the data, not to provide causal evidence. We estimate the following regression

$$\Delta \ln(A_{it}) = \beta_E \Delta \ln(E_{it}) + \beta_B \Delta \ln(B_{it}) + \beta_Y \ln(1 + \frac{Y_{it}}{A_{it}}) + \beta_c \mathbf{C}_{it} + \alpha_i + \alpha_t + \varepsilon_{it}, \quad (3)$$

where i and t index the firm and year, respectively. The term $\Delta \ln(X_{it})$ is the growth rate of variable X, and $\mathbf{C}$ is a vector of firm characteristics that includes size, tangibility, and industry q. We include firm and year fixed effects to account for time-invariant firm differences and macroeconomic conditions, respectively.

Table 2 shows the results. We interpret the estimated coefficients as the sensitivity of asset growth to changes in the sources of financing. Column 1 suggests that, in public firms, a 1% increase in equity is associated with a 0.26% increase in assets, while a 1% increase in debt is associated with a 0.14% increase in assets. This finding suggest that, among the external financing sources, asset growth is more strongly associated with equity growth than debt growth. These patterns are well-known both in the aggregate data and for public firms (Frank and Sanati, 2021). Interestingly, column 3 shows similar relations in private firms. The estimates suggest that, in private firms, a 1% increase in equity is associated with a 0.23% growth in assets, whereas a 1% increase in debt is associated with a 0.11% growth in assets. Finally, for both public and private firms, the change in operating income is positively associated with asset growth.

In columns 2 and 4 of Table 2, we separate the contributions of internal and external equity. Internal equity, $E_{Int.}$, is the accumulated retained earnings, whereas external equity, $E_{Ext.}$, is the total funds raised externally from shareholders by issuing common or preferred stocks. Columns 2 and 4 show that the sensitivity of asset growth to external equity is approximately twice as large as the sensitivity to internal equity. These findings suggest that, on average, external equity financing is strongly associated with asset growth in both public and private firms.

We use the coefficients in column 1 of Table 2 to estimate the magnitude of the relations in dollar terms. First, consider public firms. A 1% increase in equity is equivalent to an average increase of $10.55 million in equity (i.e., $0.01 \times \$1,055.32$). A 0.26% increase in assets translates to $5.98 million more in assets (i.e., $0.0026 \times \$2,301.17$). These estimates suggest that, in public firms, an extra dollar of equity issuance is associated with an extra $0.57 of real assets (i.e., $\$5.98$ mil. / $\$10.55$ mil.). Following the same procedure, we estimate that an extra dollar of debt issuance is associated with an extra $0.33 of assets. For private firms, an extra dollar of equity issuance is associated with an extra $0.46 of assets, while an extra dollar of debt is associated with an additional $0.27 in assets.

[Table 2 around here]

4 Firms' Responses to Monetary Policy Shocks

In this section, we evaluate investment and financing responses of public and private firms to unexpected monetary policy shocks.

4.1 Measuring Monetary Policy Shocks

We measure monetary policy shocks (MPS) using the high-frequency event study approach pioneered by Kuttner (2001), Gurkaynak, Sack, and Swanson (2005), and Bernanke and Kuttner (2005). The idea is to measure the surprise element of monetary policy by evaluating high-frequency interest rate changes around monetary policy announcements. The MPS is constructed as

$$MPS_t^m = \tau(t) \times (ffr_{t+\Delta_+}^m - ffr_{t-\Delta_-}^m), \tag{4}$$

where m and t are the month and time of the monetary policy announcement, ffr_t^m is the implied Federal Funds Rate from futures contracts, $\Delta_- = 15$ minutes and $\Delta_+ = 45$ minutes control the size of the time window around the announcement, and $\tau(t)$ is an adjustment factor for the timing of the announcement within the month.

In the baseline tests, we obtain the MPS data that are based on the responses of the first four quarterly Eurodollar futures contracts from Bauer and Swanson (2023). We aggregate the high-frequency shocks to the quarterly and annual frequency to merge them with our firm-level data. Compared to conventional MPS measures, Bauer and Swanson (2023) improve the relevance of monetary policy surprises by substantially expanding the set of monetary policy announcements to include press conferences, speeches, and testimonies by the Federal Reserve chair, in addition to the Federal Open Market Committee (FOMC) announcements. They also address concerns about exogeneity of the shocks by removing the component of the monetary policy surprises that is correlated with economic and financial data.

We also use two-dimensional monetary policy surprises following Gurkaynak, Sack, and Swanson (2005). The first dimension is related to the change in the current policy setting ("target component") and the second to the change in forward guidance ("path component"). The two components are orthogonal to each other by construction, so the path component captures only those revisions to expectations of interest rates up to one year ahead that are not driven by the surprise in the current policy target rate. We obtain the updated data on target and path components from Gurkaynak, Karasoy-Can, and Lee (2022).

4.2 Firms' Responses to MPS

To evaluate firm responses to monetary policy shocks, we estimate the regression

$$\Delta \ln(X_{it}) = \beta_m MPS_t + \beta_c \mathbf{C}_{it} + \alpha_i + \alpha_b + \varepsilon_{it}, \tag{5}$$

where i and t index the firm and year, respectively. The main independent variable MPS_t is the aggregated monetary policy shock in year t. The dependent variable $\Delta \ln(X_{it})$ measures the rate of change in firms' assets, debt, and equity from $t-1$ to t, representing the contemporaneous change in firm policies in the year of the policy shock. The vector $\mathbf{C_{it}}$ contains firm characteristics including firm size, tangibility, industry q, and macroeconomic controls including the inflation rate and GDP growth rate. The regressions also include firm fixed effects to remove time-invariant firm differences and reporting-bank fixed effects to eliminate time invariant differences in credit supply.

Table 3 presents the results and documents a stark difference in public and private firms' responses to monetary policy shocks. First, consider the responses of public firms in panel (a). Column 1 shows that public firms' real investment policy does not respond to the shocks. However, in response to a positive shock that increases the policy interest rate, public firms strongly reduce their debt (column 2) and increase equity (column 3). The standardized MPS_t variable has a mean of zero and a standard deviation of 0.267. So, the estimates suggest that, in response to a positive one-standard-deviation monetary policy shock, an average public firm decreases debt by 6.01%, increases equity by 7.52%, and does not significantly change its real assets. These results suggest that, as interest rates rise, public firms are able to raise equity to cancel out the reduction in debt, maintaining the same level of total financing and real assets.

Next, consider the responses of private firms in panel (b) of Table 3. Columns 1, 2, and 3 show that a positive shock to interest rates is associated with contemporaneous declines in assets, debt, and equity of private firms, respectively. The coefficients suggest that, in response to a positive one-standard-deviation shock, an average private firm decreases debt by 1.90%, equity by 3.55%, and real assets by 1.09%. Column 2 estimates in panels (a) and (b) suggest that private firms decrease total debt at a slower rate than public firms. As we show later, this is because private firms rapidly draw down on their existing lines of credit, while losing access to new loan facilities. Public firms, having access to external equity, do not use their lines of credit significantly.

[Table 3 around here]

Overall, these results suggest that monetary policy affects the financing of public and private firms quite differently. Public firms are able to use equity to minimize the impact of policy tightening on their investment plans. Private firms have much less flexibility in accessing external financing, so policy shocks have a larger effect on their investments.

To check the robustness of our main findings, we also evaluate firm responses to an alternative measurement of monetary policy surprises that decomposes the shocks into target and path components (Gurkaynak, Sack, and Swanson, 2005; Gurkaynak, Karasoy-Can, and Lee, 2022). Appendix C provides the detailed analysis. Our results indicate that responses of both public and private firms to the path component, reflecting surprises in the Fed's forward guidance on interest rates, are consistent with the baseline results. Specifically, public firms maintain their real assets while decreasing debt financing and increasing equity financing in response to positive shocks, whereas private firms decrease assets, debt, and equity. This underscores the significance of forward guidance as a key driver of monetary policy, consistent with the findings of Gurkaynak, Karasoy-Can, and Lee (2022). However, responses to the target component, representing surprises in the policy rate itself, show nuanced effects. While financing responses to target surprises are similar to those in the baseline tests, investment responses differ somewhat from the baseline results. Positive target shocks are associated with an increase in investments of public firms and have no effect on investments of private firms. The differences in firms' reactions to target shocks compared to the baseline tests might stem from the dominance of the path component over the target component in monetary policy surprises during our sample period.

4.3 Decomposing Equity Responses

We provide more details to better understand the equity financing responses to monetary policy shocks. First, note that total equity is the sum of externally issued equity ($E_{Ext.}$) and internal equity ($E_{Int.}$), which is the accumulation of internally generated profits (i.e., retained earnings). We evaluate the role of each component in shaping the documented total equity responses to monetary policy shocks.

Columns 1-2 of Table 4 present the results. Panel (a) shows the decomposition of equity responses for public firms. Column 1 shows that public firms' internal equity does not significantly change in response to shocks. Column 2 shows that their external equity strongly responds to shocks. These results show that the increase in the equity of public firms in response to a tightening shock is primarily driven by external equity issues. Panel (b) reveals a sharply different equity response by private firms. In response to a positive shock, private firms decrease both internal (column 1) and external equity (column 2). The drop in internal equity is approximately three times larger than external equity. This comparison suggests that, although private firms lose access to external equity during tight monetary policy, most of the drop in total equity is driven by less internal equity.

[Table 4 around here]

To further clarify the equity responses of public firms, we use quarterly data from Compustat to assess the dynamics of the value of external equity and the number of shares outstanding in response to monetary policy shocks. To evaluate the dynamics, we estimate Jorda (2005)-style local projections at quarterly frequency:

$$\ln(X_{it+h}) - \ln(X_{it-1}) = \beta_h \left(\sum_{q=0}^{h} MPS_{t+q} \right) + \beta_c \mathbf{C}_{it} + \alpha_i + \varepsilon_{it+h}, \tag{6}$$

where i and t index the firm and quarter, respectively, and $h \geq 0$ indexes the forecast horizon. The coefficient β_h measures the cumulative response of variable X in period $t+h$ to monetary policy shocks from quarter t to $t+h$. The vector $\mathbf{C}_{it}$ contains firms characteristics and macroeconomic controls, as in the baseline regression (Equation (5)). Also, to evaluate the anticipatory effects of the shocks, we estimate:

$$\ln(X_{it-1}) - \ln(X_{it-2}) = \beta_{-1} MPS_t + \beta_c \mathbf{C}_{it-1} + \alpha_i + \varepsilon_{it}, \tag{7}$$

where β_{-1} measures the firm's response one quarter before the shock.

Figure 1 shows the dynamics of external equity. Public firms raise external equity from one quarter before a positive shock that raises the policy interest rates. Their equity response increases after the shock, peaks in quarter two, and remains elevated over the next year. These results are consistent with public firms' equity responses documented above.

[Figure 1 around here]

In Figure 2, we use the same methodology to evaluate the dynamics of the number of common shares issued, which removes the impact of share prices at issuance and reflects the actual issuance activity. The results show that, in response to monetary tightening, public firms issue new shares for up to two quarters after the shock. The fact that firms issue more shares is interesting because policy rate hikes cause a decline in share prices (Bernanke and Kuttner, 2005). A drop in share prices makes exercising executive stock options less attractive. So, the increase in shares outstanding likely reflects share issuance for other purposes, notably fund raising by the firms at a time when debt is becoming more expensive.

[Figure 2 around here]

4.4 Decomposing Debt and Interest Rates

We also provide further details on firms debt responses and the impact of monetary policy shocks on loan interest rates. In our sample, firms' total debt is a combination of two types of contracts. One type of debt takes the form of term loan facilities in that the price (i.e., interest rate) and quantity are determined at the same time that the debt is issued. The other type of debt takes the form of a drawdown on a line of credit, with terms that are agreed upon in advance. The firm gets an option to draw on the line, given that the line remains open and has not already been maxed out.

In columns 3-5 of Table 4, we evaluate the use of the two types of debt facilities in response to monetary policy shocks. Column 3 shows the changes in the firms' total credit commitments that include term loans and total lines of credit (used and unused). Column 4 shows the changes in total utilized commitments that include term loans and the used portion of the lines of credit. Column 5 shows the changes in the undrawn portion of the lines of credit.

Columns 3-5 in Panel (a) of Table 4 show the impact of monetary policy shocks on the credit components of public firms. Consistent with the baseline results, column 3 shows that total commitments of public firms decline in response to a positive shock that increases the policy interest rate. Columns 4 and 5 show that, while utilized commitments slightly decrease, undrawn commitments do not change in response to the shock. These results suggest that the decline in public firms total debt is primarily driven by a reduction in term loans while there is no significant change in their use of credit lines.

