Debt Contracts, Investment, and Monetary Policy

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Abstract

This paper studies the effect of asset-based versus cash flow-based debt contracts on the transmission of monetary policy to firm-level investment and borrowing. Using information from detailed loan-level data matched with balance sheet data and stock return data, I document that in response to a contractionary monetary shock, asset-based borrowers experience sharper contractions in borrowing and investment than cash flow-based borrowers. Despite the fact that asset-based borrowers contribute only 15% to aggregate investment, they are responsible for 64% of the total investment *response*. To understand the channels and provide a microfoundation for the endogenous choice of these debt contracts, I set up a heterogeneous firm New Keynesian model with limited enforceability. The quantitative model shows that the traditional collateral channel explains this heterogeneous sensitivity as cash flow-based borrowers are less susceptible to collateral damage from changes in asset prices. This result indicates that the prevalence of asset-based debt contracts increases the strength of the financial accelerator channel and thereby shapes monetary policy transmission.

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

JEL classification codes: E22, E32, E44, E52

1 Introduction

How does the nature of debt contracts affect the monetary policy transmission to firm-level investment? Using information from detailed loan-level data matched with firm-level balance sheet and stock return data, I document that in response to a contractionary monetary shock, firms with asset-based contracts experience a sharper contraction in investment and borrowing than firms with cash flow-based contracts. I explain this finding by means of a heterogeneous firm model where firms optimally choose their contract type while asset-based borrowing constraints tighten more than cash-flow based constraints after an increase in the policy interest rate.

My focus on the composition of borrower contracts for the transmission of monetary policy is motivated by recent evidence and theory stressing two points. First, in contrast to the conventional, asset-based centered approach in the macrofinance literature, in the data, cash-flow based contracts are more prevalent than asset-based contracts.[1] In fact, around 80% of US corporate debt agreements reference a cash flow measure in determining the borrowing limit (Lian and Ma, 2021). Second, cash flow-based borrowing constraints respond to aggregate shocks differently from asset-based borrowing constraints.[2] The novelty of my approach is to endogenise the firm's choice of contract. In particular, I first empirically show that this choice is endogenous to the stance of monetary policy, then build a model in which firms may switch contract type when asset-based ones become too tight, thereby further weakening the collateral channel of monetary transmission.

The dataset I use in the empirical analyses is the first one to merge loan-level data from DealScan, firm-level balance sheet data from Compustat, and stock return data from CRSP.[3] Using this merged dataset, I first show that firms with higher asset pledgeability ratios (ratio of tangible assets to total assets) and stock beta (more volatile stock return) tend to choose asset-based debt contracts.[4] On the other hand, cash flow-based borrow-

[1]The financial accelerator literature emphasizes how monetary policy affects the value of asset stock and net worth, which have indirect consequences on the borrowing capacity of firms, which in turn affects their ability to make investments (Kiyotaki and Moore, 1997; Bernanke, Gertler, and Gilchrist, 1999).

[2]Drechsel (2023) shows that a positive investment shock increases investment, boosts aggregate demand and income while lowering the relative cost of capital. Therefore, higher income causes looser borrowing constraints under earnings-based formulation. On the contrary, the lower relative value of capital tightens the borrowing limits under the collateral constraint.

[3]See Section 2.3 for the detailed exposition of the dataset and how it compares to Lian and Ma (2021).

[4]To enrich the statistics by two additional stock return measures, I use CRSP stock return data and run a single factor CAPM-type regression with 36-month rolling window. Analysts and investors widely use the Capital Asset Pricing Model (CAPM), which yields two fundamental stock features. *i*) **Stock beta:** the correlation between market and stock volatility (captured by the slope term), *ii*) **Jensen's alpha:** the performance of stock compared to the market (captured by the intercept term). See Appendix B.1 for detailed discussion.

ers tend to have larger profitability as measured by higher Jensen's alpha and EBITDA.[5] However, there is no meaningful difference in terms of loan characteristics (*i.e.* credit spread and maturity) between asset-based and cash flow-based loans.

The second set of empirical findings provides evidence on how firms' investment and borrowing sensitivity to monetary policy shocks depend on their debt contract form. Using high frequency identified monetary policy shocks, I estimate impulse responses of investment and borrowing with local projections method à la Jordà (2005).Three main findings arise from this exercise. First, conditional on a rich set of firm-level and aggregate control variables, an unexpected interest rate increase causes asset-based borrowers to cut their investment two-times more than cash flow-based borrowers. The gap in the investment response between the two groups lasts up to five years following the shock and indicates wide differences in capital accumulation. Second, in terms of borrowing response, firms with asset-based contracts are approximately four-times more responsive. Third, a small fraction of firms with asset-based contracts switch to cash flow-based contracts, implying that a contractionary monetary shock may more negatively impact asset-based contracts.

Regarding aggregate implications, despite constituting only 15% of the total investment within the sample period, 64% percent of the total investment *response* to monetary policy shocks is initiated by asset-based borrowers. For the total borrowing response, the result is more stunning: 79% of the borrowing response comes from asset-based borrowers.

To explain these empirical patterns and investigate the relevance of the collateral channel in driving the heterogeneous sensitivity and the aggregate implications for the financial accelerator mechanism, I incorporate the cash flow-based borrowing constraints into a macrofinance model consisting of heterogeneous firms, limited debt enforcement, and nominal price rigidity. By employing the model, first, I investigate the relevance of the collateral channel in the heterogeneous transmission of monetary policy shocks. Second, I conduct a counterfactual experiment to demonstrate how this heterogeneous sensitivity implies that the strength of financial accelerator may diminish as more firms in the economy hold cash flow-based contracts.

In the model, firms endogenously choose whether to borrow with an asset-based or cash flow-based contract in each period. I introduce this mechanism by incorporating state contingent borrowing limits resulting from limited debt enforcement. *Ex post*, firms can renege on their promise to repay, thus breaching their contracts. *Ex ante*, by perfectly

[5]EBITDA is a widely used measure of corporate cash flow and stands for **E**arnings **B**efore **I**nterest, **T**axes, **D**epreciation, and **A**mortization.

foreseeing the outcomes, the financial intermediary sets state contingent borrowing limits for both contract types and thus ensures that firms repay in every state of tomorrow. To achieve this, the financial intermediary determines the borrowing limits based upon the incentive compatibility conditions, which require that the value of repayment must be greater than the value of default in all possible states of tomorrow.[6] Typically, the consequences of a contract breach and thus, the value of default depends on the underlying contract.[7] With asset-based contracts, firms lose the pledged portion of their capital stock when they default, which makes the associated borrowing limit a direct function of the capital price. Under cash flow-based contracts, lenders have claims against the firm entity. Therefore, the debt limit is dictated by the firm's value, approximated as a multiple of its cash flow.[8] In both contracts, limited enforceability of loan contracts directly maps into the firm's *ex ante* borrowing capacity. Finally, firms select the optimal contract in each period by observing the state-dependent debt limits.

The model is calibrated to match key moments of firm-level investment and borrowing observed in the micro data. To analyze the model's predictions while matching the empirical strategy, I estimate a variant of local projections specification on the simulated data. The model matches the observed empirical patterns and exhibits that firms with asset-based contracts reduce their investment and borrowing more than cash flow-based borrowers. These model-produced impulse responses of investment, output, and consumption at their peak are in line with Christiano, Eichenbaum, and Evans (2005), which can be interpreted as non-targeted empirical moments.

After verifying that the model performs well in terms of targeted (cross-sectional) and non-targeted (magnitude of impulse responses) moments, I analyze how capital price fluctuations drive the differences in responses among asset-based and cash flow-based borrowers by shutting down the asset price channel. When the asset price channel is shut down, the differential response of investment (borrowing) is dampened by 54% (48%).

I also conduct a counterfactual experiment comparing the baseline economy's aggregate investment and borrowing response with three alternative economies. When both types of contracts are available in the economy but the capital price is fixed, the investment (borrowing) response is 28% (41%) lower than the baseline case. When only asset-based contracts are available in the economy (and the capital price is responsive), investment and borrowing responses are larger in magnitude, 35% and 53%, respectively.

[6] This approach makes borrowing constraints endogenous. As a contribution to the recent growing literature about debt covenants, this paper attempts to provide a microfoundation for the implied borrowing limits of debt contracts.

[7] See Section 2.2 and Appendix E for further details.

[8] See Section 2.2 for details.

Finally, the responses are remarkably smaller in an economy with only cash flow-based contracts. These findings suggest that the financial accelerator mechanism is effective, and its strength is tied to the collateral channel and may diminish as more firms in the economy hold cash flow-based contracts. This exercise implies that monetary policy is less effective in the states/countries where cash flow-based contracts are more prevalent.

Finally, I analyze whether the heterogeneous responsiveness among asset-based and cash flow-based occurs only under conventional monetary policy tools or holds for quantitative tightening (QT) as well. To do so, I run the local projections regression in a similar fashion to the baseline empirical framework. The findings about QT policy resemble the conventional contractionary monetary policy as the magnitude of the impulse responses of investment and borrowing among asset-based borrowers is higher than cash flow-based borrowers.[9]

Related Literature. This paper contributes to several strands of the literature. The 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. Bernanke et al. (1999) introduces the financial accelerator mechanism, and Kiyotaki and Moore (1997) studies the business cycle implications of the collateral channel. I contribute to this literature by evaluating the relative strength of financial accelerator mechanism through asset-based and cash flow-based contract types.

