Debt Covenants, Investment, and Monetary Policy

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Abstract

This paper studies the role of debt contracts and their interplay with financial frictions in the transmission of monetary policy to firm-level investment. Empirically, using information from a detailed loan-level dataset matched with balance sheet data, I document that in response to a contractionary monetary shock, asset-based borrowers -firms with more pledgeable assets, but low profitability- experience sharper contraction in net debt issuance and investment than cash flow-based borrowers. To explore the possible channels and provide microfoundation for the coexistence of these debt contracts, I setup a heterogeneous firm New Keynesian model with limited enforceability. In the model, firms with low-productivity and more pledgeable assets choose asset-based contracts endogenously and are more responsive to monetary shocks because their borrowing constraint is more sensitive to asset price fluctuations. These results about debt contracts and balance sheet effects contribute to the discussion of how financial frictions shape the transmission mechanism of monetary policy.

Keywords: collateral constraints; debt covenants; firm balance sheets; investment; monetary policy

JEL classification codes: E22, E32, E44, E52

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1 Introduction

How are firms' balance sheet features and debt covenants are correlated? And further, what impact do debt covenants have on transmission mechanism of monetary policy? Empirically, using information from a detailed loan-level dataset matched with balance sheet data for publicly listed US nonfinancial firms, I document that in response to a contractionary monetary shock, asset-based borrowers -firms with more pledgeable assets, but low profitability- experience sharper contraction in net debt issuance and investment than cash flow-based borrowers. Quantitatively, I setup a heterogeneous firm model with financial frictions to explore the possible channels of monetary policy transmission and to provide microfoundation for the coexistence of these debt contracts. The initial set of results suggest a novel channel, in which firm heterogeneity in terms of debt covenants plays a strong role on the severity of financial frictions, thus shaping the monetary policy transmission.

The direct effects of interest rate changes on the user cost of capital and firms' expected returns are well understood by researchers. These effects apply to all firms regardless of being financially constrained or not. On the contrary, the underlying mechanisms of indirect channels —operating through firm balance sheets thus affecting firm's borrowing capacity— remain elusive. Related economic theory proposes two offsetting channels on how monetary policy shocks diffuses to the financially constrained firms. On the one hand, financial frictions cause firms to face an upward sloping marginal cost curve for investment — tighter constraints translate into steeper marginal cost curve. This channel dampens the response of borrowing (thus investment) of more constrained firms to a monetary policy shock. On the other hand, monetary policy shocks impact firms' cash flow or collateral values, and thus shift this marginal cost curve. The latter channel –coined as "financial accelerator" after Bernanke, Gertler, and Gilchrist (1999)– advocates that by affecting firms' borrowing ability, monetary policy becomes extra influential over firms' investment expenditures (Kiyotaki and Moore, 1997; Bernanke et al., 1999). The existence of these offsetting channels suggest that the impact of monetary policy shocks on financially constrained firms is ambiguous. Following the approach of recent studies (Jeenas, 2018; Ottonello and Winberry, 2020), first by presenting relevant empirical evidences, and second by employing a heterogeneous firm model to interpret the empirical findings, this paper evaluates the relative effectiveness of these two channels to identify which firm group is more sensitive to monetary policy shocks.

Financial accelerator theories indicate that firms' borrowing and investment are more sensitive if they borrow against a collateral of which value is highly responsive to monetary

policy surprises. The conventional approach in the literature is to model a firm's borrowing limit as a function of its existing asset stock value (Kiyotaki and Moore, 1997; Khan and Thomas, 2013). This approach, however, poses two challenges. First, as recent literature shows (Lian and Ma, 2021; Greenwald, 2019; Drechsel, 2018), firms face not only asset value based constraints but a variety of constraints while borrowing. Second, by ignoring the existence of cash flow based constraints, these models fail to capture the dependence of debt limits on their cash flows.[1]

Using loan level cross-sectional evidences and a heterogeneous firm New Keynesian model, I address these issues, and investigate which channels are effective on the monetary policy transmission to firm investment. In the empirical part of this paper, I merged loan information from DealScan with quarterly Compustat data. Findings suggest that investment of firms which hold asset based borrowing contracts are more sensitive to monetary policy shocks than investment of firms with cash flow based debt contracts. The results resembles with net debt issuance response. Furthermore, I illustrate that firms with more pledgeable assets have tendency to choose asset based debt contracts, while more profitable firms usually opts for cash flow based borrowing. Motivated by these cross-sectional evidences, I construct a heterogeneous firm model with financial frictions, endogenous debt limits and two types of debt contracts. Model also incorporates some New Keynesian features to be able to study the effect of a monetary policy shock. In the model, firms with more pledgeable assets endogenously choose asset based borrowing practices, while profitable firms mostly prefer cash flow based. In the near future, I will investigate the relative importance of possible channels such as asset price fluctuations and aggregate demand on the strength of the investment response of firms to a monetary policy shock. I aim to show how different forms of debt contracts lead these heterogeneous responses (asset-based vs cash flow-based contracts).[2]

Baseline empirical specification estimates the heterogeneous responsiveness of firm level net debt issuance and investment to a monetary policy surprise. These responses are estimated via local projections method as in Jordà (2005). I control for firm fixed effects to capture unobserved heterogeneity across firms which potentially confounds the results. I also control for various firm level covariates such as size, leverage and age as typical proxies for financial constraints. I find that in case of investment response, asset based borrowers are significantly more sensitive than cash flow based borrowers. Further, this

[1]Here, notice the dual role of cash flows. Apart from raising internal funds (and thus net worth), an increase in the cash flow is also beneficial for the firm by relaxing its borrowing constraints.

[2]The discussion about asset-based vs. cash flow-based covenants should not be confused with secured vs unsecured lending. This paper exclusively focuses on secured lending —lenders have the utmost priority in case of a bankruptcy. Both asset-based and cash flow based borrowing are secured with cash flow or asset stock.

responsiveness in the investment resembles in the net debt issuance responses. These results suggest that an unexpected interest rate increase causes asset based borrowers to cut their net debt issuance and thus investment, but the response of cash flow based borrowers is statistically insignificant and close to zero in magnitude.

In order to explore the possible channels at work and interpret these empirical findings, I setup a heterogeneous firm New Keynesian model with financial frictions. Moreover, debt in this model is subject to limited enforcement which enables a dynamic interaction between macroeconomy, financial frictions, and firm's investment decisions. In this economy, firm's debt limit is determined by the fact that, *ex post*, firms can renege on their promise of payment and default.[3] Typically, consequences of default depends on the underlying debt contract. If the firm signs an asset-based contract, default results in loss of a fraction of its existing asset stocks. However, when the firm borrows under a cash flow-based covenant, then in case of default, the firm loses its management rights.[4] Perfectly foreseeing the outcomes of each form of contracts, lenders write the terms of both asset based and cash flow based debt contracts and thus restrict the borrowing amount to ensure that firms repay in every state of the world next period. In this study, first part consists of setting up a model to explain firms' covenant choices, and second part (*work in progress*) presents the evaluation of the macroeconomic implications of these debt covenants and their role on heterogeneous transmission of monetary policy shocks on firm borrowing and investment.

Initial results reveal that, in line with the empirical evidences presented in Lian and Ma (2021), the model well captures the fact that cash flow-based borrowing is the prevalent method for most of the states. Some underlying dynamics are as follows. As the firm becomes more productive, its ability to generate cash flow increases, and thus provides looser borrowing constraints. Furthermore, for a given level of capital, as debt stock increases, most firms rely on asset based borrowing. It is due to the fact that higher debt directly translates into lower pledgeable cash flow. Therefore expecting an increase in the firm's likelihood of reneging from its promise of payment, lenders tighten the borrowing constraints and steer firms to sign asset based contracts. As the firms' available internal funds increase, then firms do not borrow and use their own funds to finance their investment spendings in order to avoid the costs that comes with external funding—whichever the underlying covenant is.

[3]By this method, as a contribution to the recent growing literature about the debt contract, I am able to provide microfoundation for the implied borrowing limits of these cash flow based covenants.

[4]In the *ex ante* world, the contingent value of the firm in case of default is unknown to the lender. Therefore, lenders approximate this contingent value by taking a multiple of the firm's cash flow (Lian and Ma, 2021). Further discussion regarding cash flow based covenants and their default resolution can be found in Appendix D.

The model also features heterogeneity in terms of recoverability of assets. That is, in case of a covenant breach firms which have asset based covenants lose only a fraction of their existing asset stock and continue with the remaining portion. It is due to the fact that only a portion of firm's existing capital stock is pledgeable as collateral. This mechanism directly follows the empirical findings of Lian and Ma (2021) in which the authors state that in airline and utilities sectors, firms' capital stock can be easily liquidated, so their portion of pledgeable assets are relatively higher than other sectors. Therefore, in these sectors, firms predominantly use asset-based borrowing. On the other extreme, a firm may operate in a sector which mostly relies on intangible assets, thus comparing to other sectors, their recoverable asset stock is very low. Therefore, this type of firms have to rely on cash flow based borrowing.