Columns 3-5 in Panel (b) of Table 4 show a very different response by private firms. Consistent with the baseline results, column 2 shows that private firms decrease their total credit commitments in response to a positive shock. Column 4 shows a significant increase in the utilization of existing lines of credit, and column 5 shows a significant decline in the undrawn portion of those lines. These existing credit lines are prior commitments by banks to lend to corporations at prespecified rates and up to prespecified limits. So, it appears that private firms respond to monetary tightening by rapidly drawing on the available credit through their credit lines, before the banks tighten up in response to the policy change and increase the interest rates. We discuss the changes in loan interest rates below and show patterns that are consistent with this interpretation.

FR Y-14Q provides rich quarterly data on prices and quantities of firms' borrowing. We can use these data to study the quarterly dynamics of firms' borrowing in response to monetary shocks. We use the local projections specifications in Equations (6) and (7).

Using quarterly data, Figure 3 shows the dynamics of the cost of bank loans to private and public firms around the time of monetary policy shocks. The estimates control for loan characteristics at the time of observation including the log of loan amount, log of loan maturity, loan variability type (floating versus fixed), whether the loan is secured, whether the loan is guaranteed, and loan type (line versus term). The figure shows the changes in loan interest rates for both private (panel a) and public firms (panel b).

There are two main takeaways from the results in Figure 3. First, the changes in loan prices of public and private firms are quite similar. In both cases, it takes about three quarters for the interest rates to reach the peak, and the magnitudes are similar. Since loan interest rates are primarily set by the bank (i.e., supply side), the similarity of these patterns suggest that the differences in debt responses of public and private firms are most likely driven by their heterogeneous demand for credit. Second, there are no changes to loan interest rates before the monetary policy shocks, and the changes start with the arrival of the shocks in period 0.

[Figure 3 around here]

Using quarterly data, Figure 4 shows dynamics of differential responses of utilization rates on existing lines of credit to monetary policy shocks. Consistent with our previous findings, panel (a) shows that that private firms strongly draw on their existing lines of credit in response to a tight monetary policy. However, as panel (b) shows, public firms slightly reduce the utilization of their credit lines.

[Figure 4 around here]

Finally, Figure 5 shows the amount of new credit obtained after a monetary policy tightening shock using quarterly data. To make these estimates, we aggregate all new loan commitments in a given quarter at the firm level. We do not use any loan level controls. Unlike a line of credit, these are not normally based on pre-negotiated terms. Panel (a) shows that private firms increase borrowing by taking new loans one quarter ahead of a rise in interest rates. However, after the monetary policy shock arrives and interest rates rise, they decrease total commitments starting in quarter two after the shock. Panel (b) shows that public firms do not show a strong response initially, but they also decrease their total new borrowing starting in quarter two after the shock.

[Figure 5 around here]

4.5 The Effects of Firm Size on Responses to MPS

Our results suggest that access to external finance, in particular external equity, is a critical factor in explaining the heterogeneous impact of monetary policy shocks on firms' real operations. The "public" status of firms is a reasonable proxy for their access to external equity since having better access to capital markets is a primary reason for firms to go public. However, public firms are on average much larger than private firms, and firm size also tends to be correlated with access to capital (Whited and Wu, 2006; Hadlock and Pierce, 2010). We control for firm size in all of our baseline empirical estimations. Nonetheless, we also explicitly test the effect of firm size on responses to monetary policy shocks.

In each year, we divide public and private firms separately into quintiles of firm size. We modify the baseline tests by evaluating the interactions of monetary policy shocks (MPS) with the size-quintile dummies. Table D.7 in Appendix D presents the detailed estimation results. Overall, we find that, within each type of firms, small and large firms have different responses to monetary policy shocks. The smallest public firms (quintile 1) react to shocks by decreasing their debt, not changing equity, and reducing their assets. So, their reactions are somewhat similar to the average private firm. Larger public firms (quintiles 2-5) decrease debt, raise equity, and do not change real assets, aligning with the baseline results representing "the average public firm." On the other hand, small and medium private firms (quintiles 1-3) respond to shocks by decreasing debt, equity, and assets, aligning with the baseline responses of "the average private firm." However, larger private firms (quintiles 4-5) are not significantly affected by the shocks as their assets, debt, and equity do not significantly change.

5 Model

In this section, we develop a model to provide an explanation for the observed responses of pubic and private firms to monetary policy shocks. The model builds on and modifies the general equilibrium models of Jermann and Quadrini (2012) and Frank and Sanati (2021) to incorporate monetary policy shocks. In the model, households own firms and provide labor services to them. Firms make dynamic investment, hiring, and financing decisions. They generate revenue by employing capital and labor as inputs and finance their operation with a combination of debt and equity, which are subject to three financial and real frictions. In our model, the financial frictions take the form of an equity issuance cost and an enforcement constraint on debt contracts, and the real friction takes the form of an investment adjustment cost.

The main mechanism in the model is that monetary policy shocks change the firms' optimal level of inputs by affecting the discount rates in the economy. To avoid costly adjustment of capital, firms substitute financing sources to undo the effects of the monetary policy shocks, but this is not always possible due to the financial frictions.

We start with a description of the monetary policy shocks, then present the firm's problem, and finally describe the household sector, which closes the model.

5.1 Monetary Policy Shocks

Monetary policy shocks are the only source of uncertainty in the baseline economy. For simplicity, there are no productivity shocks in the baseline model. Later on, we evaluate a model extension that includes productivity shocks. We model the monetary authority in the most parsimonious way to introduce interest rate shocks in our neoclassical framework. The monetary authority sets the policy interest rate, r_t^{pol}, according to the rule:

$$r_t^{pol} = log(1/\bar{\beta}) + mp_t, \tag{8}$$

where $\bar{\beta}$ is the long-run households' discount rate and mp_t is the monetary policy in period t. Monetary policy is persistent over time and follows the autoregressive process:

$$mp_t = \rho\, mp_{t-1} + \varepsilon_t \text{ and } \varepsilon_t \sim N(0, \sigma^2) \tag{9}$$

where ε_t is an i.i.d. shock with volatility σ.

The policy interest rate, r_t^{pol}, enters the equilibrium through households' discount rate

$$\beta_t = \frac{1}{1 + r_t^{pol}}. \tag{10}$$

This is similar to the way monetary policy enters the equilibrium in New Keynesian models, e.g., Ottonello and Winberry (2020).

5.2 Firms

Technology. There is a continuum of firms in the [0,1] interval. A firm uses capital k_t and labor n_t to generate revenue with a gross revenue function

$$F(k_t, n_t) = k_t^{\theta} n_t^{1-\theta}, \tag{11}$$

where $0 < \theta < 1$. Labor input n_t is flexibly chosen at time t. Capital input k_t is chosen at time $t-1$ and predetermined at time t. Given investment i_t at time t, next-period capital is determined by $k_{t+1} = (1-\delta)k_t + i_t$, where δ is the depreciation rate of capital.

Adjusting capital stock is costly for the firm because of disruption costs, such as planning and installation costs, learning to use new technologies, and temporary business interruptions. The investment adjustment cost function, $\psi(k_{t+1}, k_t)$, takes a standard quadratic form, similar to Hayashi (1982),

$$\psi(k_{t+1}, k_t) = \eta\left(\frac{k_{t+1} - (1-\delta)k_t}{k_t}\right)^2 k_t. \tag{12}$$

The adjustment cost is increasing and convex in the investment rate. It is also proportional to firm size, k_t, so firms cannot grow out of the adjustment costs.

Financing. Firms can use internal funds and external financing in the form of debt and equity to finance their operation. Debt, denoted by b_t, is a one-period contract and is preferred to equity because of its tax advantage, which is a common feature in capital structure models (Ai, Frank, and Sanati, 2021). Therefore, the effective interest rate on the firm's debt is $1 + (1-\tau)r_t$, where r_t is the gross interest rate charged by the lenders and τ is a tax wedge that represents the the tax advantage of debt over equity.

Firms are allowed to default on their debt obligations. Therefore, the ability to borrow is constrained by the limited enforceability of debt contracts, giving rise to a collateral constraint à la Rampini and Viswanathan (2013). At the time of borrowing, the liquidation value of the assets in place is $\gamma(1-\delta)k_t$, so the firm's choice of new debt is subject to

$$b_{t+1} \leq \gamma(1-\delta)k_t. \tag{13}$$

Intuitively, a higher stock of capital relaxes the constraint. The collateral parameter γ is constant and common to all firms, with higher values allowing firms to issue more debt, ceteris paribus.

It is important to note that, in practice, borrowing constraints may not necessarily rely on asset recovery rates. Recent studies by Lian and Ma (2021) and Kermani and Ma (2022) reveal that borrowing constraints often relate more closely to operating cash flow or going-concern values rather than the liquidation value of assets. For the purpose of our study, both versions of borrowing constraints generate similar dynamic implications for the firm's use of equity and debt, which is our primary focus. This is because our model has a single type of asset (i.e., physical capital), which has a constant recovery rate γ and primarily determines the cash flow.

Firms can also issue equity or distribute funds to shareholders. We define the net payout d_t equal to the available net cash flow in the firm at time t. Positive values of d_t represent the distribution of excess funds to shareholders, and negative values represent raising equity from shareholders. External equity financing is costly due to direct (e.g., underwriting fees) and indirect costs (e.g., announcement returns). To formulate these costs in a parsimonious way, we assume a linear equity issuance cost, similar to Gomes (2001). Given the equity payout d_t, the actual cost for the firm is

$$\phi(d_t) = d_t + \lambda(\bar{d} - d_t) \times \mathbb{I}\{d_t < \bar{d}\} \tag{14}$$

where $\lambda \geq 0$ and $\bar{d}$ is the firm's long-run (steady-state) payout target.

Firm's problem. The firm's objective is to maximize its equity market value $V(.)$, which is equal to the sum of discounted future net payouts. For easier reading, we drop the time subscripts and indicate the next-period value of variables by a prime. The firm's individual state each period is determined by the stock of capital k and debt b. The aggregate states, specified below in the equilibrium definition, are denoted by S.

Taking the stochastic discount factor (SDF) m', interest rate r, and wage rate w as given, an individual firm chooses this period's labor input n, next period's capital k', and debt liability b' to maximize the current equity value. The firm's problem can be characterized recursively by the following Bellman's equation:

$$V(S;k,b) = \max_{n,k',b'} \left\{ d + \mathbb{E}\big[m'V(S';k',b')\big] \right\}, \tag{15}$$

subject to

$$\phi(d) + k' + \psi(k',k) + wn + b = F(k,n) + (1-\delta)k + \frac{b'}{1+(1-\tau)r}, \tag{16}$$

$$b' \leq \gamma(1-\delta)k. \tag{17}$$

The expectation on the right-hand side is over the next-period aggregate state S', conditional on the current state S. Equation (16) is the firm's budget constraint. The left-hand side shows the uses of funds including the net payouts, purchase of capital and related adjustment costs, wage payments, and debt repayments. The right-hand side shows the sources of funds including the period's revenue, inherited stock of capital after depreciation, and net proceeds from new debt issuance. Let μ denote the Lagrangian multiplier for the debt constraint in Equation (17). The first-order conditions (FOCs) are

$$n : w = F_n(k, n), \tag{18}$$

$$k' : \frac{1 + \psi_{k'}(k', k)}{\phi_d(d)} = \mathbb{E}\Big[m'\Big(\mu'\gamma(1-\delta) + \frac{1 - \delta + F_{k'}(k', n') - \psi_{k'}(k'', k')}{\phi_{d'}(d')}\Big)\Big], \tag{19}$$

$$b' : \frac{1}{\phi_d(d)\big(1 + (1-\tau)r\big)} = \mu + \mathbb{E}\big[m'\frac{1}{\phi_{d'}(d')}\big]. \tag{20}$$

Equation (18) shows the labor optimality condition. The left-hand side is the marginal cost of labor, which is the wage rate. The right-hand side is the marginal benefit of an additional unit of labor in terms of added revenue.

Equation (19) shows the optimality condition for capital investments. The left-hand side captures the marginal cost of investment today. The numerator $1 + \psi_{k'}(k', k)$ captures the cost of buying a unit of capital and the associated adjustment cost. The ratio $\frac{1}{\phi_d(d)}$ is the shadow cost of available funds inside the firm, and increases when the firm is raising external equity due to equity issuance cost. The right-hand side shows the expected marginal value of the investment next period. This includes the collateral role of the invested capital in relaxing the debt constraint next period, $\mu'\gamma(1-\delta)$, in addition to the residual value of capital after depreciation and the marginal effect on revenue and adjustment costs, adjusted by the shadow cost of internal funds next period.

Finally, Equation (20) shows the debt optimality condition. The left-hand side shows the marginal value of an additional unit of debt today, which equals the debt proceeds $\frac{1}{1+(1-\tau)r}$, adjusted by the shadow cost of funds inside the firm $\frac{1}{\phi_d(d)}$. The right-hand side shows the marginal cost of debt that includes the tightening of today's borrowing constraint, captured by μ, and the expected cost of debt repayment next period.