Second, I contribute to the literature that studies 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). This paper contributes to this literature branch by providing a rationale for the coexistence of asset-based and cash flow-based debt contracts.

Third, there is a relatively new strand of literature about debt covenants. Lian and Ma (2021) empirically presents that debt covenants are often written as cash flow-based. Sharing similar findings, Drechsel (2023) develops a representative firm New Keynesian model to study the role of borrowing constraints on the transmission of investment shocks. Greenwald (2019) focuses on an environment in which only earnings-based

[9]In Appendix D, motivated by the empirical evidence about heterogeneous QT transmission, I conduct a QT experiment with the quantitative model. The results suggest that the key mechanism works through the heterogeneous responses of borrowing constraints.

covenants exist and reveals the state dependence of the effectiveness of monetary policy shocks. I contribute to this literature by deriving these borrowing limits from first principles instead of imposing *ad hoc* functional forms, thus endogenising the contract choice.

In spirit, this paper is closely related to the literature body that investigates the heterogeneous sensitivity to monetary policy shocks. The balance sheet liquidity (Jeenas, 2023), age/dividend status (Cloyne, Ferreira, Froemel, and Surico, 2023), leverage/credit spread (Anderson and Cesa-Bianchi, 2020), distance to default (Ottonello and Winberry, 2020), and debt maturity (Jungherr, Meier, Reinelt, and Schott, 2022). I contribute to this literature by focusing on the role of debt contracts, particularly the formulation of borrowing constraints. The results presented in this paper should not be seen as a contradiction to the above-mentioned studies; instead, as a complementary study that focuses on debt contract heterogeneity.

Finally, this paper borrows key insights from the corporate finance literature, focusing on the implications of debt covenants. 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 how debt covenants affect monetary policy transmission.

Road Map. The rest of the paper is organized as follows. Section 2 explains the data used in this paper and presents empirical specifications along with the results. Section 3 develops the heterogeneous firm model and discusses selected equilibrium properties. Section 4 explains the calibration strategy. Section 5 covers the role of firm characteristics in selecting the debt contract type. Section 6 discusses that firms' heterogeneous sensitivity to monetary policy shocks depends on the contract type and further elaborates that heterogeneity in the responsiveness is associated with the collateral channel. Section 7 concludes.

2 Empirical Framework

In this section, I discuss the datasets and the empirical strategy employed in the paper. To the best of my knowledge, the final dataset I use in the empirical analyses is the first one that merges loan-level data from DealScan, firm-level balance sheet data from Compustat, and stock return data from CRSP.[10] The underlying reason for bringing together these datasets is twofold. First, to investigate which firm characteristics are at play in debt contract choice, and second, to clearly identify which firm can be classified as asset-based or cash flow-based. Throughout, 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, then elaborate on the relevance of the debt contracts concept from the macroeconomics perspective. In Section 2.3, I discuss Compustat, a firm-level balance sheet and income statement dataset, and present cross sectional features of asset-based and cash flow-based borrowers. In Section 2.4, I document that compared to the asset-based borrowers, cash flow-based borrowers are less sensitive to monetary policy shocks.

2.1 Identification of Monetary Policy Shocks

As well documented by researchers, identifying the unanticipated portion of monetary policy changes requires overcoming the bilateral interaction between the federal funds rate and the aggregate economy. An extensive literature strand utilizes the asset price fluctuations around Federal Open Market Committee (FOMC) announcements to extract its unanticipated component.[11]

Monetary policy shocks are identified by using high-frequency financial market movements that arise around the press releases of Federal Open Market Committee (FOMC).[12] To obtain the monetary policy shocks, Gürkaynak et al. (2005) and Gorodnichenko and Weber (2016), 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 any other factor does not contaminate the market's expectations.

I construct the shock as below.

[10]To be clear, Lian and Ma (2021) utilizes a larger dataset by combining DealScan, Compustat, and FISD, along with the hand-collected data from 10-K filings; however, their focus is on the classification of loans into the asset-based and cash flow-based categories. This paper instead focuses on *i*) utilizing Compustat in a more comprehensive way to understand how monetary policy transmits to the firm level-investment and borrowing through the different types of borrowing constraints; *ii*) using CRSP data to bring in the novel stock return implications – profitability and volatility– on the debt contract choice, beyond usual proxies such as age, size, or leverage.

[11]Using event study based approach to extract monetary policy shocks builds on the influential studies of Kuttner (2001) Cochrane and Piazzesi (2002),Bernanke and Kuttner (2005), Gürkaynak, Sack, and Swanson (2005) and goes back to Cook and Hahn (1989).

[12]I obtain information on the exact timing of FOMC press releases, and implied shock measures from Gorodnichenko and Weber (2016).

$$\varrho_{\tau_j} = \text{ffr}_{\tau+\Delta_+} - \text{ffr}_{\tau-\Delta_-} \quad (1)$$

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 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 the shocks. Process involves summing ϱ_{τ_j} up within quarter t, as presented below:

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

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 date at which FOMC press release is issued.

Given the fact that ε_t^m is only a proxy for the purely unanticipated quarterly monetary policy shocks ε_t, 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). These studies state that within each monetary policy shock extracted à la Gürkaynak et al. (2005), the monetary component should be disentangled from another contemporaneous non-monetary component. Therefore, as a robustness exercise, to check if my results are significantly affected by the non-monetary component of the monetary policy shock, I use Nakamura and Steinsson (2018) shocks. The results are less pronounced but qualitatively persist. Details are provided in Section A.6.

2.2 Loan-level Debt Information

In this section, I explain the data I use for loan-level information and briefly describe the debt contracts and their relevant features to the macroeconomics literature. Specifically, I collect the contract data from the DealScan database and, using the linking file of Chava and Roberts (2008), merge it with Compustat.[13] Although DealScan goes back to older dates, following Greenwald (2019), the sample starts in 1997Q1 since before this date covenant variable in DealScan is sparsely populated. The sample ends in 2017Q3, which is dictated by the most recent version of Chava and Roberts (2008)'s linking file (April,

[13]Details of the merging procedure are presented in the Appendix A.4

2018).

In what follows, I provide some background information on debt contracts and discuss how the borrowing method translates into different forms of borrowing constraints. The main variables of interest are the indicator variables for having cash flow-based or asset-based debt contracts. The details about classification procedure is discussed in Appendix A.2.

Asset-based Contracts. In these contracts, the borrowing limit is mainly dictated by the liquidation value of the pledged assets. Pledgeable assets could be physical (e.g., machinery, inventory, building *etc.*) as well as suitable intangible assets such as usage rights, patents, etc. The lending procedure is as follows. Before granting the amount requested, lenders employ analysts to appraise the liquidation value of the pledged assets by conducting on-site field examinations and simulating various liquidation scenarios. Then, lenders set a borrowing limit by using their discretion in setting the borrowing limit. During the agreement's lifetime, lenders keep conducting field exams quarterly and update the liquidation value estimates accordingly. Therefore, the borrowing limit is a dynamic object, and its enforcement rule utilizes the most recent estimate.

Given the above procedure, asset-based contract's *ad hoc* contractual borrowing constraint takes the form

$$b' \leq \theta q k \tag{3}$$

where θ is the borrowing base, q is the appraised price of capital, and k is the pledged asset stock. Asset-based contracts are the traditional treatment in the classic macrofinance models (Kiyotaki and Moore, 1997).

Cash flow-based Contracts. In cash flow-based contracts, the debt limit is determined by the cash flow generated by the firm's ongoing activities. This is due to the fact that under cash flow-based debt contracts, lenders have claims against the firm entity and have the right to take over the firm's management. A significant share of cash flows based contracts belongs to syndicated loans. Therefore the lending procedure is shaped by loan syndication practice (Lian and Ma, 2021). With cash flow-based contracts, the process is as follows. When the requested loan amount exceeds a single lender's targeted risk exposure level, a consortium of lenders is formed, and they cooperate in providing the money requested. Forming a consortium mitigates the risk undertaken by each lender, as the associated risks are shared between group members. To coordinate the operation, one of the lenders in the consortium takes the lead financial institution role and carries out all the necessary procedures throughout the duration of the loan, such as initial transactions, corresponding fees, and repayments. This leader bank is also responsible for due diligence, monitoring the firm's compliance, and reporting to member banks.

A solitary loan agreement covers the entire lending process. However, depending on each lender's individual condition, terms could vary for each lender. Each bank is liable for its portion of the total loan. The loan amount undertaken by each lender, loan maturity, and collateral requirements could differ for each lender. If more than one of the lenders requires collateral, then the consortium leader assigns different assets of the borrowing firm for each lender.