Policy Implications. Coexistence of these different debt covenants provide novel channels as it implies monetary policy shocks diffuse to the firms heterogeneously, as the firm's borrowing capacity itself is heterogeneously affected by monetary policy shocks. More elaborately, firms utilizing asset-based lending suffer from tightening borrowing constraints via decreasing collateral values, however firms using cash flow-based lending do not suffer this channel. Therefore, following an interest rate increase, compared to cash flow-based borrowers, firms borrowing against their asset stock experience a sharper decrease in debt and investment. This channel also provides insights for the classification proposed in Cloyne, Ferreira, Froemel, and Surico (2018). As the authors empirically show that young and non-dividend paying firms (mostly asset-based borrowers) implement sharper cuts in debt issuance and investment as a response to a contractionary monetary policy shock.

In the spirit of financial acceleration, if a firm borrows using its asset stock as collateral, then traditional channels suggested by Kiyotaki and Moore (1997) and Bernanke et al. (1999) are still at work.[5] However, if a firm borrows against its earnings, then the traditional channels regarding the financial accelerator mechanism do not operate. For such firms, the only active channel is indirect, that is increasing interest rates suppress the aggregate demand which decreases the firm's cash flow. Therefore, one can deduce financial acceleration mechanisms induce asymmetrically across firms, suggesting some aggregate implications. In terms of monetary policy transmission, if the financial accelerator is effective on a firm (*i.e.* if the firm borrows against its asset stock), then a contractionary

[5] In Bernanke et al. (1999), higher interest rates put downward pressure on equity values by lowering asset prices. Through the costly state verification mechanism proposed by Townsend (1979), a contractionary monetary shock increases the external finance premium. This increase reinforces the increase in cost of capital, therefore leads to further decline in investment. In Kiyotaki and Moore (1997), since the debt is secured against collateral (asset stock), an increase in interest rates tightens the borrowing constraints by triggering a fall in collateral values.

monetary policy shock translates into sharper contraction in borrowing capacity and subsequently a decline in net debt issuance and investment. Consequently, this set of results suggest that financial frictions effect monetary policy transmission more severely when more firms borrow against their asset stock.

Short-term Outlook. This paper aim to explore particular channels of how asset-based and cash-flow based covenants affect the firm behavior on the margin through their influence on financial variables. This follows from investigating whether the firm's borrowing limit is implied from the liquidation value of physical assets or by cash flows. Then, I argue that different forms of debt covenants coupled with limited enforcement is a crucial mechanism explaining how monetary policy surprises have heterogeneous impacts on firms' investment decisions. The next step in this paper is that imposing a monetary policy shock to the model as an MIT shock and explore the relative strength of the possible channels at work.

Related Literature. This paper contributes to several strands of the literature. First strand is the large body of work that studies the role of financial frictions in the transmission of interest rate changes to the economy. By employing costly state verification mechanism of Townsend (1979), Bernanke et al. (1999) introduces the financial accelerator mechanism. Moreover, Kiyotaki and Moore (1997) studies the business cycle implications of collateral values. I contribute to this literature by introducing the coexistence of different types of debt covenants and evaluating the relative strength of financial accelerator mechanism through these covenant types.

Second, another body of literature investigates the characterization of optimal dynamic financial contracts under various forms of friction. Remarkable examples include implications on conflicting objectives Albuquerque and Hopenhayn (2004), technological innovations on output Cooley, Marimon, and Quadrini (2004), asset pricing (Biais, Mariotti, Plantin, and Rochet, 2007), Q-theory of investment (DeMarzo, Fishman, He, and Wang, 2012; Cao, Lorenzoni, and Walentin, 2019), interaction between financial cycles and control rights over asset-sales and cash-flow (Diamond, Hu, and Rajan, 2020). Here, this paper contributes to this literature branch, by employing recursive methods to incorporate two different types of dynamic financial contracts, providing a microfoundation for the debt covenants.

Third, there is a relatively new strand of literature about the debt covenants. Lian and Ma (2021) empirically presents that debt covenants are often written as asset based or cash flow based while the latter is more dominant. Sharing the similar findings, Drechsel

(2018) develops a representative firm New Keynesian model to study the implications of investment shocks by comparing the two economies with either asset based or cash flow based prevailing. Greenwald (2019) focuses on an environment in which only earnings based covenants exist and study the transmission of monetary policy shocks. I contribute to this literature branch by providing a rationale for the coexistence of different types of debt covenants. Further, I derive these borrowing limits from first principles, instead of imposing *ad hoc* functional forms, hence developing a microfoundation for the different forms of borrowing constraints.

In spirit, this paper is closely related to Jeenas (2018), Cloyne et al. (2018), Anderson and Cesa-Bianchi (2020), and Ottonello and Winberry (2020). Jeenas (2018) explains the heterogeneous sensitivity to monetary policy shocks by focusing on the balance sheet liquidity. He finds that firms are less responsive to monetary policy shocks if they have fewer liquid assets. Similarly, Cloyne et al. (2018) emphasize the role of firms' age/dividend status on the responsiveness to monetary policy shocks. Their main finding is younger firms paying no dividend are the most responsive group to a contractionary monetary shock. Anderson and Cesa-Bianchi (2020) focuses on the leverage level, and indicates that as a response to a contractionary monetary shock, highly leveraged firms cut their debt and investment more than lowly levered firms. Ottonello and Winberry (2020) argue that firms are more sensitive to interest rate changes when they have lower risk of default. I contribute to these studies by introducing cash flow-based collateral constraints and verify the relevance of coexistence of asset-based and cash flow-based constraints in micro data on heterogeneous sensitivity to monetary policy surprises. Results presented in this paper should not be seen as a contradiction to above-mentioned studies; instead, as a complementary study focusing on a novel channel —debt covenant heterogeneity.

Finally, the model in this paper borrows some key insights from the corporate finance literature. This literature branch empirically investigates the role of borrowing limits on investment decisions, particularly considering if they are binding —under which conditions— and finally the consequences of covenant breaches. Prominent examples include Chava and Roberts (2008), Nini, Smith, and Sufi (2009), Roberts and Sufi (2009a), Roberts and Sufi (2009b), Nini, Smith, and Sufi (2012), and Chodorow-Reich and Falato (2017). This paper contributes to this literature by employing a heterogeneous firm model to investigate the heterogeneous responses of firms to a common monetary policy shock and also by providing microfoundation for different types of covenants.

Road Map. The rest of the paper is organized as follows. Section 2 explains the datasets used in this paper, discuss how balance sheet features are correlated with the debt con-

tract form, describes the identification strategy of monetary policy shocks, and also provides empirical evidence about heterogeneity in debt covenants leads to varying degrees of firm-level sensitivity to monetary policy shocks. Section 3 develops the heterogeneous firm model, discusses selected equilibrium properties and the calibration strategy. Section 4 provides findings about firm behavior and discusses that model's predictions are consistent with the empirical facts of Section 2. Section 5 presents the firms' heterogeneous sensitivity to monetary policy shocks. Section 6 concludes.

2 Empirical Framework

In this section, I discuss the datasets and the empirical strategy employed in this paper. In particular, in Section 2.1, I discuss the methodology of identifying the monetary policy surprises. In Section 2.2, I briefly describe the loan level DealScan dataset and the construction of the main variables of interest. Then I elaborate the debt covenant concept from the macroeconomics perspective, such as heterogeneity among firms and how borrowing method affects the monetary policy transmission by altering the borrowing constraint of a firm. In Section 2.3, I discuss the corporate finance variables of interest from the Compustat data set. In Section 2.4, I document that comparing to the cash flow based borrowers, asset based borrowers are more sensitive to monetary policy shocks.

2.1 Identification of Monetary Policy Shocks

As it is well documented by researchers, identifying the unanticipated component of monetary policy changes requires to overcome the bilateral interaction between the federal funds rate and the aggregate economy. Following Gürkaynak, Sack, and Swanson (2005) and Gorodnichenko and Weber (2016) to extract the unexpected component of the monetary policy announcements, I utilize the change in the implied fed funds rate —obtained from a fed funds futures contract— in a 30-minute window encompassing the issuance of FOMC press release. There are two identifying assumptions: (i) Fed funds futures provide a good proxy for the market's expectation for the interest rates, (ii) 30-minute window is so narrow that these market's expectations are not contaminated by any other factor.

$$\varrho_{\tau_j} = \text{ffr}_{\tau+\Delta_+} - \text{ffr}_{\tau-\Delta_-} \tag{1}$$

where τ is the exact time of FOMC press releases. ffr is the current month fed funds futures rates (at time τ), Δ_- is defined as 10 minutes before the FOMC announcement and Δ_+ is 20 minutes after the FOMC announcement.

Since FOMC meetings are held 8 times in a year, the frequency of monetary policy shock is higher than quarterly. Therefore, to obtain quarterly monetary policy shock, ε_t^m, I aggregate the high-frequency measures of monetary policy shocks. Process involves summing ϱ_{τ_j} up within quarter t, as presented below:

$$\varepsilon_t^m \equiv \sum_{\tau_j \in (\tau_{j,1}, \tau_{j,2})} \varrho_{\tau_j} \tag{2}$$

where $\tau_{j,1}$ and $\tau_{j,2}$ exact dates of the beginning and the ending of quarter t, and τ_j corresponds to the exact date at which FOMC press release is issued.[6]

Given the fact that ε_t^m is only a proxy for the purely unanticipated quarterly monetary policy shocks ε_t, a relatively recent literature indicates that this measure of interest rate surprises are still contaminated, because shocks still include signals about the determinants of monetary policy (Nakamura and Steinsson, 2018; Miranda-Agrippino and Ricco, 2018; Jarociński and Karadi, 2020; Anderson and Cesa-Bianchi, 2020). These studies state that within each monetary policy shock extracted à la Gürkaynak et al. (2005), monetary component should be disentangled from other contemporaneous non-monetary component. Therefore, in the further steps, I follow some of the above-mentioned methods to check if my results are significantly affected from the non-monetary component of the monetary policy shock.