5.3 Households

A continuum of homogeneous households own shares of the firms, provide labor to the firms, and invest in debt issued by the firms. Every period, households maximize their expected lifetime utility by choosing consumption c, labor n^H, and saving decisions in terms of the next period's number of shares $s^{H'}$ and debt securities $b^{H'}$ issued by the firm. Therefore, the households' problem can be characterized recursively by

$$U(S) \;=\; \max_{c,n^H,b^{H'},s^{H'}} \Big\{ u(c,n^H) + \beta \mathbb{E}\big[U(S')\big] \Big\}, \tag{21}$$

$$\text{subject to} \qquad c + \frac{b^{H'}}{1+r} + s^{H'}p + T = wn^H + b^H + s^H(p+d), \tag{22}$$

where the discount factor is determined by the policy interest rate $\beta = \frac{1}{1+r^{pol}}$ as explained in the discussion of monetary policy shocks. Equation (22) is the household's budget constraint. The right-hand side shows the sources of funds including the labor income, face value of maturing corporate debt, and equity income consisting of dividends and total value of shares priced at p. The left-hand side shows the uses of funds including consumption, investing in new corporate debt and equity, and a lump-sum tax on the household, T. To close the model, we set this tax equal to the aggregate tax benefit of debt for the firms, that is, $T = \frac{B'}{1+(1-\tau)r} - \frac{B'}{1+r}$.

The FOCs with respect to n^H, $b^{H'}$, and $s^{H'}$, which determine the supply of labor, interest rate, and share price, respectively, are the following:

$$n^H \;:\; wu_c(c,n^H) + u_n(c,n^H) = 0, \tag{23}$$

$$b^{H'} \;:\; \frac{1}{1+r}u_c(c,n^H) - \beta\mathbb{E}\big[u_c(c',n^{H'})\big] = 0, \tag{24}$$

$$s^{H'} \;:\; pu_c(c,n^H) - \beta\mathbb{E}\big[u_c(c',n^{H'})(p'+d')\big] = 0. \tag{25}$$

Using forward substitution on the last equation, we get

$$p_t = \mathbb{E}_t \sum_{j=1}^{\infty} \Big(\prod_{i=1}^{j} \beta_{t+i} \Big) \frac{u_c(c_{t+j}, n^H_{t+j})}{u_c(c_t, n^H_t)} d_{t+j}. \tag{26}$$

Firms' optimization is consistent with households' optimization, so the firm sector's SDF is $m_{t,t+j} = \left(\prod_{i=1}^{j} \beta_{t+i}\right) \frac{u_c(c_{t+j}, n_{t+j}^H)}{u_c(c_t, n_t^H)}$ for $\forall j \in [1, \infty)$.

5.4 Equilibrium Definition

The aggregate states are the interest rate policy r^{pol}, aggregate stock of capital K, and aggregate bonds B; $S = \{r^{pol}, K, B\}$. A recursive competitive equilibrium is defined as a set of functions for:

(i) firms' value $V(S; k, b)$ that satisfies the Bellman's Equation (15), and policies $n(S; k, b)$, $k'(S; k, b)$, and $b'(S; k, b)$ that are optimal and satisfy the FOCs in Equations (18)-(20);

(ii) households' policies $c^H(S)$, $n^H(S)$, and $b^{H\prime}(S)$ that satisfy the FOCs in Equations (23)-(25);

(iii) the aggregate wage rate $w(S)$ and interest rate $r(S)$ that clear the labor and bond markets, respectively, and the SDF is $m(S, S') = \beta \frac{u_c(c', n^{H\prime})}{u_c(c, n^H)}$, where β is regulated according to Equation (10); and

(iv) the law of motion for aggregate states $S' = \Psi(S)$ that is consistent with individual decisions and the stochastic process for r^{pol}.

5.5 Model Mechanism

We use the equilibrium optimality conditions to discuss the economic mechanism of the model in explaining firms' responses to monetary policy shocks. This discussion guides the quantitative evaluation of the model in the following subsections.

Suppose the economy receives a positive monetary policy shock, increasing the policy interest rate r^{pol}, according to the policy rule in Equation (8). The policy rate hike decreases the households' discount factor β according to Equation (10). This in turn decreases the firms' discount factor m', affecting the optimal investment and financing policies of firms. First, according to Equation (19), a decline in the discount factor reduces the expected marginal benefits of newly invested capital k'. Therefore, firms find it optimal to decrease k' despite the dampening effect of the capital adjustment costs. Second, according to Equation (20), a decline in the discount factor raises the interest rate r on firms' debt, reducing the optimal level of debt b'.

We evaluate the combined effects by revisiting the firms' budget constraint:

$$\underbrace{\phi(d)}_{\downarrow/\uparrow} + \underbrace{k'}_{\downarrow} + \underbrace{\psi(k',k)}_{\uparrow} + \underbrace{wn}_{\substack{\text{static}\\ \text{choice}}} + \underbrace{b}_{\text{predetermined}} = \underbrace{F(k,n) + (1-\delta)k}_{\text{predetermined}} + \underbrace{\frac{b'}{1+(1-\tau)r}}_{\downarrow\downarrow} \tag{27}$$

Terms that depend on current capital stock k and debt outstanding b are predetermined. Labor choice n and the equilibrium wage rate w are static outcomes that depend on current capital stock, and are not affected by the monetary policy shock. Incoming funds, on the right-hand side, decline due to the lower optimal level of debt and the rise in firms' interest rates. Outgoing funds, on the left-hand side, also decline because of the lower optimal level of capital, but this decline is dampened and partially undone by the adjustment cost $\psi(k',k)$.

The two sides of the budget constraint must balance, therefore the effect of the monetary policy shock on dividends (i.e., equity financing) depends on the relative magnitude of the reduction in debt and investments. In firms with small investment adjustment costs, the decline in investments could be larger than the decline in debt. Then the firm could increase dividends (i.e., reduce equity) due to the reduction in total financing needs. If the decline in investment is small, for example due to large adjustment costs, then the firm must reduce dividends (i.e., raise equity) to pay for the debt reduction, unless equity issuance cost is prohibitively high. Therefore, the firm trades off the cost of equity issuance with the investment adjustment cost when deciding jointly about investment and financing decisions.

This discussion illustrates that firms' heterogeneities with respect to the capital adjustment cost and equity issuance cost could produce heterogeneous responses to monetary policy shocks. In the following subsections, we use the model to assess whether the differences along these dimensions are behind the distinct responses of public and private firms to monetary policy shocks.

6 Quantitative Analysis of the Model

This section examines firm responses to monetary policy shocks in the model. We parameterize the model and use it to understand the responses of public and private firms to monetary policy shocks.

6.1 Model Calibration and Parameters

Analyzing the model's quantitative implications requires choosing its parameters. We estimate some parameters directly from the data. For the rest, we solve the model numerically and calibrate those parameters by matching the model to the data. A period in the model is one year.

Directly estimated parameters. Panel (a) in Table 5 shows the parameters directly estimated in the data. First, the tax benefit of debt is $\tau = 31.8\%$ reflecting the weighted average of the top statutory corporate tax rate over the sample period, 2011-2019.

Next, we estimate the persistence and volatility of monetary policy shocks. We rearrange Equation (8) to compute $mp_t = r_t^{pol} - log(1/\bar{\beta})$ for each year, where r_t^{pol} is set to the average Federal Funds rate in year t, and the long-run discount factor is set to $\bar{\beta} = 0.971$, reflecting the average Federal Funds rate of 2.9% in the 30-year period ending in 2019. Then, we estimate the autoregressive process in Equation (9) and recover the values of $\rho = 0.928$ for persistence of monetary policy and $\sigma = 0.012$ for volatility of the shocks.

Finally, we assume that the utility function takes the form $u(c, n) = \log(c) + \alpha \log(1-n)$, where α directly affects the household's labor supply decision and is set to $\alpha = 1.789$ ensuring steady-state hours equal to 0.33.

Model solution. Given a set of parameters, we solve the model numerically via value function iteration. We adopt a nonlinear global approximation method that accommodates occasionally binding constraints. We approximate the conditional expectations in equilibrium conditions (i.e., in Equations (19), (20), and (24)) with functions that interpolate between the grid points of the three-dimensional state space (r, k, b). The interpolation is based on a cubic spline using not-a-knot end conditions. Starting with initial guesses for the conditional expectations at the grid points, we compute all variables of interest by solving the system of nonlinear equations characterizing the equilibrium.

The two inequality conditions in the model setup, one in the debt constraint and one in the equity issuance cost, create kinks in the model solution. The debt constraint could be binding or not. Also, the firm could be issuing equity ($d_t < \bar{d}$), which imposes issuance costs, or not ($d_t \geq \bar{d}$). At each grid point in the state space, we solve four versions of the model that cover all possibilities with the two inequality conditions. The set of policies creating the maximum value for the firm is chosen as the optimal set of policies at each grid point:

$$V = \max\{V_{d<\bar{d},\, b' \text{ binding}}, V_{d<\bar{d},\, b' \text{ non-binding}}, V_{d\geq\bar{d},\, b' \text{ binding}}, V_{d\geq\bar{d},\, b' \text{ non-binding}}\}. \tag{28}$$

In doing so, we essentially check for the Kuhn-Tucker conditions at each grid point. Once the equilibrium is solved on all of the grid points, we update the guesses for the conditional expectations and keep iterating until convergence. Appendix E provides details of the numerical solution.

Calibration. We use the model solution to generate a simulated sample and calibrate the remaining structural parameters $(\theta, \delta, \gamma, \eta, \lambda)$ separately for public and private firms. The goal is to choose a set of parameters that minimizes the distance between a vector of moments in the simulated data and the corresponding moments in the actual data.

To compute the model-generated moments, we use policy functions to create N simulated panels with the corresponding number of firms in the actual data (as in Table 1), and the time series length of $T + 100$, where $T = 9$ is the length of the actual data. We use $N = 10$ simulated samples to have acceptable finite sample properties (Michaelides and Ng, 2000). The first 100 periods of each simulation are discarded, allowing the final simulated sample to have a stationary distribution, after the economy works its way out of the initial point.

The reliability of the calibration depends on choosing the moments that are sensitive to variations in the structural parameters. Although all of the parameters affect all of the moments in some way, some moments have stronger monotonic ties to particular parameters because of the model structure. We choose the moments based on links that are well known in the literature following Jermann and Quadrini (2012) and Frank and Sanati (2021).

The production function parameter θ is strongly tied to the average labor share. The depreciation rate δ is strongly and monotonically related to the average investment rate. The collateral parameter γ affects the level of debt used by the firm, so the set of target moments include the firm's average debt to assets ratio. The equity issuance cost parameter λ determines the rigidity of firms' payout policy, so we add the standard deviation of the payouts to assets ratio to the set of moments. Finally, the investment adjustment cost dampens capital adjustments in response to shocks, so the adjustment cost parameter η is negatively related to the standard deviation of the investment rate. Table A.3 in Appendix A shows the variable definitions in the model.

In the data, we compute the moments for public and private firms using the firm-level data described in Section 3. However, we do not observe wage bills at the firm level. So, we calculate the labor share using aggregate data following Karabarbounis and Neiman (2014), and assume that the average public and private firms have the same labor share. Also, note that the baseline model does not include firm-level shocks, which would create firm-level heterogeneities and increase the volatility of firm policies in the simulated sample. Therefore, to calculate the standard deviation moments in the actual data, we remove firm-level heterogeneities. We compute the cross-sectional averages of payout ratio and investment rate in each year, and use the standard deviations of the two time series as the respective data moments.

Panel (b) of Table 5 shows the calibration results. The top panel contains the estimates of the actual data moments and simulated moments from the model, separately for public and private firms. The bottom panel presents the calibrated parameters for each type of firms. The two calibrated models fit the data very well, as most of the actual and simulated moments are indistinguishable. The only moment that is slightly different in the actual and simulated data is the standard deviation of the payout ratio. This could be driven by the simplicity of the linear equity adjustment cost structure in our model compared to, for instance, a quadratic form with fixed costs as used by Hennessy and Whited (2007).

Nonetheless, the calibrated models effectively capture the higher volatility of payouts in private firms compared to public firms, as demonstrated by the actual data moments. Since the differences are not economically significant for either type of firms, we stick with the simpler version of the model, which is sufficient to show the main economic mechanism.

Next, we turn to the parameter estimates in the bottom part of panel (b) Table 5. Our calibration sets the revenue function parameter θ at 0.429 for both types of firms. The depreciation rate δ of 0.081 in public firms is lower than the 0.113 in private firms, reflecting the lower average investment rate in public firms than in private firms. The collateral parameter γ of 0.435 in public firms is higher than the 0.390 in private firms, due to public firms' higher average debt ratio. Nonetheless, the differences in δ and γ between the two types of firms are not sizable.