In cash flow-based contracts, as the lenders have claims against the company entity, the debt limit is calculated via the firm's going-concern cash flow value. However, due to contractibility issues, lenders calculate a firm's going concern cash flow value by taking the multiples of the firm's operating earnings.[14] Due to its verifiability, borrowing limits are calculated based on a cash flow measure called EBITDA. Because of this relative valuation method using multiples, contracts most commonly require a variation of the following formulation

$$b' \leq \phi\pi \tag{4}$$

where π is EBITDA and ϕ is the multiple. These cash flow-based agreements are enforced through legally binding financial covenants.[15] As is easy to monitor, max. Debt-to-EBITDA covenant is popular among lenders.[16] Drechsel (2023) states more than 60% of the agreements carry max. Debt-to-EBITDA covenant.[17] As cash flow-based contracts have one master loan agreement; these debt covenants bind at the firm level. Namely, the limit dictated by max. Debt-to-EBITDA is also effective on other types of borrowing, such

[14]This valuation method is called relative valuation (multiples of EBITDA) as opposed to absolute valuation (Discounted Cash Flow analysis). The underlying reason and more details about both valuation methods are discussed thoroughly in Appendix E.1.

[15]Debt covenants are terms and conditions that borrowers are obliged to fulfill and written explicitly in the debt contracts. These terms may include limits on financial ratios as well as levels of capital expenditure, leverage, and so on. Although there are various types of covenants in these contracts, this paper focuses on cash flow-based covenants. These loan covenants mandate that throughout the life of the loan agreement, firms must satisfy some financial ratios —most prominently, max. Debt-to-Assets or max. Debt-to-EBITDA. More details can be found in Appendix E.

[16]Max. debt-to-EBITDA ratio is in fact the rearranged version of (4). It is simply $\frac{b'}{\pi} \leq \phi$ and since b' and ϕ is observable, it is easy for the lender to track the firm's compliance to the covenant.

[17]In fact, cash flow-based covenants also have two broad categories: interest payment-to-total debt or cash flow-to-total debt. Greenwald (2019) exclusively focuses on these two covenants and suggests a state-dependent mechanism in interest rate transmission.

as issuing bonds. Throughout the loan's lifetime, due diligence is carried out, and -on behalf of all lenders- the consortium leader continuously monitors the borrowing firm's cash flows and debt stock to check its compliance with the covenant.

Prevalence of Cash flow Based Contracts. Compiling the data from various data sources Lian and Ma (2021) shows that (median) share of asset-based lending is less than 20% while cash flow-based is over 80%, and more importantly, the shares are steady over time. The sample set consists of large US non-financial firms, of which the total debt of these firms constitutes over 96% of debt outstanding among Compustat firms. Similarly, by using DealScan data, Drechsel (2023) presents that cash flow-based debt agreements are more common than other practices in the lending markets.

2.3 Firm-level Balance Sheet and Income Statement Data

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 make it suitable for empirical analyses. Quarterly frequency makes it possible to 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.[18]

To the best of my knowledge, the data set utilized in this paper is the first attempt that assembles loan-level data from DealScan, firm-level balance sheet data from Compustat, and stock return data from CRSP.[19] To merge DealScan and Compustat, I use the linking file provided by Chava and Roberts (2008) and connect the firm identifiers of both datasets. In particular, I extract the available loan data from DealScan and keep the portion matched to the balance sheet data from Compustat. Then, I merge Compustat with CRSP by employing the Compustat/CRSP link table available in WRDS.[20] The aim of merging CRSP data is to measure firm performance with the well-known financial indicators obtained via single factor CAPM-type regression. Below, I briefly discuss the variable construction for some selected variables. Further details on data treatment can be found in Appendix A.4.

[18] The only drawback is that Compustat only includes publicly listed firms which restrict the sample set to mostly have relatively large firms. Moreover, large firms are considered more trustworthy and less financially 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 -regardless of their size- asset-based borrowers have relatively impeded access to external financing than cash flow-based borrowers.

[19] See Figure A.1 for a succinct depiction.

[20] Wharton Research Data Services.

Corporate finance variables of interest include (but are not limited to) investment (calculated via perpetual inventory method), cash flow (proxied by EBITDA), short-term and long-term debt, interest related expenses, dividend 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. Firm size is proxied by the value of total assets rather than employment since Compustat reports employment measures only in the annual frequency. Further, employment related data is less populated than total assets. Following Cloyne et al. (2023) age variable is not taken directly from Compustat's native initial public offering date as it is not well populated. Instead, I blend Compustat's IPO and incorporation dates from the WorldScope database.

Moreover, since some of the Compustat variables are provided as cumulative values within the firm's fiscal year, I calculate the first differences of those variables within the firm's fiscal year to obtain quarterly data. I limit the sample to firms observed for at least 20 quarters since the impulse response functions are estimated over a five-year forecast horizon. Finally, variables in levels are normalized by firm size, and nominal items are deflated by the GVA deflator. Exact data items, variable codes, and corresponding variable construction procedures can be found in Appendix A.1.

Summary Statistics. Before starting the dynamic analysis, I report some descriptive statistics depicting the salient features of each firm group to explore the link between firm characteristics and debt contracts. Details about the classification into asset-based or cash flow-based categories are presented in Appendix A.2. Table 1 presents the descriptive statistics for asset-based borrowers and cash flow-based borrowers.[21] It would be beneficial to state that these statistics are enriched by two additional stock return measures obtained via running a CAPM-type regression.

Summary statistics illustrate that firms with a higher asset pledgeability ratio (measured by the ratio of tangible fixed assets to total assets as in Cloyne et al. (2023) and Dinlersoz et al. (2018)) tend to choose asset-based debt contracts. Furthermore, asset-based borrowers are mainly among the firms with a higher stock beta, implying a positive correlation between more volatile stock returns and collateral dependence in the contracts. Cash flow-based borrowers mostly have larger profitability as measured by higher

[21] As the final version of data set only includes the observations that could be matched via Chava and Roberts (2008) linking file, the number of observations for the asset-based and cash flow based borrowers are not representative of the population. However, the analyses of Lian and Ma (2021), which includes a more comprehensive dataset suggest cash flow-based borrowers constitute the major portion of all observations. My data set here is in line with their findings in this sense.

Table 1

Summary Statistics: Asset-Based vs. Cash flow-Based

	Asset-Based				
	Mean	SD	P25	Median	P75
Firm Total Assets ($M)	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
Stock Jensen's Alpha (x10^{-2})	-0.54	3.39	-2.00	-0.30	1.15
Stock Beta	1.68	1.06	0.99	2	2.29
Total Observations	8,135				

	Cash flow-Based				
	Mean	SD	P25	Median	P75
Firm Total Assets ($M)	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
Stock Jensen's Alpha (x10^{-2})	-0.33	2.80	-1.39	-0.10	0.97
Stock Beta	1.44	0.99	0.82	1	1.89
Total Observations	55,405				

Note. Summary statistics for asset-based and cash flow-based contracts in the sample. The sample period is from 1997Q1 and 2017Q3. Asset pledgeability refers to the ratio of tangible fixed assets to total assets as in Dinlersoz, Kalemli-Ozcan, Hyatt, and Penciakova (2018) and Cloyne et al. (2023). Profitability is measured as Return-on-Assets as widely used in corporate finance literature. Loan spread is measured in percentage points. The sample consists of 2,236 firms of which 614 firms are asset based borrowers and 1602 are cash flow based borrowers. There are 30,591 loans and 11,457 packages.

Jensen's alpha, EBITDA, and Return-on-Assets.

Table 1 also shows no serious heterogeneity in the age and leverage dimensions. In line with Lian and Ma (2021), asset-based borrowers are generally smaller (as measured by total assets).

Regarding loan characteristics, asset-based and cash flow-based loans' average credit spreads are close to each other (with only a minor difference of 37 basis points). Loan maturities also don't exhibit heterogeneity as both groups have 60 months maturities at the median (with 5.5 month difference at the mean).

2.4 Heterogeneous Sensitivity to Monetary Policy Shocks

The central thought in the empirical analyses is to provide evidence that a firm's debt contract form plays a role in the heterogeneous responsiveness of their investment and borrowing to monetary policy shocks. Following the recent literature on heterogeneous monetary policy transmission (Cloyne et al., 2023; Jeenas, 2023; Anderson and Cesa-Bianchi, 2020; Ottonello and Winberry, 2020), I estimate the impulse response functions using local projection method à la Jordà (2005). I then estimate variants of the baseline empirical specification to better identify the impact of debt contract type.

I start the exercises by estimating the average dynamic effect of monetary policy shock on a variable of interest by borrowing method. The borrowing method indicator splits the entire sample into two, based on whether each firm utilizes an asset-based or cash flow-based debt contract. Regressions are carried out in quarterly frequency. (5) presents the baseline empirical specification.