2.2 Loan-level Debt Information

In this section, I explain the data source I use for loan-level information and briefly describe the debt covenants and their various features relevant to macroeconomics literature.

Data Source. The DealScan database provides loan level credit information. Along with many crucial loan information, DealScan also contains the relevant covenant information. Although DealScan goes back to older dates, following Greenwald (2019), sample starts in 1997 Q1. The reason for this choice is that before 1997, covenant information in DealScan is sparsely populated. The sample ends in 2017 Q3, which is dictated by the most recent version of Chava and Roberts (2008)'s linking file (April, 2018). More details for this linking file is provided in Appendix A.1.

Definition of Debt Covenants. The contracts that both lenders and borrowers agree on the borrowing terms are called debt covenants. Covenants state terms for the firm to fulfill.

[6]The exact times of these announcements and corresponding measures of shocks are taken from Gürkaynak et al. (2005) and Gorodnichenko and Weber (2016).

Table 1

SUMMARY STATISTICS: ASSET VS. CASH FLOW BASED

	Asset Based				
	Mean	SD	P25	Median	P75
Firm Total Assets ($K)	1679.83	3708.59	167.66	527.41	1514.06
Firm Age (years)	32.94	31.86	11.75	21.50	39.50
Firm Leverage	0.32	0.24	0.14	0.28	0.46
Firm Asset Pledgeability	0.70	0.19	0.59	0.74	0.85
Firm Profitability ($x10^{-2}$)	0.15	3.02	-0.63	0.55	1.64
Firm Tobin's Q	1.57	1.50	1.03	1.28	1.73
Firm EBITDA	0.44	1.60	0.02	0.10	0.39
Loan Spread (pp)	2.36	0.95	1.75	2.25	2.75
Loan Maturity (months)	53.62	23.41	36.00	60.00	60.00
Total Observations	8,135				
	Cash flow Based				
	Mean	SD	P25	Median	P75
Firm Total Assets ($K)	2596.18	4659.20	378.98	973.15	2419.20
Firm Age (years)	34.73	35.05	11.25	22.25	44.25
Firm Leverage	0.32	0.25	0.16	0.29	0.44
Firm Asset Pledgeability	0.57	0.23	0.40	0.59	0.75
Firm Profitability ($x10^{-2}$)	0.75	2.47	0.05	0.97	1.92
Firm Tobin's Q	1.77	1.12	1.15	1.47	2.00
Firm EBITDA	0.84	1.82	0.10	0.30	0.84
Loan Spread (pp)	1.99	1.15	1.25	1.75	2.50
Loan Maturity (months)	59.16	18.37	57.00	60.00	60.00
Total Observations	55,405				

NOTE. Summary statistics for asset-based and cash flow-based in the sample. The sample period covers the period between 1997Q1 and 2017Q3. Asset pledgeability refers to the ratio of tangible fixed assets to total assets as in Cloyne et al. (2018) Dinlersoz, Kalemli-Ozcan, Hyatt, and Penciakova (2018). Profitability is measured as Return-on-Assets as widely used by corporate finance literature. Loan spread is measured in percentage points.

These terms may include limits on financial ratios and also the consequences in case of a breach. Although there are various types of covenants in these contracts, the focus of this paper is cash flow based covenants.[7] These loan covenants mandate that throughout the life of loan agreement, firms must satisfy some financial ratios —most prominently, debt-to-assets or debt-to-EBITDA. More details can be found in Appendix D.

Covenant Types. In essence, the main determinant of covenant type is the resolution of default. If in a covenant, creditors have the right to seize the firm's assets, then the borrowing limit is determined by the liquidation value of physical assets. This type of covenants are referred to asset-based covenants. Moreover, if creditors' have the right to take over the management of the firm, then borrowing is calculated via the firm's going-concern cash flow value. This type of covenants are called cash flow-based (or earnings-based covenants).[8] Furthermore, the disscussion about asset-based versus cash flow-based covenants should not be confused with the discussion about secured versus unsecured debt. Both covenant types are secured, and thus creditors have priority in case of bankruptcy.

Prevalence of Cash flow Based Covenants. By compiling the data from various data sources and hand-collected data from 10-K filings, Lian and Ma (2021) shows that (median) share of asset-based lending is less than 20% while cash flow-based is slightly over 80%, and the shares are steady over time. The sample set consists of US large non-financial firms of which the total debt of these firms constitute over 96% of debt outstanding among Compustat firms. Therefore, the authors assert that these statistics well represent the total debt composition in Compustat. Furthermore, by using DealScan data, Drechsel (2018) presents that earnings-based debt agreements are more common that other practices in the lending markets.

Sectoral Heterogeneity. Covenant types are strongly correlated with some sectoral characteristics. The most prominent features are the share of standardized assets and profitability. Lian and Ma (2021) indicates that firms in the airline industry constitute good example as they predominantly employ asset-based lending due to having substantial amounts of standardized, transferable assets such as aircrafts and hangars.

[7]Depending on the sector operated, firms have a variety of covenants. These covenants maybe positive or negative. Positive covenants include ensuring employees are satisfied and productive, perform regular maintenance of physical machinery and so on. Negative covenants include reducing debt below a certain threshold, liquidating the risky assets in the firm's portfolio and so on.

[8]Cash flow based covenants also have two broad categories in itself: interest payment-to-total debt or cash flow-to-total debt. Greenwald (2019) exclusively focus on these two covenants and suggest a state dependent mechanism in interest rate transmission.

On the other extreme, firms operating in services and technology (*e.g.* software) sectors mostly rely on cash flow based lending. In these sectors, firms mostly operate using intangible capital rather than tangible capital. Therefore these firms do not have enough tangible assets to pledge as collateral, so they rely on cash flow-based lending. One caveat for this group is that if these firms are low on productivity, then they cannot generate enough cash flows, leading to tighter borrowing constraints Giglio and Severo (2012).

How are the borrowing limits determined? In cash flow-based covenants, due to its verifiability, borrowing limits are calculated based on a cash flow measure called EBITDA.[9] Lenders impose limits on firm's borrowing capacity by explicitly stating that total debt cannot exceed a certain ratio of debt-to-EBITDA.[10] Since these limits are explicitly written in loan contracts, therefore actively setting limits to firm's total borrowing. Therefore, these implied limits in the contracts act as borrowing constraints. Note that cash flow-based covenants restricts not only the loan amount but firm's total debt stock. Therefore, cash flow-based covenants also have implications for firm's bond issuance. Further discussion about loan borrowing versus bond borrowing can be found in Appendix D.

Affected monetary policy transmission channels. The main component of these debt agreements differ in the sense that -as its name suggest- in asset based debt contracts, the borrowing limit is determined by the price of the underlying asset. Therefore, asset based borrowers mostly vulnerable to asset price fluctuations. On the other hand, cash flow based debt agreements are built upon the EBITDA of the firm. Therefore, cash flow based borrowers are sensitive to demand fluctuations.

2.3 Firm-level Balance Sheet and Income Statement Data

By employing the linking file provided by Chava and Roberts (2008), I connect the firm identifiers of both datasets. Thus, the final firm-level data is compiled by merging DealScan and Compustat data sets. DealScan contains loan-level information of covenants for syndicated loans and Compustat contains firm-level balance sheet and income statement items of interest. Therefore, final data set includes loan-level and firm-level information for the variables of interest. In particular, I extract the entirely available loan data from DealScan, and keep the portion matched to the balance sheet data from Compustat. Below, I briefly discuss the sample selection and variable construction for each data set. Further details on data treatment can be found in Appendix A.1.

[9] Acronym for (**E**arnings **B**efore **I**nterest, **T**axes, **D**epreciation and **A**mortization).

[10] This ratio is usually around 3.5 where its interquartile range is $3 \sim 4.5$ (Lian and Ma, 2021)

Firm-level balance sheet and income statement items come from the quarterly Compustat database. Apart from being widely accepted in the literature, Compustat has nice features that makes it suitable for the empirical analyses. Quarterly frequency makes it possible to carry out the observe the implications of monetary policy. Furthermore, being a long panel dataset, it is possible to analyze not only cross-sectional variation but also the within firm variation.[11] Finally, by employing the linking file provided by Chava and Roberts (2008), I merged these two datasets by connecting the firm identifiers of both datasets. As Compustat covers longer period then DealScan, therefore sample period is determined by DealScan's limitations.

Corporate finance variables of interests include (but not limited to) investment (calculated via perpetual inventory method), cash flow (proxied by EBITDA), net debt issuance, short term and long term debt, interest related expenses, divident paying status, collateral value, and sales revenue. Using these variables, I construct some firm measures such as size (book value of total assets), age (years since incorporation), leverage (ratio of total debt to total assets), liquidity (short term cash and investments), and Tobin's Q. Insted of employment, firm size is proxied by value of total asssets, since Compustat provides employment measures annually rather than quarterly, and further, employment data is relatively sparsely populated. Similarly, following Cloyne et al. (2018) age variable is not taken directly from Compustat's native initial public offering date as it is not well populated, but instead I blend the Compustat's IPO date and incorporation date from WorldScope Database. Also, some of the Compustat variables are provided (from the source) as cumulative within the firm's fiscal year. Therefore, to obtain quarterly data, I calculate the first differences of those variables within the firm's own fiscal year. Finally, variables in levels are normalized by its size. Exact data items, variable codes, and corresponding data construction procedures can be found in Appendix A.1.