The remaining two parameters, however, are radically different between public and private firms. The equity issuance cost λ is 0.075 for public firms, significantly lower than the issuance cost of 0.325 for private firms. This is consistent with the real world where having less costly access to equity capital is the primary reason firms go public. Finally, the investment adjustment cost η is 3.250 in public firms, much larger than the adjustment cost of 0.400 in private firms. This is also consistent with private firms being smaller and nimbler than public firms in adjusting their investments (Jensen, 1997).

[Table 5 around here]

6.2 Firms' Responses to Monetary Policy Shocks in the Model

We use the calibrated models to evaluate whether the responses of public and private firms to monetary policy shocks in the model, resemble those in the actual data. We use the simulated data on public and private firms to estimate regressions of asset growth, debt growth, and equity growth on monetary policy shocks. In other words, we replicate Table 3 using the model-simulated data and compare the estimated coefficients in the model with those in the actual data. Note that the regression coefficients are moments of data that are not targeted in the calibration process. So, similarities between these moments in the model and the actual data externally validates the calibrated models.

In the model, monetary policy shocks are defined as the one-period rate of change in monetary policy mp_t, that is $MPS_t = \Delta \ln(mp_t)$. Table A.3 in Appendix A shows the definitions for the growth rates of assets $\Delta \ln(A_{it})$, debt $\Delta \ln(B_{it})$, and equity $\Delta \ln(E_{it})$ in the model.

Table 6 shows the estimated coefficients in the simulated data. The table also shows the signs of estimated coefficients in the actual data for easier comparison. Panel (a) shows that a 1% increase in the policy interest rate has no effect on the investments of public firms as the assets change by -0.001%. However, in response to the policy change, public firms decrease debt by 0.023% and increase equity by 0.015%. The patterns are consistent with public firms raising equity to finance the reduction in debt while assets remain constant. The results show that public firms' responses to monetary policy shocks in the model are similar to those in the actual data.

Panel (b) of Table 6 shows the equivalent comparison for private firms. In response to a 1% increase in the policy interest rate, private firms reduce assets by 0.011%, debt by 0.005%, and equity by 0.010%. The results suggest that private firms decrease both debt and equity, and the reduction in total financing is consistent with the decline in investments. These patterns mirror those observed for private firms in the actual data.

[Table 6 around here]

We also assess firm responses to a monetary policy shock by evaluating the impulse response functions. For each type of firms, we simulate the model in the steady state and then give the economy an unexpected one-standard deviation positive monetary policy shock. The economy is at the steady state at year 0, and the shock arrives at year 1, as shown in Figure 6(a). Figure 6(b)-(d) show the responses of public (black lines) and private (grey lines) firms in the first 10 periods after the shock.

First, consider the initial responses of public firms to the unexpected increase in the policy interest rate. Figure 6(b) shows that the investment policy of public firms is not strongly affected by the shock. However, Figure 6(c) shows a strong immediate drop in debt as the interest rates rise. Also, Figure 6(d) shows a strong initial decline in net dividends, which is equivalent to an increase in equity financing in the model. It appears that public firms find it optimal to raise equity at the arrival of the shock to pay for the reduction in debt financing, while their investment policy remains relatively unchanged.

In later periods, the optimal level of capital slightly declines due to the elevated discount rates in the economy. Starting in year 2, as the shock wanes and interest rates start to decline, public firms slowly increase debt toward the steady state, as Figure 6(c) shows. This allows the firm to increase the payouts before gradually converging to the steady state, as shown in Figure 6(d).

Next, consider the responses of private firms to the monetary policy shocks. Figure 6(b) shows a strong decline in investment driven by the higher discount rates. Figures 6(c) and 6(d) show that private firms find it optimal to decrease both debt and equity financing, and the effects are more persistent than in public firms. The decline in debt is driven by higher interest rates and by the collateral constraint due to the lower capital stock. The decline in equity, which is shown by the elevated level of net dividends, is driven by the decline in total financing needs due to lower investment rates and the higher discount rate in the economy that makes households (i.e., shareholders) less patient. This is consistent with anecdotal evidence on the decline in initial public offerings during the recent monetary tightening cycle in the U.S., as private firms have fewer incentives to publicly list their shares (Wall Street Journal, 2023).

[Figure 6 around here]

Overall, these results from the regressions and the impulse responses show that the responses of public and private firms to monetary policy shocks in the model closely mirror those in the actual data. This is reassuring of the model's ability to reveal the mechanisms behind the empirical patterns. Next, we analyze the differences between public and private firms in the model to explore the underlying mechanisms that create the divergence in monetary policy responses in the real world.

6.3 What Explains the Differences in Responses to Monetary Policy?

To clarify the mechanism behind the heterogeneity in firm responses to monetary policy, we compare different versions of the model. Each comparison isolates one dimension of difference between public and private firms in the calibrated models, and shows the effects on the simulated moments. As previously shown in Table 5, calibration results suggest that the two types of firms have slightly different depreciation rates and collateral parameters, and largely different equity issuance costs and investment adjustment costs.

Table 7 presents the comparisons. Panel (a) shows firm responses to monetary policy shocks by reporting the coefficients from the regressions of firm policies on MPS in each model. The last two columns report the sign of the coefficients in the data for comparison. Panel (b) shows the parameters of each model. Columns 1 and 7 present the calibrated model of public and private firms, respectively, as benchmarks. In columns 2-6, we change one parameter at a time, from the value calibrated to public firms to the value calibrated to private firms, while keeping the remaining parameters consistent with those in column 1.

Our goal is to identify the parameters that contribute the most to the differences in MPS coefficients between public and private firms. Columns 2 and 3 of Table 7 show that the changes in the depreciation rate and collateral parameter, respectively, do not fundamentally change the investment and financing responses. In both cases the investment response is essentially zero, and firms decrease debt and raise equity in response to an increase in the policy rate. Column 4 shows that the equity issuance cost is a key determinant of the financing responses, but it does not affect the investment response. When equity issuance is more costly (as in column 4 compared to column 1), firms respond to the shock by reducing equity instead of raising equity, and pay for it by raising debt instead of reducing debt. Finally, column 5 shows that the investment adjustment cost is a key determinant of investment responses to the shocks. When investment adjustment is less costly (as in column 5 compared to column 1), the asset growth rate drops much more strongly in response to an increase in the policy rate.

These results suggest that the equity issuance and investment adjustment costs are the two critical dimensions driving the differences in financing and investment responses between public and private firms. Therefore, in column 6 of Table 7, we evaluate the combined effects. The regression coefficients suggest that if public firms' equity issuance cost was as high and investment adjustment cost was as low as in private firms, public firms' responses to monetary policy shocks would be qualitatively similar to those of private firms. These results confirm our conjectures in the description of the model mechanism (Section 5.5) that firms' heterogeneities with respect to the capital adjustment cost and equity issuance cost drive the heterogeneous responses to the monetary policy shocks.

[Table 7 around here]

7 Model Extension and Policy Experiments

This section provides a model extension that adds productivity shocks to the baseline model. First, we use this model extension to confirm that the main results in the baseline model are robust to the inclusion of productivity shocks. Second, we use this model to conduct counterfactual monetary policy experiments by evaluating the model behavior when monetary policy and productivity shocks are correlated.

7.1 Adding Productivity Shocks to the Model

To add productivity shocks to the model, we modify the revenue function such that

$$F(z_t, k_t, n_t) = z_t k_t^{\theta} n_t^{1-\theta}, \tag{29}$$

where z_t is the stochastic productivity that is common to all firms and follows an AR(1) process in logs with i.i.d. shocks,

$$\log(z_t) = \rho_z \log(z_{t-1}) + \nu_t \text{ and } \nu_t \sim N(0, \sigma_z^2). \tag{30}$$

The rest of the model structure remains the same as in the baseline case, including the monetary policy shocks. The optimality conditions and equilibrium definition are also similar to the baseline model. The only difference is that, in this version, the aggregate state is determined by the productivity z, interest rate policy r^{pol}, aggregate capital K, and aggregate bonds B; $S = \{z, r^{pol}, K, B\}$.

Our first goal is to test whether the baseline firm responses to monetary policy shocks are robust to the inclusion of productivity shocks. We assume that the productivity shocks (ν_t) and the monetary policy shocks (ε_t in Equation (9)) are independent, and simulate the model for public and private firms using the baseline set of parameters for each type of firms. In addition, we estimate the persistence ρ_z and volatility σ_z of the aggregate productivity process in the data using a standard Solow residual approach following Frank and Sanati (2021). Using the revenue function above, we estimate z_t in the data by computing $\log(z_t) = \hat{F}_t - \theta\hat{k}_t - (1-\theta)\hat{n}_t$, where $\hat{F}_t$, $\hat{k}_t$, and $\hat{n}_t$ are log deviations from the deterministic trends of output, nonfinancial assets, and hours worked in the aggregate U.S. data. Then, we use the time series of aggregate productivity z_t to estimate the AR(1) process in Equation (30), resulting in the estimates of $\rho_z = 0.848$ and $\sigma_z = 0.018$.

Table 8 shows the simulated moments. Columns 1-2 show the moments for public and private firms, respectively, in the model with the two types of shocks when they are independent. Columns 5-6 show the simulated moments from the baseline model as a benchmark. Panel (a) shows the set of targeted moments in the baseline calibration. Comparing columns 1-2 with 5-6 shows that, in the model with both types of shocks, the average labor share and investment rates are the same as in the baseline case. The average debt ratio is slightly lower, and the volatilities of payouts and investments are higher than those in the baseline model. These differences could be driven by the higher volatility of factor demands and cash flows in the model with two sources of uncertainty.

Panel (b) of Table 8 shows the coefficients from the regressions of firm policies on monetary policy shocks (MPS) in each model. Similar to before, the dependent variables in the regressions are the growth rates of assets $\Delta\ln(A_{it})$, debt $\Delta\ln(B_{it})$, and equity $\Delta\ln(E_{it})$. In the model with independent shocks (columns 1-2), the regressions also include productivity as an independent control variable. Overall, the estimated coefficients in columns 1-2 are qualitatively similar to those in columns 5-6. These results show that public and private firms' responses to monetary policy shocks in the model with the two types of shocks also resembles the patterns observed in the data. This finding suggests that the main economic mechanism in the baseline model is robust to the inclusion of productivity shocks.

The MPS responses are generally smaller in magnitude compared to the baseline model, aligning with the notion that firms are less responsive to shocks in an economy with adjustment costs amid heightened uncertainty, resulting from the additional shocks. The only exception is that private firms reduce their debt more significantly than in the baseline model when the policy rate increases. This is consistent with the decline in the optimal debt ratio for private firms (see panel (a)) because they value the financial flexibility offered by unused debt capacity amid increased uncertainty due to the productivity shocks and the high cost of external equity financing.

[Table 8 around here]

7.2 Policy Experiment: "Leaning Against the Wind"

We use the model extension with the two types of shocks to conduct counterfactual monetary policy experiments. Central banks often use monetary policy tools to counteract economic fluctuations and stabilize the economy, i.e., "leaning against the wind." For example, during an economic downturn or recession, the monetary authority may lower interest rates and employ other expansionary measures to encourage investment, borrowing, and spending. Conversely, during periods of an overheating economy, the monetary authority may raise interest rates to cool down economic activity.

How does a "leaning against the wind" policy alter the short run firm responses to shocks and the long run equilibrium for the model economy? We evaluate the effects on the economy and firms by examining the model behavior when monetary policy and productivity shocks are correlated. We assume that productivity shocks are the only exogenous source of uncertainty in the economy, and the monetary authority chooses the monetary policy to undo the effect of productivity shocks. For simplicity, we assume that the monetary authority sets the monetary policy shocks (ε_t in Equation (9)) as a linear function of the productivity shocks (ν_t in Equation (30)) scaled by the ratio of the volatilities

$$\varepsilon_t = \frac{\sigma_{mp}}{\sigma_z}\nu_t. \tag{31}$$

This means that in response to a positive ν_t, which increases productivity and incentivizes economic activity, the monetary authority increases the policy interest rate by $\frac{\sigma_{mp}}{\sigma_z}\nu_t$ to reduce the effects of the shock.

We simulate this economy for public and private firms using the baseline set of parameters. Columns 3-4 in Table 8 show the simulated moments for public and private firms, respectively. Panel (a) shows that, for both types of firms, the average labor share, investment rate, and debt ratio are economically and statistically indistinguishable from the model with independent shocks shown in columns 1-2, suggesting that the long-run averages are not affected. However, the volatility of payouts and investments are significantly lower than when the shocks are independent, suggesting that "leaning against the wind" successfully reduces economic fluctuations created by the productivity shocks.

This finding is also corroborated by the moments in panel (b). Note that, in columns 3-4, the estimated coefficients from the regressions of firm policies on monetary policy shocks reflect firm responses to the combined effects of these shocks and the accompanying productivity shocks. The coefficients in columns 3-4 show much smaller responses compared to those in the economy with independent shocks (columns 1-2) and the baseline economy (columns 5-6). Interestingly, both public and private firms respond to the combined shocks by slightly reducing their debt and equity. This is a different pattern than those in the independent-shock and baseline models, and is explored below.