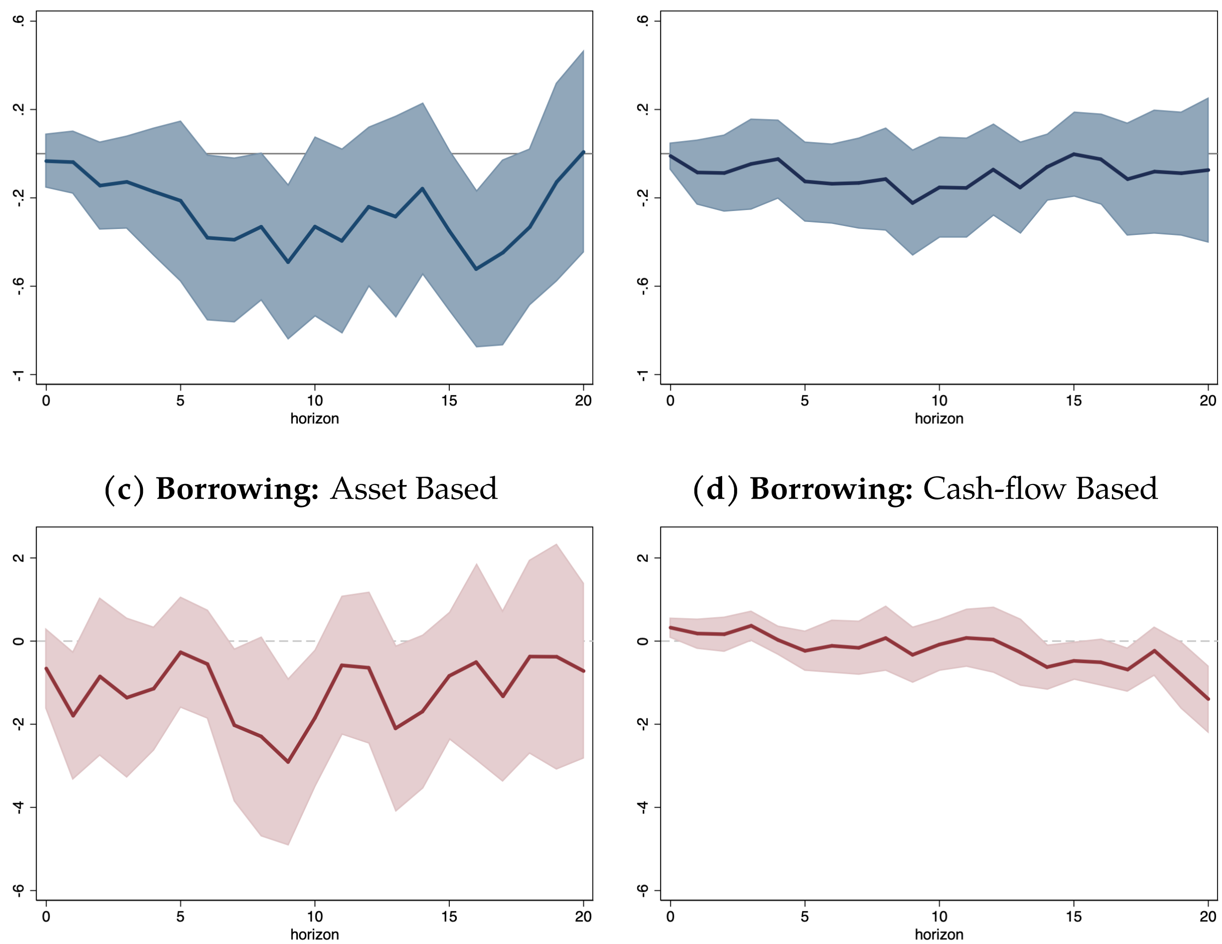
$$y_{j,t+h} - y_{j,t-1} = \alpha_j^h + \beta_1^h \left(\epsilon_t^m \mathcal{I}_{j,t-1}^{Asset}\right) + \beta_2^h \left(\epsilon_t^m \mathcal{I}_{j,t-1}^{Cash}\right) + \sum_{p=1}^{P_Z} \Gamma_p \mathbf{Z}_{j,t-p} + \sum_{p=1}^{P_X} \Gamma_p \mathbf{X}_{t-p} + e_{j,t+h} \quad (5)$$

$h = 0, 1, ..., H$ represents the active time horizon where $H = 20$ quarters. $y_{j,t+h}$ is the dependent variable of interest at horizon h: investment and borrowing. 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 contracts in the prior quarter of the monetary policy shock (otherwise zero) and $\mathscr{I}_{j,t-1}^{Cash} = 1$ when firm j is a cash flow based borrower in the quarter that precedes the monetary policy surprise (otherwise zero). Baseline empirical specification also controls for a variety of idiosyncratic and aggregate factors that may simultaneously affect dependent variables and borrowing method.[22] $\mathbf{Z}$ is

[22]Some of the control variables included in (5) are beyond the scope of the quantitative economic model

the firm level control variable set including leverage, size, age, and current assets share, with $P_Z = 1$. $\mathbf{X}$ is the aggregate control variable set, including GDP, inflation, unemployment rate, and the VIX volatility index, with $P_X = 4$. β_1^h and β_2^h are the regression coefficients of interest capturing the impulse responses among subgroups.

Figure 1
IMPULSE RESPONSES:
ASSET-BASED VS. CASH FLOW-BASED



(a) **Investment:** Asset Based

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

(c) **Borrowing:** Asset Based

(d) **Borrowing:** Cash-flow Based

NOTE. Average impulse response functions for the investment and borrowing following a 25 bps increase in 3-month T-bill rate. The responses are estimated with the local projection specification given by (5). Monetary policy shock is interacted with indicator variable based on the firm borrowing status. The shaded areas display 90 percent confidence intervals. Standard errors are clustered two-way clustered at firm and quarter.

There are two themes in these exercises: *i*) response of borrowing and investment, *ii*) compositional change between contract groups.

depicted in Section 3.

Investment and Borrowing. Figure 1 exhibits the estimated impulse responses using (5). β_1^h and β_2^h belong to the subgroups asset-based and cash flow based, respectively. The top row, Panel (A) and Panel (B) are for investment, and the bottom row, Panel (C) and Panel (D) are for borrowing. The shaded areas denote the 90 percent confidence intervals based on two-way clustered standard errors at firm and quarter. Impulse response functions are estimated over 20 quarters period.

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 flow-based borrowers' response is not statistically significant. Second, the peak response of investment among asset-based borrowers (which occurs 2 years after impact) is almost three times larger than cash flow-based borrowers. Third, these two main points echo in Panel (C) and Panel (D). The borrowing response among cash flow-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.

At this point, it is worth mentioning that Compustat firms are publicly listed and thus relatively larger compared to private firms. Literature frequently assumes that large firms have comparatively easy access to external funding and therefore use size as a proxy for the financial constraints (Gertler and Gilchrist, 1994; Farre-Mensa and Ljungqvist, 2016). However, the empirical results suggest that financial frictions are effective even among firms considered relatively unconstrained.

Contribution to the aggregate response According to the evidence in Figure 1, firms with asset-based contracts are mainly accountable for the aggregate response of investment and borrowing to monetary policy shocks. To demonstrate more formally, I calculate the shares of investment and borrowing responses of asset-based and cash flow-based contract holders. The procedure is as follows. For each group of firms, I start by calculating the discounted percentage changes in borrowing and investing over the forecast horizon. Then, I compute the investment response of each group by multiplying this value by the level of investment for each group. In the last step, I estimate each group's contribution to the total investment response by multiplying this object by the sum of the same statistics for both groups.

The results are shown in Table 2. Despite constituting only 15% of the aggregate investment within the sample period, 64% of total investment *response* to monetary policy shocks are initiated by asset-based borrowers. For the total borrowing response, the result is more stunning. 79% of the borrowing response comes from asset-based borrowers.

Table 2

CONTRIBUTION TO THE AGGREGATE RESPONSE

	Asset-Based	**Cash flow-Based**
Investment	65.9%	34.1%
Borrowing	78.8%	21.2%

NOTE. This table shows the weighted share of the responses by the asset-based and cash flow-based contract holders. For each group, the discounted percentage changes in borrowing and investment over the forecast horizon is calculated. Then, the investment response of each group is computed by multiplying this value by the level of investment for each group. Each group's contribution to the total investment response is estimated by multiplying this object by the sum of the same statistics for both groups.

Note that these calculations are based on an assumption regarding private firms' borrowing methods. Following the census in the literature about private firms being smaller, and given the descriptive statistics about asset-based contracts are taken mainly by smaller firms, it is likely that private firms mostly borrow with asset-based contracts. Therefore, the results depicted in Table 2 would constitute a lower bound for asset-based borrowers' contribution to aggregate investment and borrowing response to monetary policy shocks.

Compositional Change. Figure 2 shows that a fraction of firms with asset-based contracts switch to cash flow-based contracts, and the responses are significant. This shows that contract choice is endogenous to the stance of monetary policy. This finding supports the evidence provided above, as asset-based borrowers are severely affected by a contractionary monetary policy shock while cash flow-based borrowers are relatively not responsive. Indeed, the question arises: if there was nothing wrong with asset-based contracts, why would the firms try to switch cash flow-based contracts? Furthermore, the responses are limited in magnitude since monetary policy shocks are not strong enough for most firms to change their contracts. Taken together, Figure 2 indicates that the baseline empirical results remain valid.

Taking stock of the empirical evidence. First set of findings includes descriptive statistics. The comprehensive dataset used in the paper suggests that the majority of firms use cash flow-based borrowing. Firms with higher asset pledgeability ratios and higher beta tend to choose asset-based debt contracts, while cash flow-based borrowers typically have larger profitability.