2.4 Heterogenous Sensitivity to Monetary Policy Shocks

The central thought in these empirical analyses is to show the heterogeneous effects of monetary policy surprises on firm-level investment and net debt issuance. Following the recent literature on heterogeneous monetary policy transmission (Anderson and Cesa-

[11] The only drawback is that Compustat only includes publicly listed firms which restricts the sample set to mostly have relatively large firms. Moreover, large firms are considered more trustworthy and less financial constrained by several studies (Gertler and Gilchrist, 1994; Farre-Mensa and Ljungqvist, 2016). However, within the framework of this paper, the aim is to show that asset based borrowers have relatively impeded access to external financing than cash flow based borrowers. On the other hand, Cloyne et al. (2018) points out, private firms face similar or more severe financial frictions than publicly listed firms. Therefore, results in this paper can be imagined as a lower bound of the effectiveness of proposed channels of the monetary policy transmission.

Bianchi, 2020; Cloyne et al., 2018; Jeenas, 2018; Ottonello and Winberry, 2020), I estimate the impulse response functions using local projection method as in Jordà (2005). I then estimate variants of the baseline empirical specification to better identify the impact of borrowing practice method.

I start the exercises by regressing the variables of interest on the interaction terms of the firms' borrowing method indicator at time $t-1$ and the monetary policy shock at time t. The borrowing method indicator splits the entire sample into two based on whether each firm utilize an asset based or cash flow based borrowing method. Equation 3 governs the process.

$$y_{j,t+h} - y_{j,t-1} = \alpha_j^h + \beta_1^h \left(\epsilon_t^m \mathscr{I}_{j,t-1}^{Asset}\right) + \beta_2^h \left(\epsilon_t^m \mathscr{I}_{j,t-1}^{Cash}\right) + \sum_{p=1}^{P_Z} \Gamma_p \mathbf{Z}_{j,t-p} + \sum_{p=1}^{P_X} \Gamma_p \mathbf{X}_{t-p} e_{j,t+h} \quad (3)$$

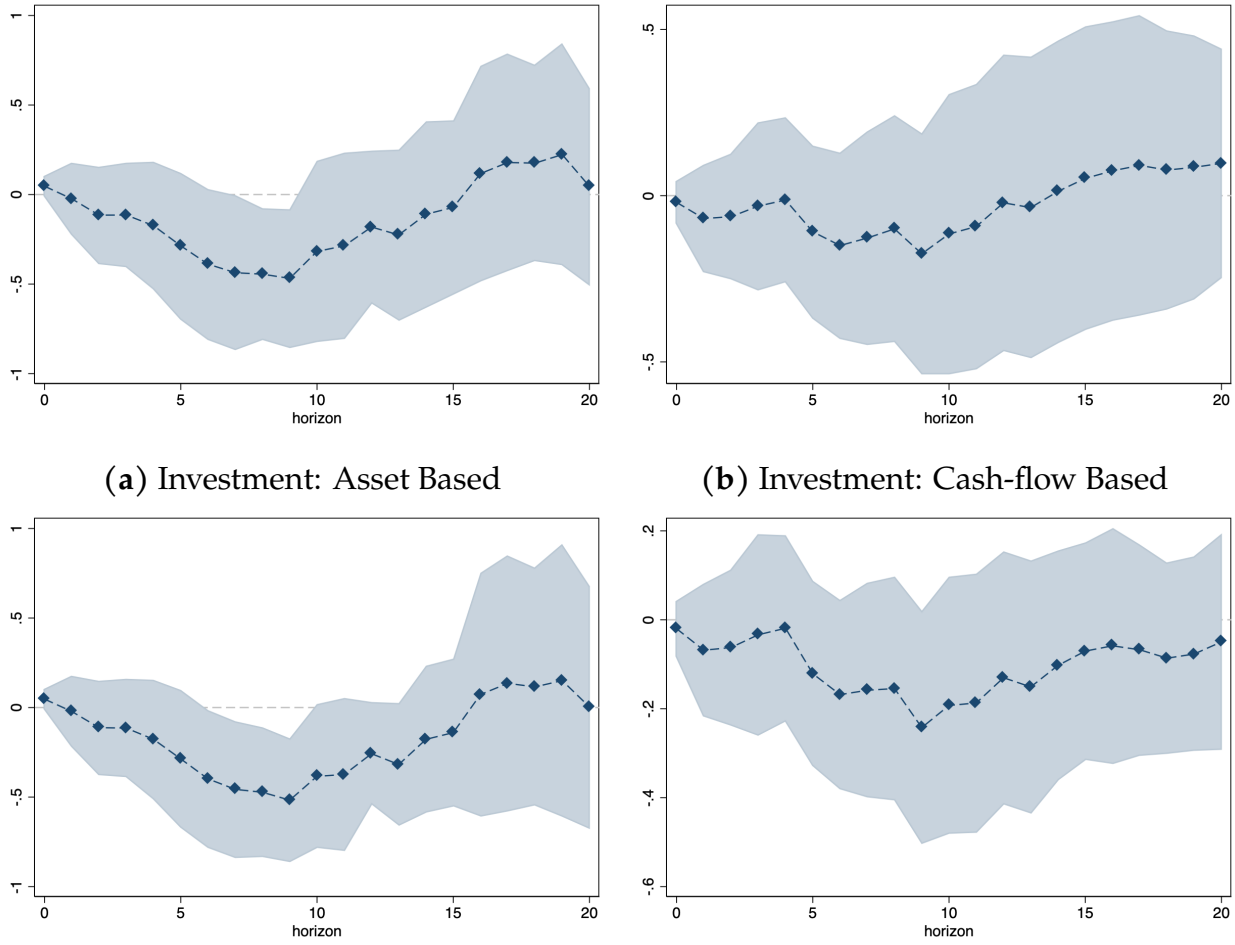
$h = 0, 1, ..., H$ represents the active time horizon in which I estimate the relative impact effect on the dependent variable of interest. $y_{j,t+h}$ is the dependent variable of interest at horizon h: investment and net debt issuance. α_j^h is the firm fixed effect, ϵ_t^m is the quarterly monetary policy surprise of which calculation is described in Section 2.1. $\mathscr{I}_{j,t-1}^{Asset} = 1$ when firm j use asset based borrowing practices in the quarter that precedes the monetary policy surprise (otherwise zero) and $\mathscr{I}_{j,t-1}^{Cash} = 1$ when firm j use cash flow based borrowing practices in the quarter that precedes the monetary policy surprise (otherwise zero). Baseline empirical specification also controls for a number of idiosyncratic and aggregate factors that may simultaneously influence dependent variables and borrowing method.[12] $\mathbf{Z}$ is the firm level control variable set including leverage, size, age, Return-on-Assets (RoA) and current assets share, with $P_X = 1$. $\mathbf{X}$ is the aggregate control variable set including inflation and the VIX volatility index, with $P_Z = 4$. Finally, β_1^h and β_2^h are the regression coefficients of interest capturing the impulse responses among subgroups.

Figure 1 exhibits the estimated impulse responses using Equation 3. β_1^h and β_2^h belongs to the subgroups asset based and cash flow based, respectively. The top two subfigures; Panel (A) and Panel (B) are for investment and the bottom two subfigures; Panel (C) and Panel (D) are for net debt issuance. The shaded areas are the 90 percent confidence intervals based on two-way clustered standard errors at firm and quarter. Impulse response functions estimated over 20 quarters period.

Investment declines significantly following a 25 bp rise in the interest rate. The effect becomes significant around the middle of the second year and the peak effect is reached

[12] Some of the control variables included in Equation 3 are beyond the scope of the quantitative economic model depicted in Section 3.

Figure 1
Impulse Responses:
Asset-based vs. Cash flow-based



(**a**) Investment: Asset Based

(**b**) Investment: Cash-flow Based

(**c**) Net Debt Issuance: Asset Based

(**d**) Net Debt Issuance: Cash-flow Based

Note. This figure shows the average impulse response functions for the investment rate and net debt issuance following a 25 bps increase in 3-month T-bill rate. The responses are classified into asset-based and cash flow-based borrowers and estimated with the local projection specification given by Equation 3. Monetary policy shock is interacted with indicator variable based on the firm borrowing status. The shaded areas display 90 percent confidence intervals based on two-way clustered standard errors at firm and quarter.

at the end of the second year after the shock, at a value around -0.5. After that, the dynamic effects dissipate and become statistically negligible by the end of the forecast horizon. There are three key takeaways from Figure 1. First, Panel (A) shows that the decline in investment of asset based borrowers is statistically significant, while Panel (B) shows that cash based borrowers' response is not statistically significant. Second, the peak response of investment among asset based borrowers (which occurs at 2 years after impact) are almost three times larger than cash based borrowers. Third, these two main points exactly echo in Panel (C) and Panel (D). The response of net debt issuance among cash based borrowers is not statistically significant and small in magnitude, while asset based borrowers respond in a statistically significant way and larger in magnitude. Again the peak response is experienced around 2 years after the impact.