Finally, we analyze the impulse response functions, in Figure 7, to better understand the firms' investment and financing responses to the correlated shocks in the short-run. For each type of firms, we simulate the model in the steady state and then give the economy an unexpected one-standard deviation positive productivity shock, which immediately triggers a one-standard deviation positive monetary policy shock. The economy is at the steady state at year 0, and the shocks arrive at year 1, as shown in Figure 7(a). Figure 7(b)-(d) show the responses of public (black lines) and private (grey lines) firms in the first 10 periods after the shocks.

Figure 7(b) shows that both public and private firms slightly decrease their capital because of the large and immediate response by the monetary authority to the rise in productivity. These responses are in the opposite direction to a typical increase in capital in response to positive productivity shocks in standard models without monetary policy shocks. The response of public firms is much smaller than private firms due to larger adjustment costs. Also, for both types of firms, the responses are much smaller than those in the baseline model (Figure 6(b)) because the two shocks cancel out their opposite effects on investment incentives.

Figure 7(c) shows that both types of firms reduce debt with a stronger effect on private firms, because of the higher interest rates and the lower collateral value of the smaller capital stock. Finally, Figure 7(d) shows that both types of firms increase their net payouts, which is the model equivalent of a reduction in equity financing. For private firms, the response is smaller in magnitude than in the baseline model. For public firms, the equity response is noticeably different from the baseline model. In this version of the model, the rise in productivity increases firms' revenue, especially in public firms where capital stock is barely reduced. Firms use the additional revenue to pay for the reduction in debt and the increase in payouts.

[Figure 7 around here]

8 Conclusion

In this study, we evaluate corporate responses to monetary policy shocks, and provide a comprehensive perspective on how firms adjust their investments, debt, and equity financing. Our analysis uses the Federal Reserve's supervisory data to distinguish between public and private firms. In response to a surprise increase in interest rates, public firms reduce their debt while simultaneously raising equity. The offsetting effect of these actions allows them to maintain their real assets. In contrast, private firms, constrained by limited access to external equity, initially resort to an increase in debt issuance, primarily via existing credit lines. However, they subsequently decrease both their debt and equity, leading to a reduction in real assets.

Our structural model is able to rationalize the observed responses of both public and private firms to monetary policy shocks. The main mechanism of the model is that monetary policy shocks influence firms' optimal input levels by affecting discount rates in the economy. To avoid the costly adjustment of capital, firms adjust their financing sources to counteract the effects of monetary policy shocks. However, this is not always feasible due to the presence of financing frictions. Our model effectively explains the disparities in policy impacts, attributing them to a combination of higher equity issuance costs at private firms and greater investment adjustment costs at public firms.

Our work goes beyond previous studies in several respects. The previous literature has not established the role of external equity, which we have shown to be important for understanding firms' responses to monetary policy. Also, private firms represent a substantial part of the economy, contributing significantly to economic growth, job creation, and innovation. Yet, they have often been overlooked in the context of how monetary policy affects businesses, primarily due to the scarcity of high-quality data. The heterogeneous elasticities with respect to monetary policy across different types of firms poses a challenge for policymakers. A one-size-fits-all policy may strongly affect smaller financially constrained firms while larger firms with more financial flexibility are not affected. Moreover, the identified delays in firm responses to monetary policy shocks introduce a temporal dimension that complicates policy setting. Our results highlight the importance of accounting for the time lag in the adjustment of firms to changes in interest rates, recognizing that the full impact on the real economy may take a few quarters to materialize. Overall, our study contributes novel insights into how monetary policy impacts businesses in the U.S., with implications that can be valuable for both policymakers and academic research.

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Figure 1: **Responses to Monetary Policy Shocks: External Equity**

This figure shows the impact of monetary policy shocks on external equity issuance by public firms. The sample is based on quarterly Compustat data from 1988 to 2019, and we require firms to have at least 5 consecutive quarters of data. The plot shows the coefficient β_h from the local projection regressions in Equations (6) and (7), where β_h estimates the cumulative response of the dependent variable in quarter $t+h$ to monetary policy shocks from quarter t to $t+h$. The vertical lines show the 90% confidence intervals. Table A.2 in Appendix A provides variable definitions in Compustat.

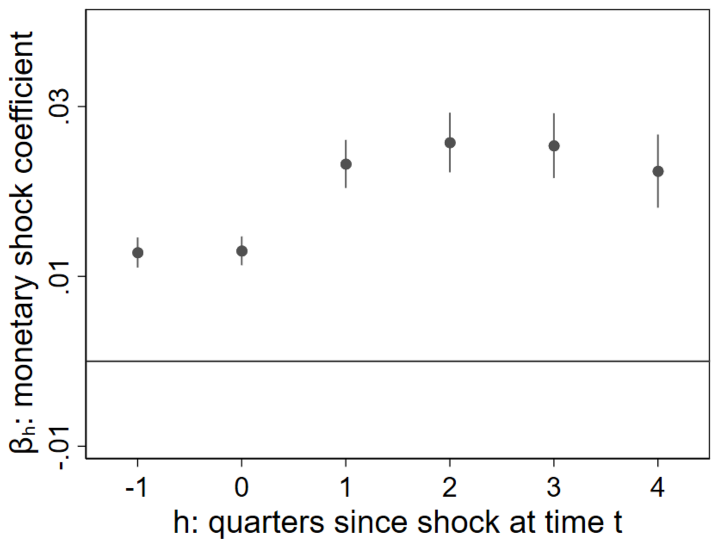


Figure 2: **Responses to Monetary Policy Shocks: Number of Common Shares Issued**

This figure shows the impact of monetary policy shocks on the number of common shares issued by public firms. The sample is based on quarterly Compustat data from 1988 to 2019, and we require firms to have at least 5 consecutive quarters of data. The plot shows the coefficient β_h from the local projection regressions in Equations (6) and (7), where β_h estimates the cumulative response of the dependent variable in quarter $t+h$ to monetary policy shocks from quarter t to $t+h$. The vertical lines show the 90% confidence intervals. Table A.2 in Appendix A provides variable definitions in Compustat.

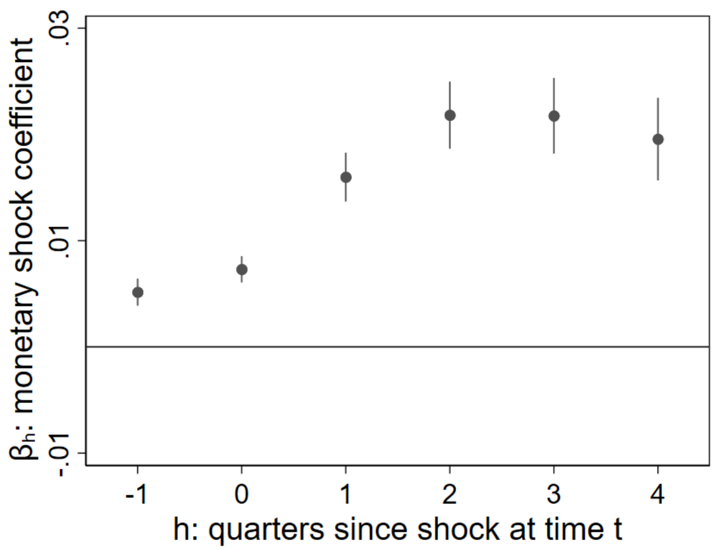


Figure 3: **Responses to Monetary Policy Shocks: Cost of Bank Loan**

This figure shows the impact of monetary policy shocks on the cost of a bank loan (i.e., interest rates) for private (panel (a)) and public (panel (b)) firms. The sample is based on loan-quarter observations from FR-Y14Q from 2011 to 2019, and we require loans to have at least 5 consecutive quarters of data. The plots show the coefficient β_h from the local projection regressions in Equations (6) and (7), where β_h estimates the cumulative response of the dependent variable in quarter $t+h$ to monetary policy shocks from quarter t to $t+h$. The vertical lines show the 90% confidence intervals. Table A.1 in Appendix A provides variable definitions in FR-Y14Q.

(a) Private firms

(b) Public firms

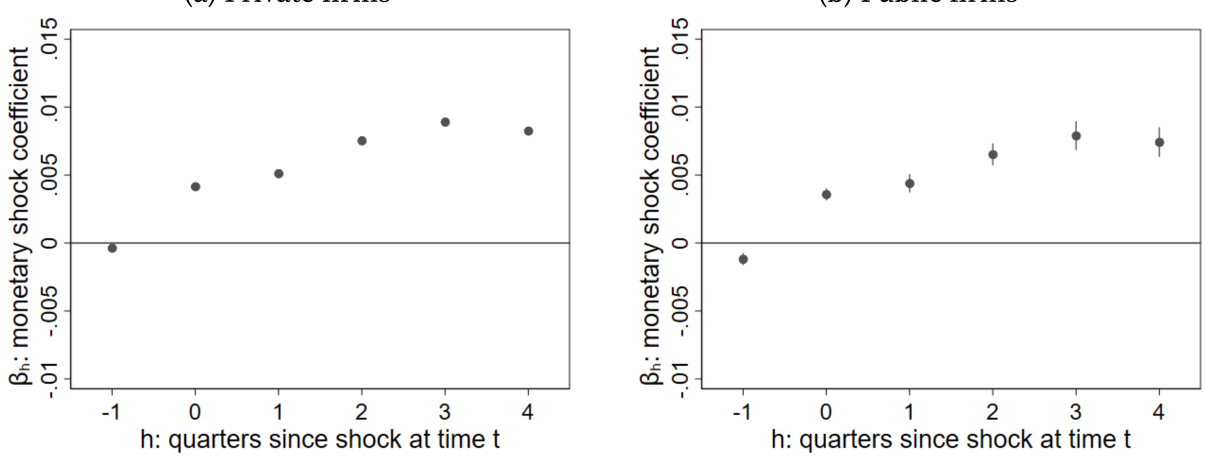
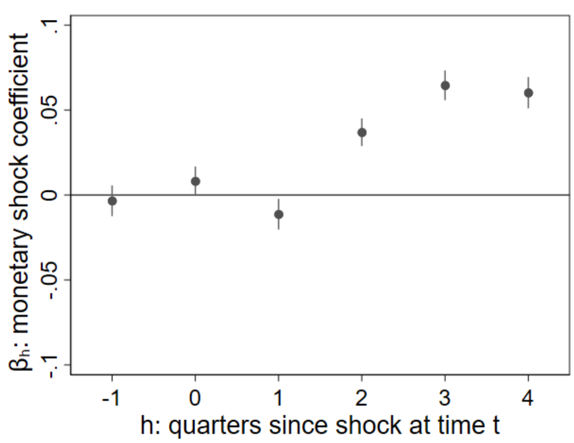


Figure 4: **Responses to Monetary Policy Shocks: Utilization Rate on Existing Lines of Credit**

This figure shows the impact of monetary policy shocks on the utilization rates of the credit lines for private (panel (a)) and public (panel (b)) firms. The sample is based on loan-quarter observations from FR-Y14Q from 2011 to 2019, and we require loans to have at least 5 consecutive quarters of data. The plots show the coefficient β_h from the local projection regressions in Equations (6) and (7), where β_h estimates the cumulative response of the dependent variable in quarter $t+h$ to monetary policy shocks from quarter t to $t+h$. The vertical lines show the 90% confidence intervals. Table A.1 in Appendix A provides variable definitions in FR-Y14Q.

(a) Private firms



(b) Public firms

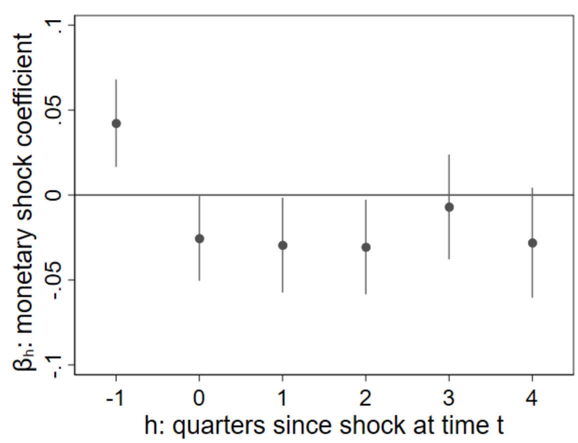


Figure 5: **Responses to Monetary Policy Shocks: Amount of New Credit Obtained**

This figure shows the impact of monetary policy shocks on the total amount of new bank credit obtained by private (panel (a)) and public (panel (b)) firms. The sample is based on loan-quarter observations from FR-Y14Q from 2011 to 2019, and we require loans to have at least 5 consecutive quarters of data. The plots show the coefficient β_h from the local projection regressions in Equations (6) and (7), where β_h estimates the cumulative response of the dependent variable in quarter $t+h$ to monetary policy shocks from quarter t to $t+h$. The vertical lines show the 90% confidence intervals. Table A.1 in Appendix A provides variable definitions in FR-Y14Q.