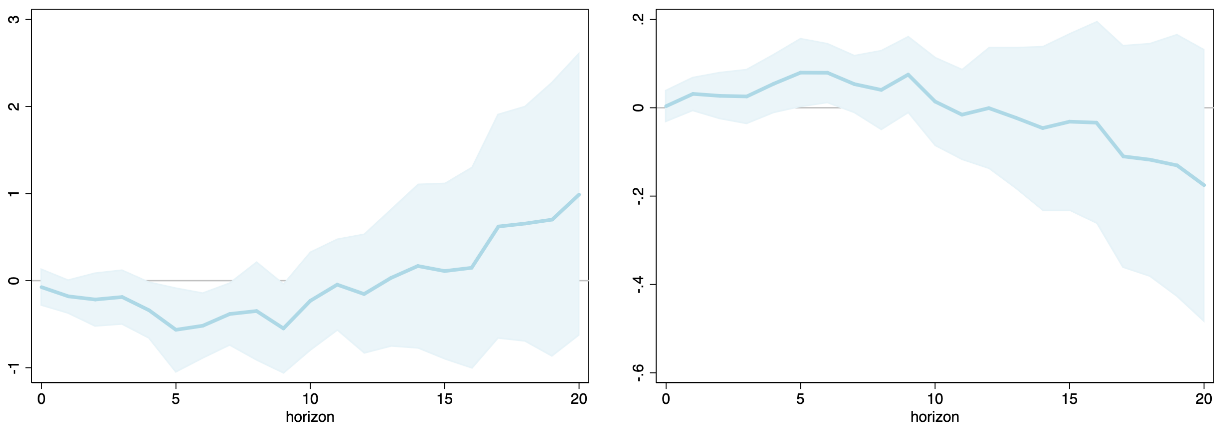
The second set of findings is obtained via a dynamic monetary policy shock experiment. Three main findings arise from this exercise. First, conditional on a rich set of

Figure 2

Impulse Responses: Shares

Asset-based vs. Cash flow-based

(a) Share: Asset Based **(b) Share:** Cash-flow Based



Note. Average impulse response functions for the shares of contracts following a 25 bps increase in 3-month T-bill rate. The responses are estimated with the local projection specification given by $y_{t+h} - y_{t-1} = \alpha^h + \beta^h(\epsilon_t^m) + \sum_{p=1}^{P_X} \Gamma_p \mathbf{X}_{t-p} + e_{j,t+h}$. The dependent variable is the share of asset based contract (for panel (a) and cash flow based contract (for panel (b)). The shaded areas display 90 percent confidence intervals. Standard errors are clustered two-way clustered at firm and quarter.

firm-level and aggregate control variables, an unexpected interest rate increase makes asset-based borrowers cut their investment sharper than cash flow-based borrowers. Second, this investment responsiveness pattern also resembles in the borrowing responses. Third, a small portion of firms with asset-based contracts switch to cash flow-based contracts, as asset-based contracts are affected more severely by the monetary policy shock. Finally, even though the central focus is the debt contract as the main source of firm-level heterogeneity, the main result –the response of borrowing and investment for the asset-based borrowing firms is significantly larger in magnitude– persists after carrying out robustness checks for the possible confounding factors. Particularly, I check whether the baseline results are driven by the spread response, external finance dependence, and regional heterogeneity. See Appendix B.3 for further details about the robustness exercises.

Putting together all of this evidence, a likely explanation of the underlying mechanism behind the heterogeneous responses between asset-based and cash flow-based firms is as follows. The firms issuing new debt with asset-based contracts have to rely on the value of their asset stock to serve as collateral. Therefore, by reducing the asset price, contractionary monetary policy shocks tighten the borrowing constraint for these firms and force them to cut back their borrowing and investment. Whereas the debt limits of cash flow-based debt contracts do not depend on asset prices, they are not affected by the decreasing values of asset prices/collateral values. To evaluate the validity of this mechanism, I set up a quantitative model which captures both the cross-sectional and the dynamic empirical patterns; then, I assess the relevance of this asset price/collateral channel by switching it off and comparing the differential responses.

3 Model

In this section, I develop a heterogeneous firm New Keynesian model to interpret the empirical findings presented in Section 2. The key components of the model are as follows. Production side, which generates heterogeneous responses of investment and borrowing to monetary policy shocks; the financial side, which captures incorporates the state contingent debt contracts; and the New Keynesian components, which help to embed price stickiness.

Heterogeneous production firms are specified in a standard way (Khan and Thomas, 2013; Ottonello and Winberry, 2020). I extend this structure by including cash flow-based debt contracts. Both asset-based and cash flow-based contracts imply state contingent borrowing limits derived from first principles via limited enforcement. The underlying reason for this modeling strategy is twofold. First, to ensure both asset-based and cash flow-based contracts can coexist in the economy. Second, firms can switch between these contract types in each period depending on their idiosyncratic state.

Moreover, as in typical models of the financial accelerator literature, to generate time-varying capital price, the model economy also inhabits capital good producers subject to the convex adjustment cost of aggregate capital. This agent incorporates the financial accelerator mechanism into the model, resulting in a positive correlation between capital price and aggregate investment.

There is also a retail good producer with some market power to set the price, a representative household that owns all production entities in the model economy, and the monetary authority that follows a Taylor-type rule.

There is no aggregate uncertainty in the model, and I study the perfect foresight transition paths in response to an unexpected monetary policy shock. Finally, I use time subscripts to indicate variations in equilibrium prices and value functions. Prime notation is employed to refer to future values in the choice variables.

3.1 Production Firms

Each period, there is a unit mass of heterogeneous production firms investing in capital and participating in the financial markets.[23] Each 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

$$y_{j,t} = z_{i,t} k_{i,t}^{\theta} l_{i,t}^{\nu}. \tag{6}$$

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

$$z_t = \rho z_{t-1} + \sigma \epsilon_t; \quad \epsilon \sim N(0, 1). \tag{7}$$

Since this paper focuses on understanding how different formulations of borrowing constraints shape monetary policy transmission, I incorporate three measures to prevent firms from circumventing financial frictions. The first measure is that each period with probability π_d firms may be hit by an exogenous exit shock which pushes the firm out of the economy regardless of its financial situation. By this method, I prevent all firms from growing to such a size that they are never subject to borrowing restrictions. Exiting firms are replaced by an equivalent mass of new entrants each period to keep the mass constant. The second measure is the existence of operating cost. By incorporating this additional cost of production, firms' dependence on an external finance source increases as some of their cash flow is absorbed by this extra cost of production. The third is imposing a non-negativity constraint on the firms, which prevents firms from raising equity to avoid borrowing limits.

Timing of events Within each period, the following events take place consecutively.

i. The entrant firms with a mass of exiting incumbents enter the economy at the beginning of period t. They hold an initial capital stock k_0, and no initial debt $b_0 = 0$.

ii. Idiosyncratic productivity shock and exogenous exit shock are realized for incumbents and new entrants.

[23] For brevity, hereafter, I refer to production firms as "firms" and other firms are distinguished by using their exact names (*i.e.* retailers, capital good producers, etc.).

iii. Firms produce intermediate good by using their existing capital stock and hiring labor $l_{i,t}$ from a frictionless, competitive labor market. Firms pay the operating cost Φ and the wage bill at w_t, then sell their undifferentiated goods to the retailers with nominal price p_t.

iv. Firms repurchase all outstanding debt.

v. Exiting firms liquidate their total capital stock and pay the remaining funds as dividends to the households. Conditional on survival, firms decide the following simultaneously. *i*) purchase new capital $k_{i,t+1}$ with capital price q_t, *ii*) purchase new debt $b_{i,t+1}$, and *iii*) contract type of the newly issued debt.

vi. The remaining funds (if any) are distributed to the households as dividend payments.

3.2 Debt Contracts

To introduce the coexistence of asset-based and cash flow-based contracts to the model economy, I formulate state contingent borrowing limits derived from limited enforcement. Combined with the heterogeneity across productivity, firms switch between the two contract types depending on the tightness of these endogenous borrowing limits. More elaborately, the borrowing constraints are determined as follows. *Ex post*, firms can renege on their promise to repay, thus breaching their contracts. By having complete information, financial intermediary writes both asset-based and cash flow-based contracts by ensuring that firms repay their debt in every state of tomorrow. To do so, the financial intermediary sets the borrowing limits of both contracts, $\bar{b}^{Asset}\left(z, nw, k'; q\right)$ and $\bar{b}^{Cash}\left(z, nw, k'; \pi\right)$, to satisfy the relevant incentive compatibility constraints, which mandate that the value of repayment has to be greater than the value of default for all possible states of tomorrow. Therefore, limited enforceability of loan contracts directly maps into the firm's *ex ante* borrowing capacity. Thus, by this method, borrowing constraints become state contingent and derived from first principles rather than imposed exogenously.

Each period, firms are offered two types of debt contracts: asset-based or cash flow-based, which differ in terms of default resolution. By observing the terms of both contracts, firms choose the contract with looser constraints.[24] In this setup, a firm's borrowing

[24] However, it is possible in the model that given the initial state (z, nw), the financial intermediary may not ensure the repayment with one of the contracts. If that is the case, financial intermediary only offers one type of contract.

decisions have two dimensions: (i) in the extensive margin, whether to opt for an asset-based or cash flow-based contract; and (ii) in the intensive margin, how much to borrow. Firms can borrow up to the amount which satisfies the relevant enforcement constraint of each contract type.