As a bottom line, Figure 1 shows that mostly asset based borrowers are affected from an unexpected interest rate increase, as their net debt issuance is significantly reduced. The finding that net debt issuance and invesment response resembles each other, suggests that mostly asset-based borrowers respond to an interest rate increase.

3 Model

I develop a heterogeneous firm model which demonstrates the impact of different forms of debt covenants on the heterogeneous responses to monetary policy shocks, in line with the empirical facts presented in Section 2.

In the model, time is discrete and infinite. Model economy has the following components, production firms —facing financial frictions, financial intermediary, monetary authority, and a representative household, which closes the model. There is no aggregate uncertainty. Following Bernanke et al. (1999) price setting problem is kept separate from the production firms. There are also monopolistically competitive retailers and perfectly competitive final good producers. Wage and price of heterogenous production firms' goods are flexible, while the price of variety produced by retailers are sticky.

For brevity, the model presented in this section is in real terms. Numeraire is the final good. Also note that except the initial unanticipated monetary policy shock, there is no aggregate uncertainty. Therefore, given the rational expectations, agents have the perfect foresight of the future prices. Monetary policy experiment is carried out by studying the transition path when an unexpected monetary shock is applied to the economy. I further present the model in nominal terms and discuss key assumptions in Appendix B.

3.1 Production Firms

In every period, each heterogeneous production firm $i \in [0,1]$ produces an undifferentiated good i, by using labor $l_{i,t}$ and predetermined capital $k_{i,t}$ using a decreasing returns to scale production function given below

$$y_{j,t} = z_{i,t} k_{i,t}^{\theta} l_{i,t}^{\nu}. \tag{4}$$

Labor market is perfectly competitive, and firms hire labor at the real wage, w_t. Idiosyncratic firm productivity $z_{i,t}$ follows a log–$AR(1)$ process presented by (5):

$$z_t = \rho z_{t-1} + \sigma \epsilon_t; \quad \epsilon \sim N(0,1). \tag{5}$$

The set of individual state variables of a firm is (z,k,b). Net worth nw is defined as firms' total funds before acquiring new debt or purchasing new capital. Due to its static nature, given predetermined capital and idiosyncratic productivity shock, labor choice problem can be merged with the definition of net worth (by plugging the optimal value of labor input)

$$nw = \max_{l} pz(k)^{\theta} l^{\nu} - wl + q(1-\delta)k - b - \Phi \tag{6}$$

where Φ is the operating cost. The real equity value $v^{\chi}(z,k,b)$ solves the Bellman equation

$$\begin{aligned} v^{\chi}(z,k,b) = \max_{k',b'} \quad & nw - qk' + \mathscr{Q}b' \\ & + \mathbb{E}_{z'|z}\left[\Lambda^{h} v'(z',k',b')\right] \quad \chi \in \{\text{Asset}, \text{Cash}\} \end{aligned} \tag{7}$$

subject to a non-negativity constraint on dividends:

$$nw - qk' + \mathscr{Q}b' \geq 0, \tag{8}$$

and the debt covenants which will be explained in the next subsection in detail.

3.2 Debt Covenants

In this model, borrowing constraints are derived from first principles rather than imposing exogenously. Therefore, in order to provide microfoundation for the borrowing con-

straints, the firm's debt limit is determined as follows. In this economy, *ex post* firms can renege on their promise to repay, thus breaching their covenants. Following Cao et al. (2019), borrowing limits are specified by the lenders subject to an enforcement constraint. Incentive compatibility constraints mandate that the value of repayment has to be greater than the value of breaching the covenant for all possible states of tomorrow. Therefore, limited enforceability of loan contracts directly maps into the firm's *ex ante* borrowing capacity.

Lenders offer two types of debt covenants: asset-based or cash flow-based. Firms choose the optimal debt covenant by comparing them. These covenants differ in terms of default resolution. If the firm opts for asset-based debt covenant, default results in a loss of a fraction of its asset stocks. However, if the firm borrows with cash flow-based debt covenant, then in case of default, the firm loses the management rights. In this case, the firm's contingent value is calculated as the multiple of its cash flow.[13]

In this setup, firm's borrowing decisions have two dimensions. In the extensive margin whether to opt for asset-based covenant or cash flow-based covenant, and in the intensive margin how much to borrow. In the extensive margin, firm's value is governed by the upper envelope of v^{Asset} and v^{Cash} as given below:[14]

$$v\left(z,k,b\right)=\max\left\{v^{Asset}(z,k,b),v^{Cash}(z,k,b)\right\} \tag{9}$$

To complete the exposition of the production firms, specifications of the debt covenants (*i.e.* borrowing limits) are explicitly presented below. If firm opts for using their asset stock as collateral, lenders specify the borrowing limits to satisfy:

$$v^{Asset}\left(z',k',b'\left(z',k'\right)\right)\geq v^{Asset}\left(z',(1-\Theta)k',0\right)\qquad\text{for all } z'. \tag{10}$$

The interpretation of (10) originates from the fact that in case of a covenant breach firms lose a fraction Θ of their existing asset stock and continue with the remaining portion. It is due to the fact that only a portion of firm's existing capital stock is pledgeable as collateral (Lian and Ma, 2021).[15] As shown in Section **??**, the fraction of asset stock that is pledgeable

[13] *Ex ante*, the contingent value of the firm when the management rights are transferred to the lender is unknown. Therefore, lenders use an approximation for this contingent value by accepting that it approximately equals to some multiple of its cash flow (Lian and Ma, 2021). Further discussion can be found in Appendix D.

[14] For expositional purposes, to differentiate between the value of firm under different covenants I used superscripts asset and cash. However, this is a bit abuse of notation, since value of the firm next period (before the covenant decision made) does not depend on today's covenant.

[15] Lian and Ma (2021) states that in airline and utilities sectors, firms' capital stock can be easily liquidated, so their portion of pledgeable assets are relatively higher than other sectors. It is because firms in these sectors have highly standardized asset stock. Therefore, for these sectors, regardless of their size, firms

mostly depends on the sector operated. For instance, if a firm operates in a sector then mostly uses highly specific capital, then its share of pledgeable assets will be low (most of the time, only real estate). Therefore, Θ in (10) is idiosyncratic and drawn from its own distribution. However, it is treated as a parameter rather than a shock, because once a firm starts to operate in a sector, then throughout its life time, its share of pledgeable asset stock remains the same (except temporary disturbances).

Lenders set the debt limits, for the firms using their cash flow as collateral:

$$v^{Cash}\left(z', k', b'\left(z', k'\right)\right) \geq v^{Cash}\left(z', k', 0\right) - \phi\left(pz'\left(k'\right)^{\theta}\left(l'\right)^{\nu} + wl'\right) \quad \text{for all } z'. \tag{11}$$

Since v is decreasing in b, it can be shown that there is an upper bound on the debt limits, $\bar{b}\left(z', k'\right)$ such that a borrowing constraint can take the form below:[16]

$$b'\left(z', k'\right) \leq \bar{b}\left(z', k'\right) \quad \text{for all } z' \text{ and } k'. \tag{12}$$

As mentioned above, firms have an incentive to pay back the debt rather than to default, for all states of tomorrow, thus firms can only borrow up to the amount which satisfies the above inequality.

Ad hoc borrowing constraints. I also run experiments for economies with ad hoc borrowing constraints. First economy does not allow any form of borrowing, thus firms finance their investment only with internal funding.[17] Therefore, borrowing limit is specified as:

$$\bar{b}\left(z, k'\right) = 0 \tag{13}$$

Second economy allows for borrowing practices, in which debt limits are specifically calculated as a percentage of their asset stock. In this economy, borrowing limits are exogenously specified as:

$$\bar{b}\left(z, k'\right) = -\kappa k'. \tag{14}$$

(14) follows the spirit of previous works about firm borrowing usually assumes similar

predominantly use asset-based borrowing.

[16] **[TO DO]** In the near future, will be proven in the appendix.

[17] Zero borrowing is not a reasonable setup in an economy with collateralizable assets. However, in order to show the impact of external funding in this economy, I imposed zero borrowing limit. Also, notice that in this economy, since borrowing is prohibited, there is no heterogeneity among firms in terms of debt covenants.

formulation for the borrowing limit. For the ease of expositional comparison, I here follow the same specification (Khan and Thomas, 2013; Jeenas, 2018; Ottonello and Winberry, 2020).[18]

Dual roles of collateral. In this economy, asset stock and cash flow have dual roles. Apart from generating value for the firm, they also serve as collateral. Insights about the collaterals are similar to the notion of household default mechanism of Fernandez-Villaverde and Krueger (2011) and yet have some crucial differences. In the earlier periods of firm's life, not generating enough cash flows, young firms have to use asset-based borrowing. Therefore, for young firms an increase in capital stock is beneficial for two reasons: $i()$ increase the net worth, and (ii) relax borrowing constraint. Under these circumstances young firms are ready to compromise on dividends in favor of building capital stock. On the contrary old firms —mostly— having already accumulated enough capital stock, they are not wager to borrow from the lenders, so that they can provide dividends to their stakeholders.