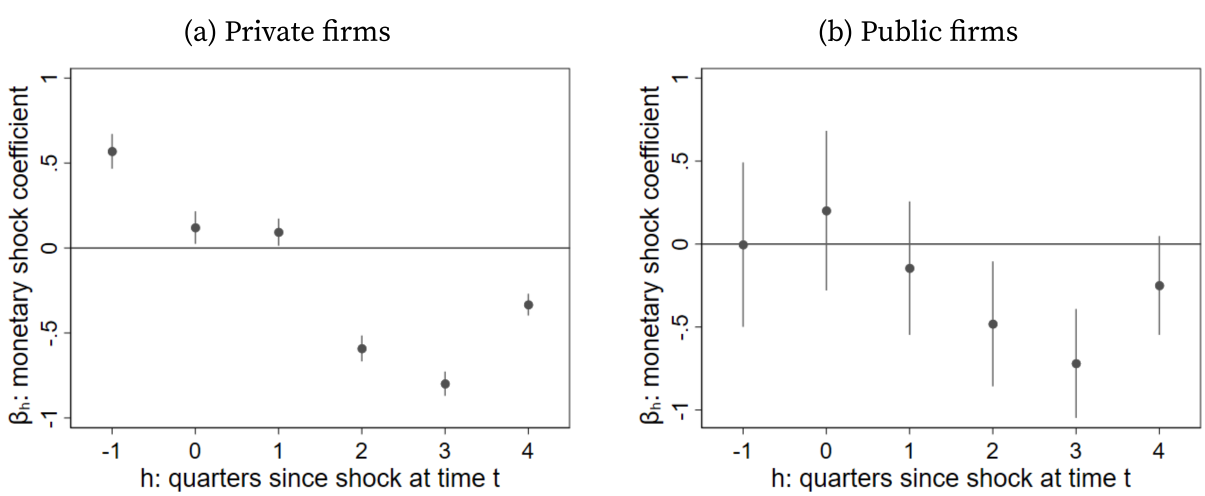


Figure 6: **Monetary Policy Shocks: Impulse Responses for Public and Private Firms**

This figure shows the responses of private (grey lines) and public (black lines) firms to a one-standard-deviation monetary policy shock in the baseline model. The horizontal axis shows the number of years after the shock, and the vertical axis shows the percentage deviation from the steady state.

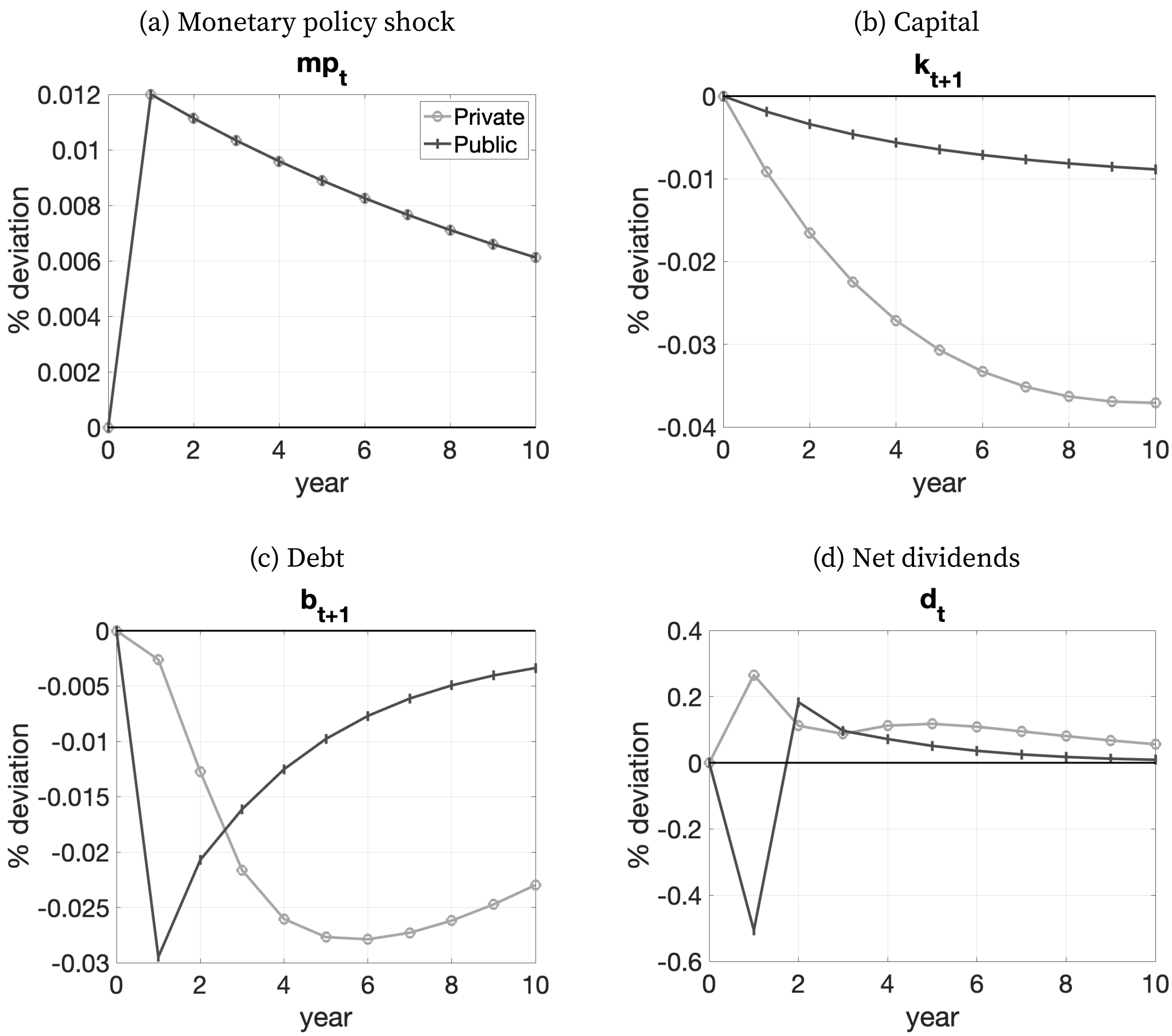
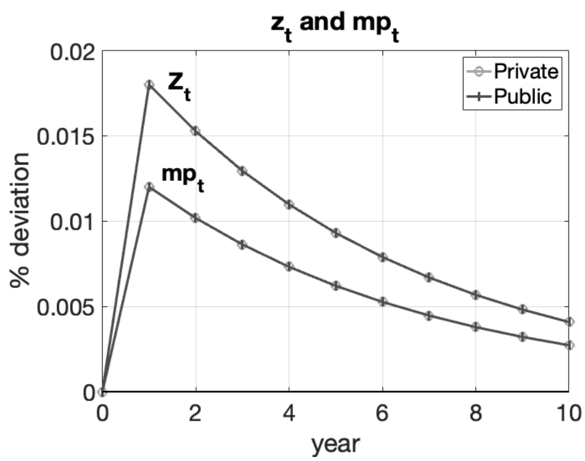


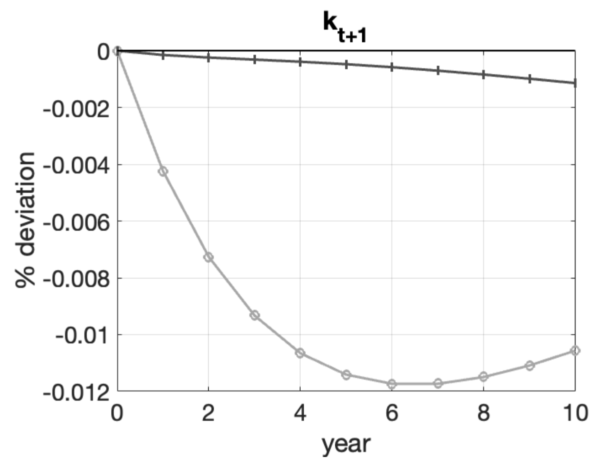
Figure 7: **Impulse Responses with Correlated Monetary Policy and Productivity Shocks**

This figure shows the responses of private (grey lines) and public (black lines) firms to one-standard-deviation productivity and monetary policy shocks. The figures are from a model extension that includes correlated productivity and monetary policy shocks, where the monetary authority sets the policy interest rate to undo the effects of productivity shocks on economic activity. The horizontal axis shows the number of years after the shock, and the vertical axis shows the percentage deviation from the steady state.

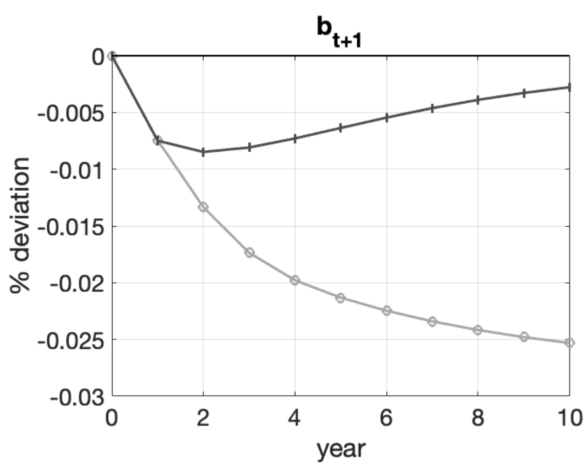
(a) Monetary policy shock and productivity shock



(b) Capital



(c) Debt



(d) Net dividends

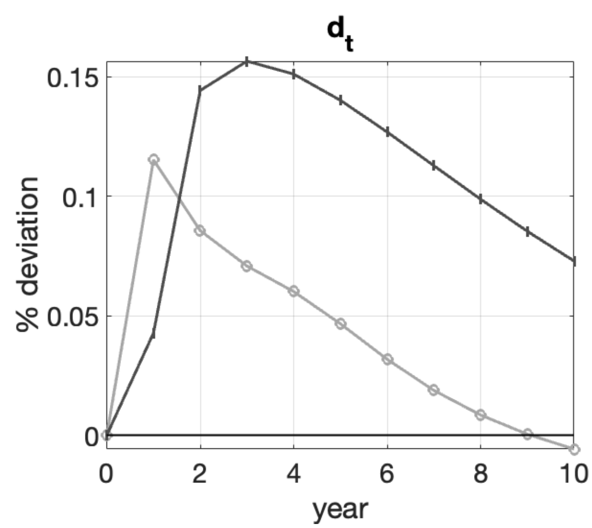


Table 1: **Descriptive Statistics**

This table contains descriptive statistics for U.S. public and private firms. The data source is FR Y-14Q. The sample is at the firm-year level covering the period from 2011 to 2019. We match the data with Compustat and identify firms that have publicly traded equity according to Compustat as public firms. Firms that are not in the Compustat data are considered private firms. Real quantities are in millions of 2015 U.S. dollar.

		Public firms				Private firms			
		N	Mean	SD	p50	N	Mean	SD	p50
Real quantities ($ Millions)									
Total assets	–	22,669	3,007.99	2,415.34	2,271.02	575,415	93.07	374.59	12.82
Nonfin. assets	A	22,669	2,301.17	1,919.51	1,695.74	575,415	68.68	296.87	7.41
Assets growth	ΔA	16,911	63.04	362.76	0.00	382,042	3.81	58.82	0.06
Equity	E	22,668	1,055.32	897.91	740.63	574,733	34.52	149.41	4.19
Equity issuance	ΔE	16,909	16.65	235.38	0.00	381,010	1.60	34.49	0.17
Debt	B	22,595	951.38	906.56	616.41	562,761	26.55	141.03	1.21
Debt issuance	ΔB	16,834	37.23	256.03	0.00	371,933	1.63	38.96	0.00
Oper. Income	Y	22,352	343.99	297.00	253.19	565,122	10.95	47.13	1.40
Growth rates									
Asset growth	$\Delta \ln(A)$	16,911	0.05	0.21	0.00	382,042	0.06	0.29	0.01
Equity growth	$\Delta \ln(E)$	15,947	0.03	0.25	0.00	349,280	0.06	0.33	0.05
Debt growth	$\Delta \ln(B)$	15,004	0.06	0.48	0.00	270,013	0.01	0.68	-0.05
Oper. Income	$\ln(1+\frac{Y}{A})$	22,318	0.16	0.13	0.14	561,315	0.29	0.38	0.16
Number of unique firms		5,070				167,297			

Table 2: **Decomposing Asset Growth**

This table shows the contribution of each form of financing to asset growth using firm-level data on U.S. public and private firms. Each column shows a regression of the annual percentage asset growth on the percentage growth in financing sources according to Equation (2). The percentage growth in each variable X is computed as $\Delta \ln(X)$, and, for operating income, it is computed as log(1+operating income/assets). All regressions control for firm size, tangibility, and industry q. The data source is FR Y-14Q covering the period from 2011 to 2019. Appendix A defines the variables. $t-$statistics calculated based on clustered standard errors at the firm level are shown in parentheses. * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$.