Asset based contracts. In these contracts, in case of default, firms lose their debt and, as the penalty, lose a fraction Θ of their existing capital stock. Financial intermediary determines the borrowing limit $\bar{b}\left(z, nw, k'; q\right)$ to satisfy the below enforcement constraint

$$v_{t+1}^{Asset}\left(z', nw_{t+1}\left(z', k', b'\right)\right) \geq v_{t+1}^{Asset}\left(z', nw_{t+1}\left(z', (1-\Theta)k', 0\right)\right). \tag{8}$$

(8) states that continuation value under repayment has to exceed (or be equal to) continuation value under default. Also, notice that, since the penalty is based on losing some portion of the capital stock, the associated borrowing limit is closely connected with the capital price.

Cash flow-based contracts. As explained in Section 2.2, lenders have claims against the firm entity and have the right to take over the management in cash flow-based contracts. Therefore the debt limit is dictated by the value of the firm. In the model, following the industry tradition, the firm's value is approximated via its cash flow. If a firm chooses to default on its debt, the penalty is the firm value –as approximated by the multiple of their cash flow. As in asset-based contract, financial intermediary determines the borrowing limit $\bar{b}\left(z, nw, k'; \pi\right)$ to satisfy the below incentive compatibility constraint

$$v_{t+1}^{Cash}\left(z', \hat{nw}_{t+1}\left(z', k', b'\right)\right) \geq v_{t+1}^{Cash}\left(z', \hat{nw}_{t+1}\left(z', k', 0\right)\right) - W_{t+1}\left(z', \hat{nw}_{t+1}\left(z', k', b'\right)\right) \tag{9}$$

where

$$W_{t+1}\left(z', \hat{nw}_{t+1}\left(z', k', b'\right)\right) = \varphi[\underbrace{p_{t+1}z'\left(k'\right)^{\theta}\left(l'\right)^{\nu} - w_{t+1}l'}_{\approx \pi}] \quad \text{for all } z'.$$

Below, I recursively characterize the firm's problem, which introduces the relationship between firms and the financial intermediary regarding debt contracts.

Recursive formulation. The set of individual state variables of a firm includes idiosyncratic productivity shock and net worth; (z, nw). Net worth, nw is defined as firms' total funds before acquiring new debt or purchasing new capital. Due to its static nature, given the idiosyncratic productivity shock, the labor choice problem is merged with the definition of net worth.

In this economy, a firm's investment decision is intertwined with its ability to borrow and the terms of debt it carries into the next period. The financial intermediary writes the debt contracts by taking into account their *future* ability of repayment, thus focuses not on today's but instead on the next period's capital. Therefore, it is essential to keep in mind that in this economy, a firm's individual levels of k and b do not directly influence any of its decisions outside of their impact on net worth.[25] The firm value depends only on z and nw and does not depend separately on k and b because nw completely captures earlier choices that influenced its current choice set. This enables us to lower the dimension of the state vector.

$$nw = \max_{l} \quad p_t z(k)^{\theta} l^{\nu} - w_t l + q_t(1-\delta)k - b - \Phi \tag{10}$$

where Φ is the fixed operating cost to be paid by the firm in order to produce in period t. After production, and dept purchase, conditional on surviving the exit shock, firm chooses between asset-based contract, and cash flow-based contract. This discrete choice of contract is given by the upper envelope:

$$v_t(z, nw) = \max \left\{ v_t^{Asset}(z, nw), v_t^{Cash}(z, nw) \right\} \tag{11}$$

for all states (z, nw).

A firm choosing to borrow with asset-based contract selects the amount of capital and debt to solve the below recursive problem:

$$v_t^{Asset}(z, nw) = \max_{k', b'} \quad nw - q_t k' + \mathcal{Q}_t b' + \mathbb{E}_t[\Lambda_{t+1}(\pi_d nw_{t+1}(z', k', b') + (1-\pi_d) v_{t+1}(z', nw_{t+1}(z', k', b')))] \tag{12}$$

subject to the non-negativity constraint on dividends

$$nw - qk' + \mathcal{Q}b' \geq 0,$$

and the rationality constraint of the asset-based contract

[25] This outcome is impossible in the models with capital adjustment frictions since the adjustment cost is a direct function of investment and today's capital.

$$v_{t+1}^{Asset}\left(z', nw_{t+1}\left(z', k', b'\right)\right) \geq v_{t+1}^{Asset}\left(z', nw_{t+1}\left(z', (1-\Theta)k', 0\right)\right). \quad (13)$$

The recursive problem of the heterogeneous production firm which opt for a cash flow-based contract is as follows.

$$v_t^{Cash}(z, nw) = \max_{k', b'} \quad nw - q_t k' + \mathcal{Q}_t b' + \mathbb{E}_t[\Lambda_{t+1}(\pi_d nw_{t+1}\left(z', k', b'\right) + (1-\pi_d) v_{t+1}(z', nw_{t+1}(z', k', b')))] \quad (14)$$

subject to the non-negativity constraint on dividends

$$nw - qk' + \mathcal{Q}b' \geq 0,$$

and the incentive compatibility constraint of the cash flow-based contract

$$v_{t+1}^{Cash}\left(z', nw_{t+1}\left(z', k', b'\right)\right) \geq v_{t+1}^{Cash}\left(z', nw_{t+1}\left(z', k', 0\right)\right) - W_{t+1}\left(z', nw_{t+1}\left(z', k', b'\right)\right) \quad (15)$$

and

$$W_{t+1}\left(z', n\hat{w}_{t+1}\left(z', k', b'\right)\right) = \varphi\left[p_{t+1} z' \left(k'\right)^{\theta} \left(l'\right)^{\nu} - w_{t+1} l'\right] \quad \text{for all } z'. \quad (16)$$

3.3 Financial Intermediary and Capital Good Producers

Financial intermediary. This entity operates in a perfectly competitive market, takes deposits from representative households, and lends these funds to the production firms in need. The household owns financial intermediary, and its recursive problem is

$$v_I(D, B) = \max_{D', B'} \quad D' - B' + \Lambda^h v_I(D', B') \quad (17)$$

subject to

$$D' - B' \leq (1 + r^B)B - (1 + r^D)D \quad (18)$$

where Λ^h is the household's stochastic discount factor, D stands for the deposit, and B is the loan granted.

Finally, the financial intermediary's optimality condition reads:

$$r'_B = r'_D \tag{19}$$

Capital good producers. There is a representative, perfectly competitive capital good producer which produces next period's capital stock K_{t+1} by using the existing capital stock, K_t and I_t units of final good as inputs to the production technology, $K_{t+1} = \Phi\left(\frac{I_t}{K_t}\right) K_t$. The production of the capital good is subject to adjustment cost, $\Phi\left(\frac{I_t}{K_t}\right)$. Capital good producers' profit maximization problem yields the relative price of capital as

$$q_t = \frac{1}{\Phi'\left(\frac{I_t}{K_t}\right)} = \left(\frac{I_t/K_t}{\hat{\delta}}\right)^{1/\phi} \tag{20}$$

where $\hat{\delta}$ is the investment rate at the steady state. Note that full characterization of capital good's problem can be found in Appendix C.2.

3.4 Retailers, Final Good Producers, and the Monetary Authority

Retailers. Model inhabits a continuum of retailers of which mass is fixed, $i \in [0, 1]$. Each retailer operates in a monopolistically competitive market and thus can set a price with a markup. Retailers buy the undifferentiated intermediate good from the heterogeneous production firm i to produce a differentiated variety $\tilde{y}_{j,t}$ by the production process

$$\tilde{y}_{j,t} = y_{j,t}. \tag{21}$$

Having market power, retailers can set a relative price, $\tilde{p}_{j,t}$ for their variety, subject to the quadratic price adjustment cost: $\frac{\varphi}{2}\left(\frac{\widetilde{p}_{j,t}}{\widetilde{p}_{j,t-1}} - 1\right)^2 Y_t$, where Y_t is the final good. Retailers take the demand curve for the differentiated good as given, which is the outcome of the final good producers' problem.

Final Good Producer. The final good producer operates in a perfectly competitive market and thus takes the prices of the retail goods, $\tilde{p}_{j,t}$, and the final good p_t as given. Final good producers use the retail goods as input and bundle them into the final good by using the CES production technology:

$$Y_t = \left(\int \tilde{y}_{j,t}^{\frac{\gamma-1}{\gamma}} \, \mathrm{d}j \right)^{\frac{\gamma}{\gamma-1}} . \tag{22}$$

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

Monetary Authority. Monetary policy is conducted by setting the interest rate on the risk-free bond r_t^f according to the Taylor rule given below.

$$\log r_t^f = \log \frac{1}{\beta} + \varphi_\pi \log \Pi_t + \varepsilon_t^{\mathrm{m}}, \text{ where } \varepsilon_t^m \sim N\left(0, \sigma_m^2\right), \tag{23}$$

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

3.5 Household and Equilibrium

There is a representative household who consumes the final good c_t and supplies labor l_t in exchange for the real wage w_t. To accumulate their wealth, the household uses two different financial instruments: (*i*) one-period risk-free bond (issued by financial intermediary), (*ii*) one-period firm share. Along with the production firms, households own retailers, final good producers, and the financial intermediary in the economy. Furthermore, I assume that the price adjustment cost is rebated lump sum to the household and thus does not exhaust the economy's resources.