Sources of funds for investment. Firms have two sources of funds. First, as explained above, they can use external funding subject to the debt covenants. Second source of investment is internal funding. In this case, firms lower dividend payments d_{it} and use retained earnings. Note that dividend payments cannot fall below zero, $d_{i,t} \geq 0$.. This non-negativity constraint on dividend payments captures the fact that firms are not allowed to issue new equity in this economy.[19]

3.3 Financial Intermediary

Financial intermediary operates in a perfectly competitive market and takes deposits from the representative households and lends these funds to the production firms in need. This *pass-through* financial intermediary does not differentiate between the firms whether they sign up for asset-based or cash flow-based covenants. Λ^h is the households' stochastic discount factor, since financial intermediary is owned by the household. The recursive problem of the intermediary is:

$$V_I(D, B) = \max_{D', B'} \quad D' - B' + \Lambda^h V_I(D', B') \tag{15}$$

[18] Without imposing exogenously, my model can also generate a similar borrowing constraint even under limited commitment, if the production function is linear in capital. Derivations will be added to Appendix B, in the near future.

[19] Corporate finance literature states that firms' equity issuance occur very infrequently. **[CITATIONS HERE!]**

subject to

$$D' - B' \leq (1 + r^B)B - (1 + r^D)D \tag{16}$$

No arbitrage condition mandates that the intermediary sells (buy) risk-free bonds from the households/firms at a rate $r^B = r^D$.

3.4 Household

There is a representative household who consumes the final good c_t and supplies labor l_t. Household's expected utility function is

$$\mathbb{E}_0 \sum_t^{\infty} \beta^t \left(\log c_t - \Psi l_t\right). \tag{17}$$

The household saves by using two different financial instruments: (i) one period risk-free bond, a (issued by financial intermediary), (ii) one period firm share, η^h. Distribution of the households' ownership over the heterogeneous production firms' shares is represented by the measure η^h. Along with the production firms and the financial intermediary, households also own retailers and final good producers in the economy.

Representative household's lifetime utility is governed by the Bellman equation:

$$V(a, \eta) = \max_{c,l,a',\eta'} \quad (\log c - \Psi l) + \beta V(a', \eta') \tag{18}$$

subject to

$$\begin{aligned} c + a' + \int_{\mathbf{S}} \rho\left(z, k', b',\right) \eta'\left(z, k', b'\right) = \\ wl + (1 + r)a + \int_{\mathbf{S}} \rho\left(z^-, k, b\right) \eta\left(z^-, k, b\right) + \int_{\mathbf{S}} div\left(z^-, k, b\right) \eta\left(z^-, k, b\right) + \Upsilon \end{aligned} \tag{19}$$

where $\rho\left(z, k, b\right)$ is the price of production firms' shares. div is the dividend from owning these shares. Finally, Υ is the profit of the retail goods producers. Note that since financial intermediary, final good producer and production firms operate in perfectly competitive markets, for the sake of simplicity, their profits are omitted in the budget constraint.

3.5 Equilibrium

In this economy, households own production firms and financial intermediary.[20] Therefore, these entities share the stochastic discount factor of households, obtained from Euler equation of risk-free bonds, which is given below:

$$\Lambda^h = \beta \frac{u_c(c', l')}{u_c(c, l)} \tag{20}$$

Financial intermediary's optimality condition reads:

$$r'_B = r'_D \tag{21}$$

(20) and (21) together yields:

$$\Lambda^h \left(1 + r'_B\right) = 1 \tag{22}$$

Note that full characterization of the equilibrium can be found in Appendix E.

3.6 Further Work in the Model

Retailers. Model inhabits a continuum of retailers. Following Bernanke et al. (1999), it is assumed that nominal rigidities are separate from the production sector of the model. Each retailer operates in a monopolistically competitive market, thus can set a price with markup.

Retailers buy heterogeneous production firm j's good $y_{j,t}$ and produce a differentiated variety $\tilde{y}_{j,t}$ by the production process:

$$\tilde{y}_{j,t} = y_{j,t} \tag{23}$$

Due to having market power, retailers can set a relative price, $\tilde{p}_{j,t}$ for their variety subject to the quadratic price adjustment cost: $\frac{\varphi}{2}\left(\frac{\tilde{p}_{j,t}}{\tilde{p}_{j,t-1}} - 1\right)^2 Y_t$, where Y_t is the final good.

Final Good Producer. Final good producer operates in a perfectly competitive market and use the retail goods as input and bundles them into the final good by using the production technology:

$$Y_t = \left(\int \tilde{y}_{j,t}^{\frac{\gamma-1}{\gamma}} \, \mathrm{d}j\right)^{\frac{\gamma}{\gamma-1}}. \tag{24}$$

[20] In the later versions, households will also own retailers and final good producers

Note that final good is the numeraire in this economy. Cost minimization problem of the final good producer generates the retailers' demand curve.

Capital Good Producer. Capital good producers operate in a perfectly competitive market. They produce new capital using the final good and previously installed capital as inputs. This production process is subject to adjustment costs.

Corresponding law of motion for capital

$$K_{t+1} = \Phi\left(\frac{I_t}{K_t}\right) K_t + (1-\delta)K_t \tag{25}$$

where

$$\Phi\left(\frac{I_t}{K_t}\right) = \frac{\hat{\delta}^{1/\phi}}{1-1/\phi}\left(\frac{I_t}{K_t}\right)^{1-1/\phi} \tag{26}$$

Monetary Authority. Monetary policy is conducted by the monetary authority which sets the interest rate on the risk-free bond r_t^f according to a Taylor rule. In the steady state, household discount factor, β pins down the interest rate, *i.e.* $r_t^f = \beta^{-1} - 1$

$$\log R_t^f = \log\frac{1}{\beta} + \varphi_\pi \log \Pi_t + \varepsilon_t^{\mathrm{m}}, \text{ where } \varepsilon_t^m \sim N\left(0, \sigma_m^2\right), \tag{27}$$

where φ_π is the inflation coefficient in the Taylor rule, and $\varepsilon_t^{\mathrm{m}}$ is the monetary policy shock.

4 Firm Dynamics at the Steady-State

In this subsection, I present three mechanisms in which different forms of debt covenants affect firms' behavior in the stationary equilibrium. First, I show that firm's extensive margin decisions on which covenant to sign depend on its financial position. Second, I present the typical life cycle of an average firm. Third, how the choice of optimal debt instrument affects the firm's asset accumulation.

4.1 Corporate Borrowing Form

Figure 2 and 3 show the firms' debt covenant choices in the stationary equilibrium depend on their size of existing asset stock, ability to generate cash flow, current leverage and its

productivity. Blue area and red area represent the firms preferring cash flow based, and asset based covenants, respectively. White area is the off-the-equilibrium region, in which it is impossible for the lender to offer a covenant ensuring that borrowers repay their debt in every state of the following period. Note that, in line with the empirical facts presented in Section 2, the model well captures the fact that cash flow-based borrowing is the prevalent method for most of the states.

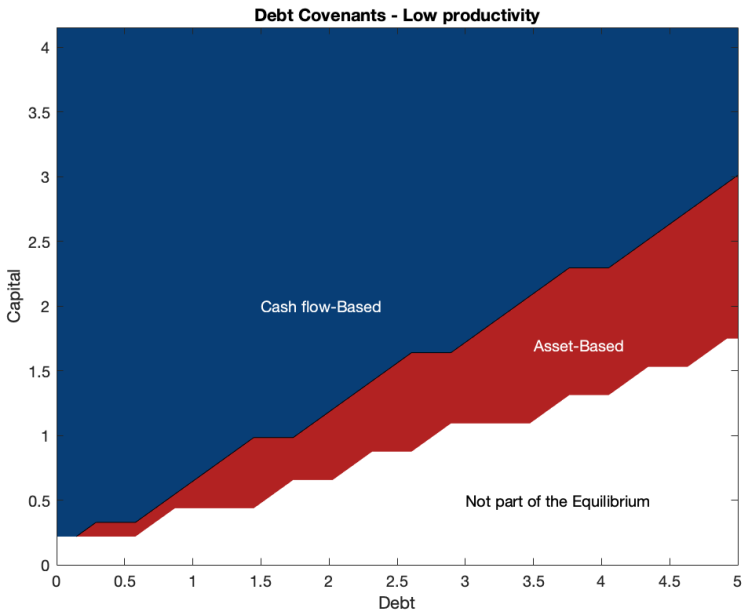


Figure 2

Covenant Choices —Low Productivity

Comparing Figure 2 and 3 as low productivity versus high productivity, the area for asset based borrowing is narrower for high productivity case. This is an indication that, as firms have higher productivity, their ability to generate cash flow increases. Furthermore, for a given level of capital, as debt increases red area widens. This is because, higher debt directly translates into lower cash flow, and thus steering firms to borrow against their asset stock. For the white region, in low productivity case, it is larger. The underlying reason is due to the higher productivity, lenders find it easier to offer a contract which ensures the repayment. Note that, both for low and high productivity cases, the southwest region states that if a firm's capital stock is very low, then the firm can only borrow against its cash flow. It makes sense because, if this firm cannot pledge its cash flow, then lenders cannot offer any contract. Thus, there is no tampon of red region between blue and white.