	$\Delta \ln(A)$			
	Public firms		Private firms	
	(1)	(2)	(3)	(4)
$\Delta \ln(E)$	0.262***		0.227***	
	(18.46)		(61.76)	
$\Delta \ln(E_{Int.})$		0.159***		0.179***
		(11.10)		(53.08)
$\Delta \ln(E_{Ext.})$		0.304***		0.327***
		(14.38)		(42.77)
$\Delta \ln(B)$	0.137***	0.134***	0.106***	0.105***
	(20.10)	(19.45)	(67.70)	(66.96)
$\ln(1+\frac{Y}{A})$	0.664***	0.702***	0.375***	0.373***
	(12.33)	(12.51)	(46.09)	(45.88)
Firm Controls	Yes	Yes	Yes	Yes
Firm and Year FEs	Yes	Yes	Yes	Yes
N	9,762	9,732	132,685	132,605
adj. R^2	0.571	0.536	0.445	0.442

Table 3: **How Does Monetary Policy Affect Firm Financing and Growth?**

This table presents the regression results that explain the effect of monetary policy shocks (MPS) on the growth rate of assets, debt, and equity. The results are based on firm-level data on U.S. public and private firms from FR Y-14Q covering the period from 2011 to 2019. MPS_t is the cumulative value of MPS in year t provided by Bauer and Swanson (2023). We evaluate the relation between MPS and each variable's growth rate from year $t-1$ to t. The growth rate in each variable X is computed as $\Delta\ln(X)$. All regressions control for firm size, tangibility, industry q, inflation rate, GDP growth rate, and include firm and reporting bank fixed effects. Appendix A defines the variables. $t-$statistics calculated based on clustered standard errors at the firm level are shown in parentheses. * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$.

	$\Delta\ln(A_{it})$	$\Delta\ln(B_{it})$	$\Delta\ln(E_{it})$
	(1)	(2)	(3)
(a) Public firms			
MPS_t	0.045	-0.225**	0.282***
	(1.42)	(-2.47)	(6.70)
Firm & Macro Controls	Yes	Yes	Yes
Firm & Bank FEs	Yes	Yes	Yes
N	15,798	13,937	14,846
adj. R^2	0.388	0.212	0.317
(b) Private firms			
MPS_t	-0.041***	-0.071**	-0.133***
	(-3.80)	(-2.10)	(-10.05)
Firm & Macro Controls	Yes	Yes	Yes
Firm & Bank FEs	Yes	Yes	Yes
N	325,318	225,527	296,585
adj. R^2	0.330	0.242	0.306

Table 4: **How Does Monetary Policy Affect the Use of Equity Financing and Lines of Credit?**

This table presents the regression results that explain the effect of monetary policy shocks (MPS) on the growth in equity financing components and three variables related to lines of credits using firm-level data on U.S. public and private firms. The results are based on firm-level data on U.S. public and private firms from FR Y-14Q covering the period from 2011 to 2019. MPS_t is the cumulative value of MPS in year t provided by Bauer and Swanson (2023). The two components of equity financing are retained earnings ($E_{Int.}$) and common shares ($E_{Ext.}$). The variables related to credit lines include total commitments ($\Delta \ln$(Commit)), total utilization ($\Delta \ln$(Utilization)), and total undrawn ($\Delta \ln$(Undrawn)). $\Delta \ln$(Commit) is the total amount of credit that a bank has committed to a firm inclusive of the used and unused portions of the commitment. $\Delta \ln$(Utilization) refers to the portion of the commitment used (drawn) by the borrowing firm. $\Delta \ln$(Undrawn)) refers to the portion of commitment that is not yet used by the borrowing firm. We evaluate the relation between MPS and each variable's growth rate from from year $t-1$ to t. The growth rate in each variable X is computed as $\Delta \ln(X)$. All regressions control for firm size, tangibility, industry q, inflation rate, GDP growth rate, and include firm and reporting bank fixed effects. Appendix A defines the variables. $t-$statistics calculated based on clustered standard errors at the firm level are shown in parentheses. * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$.

	Equity Components		Debt Components		
	$\Delta \ln(E_{Int.})$	$\Delta \ln(E_{Ext.})$	$\Delta \ln$(Commit)	$\Delta \ln$(Utilization)	$\Delta \ln$(Undrawn)
	(1)	(2)	(3)	(4)	(5)
(a) Public firms					
MPS_t	0.014	0.048***	-0.104**	-0.203	0.060
	(0.95)	(4.99)	(-2.15)	(-1.52)	(0.61)
Firm Controls	Yes	Yes	Yes	Yes	Yes
Macro Controls	Yes	Yes	Yes	Yes	Yes
Firm & Bank FEs	Yes	Yes	Yes	Yes	Yes
N	15,710	15,707	13,675	8,268	12,193
adj. R^2	0.285	0.318	0.196	0.184	0.153
(b) Private firms					
MPS_t	-0.022***	-0.008***	-0.041***	0.079***	-0.458***
	(-4.55)	(-3.99)	(-3.91)	(3.58)	(-12.99)
Firm Controls	Yes	Yes	Yes	Yes	Yes
Macro Controls	Yes	Yes	Yes	Yes	Yes
Firm & Bank FEs	Yes	Yes	Yes	Yes	Yes
N	321,766	321,452	256,668	197,238	164,525
adj. R^2	0.313	0.241	0.255	0.221	0.161

Table 5: **Model Parameters**

This table presents the model parameters. Panel (a) shows the paramters that are directly estimated in the data. Panel (b) presents the calibration results for public and private firms. This panel shows the target moments in the calibration process and the resulting paramters for each type of firms. Table A.3 in Appendix A shows the variable definitions in the model.

(a) **Directly estimated parameters**

Tax advantage of debt	τ	0.318
Long run discount rate	$\bar{\beta}$	0.971
Persistence of monetary policy (mp)	ρ	0.928
Volatility of mp shocks	σ	0.012
Utility parameter	α	1.789

(b) **Calibrated parameters**

	Public firms		Private firms	
Moments	Actual	Model	Actual	Model
Mean labor share	0.571	0.571	0.571	0.571
Mean investment rate	0.081	0.081	0.112	0.112
Mean debt ratio	0.382	0.396	0.321	0.332
SD aggregate payout ratio	0.004	0.006	0.006	0.013
SD aggregate investment rate	0.001	0.001	0.008	0.008

Parameters		Public firms	Private firms
Production technology	θ	0.429	0.429
Depreciation rate	δ	0.081	0.113
Collateral parameter	γ	0.435	0.390
Equity issuance cost	λ	0.075	0.325
Investment adjustment cost	η	3.250	0.400

Table 6: **Monetary Policy Regressions Using Simulated Data**

This table shows the estimated coefficients from the regressions of firm policies on monetary policy shocks in the model. Panel (a) shows the results for public firms, and panel (b) shows the results for private firms. In the model, monetary policy shocks are defined as the one-period rate of change in monetary policy mp_t, that is $MPS_t = \Delta \ln(mp_t)$. The dependent variables are the growth rates of assets $\Delta \ln(A_{it})$, debt $\Delta \ln(B_{it})$, and equity $\Delta \ln(E_{it})$ in the model. Table A.3 in Appendix A shows the variable definitions in the model. In each panel, we report the sign of the coefficients from the equivalent regressions in the actual data as a benchmark.

	$\Delta_h \ln(A_{it})$	$\Delta_h \ln(B_{it})$	$\Delta_h \ln(E_{it})$
	(1)	(2)	(3)
(a) Public firms			
MPS_t	-0.001	-0.023	0.015
Sign from actual data (Panel (a) of Table 3)	0	$-$	$+$
(b) Private firms			
MPS_t	-0.011	-0.005	-0.010
Sign from actual data (Panel (b) of Table 3)	$-$	$-$	$-$

Table 7: **Which Parameters Are Critical to MPS Responses?**

This table compares different versions of the model, where each comparison isolates one parameter of difference between public and private firms, and shows the effects on a set of non-targeted moments. The parameters that are isolated in columns (2)-(5) are depreciation rate, collateral parameter, equity issuance cost, and investment adjustment cost, respectively. Two parameters that are isolated in column (6) are equity issuance cost and investment adjustment cost. The moments include the coefficients from the regressions of firm policies on MPS in each model. The last two columns report the sign of the coefficients in the data for comparison. Monetary policy shocks are defined as the one-period rate of change in monetary policy mp_t, that is $MPS_t = \Delta \ln(mp_t)$. The dependent variables in the regressions are the growth rates of assets $\Delta \ln(A_{it})$, debt $\Delta \ln(B_{it})$, and equity $\Delta \ln(E_{it})$ in the model. Table A.3 in Appendix A shows the variable definitions in the model.

(a) Untargeted Moments

Coeff on MPS in the regression of:		Model							Actual	
		public (1)	(2)	(3)	(4)	(5)	(6)	private (7)	public (8)	private (9)
$\Delta \ln(A)$ on MPS		-0.001	0.000	-0.001	-0.001	-0.010	-0.010	-0.011	0	$-$
$\Delta \ln(B)$ on MPS		-0.023	-0.019	-0.006	0.018	-0.017	-0.013	-0.005	$-$	$-$
$\Delta \ln(E)$ on MPS		0.015	0.014	0.004	-0.016	0.006	-0.009	-0.010	$+$	$-$

(b) Parameters

		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Production tech.	θ	0.429						0.429		
Depreciation rate	δ	0.081	0.113					0.113		
Collateral parameter	γ	0.435		0.390				0.390		
Equity issuance cost	λ	0.075			0.325		0.325	0.325		
Investment adj. cost	η	3.250				0.400	0.400	0.400		

Table 8: **Responses to Monetary Policy in the Presence of Productivity Shocks**

This table shows the moments in the simulated data from three different versions of the model. Columns 1-4 use a model extension that includes both productivity shocks and monetary policy shocks. Columns 1-2 show the moments for public and private firms, respectively, when the two shocks are independent. Columns 3-4 show the moments when the shocks are correlated. Columns 5-6 show the moments from the baseline model as a benchmark. All simulations use the baseline set of parameters shown in Table 5. Panel (a) shows the set of targeted moments in the baseline calibration. Panel (b) shows a set of non-targeted moments that includes the coefficients from the regressions of firm policies on MPS in each model. Columns 1-2 regressions also include productivity on the right-hand side. Monetary policy shocks are defined as the one-period rate of change in monetary policy mp_t, that is $MPS_t = \Delta \ln(mp_t)$. The dependent variables in the regressions are the growth rates of assets $\Delta \ln(A_{it})$, debt $\Delta \ln(B_{it})$, and equity $\Delta \ln(E_{it})$ in the model. Table A.3 in Appendix A shows the variable definitions in the model.

Shocks in the model:	mp and z				only mp	
	Independent Shocks		Correlated Shocks		Baseline Model	
	Public	Private	Public	Private	Public	Private
(a) Targeted Moments	(1)	(2)	(3)	(4)	(5)	(6)
Mean labor share	0.571	0.571	0.571	0.571	0.571	0.571
Mean investment rate	0.081	0.114	0.081	0.113	0.081	0.112
Mean debt ratio	0.395	0.318	0.399	0.320	0.396	0.332
SD aggregate payout ratio	0.008	0.039	0.002	0.015	0.006	0.013
SD aggregate investment rate	0.002	0.010	0.001	0.004	0.001	0.008
(b) Untargeted Moments						
Coeff on MPS in the regression of:						
$\Delta \ln(A)$ on MPS	-0.001	-0.008	0.000	-0.004	-0.001	-0.011
$\Delta \ln(B)$ on MPS	-0.013	-0.117	-0.002	-0.013	-0.023	-0.005
$\Delta \ln(E)$ on MPS	0.004	-0.010	-0.002	-0.003	0.015	-0.010

A Variable Definitions

Table A.1: **Variable Definitions in FR Y-14Q Data**

This table reports the definitions for firm-year variables used in the empirical analyses when the source of firm data is FR Y-14Q Schedule H.1. The description of Y-14Q data and its schedules as well as detailed description of data items can be found at https://www.federalreserve.gov/apps/reportingforms/Report/Index/FR_Y-14Q.

Variable	**Notation**	**Definition**
Nonfin. assets	A	Total assets − cash and marketable securities
Equity	E	Total assets − total liabilities
Internal equity	$E_{Int.}$	Retained earnings
External equity	$E_{Ext.}$	Equity − retained earnings = common stock
Debt	B	Long-term debt
Operating income	Y	Operating income before depreciation
Size		Logarithm of total assets
Tangibility		Tangible assets/total assets
Industry Q		Matched Industry Q from Compustat based on NAICS4
Monetary policy shocks	MPS	Cumulative annual MPS by Bauer and Swanson (2023) (see Section 4.1 for more details)
Path	$Path$	The forward guidance (path) component of monetary policy shock (Gurkaynak, Karasoy-Can, and Lee, 2022)
Target	$Target$	The policy setting (target) component of monetary policy shock (Gurkaynak, Karasoy-Can, and Lee, 2022)
Rate of change in firm policies (where X could be firms' assets A, debt B, or equity E):		
	$\Delta \ln(X_{it})$	$\ln(X_{i,t}) - \ln(X_{i,t-1})$

Table A.2: **Variable Definitions in Compustat Data**

This table reports the definitions of variables used in the empirical analyses when the source of firm data is Compustat.