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

$$V(a,\eta) = \max_{c,l,a',\eta'} \quad (\log c - \Psi l) + \beta V(a',\eta') \tag{24}$$

subject to

$$\begin{aligned} c + a' + \int_{\mathbf{S}} \rho_t^1 \left(z', nw'\right) \eta' \left(z', nw'\right) = \\ w_t l + (1 + r_t) a + \int_{\mathbf{S}} \rho_t^0 \left(z, nw\right) \eta \left(z, nw\right) + \Upsilon + \vartheta. \end{aligned} \tag{25}$$

The distribution of the households' ownership over the heterogeneous production firms' shares are represented by the measure η^h. $\rho_t^0 \left(z, nw\right)$ is the *cum dividend* price of production firms' shares at the beginning of period t with the state vector (z, nw). $\rho_t^1 \left(z', nw'\right)$ is the firms' new share price to be inherited to the next period. Υ is the profit of the retail goods producers.[26] ϑ is the lump sum amount the household receives from the price adjustment cost.

In this economy, since households own all firms and financial intermediary, these entities share the stochastic discount factor of households, obtained from the Euler equation of risk-free bonds, which is given below:

$$\Lambda^h = \beta \frac{u_c(c', l')}{u_c(c, l)} \tag{26}$$

(19) and (26) together yields:

$$\Lambda^h \left(1 + r'_B\right) = 1 \tag{27}$$

Note that full characterization of the equilibrium can be found in Appendix C.3.

4 Calibration

Calibration strategy involves two main stages: external and internal calibration. In the external calibration, I fix some model parameters *a priori* based on the estimated values in the previous literature. Whereas in the internal calibration, by focusing on the mechanisms of interest at work, the remaining parameters are chosen to match the model's moments at the stationary equilibrium to the observed data moments. The majority of the data moments are calculated based on the merged Compustat/DealScan/CRSP dataset. I also compare the resulting parameter values and moments with their counterparts in the literature. The main anchor in the calibration strategy is to ensure that firms always repay their outstanding debt, and thus there is no equilibrium default.

External Calibration. The length of a model period is one quarter. I set the household discount factor β, to imply an average annual interest rate of 4 percent.[27] and I set $\theta = 0.21$ and $\nu = 0.64$ which imply decreasing returns to scale of 0.85. Quarterly capital depreciation rate is $\delta = 0.025$. The elasticity of substitution between the differentiated intermediate goods (produced by retailers to be sold to the final goods producers) is $\gamma = 10$, which im-

[26]Note that since financial intermediary, final good producer, and production firms operate in perfectly competitive markets, for brevity, their profits are omitted in the budget constraint.

[27]Quarterly discount rate $\beta = 0.99$ corresponds to the 4 percent annual rate of return. This value can be considered as the sum of the risk-free policy rate and the average corporate borrowing spread. For the sample period of the dataset (1997-2018), the average annual fed funds rate is approximately 2 percent. Median corporate borrowing spread the period is 200 basis points (see Table 1).

plies a steady state markup of 11% over marginal costs through the formula $\frac{\gamma}{\gamma-1} = 1.11$.[28] Following Ottonello and Winberry (2020) which in turn builds on Kaplan, Moll, and Violante (2018), I set $\varphi = 90$ which yields the NKPC slope $\frac{\gamma-1}{\varphi} = 0.1$. Again, following Ottonello and Winberry (2020) and Bernanke et al. (1999), I set the curvature parameter of the aggregate adjustment costs which govern the price elasticity with respect to investment rate as $\phi = 4$. I set the exogenous exit rate $\eta = 0.087$ to match the exit rates of Jeenas (2023) and Ottonello and Winberry (2020) which are calculated from the survey of Business Dynamics Statistics.

Table 3
PARAMETERS

Parameter	Description	Value
	External Calibration	
β	Discount factor	0.99
θ	Capital share	0.21
ν	Labor share	0.64
δ	Depreciation rate	0.025
ϕ	Capital Adjustment Cost Coeff.	4
γ	Demand elasticity	10
φ_π	Taylor rule coefficient	1.25
φ	Price adjustment cost	90
π_D	Exogenous exit rate	0.087
	Internal Calibration	
ρ	Persistence of TFP	0.90
σ	SD of innovations to TFP	0.05
k_0	Initial capital	0.27
Φ	Operating cost	0.02
Θ	Recoverability parameter	0.71
φ	Value-to-EBITDA ratio	9

Internal Calibration. I set the parameters in the internal calibration to match the empirical targets depicted in Table 4. Targeted empirical moments are calculated from the

[28]For most production and New Keynesian parameters, I follow Ottonello and Winberry (2020). The resulting moments: the decreasing returns to scale of 0.85 is from Winberry (2021) and the steady state labor share $\frac{\gamma-1}{\gamma}\nu = 0.58$, is in line within range of the labor share of U.S. estimated in Karabarbounis and Neiman (2014)

Table 4

CALIBRATION TARGETS AND MODEL FIT

Moment	Description	Data	Model
k_0	Initial capital	0.25	0.27
$\frac{b}{k}$	Average Gross Leverage Ratio	0.42	0.47
Share (b_A)	Fraction of asset based to total debt	0.16	0.16
Share (b_C)	Fraction of cash flow based to total debt	0.84	0.84
Share $(b > 0)$	Firms with positive debt	0.81	0.63
$\mathbb{E}\left(\frac{i}{k}\right)$	Average investment rate	0.23	0.21
$\sigma\left(\frac{i}{k}\right)$	SD investment rate	0.45	0.48

Compustat/DealScan/CRSP merged sample I used in the empirical exercises in Section 2.

First, I set $k_0 = 0.27$ so that new entrants in any given quarter start their lifecycle with a relative size of 0.27 to the average firm size. This calibrated value is higher than its empirical counterpart from the Compustat sample (0.25). It is because the model economy includes operating costs, so firms need to have enough capital to survive their first period.[29]

Naturally, each parameter affects all of the model results, but since the novel part of this paper is the borrowing mechanisms –incorporation of cash flow-based contracts– I first discipline the parameters of idiosyncratic productivity shock $AR(1)$, then using these calibrated parameters try to match the empirical moments regarding the borrowing concept. Parameters governing the $AR(1)$ idiosyncratic productivity shock process; persistence parameter ρ and the dispersion of innovations σ to the productivity are chosen to reproduce firm-level investment dynamics (mean and dispersion of investment rate) in the data.

Having set the other parameters, I target the three moments regarding the firm level borrowing: *i*) shares of asset-based and cash flow-based borrowers, *ii*) the percentage of firms having positive debt, and *iii*) mean of the firm-level gross leverage ratio. Here note that for the third target, I choose 0.81 from Crouzet and Mehrotra (2020), not this paper's

[29] The value is still close to 0.23 in Begenau and Salomao (2019) and 0.24 in Jeenas (2023).

dataset from Section 2. The reason is that the merged Compustat/DealScan sample mostly consists of firms with positive debt, thus yielding biased moments.

The calibration strategy leads to the values in Table 4. The model performs well in matching the shares of asset-based and cash flow-based debt. Also, the model roughly matches the debt related moments: leverage ratio and firms with positive debt. In terms of investment rate moments, the model overpredicts the dispersion since the model does not include the cost of capital adjustment at the firm level. However, the mean investment rate is lower than the data. The underlying reason could be that in this type of models, firms accumulate capital very quickly and reach their optimal scale (Ottonello and Winberry, 2020). Therefore, the model could be producing the ratio of investment to capital lower than the data.

The calibrated loan recovery rate is 0.71 which is higher than 0.54 in Khan, Senga, and Thomas (2016) and Ottonello and Winberry (2020), and 0.62 in Jeenas (2023). It is because, lower values of Θ lead to underborrowing in the model economy. EBITDA multiple in the cash flow based contract, φ value is 9, lower than 14 in Lian and Ma (2021). The reason is that higher values of φ lead most cash flow-based borrowers to renege on their promise to repay.

In gross leverage ratio, the empirical moment of 0.42 is higher than 0.34 as reported in Crouzet and Mehrotra (2020), since the merged dataset of Section 2 is a subgroup that consists of loan borrowers. Therefore, gross leverage ratio is higher than the Census data employed in Crouzet and Mehrotra (2020) which is obtained from the US Census Bureau's Quarterly Financial Report (QFR), a survey that collects income statements and balance sheets of manufacturing, retail, and wholesale trade firms.

About the investment rate moments, it is helpful to compare the moments with the moments of Cooper and Haltiwanger (2006), which is widely used as a benchmark in the literature. Both mean and standard deviation of investment rate are higher than their Cooper and Haltiwanger (2006) counterparts (0.12 and 0.33, respectively). It is because, balanced dataset of Cooper and Haltiwanger (2006) includes large manufacturing plants that operated unceasingly between 1972 and 1988. Therefore, their dataset and results are not contaminated with firm entry/exit, which exists in my Compustat/DealScan dataset. Furthermore, since they only focus on large plants, their need for investment is relatively weaker compared to newly established, younger firms which are also included in my dataset. Putting together, having firm entry/exit and the existence of younger firms in the sample boosts the mean investment rate and its standard deviation.