Figure 4 shows the choice of debt in the capital-debt grid for a given low productivity level, when the asset specificity is zero. In the figure, the northwest triangle belongs to

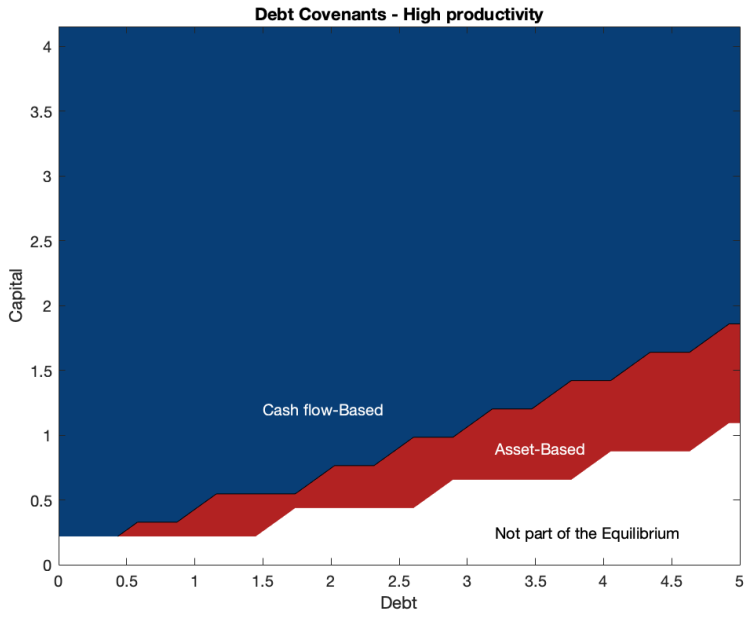


Figure 3

Covenant Choices —High Productivity

the no borrowing region, in which firms fund their investment spendings by their own internal funds. However, the southeast triangle, chiming with Figure 2, represents the region which is not part of the equilibrium.

In the figure, as the color moves from blue to yellow, the amount of debt undertaken by the firms increase. Thus, as firm's capital stock decreases and debt stock increases (moving towards southeast), firm is more likely to borrow more.

Similarly Figure 5 presents the results for a high productive firm. Being able to earn more profits, comparing to Figure 4, no borrowing region is bigger, and no equilibrium region is smaller. In terms of leverage, both 4 and, 5 indicates that low leveraged firms (the left half of the figures) mostly prefer cash flow based borrowing, again in line with empirical evidences presented in Cloyne et al. (2018). Moreover, as the firms' available internal funds increase, then they do not borrow but use their own funds to finance their investment spendings in order to avoid the costs that comes with external funding—whichever the underlying covenant is.

4.2 Life Cycle of an Average Firm

Figure 6 displays the life cycle characteristics of the heterogeneous production firms. It is simulated from an economy which inhabits 1000 firms, and the capital and debt choices

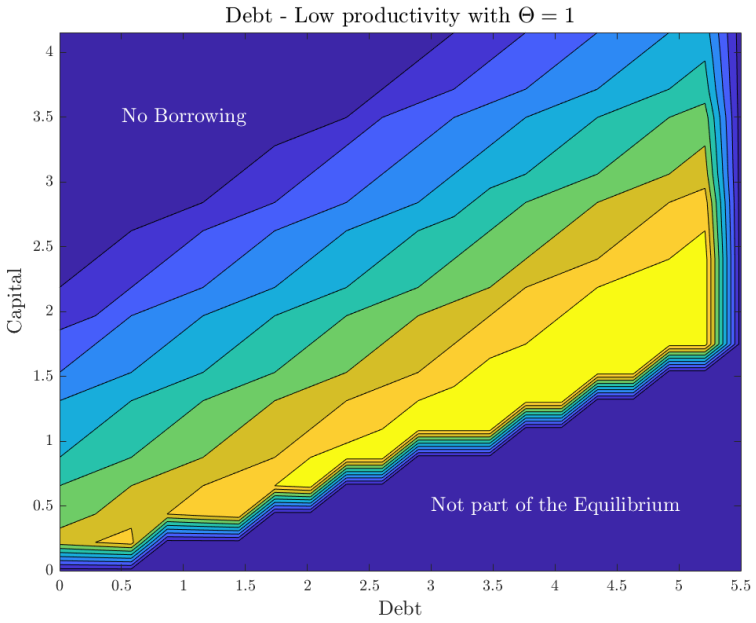


Figure 4

Debt Level —Low Productivity

corresponds to the average behavior of these 1000 firms. Approximately, for the first 8 periods of their life, firms try to grow up by accumulating capital and finance their investment by acquiring debt. After 10 periods, firms start to decumulate their debt stock, while still (slowly) growing. This is a clear identification that firms use their internal fundings, when they have enough funds as in Cooper and Ejarque (2003). Approximately after 15 periods, firms pay off all of their debt stock.

5 Quantitative Monetary Policy Analysis

5.1 Aggregate Response to Monetary Policy

5.2 Heterogeneous Responses to Monetary Policy

5.3 Aggregate Implications of Financial Heterogeneity

6 Conclusion

In this paper I investigate the relevance of firm debt contracts on the transmission of monetary policy to firm investment. By employing loan level credit information and firm-level

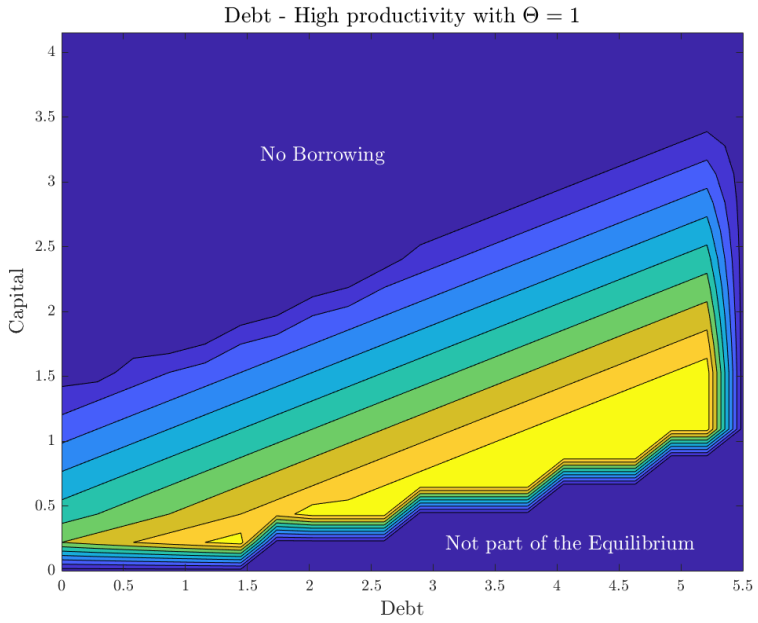


Figure 5

Debt Level —High Productivity

balance sheet data, first I show that firms with more pledgeable assets prefer to sign asset based debt agreements, while more profitable firms usually opts for cash flow based debt contracts. Second I show that following a contractionary monetary policy shock, firms with asset based borrowing contracts invest significantly less than firms with cash flow based debt contracts.

To interpret these empirical findings, I construct a heterogeneous firm New Keynesian model with financial frictions and two types of debt contracts. In the model, monetary policy transmits to firm investment through cost of capital and borrowing constraints. In the near future, I will show that asset based borrowers are more responsive to monetary shocks because their borrowing constraint is more sensitive to asset price fluctuations.

The results of this paper is of crucial interest to monetary policy makers as these results contribute to the understanding about how monetary policy transmits to firm investment and borrowing. In a nutshell, my findings emphasize the role of debt contracts and their interactions with financial frictions in the transmission of monetary policy to investment and contributes to the growing literature body about heterogeneity and its impact on the monetary policy transmission mechanism.

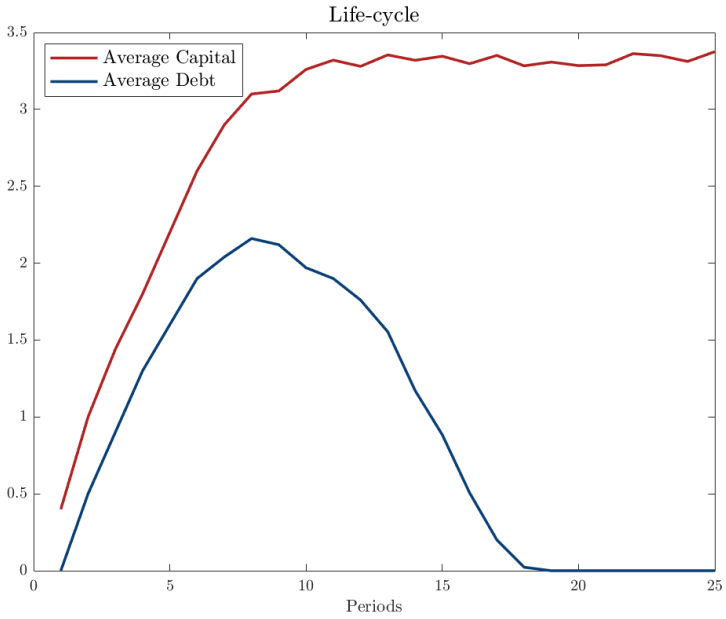


Figure 6

Lifecycle of an Average Firm

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Appendix

A Data Appendix

A.1 Dataset Construction

Further treatment about the linking procedure will be explained here.

A.2 Variable Construction

Construction of the variables will be explained here.