Variable	**Notation**	**Definition**	**Compustat items**
Nonfin. assets	A	Total assets − cash and cash equivalents	$at - che$
Equity	E	Book value of common equity	ceq
Internal equity	$E_{Int.}$	Retained earnings	re
External equity	$E_{Ext.}$	Common stock + share premium reserve	$cstk + caps$
Debt	B	Long-term debt	$dltt$
Operating income	Y	Operating income before depreciation	$oibdp$
Size		Logarithm of total assets	$\log(at)$
Tangibility		Property, plant, and equipment/total assets	$ppent/at$
Industry Q		Mean of ((Mkt value of equity + total liabilities)/total assets) at the industry (NAICS4) level	$\frac{(prcc\_f \times csho) + (at - ceq)}{at}$
Number of common shares		Common shares outstanding + common shares in treasury stock	$csho + tstk$

Table A.3: **Variable Definitions in the Model**

Variable	**Definition in the model**
Labor share	$w_t n_t / k_t^{\theta} n_t^{1-\theta}$
Assets growth rate	$\big(k_{t+1} - k_t\big)/k_t$
Investment rate	$\big(k_{t+1} - (1-\delta)k_t\big)/k_t$
Payout ratio	d_t/k_t
Debt ratio	b_{t+1}/k_t
Monetary policy shocks	$MPS_t = \Delta \ln(mp_t) = \ln(mp_t) - \ln(mp_{t-1})$
Asset growth rate	$\Delta \ln(A_{it}) = \ln(k_{t+1}) - \ln(k_t)$
Debt growth rate	$\Delta \ln(B_{it}) = \ln(b_{t+1}) - \ln(b_t)$
Equity growth rate	$\Delta \ln(E_{it}) = -(d_t - \bar{d})/(k_t - b_t)$

B FR Y-14Q Data Cleaning

Table B.4: **FR Y-14Q data cleaning steps**

Data cleaning step	**Firms *(Obs.)***	**% dropped**
Firm-year panel financial data (2011-2019)	201,647 *(1,054,112)*	
Drop special purpose entities	200,681 *(1,048,470)*	0.5% *(0.5%)*
Drop the following observations:		
- Total loan commitment/Assets less than 0.001 or more than 10	199,253 *(1,024,009)*	0.7% *(2.3%)*
- Missing Assets, Liabilities>Assets, Liquid Assets>Assets, Tangible Assets>Assets, Long Term Debt>Liabilities, Operating Income>Sales, missing Sales or negative Inventory	196,154 *(996,577)*	1.6% *(2.7%)*
- Firms with Assets<$0.5 million (firms in the sample obtain loans with a value of $1 million or above)	182,885 *(947,239)*	6.8% *(5.0%)*
- Trim at 1%, 99% of asset growth (reporting errors M&A Activities)	182,850 *(934,979)*	0.0% *(1.3%)*
Drop financial firms (NAICS 2-digit 52), offices of banks and intermediate holding companies (NAICS 551111), utilities (NAICS 2-DIGIT 22), public admin/government (NAICS 2-digit 92)	177,352 *(901,287)*	3.0% *(3.6%)*
Drop if bank reports the information of a public parent company for an nonpublic borrower (asset size in FR Y-14Q is less than 80% of asset size in the matched Compustat firm) (public firms only)	176,545 *(881,811)*	0.5% *(2.2%)*
Drop private subsidiaries of foreign public firms (private firms with nonmissing ticker, CUSIP, or stock exchange information)	173,022 *(835,564)*	2.0% *(5.2%)*
Trim the sample of private firms on borrower size at the 99.5th percentile (to ensure that our results are not affected by the sample of public firms mistakenly classified as private firms)	172,367 *(831,817)*	0.4% *(0.4%)*
Drop duplicates to address over-representation. 28.49% of TINs are associated with more than one internal obligor IDs resulted by two characteristics of the loan data: (1) A borrower can be on multiple bank's balance sheet for the same loan (e.g. syndicated loans) or the borrower might simply obtain loans independently from multiple banks at the same time. (2) It is possible that two stand-alone subsidiaries or stand-alone subsidiaries and their parent company borrow from a bank/multiple banks at the same time, but banks report the financial information of the parent company in all cases (also discussed in Brown et al. (2021)). To that end, for each TIN we keep only the Internal Obligor ID with the largest coverage in terms of number of years to avoid duplication. This also addresses the inconsistency of reporting across banks as pertains to the same firm.	172,367 *(598,084)*	0.0% *(28.1%)*

C Decomposition of Monetary Policy Shocks into Forward Guidance (Path) and Policy Setting (Target) Components

In exploring the effects of monetary policy on public and private firms' investment and financing, we conduct robustness checks using an alternative measurement method that decomposes shocks into target and path components. (à la Gurkaynak, Sack, and Swanson, 2005; Gurkaynak, Karasoy-Can, and Lee, 2022). The target component measures the surprise in the policy rate whereas the path component measures the surprise in the Federal Reserve's forward guidance.

Table C.5 shows firms' responses to the path component of the monetary policy surprises, $Path_t$. Consider responses to a positive shock, which implies a surprise increase in forward guidance on interest rates. Columns 1-3 in panel (a) show that public firms do not change their real assets, decrease debt financing, and increase equity financing, respectively. Columns 1-3 of panel (b) show that private firms decrease their assets, debt, and equity, respectively. These responses are similar to those observed in the baseline case, consistent with the idea that forward guidance is an important component and a critical driver of monetary policy (Gurkaynak, Karasoy-Can, and Lee, 2022).

Table C.6 shows firms' responses to the target component of the monetary policy surprises, $Target_t$. Columns 2-3 in panel (a) show that, in response to a positive shock, public firms decrease debt financing and increase equity financing, respectively. These responses are similar to how public firms respond to the path surprises and the overall surprises in the baseline tests. However, column 1 shows that a positive target shock is associated with an increase in investments of public firms. Panel (b) shows that private firms decrease debt financing (column 2), but their equity financing (column 3) and real assets (column 1) are not affected. The discrepancies between firms' responses to target shocks with those in the baseline case may be due to the fact that, during our sample period, the target component of monetary policy surprises are dominated by the path component.

Table C.5: **How Does the Forward Guidance (Path) Component of Monetary Policy Surprise Affect Firm Financing and Growth?**

The regressions are similar to those in the baseline regressions (see Table 3) using growth rates of assets, debt, and equity as dependent variables. Instead of using our aggregate measure for monetary policy surprise (MPS), we consider its forward guidance (path) component (à la Gurkaynak, Karasoy-Can, and Lee, 2022) as the main explanatory variable. Appendix A defines the variables. $t-$statistics calculated based on clustered standard errors at the firm level are shown in parentheses. * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$.

	$\Delta\ln(A_{it})$	$\Delta\ln(B_{it})$	$\Delta\ln(E_{it})$
	(1)	(2)	(3)
(a) Public firms			
$Path_t$	0.030	-0.075**	0.097***
	(1.43)	(-2.13)	(5.49)
Firm & Macro Controls	Yes	Yes	Yes
Firm & Bank FEs	Yes	Yes	Yes
N	13,792	12,122	12,955
adj. R^2	0.409	0.233	0.333
(b) Private firms			
$Path_t$	-0.022***	-0.034***	-0.057***
	(-5.45)	(-2.61)	(-11.33)
Firm & Macro Controls	Yes	Yes	Yes
Firm & Bank FEs	Yes	Yes	Yes
N	285,179	197,657	259,639
adj. R^2	0.346	0.254	0.319

Table C.6: **How Does the Policy Setting (Target) Component of Monetary Policy Surprise Affect Firm Financing and Growth?**

The regressions are similar to those in the baseline regressions (see Table 3) using growth rates of assets, debt, and equity as dependent variables. Instead of using our aggregate measure for monetary policy surprise (MPS), we consider its policy setting (target) component (à la Gurkaynak, Karasoy-Can, and Lee, 2022) as the main explanatory variable. Appendix A defines the variables. $t-$statistics calculated based on clustered standard errors at the firm level are shown in parentheses. * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$.

	$\Delta \ln(A_{it})$	$\Delta \ln(B_{it})$	$\Delta \ln(E_{it})$
	(1)	(2)	(3)
(a) Public firms			
$Target_t$	0.205**	-0.454***	0.568***
	(2.39)	(-2.69)	(6.95)
Firm & Macro Controls	Yes	Yes	Yes
Firm & Bank FEs	Yes	Yes	Yes
N	13,792	12,122	12,955
adj. R^2	0.409	0.233	0.334
(b) Private firms			
$Target_t$	0.025	-0.488***	-0.033
	(1.15)	(-7.44)	(-1.28)
Firm & Macro Controls	Yes	Yes	Yes
Firm & Bank FEs	Yes	Yes	Yes
N	285,179	197,657	259,639
adj. R^2	0.346	0.255	0.319

D The Effect of Firm Size on MPS Responses

Table D.7: **How Does Size Affect the Relationship between Monetary Policy and Firm Financing and Growth?**

These regressions build on the baseline regressions (see Table 3). Public and private firms are separately divided into firm-size quintiles in each year, and the quintile dummies are interacted with the MPS. Appendix A defines the variables. $t-$statistics calculated based on clustered standard errors at the firm level are shown in parentheses. * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$.

	$\Delta\ln(A_{it})$	$\Delta\ln(B_{it})$	$\Delta\ln(E_{it})$
	(1)	(2)	(3)
(a) Public firms			
MPS_t	-0.220***	-0.353	0.059
	(-3.35)	(-1.46)	(0.78)
$Quintile\ 2 \times MPS_t$	0.146*	-0.306	0.191*
	(1.82)	(-1.05)	(1.94)
$Quintile\ 3 \times MPS_t$	0.455***	0.217	0.500***
	(5.82)	(0.84)	(5.00)
$Quintile\ 4 \times MPS_t$	0.397***	0.350	0.261***
	(5.33)	(1.42)	(2.87)
$Quintile\ 5 \times MPS_t$	0.271***	0.238	0.118
	(4.17)	(1.01)	(1.44)
Firm & Macro Controls	Yes	Yes	Yes
Firm & Bank FEs	Yes	Yes	Yes
N	15,798	13,937	14,846
adj. R^2	0.391	0.213	0.319
(b) Private firms			
MPS_t	-0.263***	-0.237***	-0.375***
	(-10.74)	(-3.08)	(-11.45)
$Quintile\ 2 \times MPS_t$	0.157***	0.132	0.190***
	(5.42)	(1.44)	(5.11)
$Quintile\ 3 \times MPS_t$	0.234***	0.170*	0.250***
	(8.49)	(1.96)	(7.10)
$Quintile\ 4 \times MPS_t$	0.282***	0.249***	0.307***
	(10.62)	(2.95)	(8.90)
$Quintile\ 5 \times MPS_t$	0.333***	0.173**	0.336***
	(12.80)	(2.14)	(9.80)
Firm & Macro Controls	Yes	Yes	Yes
Firm & Bank FEs	Yes	Yes	Yes
N	325,318	225,527	296,585
adj. R^2	0.331	0.242	0.306

E Details of the Model's Numerical Solution

To perform value function iteration, we discretize the state space. The AR(1) process for the monetary policy in Equation (9) is discretized on a grid with $N_r = 3$ points, and the transition matrix is computed using the algorithm by Tauchen and Hussey (1991). The quantitative implications of the model do not change when we use finer productivity grids, for example, $N_r = 5$, 7, or 9. In Section 7, we introduce a model extension that includes productivity shocks. In solving that version of the model, the AR(1) process for productivity (Equation (30)) is also discretized on a grid with $N_z = 3$ points.

The capital and labor grids are equally spaced, with $N_k = N_n = 30$ grid points that are set around the steady state. We set the bounds at $[0.70k_{ss}, 1.30k_{ss}]$ and $[0.80n_{ss}, 1.20n_{ss}]$ so that they are never binding. The grid for net debt is also equally spaced with $N_b = 30$ grid points. The upper bound (b^{UB}) is set at the highest possible value in the borrowing constraint in Equation (13), given the capital grid, and the lower bound is set as $b^{LB} = -0.25 \times b^{UB}$. Note that b is the net corporate debt, with positive values interpreted as borrowing and negative values interpreted as firms having a net saving position.

Finally, we use the steady-state values as the initial guess to start the value iteration and use the policy function iteration algorithm (Howard's improvement) to improve efficiency.