Table 2
Compustat Variable Definitions

Variable	COMPUSTAT
Capital Expenditures	CAPXY
CAPXQ	D.CAPXY (within year)
Investment Ratio	(CAPXQx4) / L.PPENTQ
Total Assets (Book Value)	ATQ
Debt in Current Liabilities (Book Value)	DLCQ
Long-term Debt (Book Value)	DLTTQ
Total Debt (Book Value)	DLCQ + DLTTQ
Leverage (Book Value)	(DLCQ + DLTTQ) / ATQ
Cash and Short-term Investments (Book?)	CHEQ
Liquidity Ratio (Book Value)	CHEQ / ATQ
Sales / Turnover	SALEQ
Cost of Goods Sold	COGSQ
Selling, General and Administrative Expenses	XSGAQ
EBITDA	SALEQ - COGSQ - XSGAQ
EBITDA	OIBDPQ
Interest and Related Expenses (!) [Interest Paid]	XINTQ
Interest Paid [Some negative values]	INTPNY
INTPNQ	D.INTPNY (within year)
Rent Expense	XRENT
Subordinated debt	DS
Cash Dividends (!) [Dividends Paid]	DVY
DVQ	D.DVY (within year)
Dividends - Preferred / Preference	DVPQ
Acquisitions [Why within year?]	AQCY
AQCQ	D.AQCY (within year)
Acquisitions [Why normalize?]	AQCY / ATQ
Price Close	PRCCQ
Common Shares Outstanding	CSHOQ
Common Equity	CEQQ
Deferred Taxes and Investment Tax Credit	TXDITCQ
Property, Plant and Equipment, Gross (Book Value, Annual)	PPENT
Property, Plant and Equipment, Net (Book Value, Annual)	PPEGT
Inventories(Book Value, Annual) and Quarter	INVT
Receivables (Book Value, Annual) and Quarter	RECT
Collateral (Book Value, Annual)	PPENT + INVT + RECT
Operating Activities Net Cash Flow (Annual)	OANCFY
OANCFQ	D.OANCFY (within year)
Cash Receipts (Annual) [Why normalize?]	(OANCF + XINT) / AT

Table 3
CONSTRUCTED VARIABLE DEFINITIONS

Variable	COMPUSTAT
Net Debt Issuance	(DLTIS - DLTR) / L.AT
ΔLong-term Debt (Book Value)	(DLTTQ - L.DLTTQ) / L.AT
Δ Total Debt (Book Value)	(DLTTQ + DLCQ - L.DLTTQ - L.DLCQ) / L.AT
Capital Expenditure	CAPX / L.AT
CAPXQ	D.CAPXY (within year)
Investment Ratio	(CAPXQx4) / L.PPENTQ

B Model Appendix

Further details about the model will be added here.

C Computational Algorithm

Step 1 Solve the problem under full commitment assumption, and obtain the value function $V_{FC}(z,k,b)$ and the policy functions $k'_{FC}(z,k,b)$ and $b'_{FC}(z,k,b)$. Here, full commitment problem refers to maximization of (7) subject to (8) and an optimal debt covenant in which firms are not allowed to walk away from their contracts.

Step 2 Now, allowing for limited commitment, find the level of the borrowing constraints that lenders ensure in every state of the next period. The necessary steps are:

- Find the set of b values that imply negative values for (10) and (11) for each point in the capital grid and state of idiosyncratic productivity shock.
- Looking for the loosest of borrowing constraint values in the idiosyncratic productivity process, find the vector of minimum values in z for each possible choice of capital stock.
- Vector $\bar{b}(z',k')$, contains the value of the borrowing constraint evaluated at each point in the capital grid and state of idiosyncratic productivity shock.

Step 3 Given the borrowing constraint for each point in (z,k) grid, update the objective function implied by $nw - qk' + \mathcal{Q}b'$. Thus, firms never visit the areas that belong to debt levels greater than borrowing constraint.

Step 4 Solve the constrained problem by taking into account the borrowing limit, $\bar{b}(z',k')$. Obtain the value function $V(z,k,b)$ and the policy functions $k'(z,k,b)$ and $b'(z,k,b)$.

D Discussions About Debt Covenants

What happens upon breaching a covenant? United States legal structure that governs default resolutions prevent lenders to seize firms' assets in case of bankruptcy. This is to ensure that firms can continue their operations, albeit under different management. These bankruptcy laws have different chapters depending on the debt type. For instance, Chapter 7 regulates the liquidation of assets which are pledged as collateral. Courts apply Chapter 7, when firms borrow with asset-based covenants and these covenants are breached. Therefore, in any asset-based covenant, firm borrowing is limited by the liquidation value of pledged assets.

Furthermore, when cash flow-based covenants are breached by the firm, then courts apply Chapter 11, which regulates restructuring of the defaulting firm. In this case, upon violation of a covenant, lenders have the right to accelerate the loan which means borrowers have to pay the debt due immediately when requested. In most cases this does not happen, and both parties come together and agree on new terms such as transferring the management rights, or apply strict limits on borrowing etc. (Chava and Roberts, 2008; Roberts and Sufi, 2009a; Nini et al., 2009, 2012).

Loan vs Corporate Bond. Kahan and Tuckman (1993) states that compared to terms of corporate bond issuance, loan agreements more aggressively dictate terms and thus impose strict limits to the firm's actions (mostly borrowing). Verde (1999) compares firms' choice of debt instruments and finds that borrowing via bonds generally comes with looser restrictions. Furthermore, Billett, King, and Mauer (2007) suggests that only 5% of bond indentures dictates restriction on firm. However, given the fact that bonds do not contain such limits on firm's actions, they are still bound by the existence of loan covenants. It is due to the fact that a loan covenant limits a firm's total debt, regardless the underlying source of the debt (*i.e.* through bond issuance, or loans). The underlying reasons behind why firms comply with the loan covenants: (*i*) loans are faster way to borrow, (*ii*) bond issuance are subject to considerable amount of transaction costs, (*iii*) credit rating agencies charge significant amount to grade the issued bonds (sometimes this cost is high enough that some firms opt for issuing ungraded bonds which are significantly cheaper than their graded counterparts), *iv*) if a firm is rated as "below investment grade" then the premium they are obliged to pay is very large. To sum up, due to the above-mentioned reasons firms are willing to comply with the limits that lenders impose.

E Equilibrium Definition

A recursive equilibrium in this economy, given prices $\left\{\rho, r^D, r^B, w, p, q\right\}$, the borrowing constraint rules, operating cost, initial distribution $\mu_0(z,k,b)$ of firms over idiosyncratic states, set of value functions $\left\{V(a,\eta), V(z,k,b), V^{Asset}(z,k,b), V^{Cash}(z,k,b), V_I(B,D)\right\}$ and allocations $\{c, l, a', \eta'\left(z', k', b'\right), B', D', k', b', l'\}$ such that:

1) Production firms. Given the borrowing constraint rules and operating cost $\{\Phi\}$ and prices $\{p, q, \mathscr{Q}, w\}$; allocation $\{k', b', l\}$ and the value functions $\left\{v(z,k,b), v^{Asset}(z,k,b), v^{Cash}(z,k,b)\right\}$ solves production firm's problem governed by 6, 7 and 8, by satisfying the optimal choice of debt covenant governed by 9, 10, 11, and 12.

2) Financial Intermediary. 21 holds and financial intermediary earns zero profits. Also, intermediary's lending operations are solely funded through deposits it receive, *i.e.* $B' = D'$;

3) Household. Given prices $\{r, w, \rho\}$, value function $\{V(a,\eta)\}$ and allocation $\{c, l, a', \eta'(z,k',b')\}$ solves the household's problem governed by 18, 19. And it satisfies 20 and the intratemporal optimality condition $w = \psi c$;

4) Stationary distribution. Stationary distribution of firms

$$\mu(z,k,b) = \mu'(z,k,b) \tag{E.1}$$

5) Labor market clearing. Labor market clears.

$$l = \int_{\mathbf{S}} l\mu(z,k,b)\, d(z,k,b) \tag{E.2}$$

6) Equity market clearing. The equity market clears.

$$\eta(z,k',b') = 1 \quad \text{for each firm } (z,k',b') \in \mathbf{S} \tag{E.3}$$

7) Debt market clearing. The debt market clears.

$$B' = \int_{\mathbf{S}} b'\mu(z,k,b)\, d(z,kb) \tag{E.4}$$

8) Deposit market clearing. The deposit market clears.

$$D' = a' \tag{E.5}$$

9) Goods market clearing. The goods market clear by Walras Law.

$$\begin{aligned} C + &\int_{\mathbf{S}} k'\mu(z,k,b)\, d(z,k,b) + \int_{\mathbf{S}} \Phi\mu(z,k,b)\, d(z,k,b) \\ &= \int_{\mathbf{S}} zk^{\theta}l^{\nu}\mu(z,k,b)\, d(z,k,b) + (1-\delta)\int_{\mathbf{S}} k\mu(z,k,b)\, d(z,k,b) \end{aligned} \tag{E.6}$$

F Impact of Volatility on the Firms' Covenant Choice

If idiosyncratic productivity shocks are highly volatile, asset based lending is more plausible. Since lenders write contracts to ensure that firms repay their debt in every state, the lowest realization of the shock becomes crucial. The mechanism is as follows, higher dispersion in the idiosyncratic productivity distribution means lower worst realization, this yields tighter borrowing constraints.