5 Debt Contracts Heterogeneity in the Model

This section discusses the firm's contract choice in the steady state and validates the consistency of the quantitative model with the empirical patterns observed in Section 2.3. The central thought in the analyses is to investigate how firm characteristics affect the debt contract choice in the stationary equilibrium.

Figure 3 depicts the firm's contract preferences in the state space (z, nw). The blue and red areas represent the firms adopting cash flow-based and asset-based contracts, respectively. Note that both Panel (A) and (B) could be used for the exposition as they imply the same mechanisms, however for the sake of consistency, I use Panel (A) in the discussions throughout and employ Panel (B) only when I analyze the impact of volatility.

Before moving on to the underlying mechanisms, it is beneficial to recall how contracts are written. Perfectly foreseeing all possible outcomes (*i.e.* whether to pay or renege), the financial intermediary restricts the borrowing amount to ensure that firms repay in every state of the world next period. As anticipated, the tightness of the borrowing constraints is state contingent. Depending on the firm's place in the state space, one of the contracts could have looser borrowing limit than the other. Then, seeing the contracts, firms choose whether to borrow with an asset-based or a cash flow-based contract.

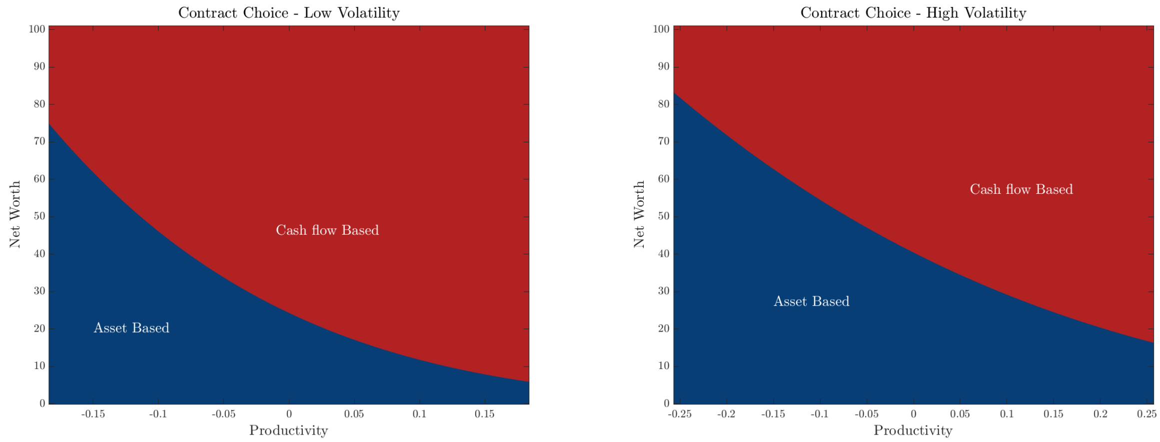
Here note the dual roles of productivity. First, as the productivity follows a persistent process, having low (high) productivity) increases the chance of having low (high) productivity tomorrow. Therefore, today's productivity constitutes a strong signal about repayment probability in the next period. The second role of productivity comes from the cash flow-based contracts, as the tightness of the borrowing constraint is determined by the multiple of the firm's cash flow in these contracts. Therefore, cash flow-based contracts are more responsive to productivity levels, as they are affected through two distinct channels.

As can be seen from Figure 3, steady state analyses reveal that in line with the empirical evidence presented in Section 2 and Lian and Ma (2021) as well; the quantitative model well captures the fact that cash flow-based borrowing is the prevalent method for most of the states.

In order to illustrate the underlying mechanisms at work producing Figure 3, it would be helpful to compare the left to the right half. When a firm with higher productivity than average wants to borrow, the financial intermediary offers the contract as follows. The intermediary calculates the two borrowing limits for each point in the state space, i.e. $\bar{b}^{Asset}(z, nw, k'; q)$ and $\bar{b}^{Cash}(z, nw, k'; \pi)$. Given that high productivity means the ability to generate cash flow from the existing capital stock is better and also signals that the firm

Figure 3
CONTRACT CHOICES

(a) Low Volatility　　　**(b)** High Volatility



NOTE. This figure shows the policy function of debt contracts. High (low) volatility means the dispersion of the error term is high (low) in (7). In the high volatility case, dispersion is 10% than the low volatility case.

remains in the high productive state in the next period, for the firms with above average productivity, their repayment is guaranteed for more cases in the state space. Therefore, firms mostly prefer cash flow-based contracts due to having looser borrowing constraint in most cases. On the other hand, if a firm has low productivity, anticipating that firm would default in most cases, the financial intermediary tightens the borrowing constraints under cash flow-based contracts, leading low productive firms to borrow with asset-based contracts. These findings align with the empirical patterns presented in Section 2.3, as more profitable firms mostly choose cash flow-based contracts.

Another factor investigated is volatility which is defined as the dispersion of idiosyncratic productivity shock distribution and governed by σ in (7). The experiment is increasing σ by 10%. Compared to Panel (A), firms prefer asset-based debt contracts in more states. Again, here the underlying mechanism originates from the financial intermediary. Since the intermediary writes contracts to ensure that firms repay their debt in every state of the next period, when volatility increases, the lowest realization(s) of the idiosyncratic productivity shock becomes crucial. It is because as the dispersion of the shock distribution increases, the left tail of the distribution goes further left, yielding lower outcomes than the low volatility case. In this case, firms are more likely to fail repayment, as their income would not be enough the cover the debt. Therefore expecting an increase in the firm's likelihood of reneging from its promise of payment, the intermediary tightens the borrowing constraints for both contracts, but even tighter for cash flow-based contracts as their borrowing limit is a direct function of productivity. This steer more firms to sign asset-based contracts, as asset-based contracts constitute a larger area in Panel (B).

6 Quantitative Monetary Policy Analysis

In this section, I analyze the response of the model economy to a one-time unexpected contractionary monetary policy shock. The quantitative model is designed to validate the proposed asset price channel on the monetary policy transmission while staying consistent with the empirical responses presented in Section 2. The layout of this section is as follows. Section 6.1 presents the computed the aggregate impulse responses of key variables to a contractionary monetary policy shock. Section 6.2 depicts the heterogeneous sensitivity of asset-based and cash-flow based borrowers to a common monetary policy shock. The results are in line with the empirical evidences from Section 2, as firms with asset-based debt contracts are more responsive. To show the relevance of the proposed asset price channel, Section 6.3 presents the results of an alternative scenario in which there is no capital adjustment cost and thus the price of capital is not time-varying. Consistent with the suggested mechanism, when the capital channel is shut down, asset-based borrowers' responsiveness is substantially reduced compared to cash flow-based borrowers. Finally, Section 6.4 discusses the aggregate implications of the debt contract heterogeneity and argues that the strength of the financial accelerator mechanism depends on the share of asset-based borrowers in the economy.

6.1 Aggregate Responses to Monetary Policy

The aggregate responses of some selected variables to a contractionary monetary policy shock are shown in Figure 4. First row presents the responses of the nominal interest rate, rate of inflation, and the implied changes in the real interest rate—the nominal interest rate increases in response to a contractionary, one-time innovation to the Taylor rule. Second figure shows that innovation lowers inflation by cooling down the economy. As demonstrated by the third figure in the first row, an increase in the nominal interest rate passes through the real interest rate. Since due to the staggered pricing mechanism, prices cannot adapt immediately to the nominal changes.

Second row in Figure 4 reports the effects of a contractionary monetary policy shock on consumption, investment, and output. A higher real interest rate cools down the economy, as it depresses consumption and investment, and thus output and inflation.[30] Moreover, the model's impulse responses are in line with the literature. Response of consumption is milder than output due to households' consumption smoothing motive and investment appearing as the most volatile element. Furthermore, the magnitude of the model's impulse responses are consistent with the peak impulse responses to monetary policy shocks estimated in Christiano et al. (2005) and those computed with the heterogeneous quantitative models in Kaplan et al. (2018) and Ottonello and Winberry (2020).

The third row depicts the impulse responses of prices in the economy. First figure shows the impulse response of capital price. Note that a contractionary monetary policy shock mitigates investment demand. In the presence of capital adjustment costs, the marginal cost of capital declines. As can be seen from the second and third figures, lower aggregate demand for goods (whether it comes from consumption or investment) reduces other prices in the economy, such as intermediate good prices and real wages.

Here it is helpful to discuss the lack of hump-shaped responses as opposed to the estimations in the typical New Keynesian literature (Christiano et al., 2005; Smets and Wouters, 2007). Such hump shapes in investment and consumption would require some impedance mechanisms. For instance, habit formation is widely used in the literature to produce hump-shaped consumption responses. Further, one could produce a hump-shaped investment response by formulating costly adjustments as a function of investment rather than capital. The main reason behind excluding these extensions is that the quantitative section of this paper focuses on the role of capital price movements on borrowing constraints and investment. If these extensions had been included, the underlying mechanisms would have been entangled with the collateral channel of monetary policy transmission. Thus it would be challenging to isolate the collateral channel.

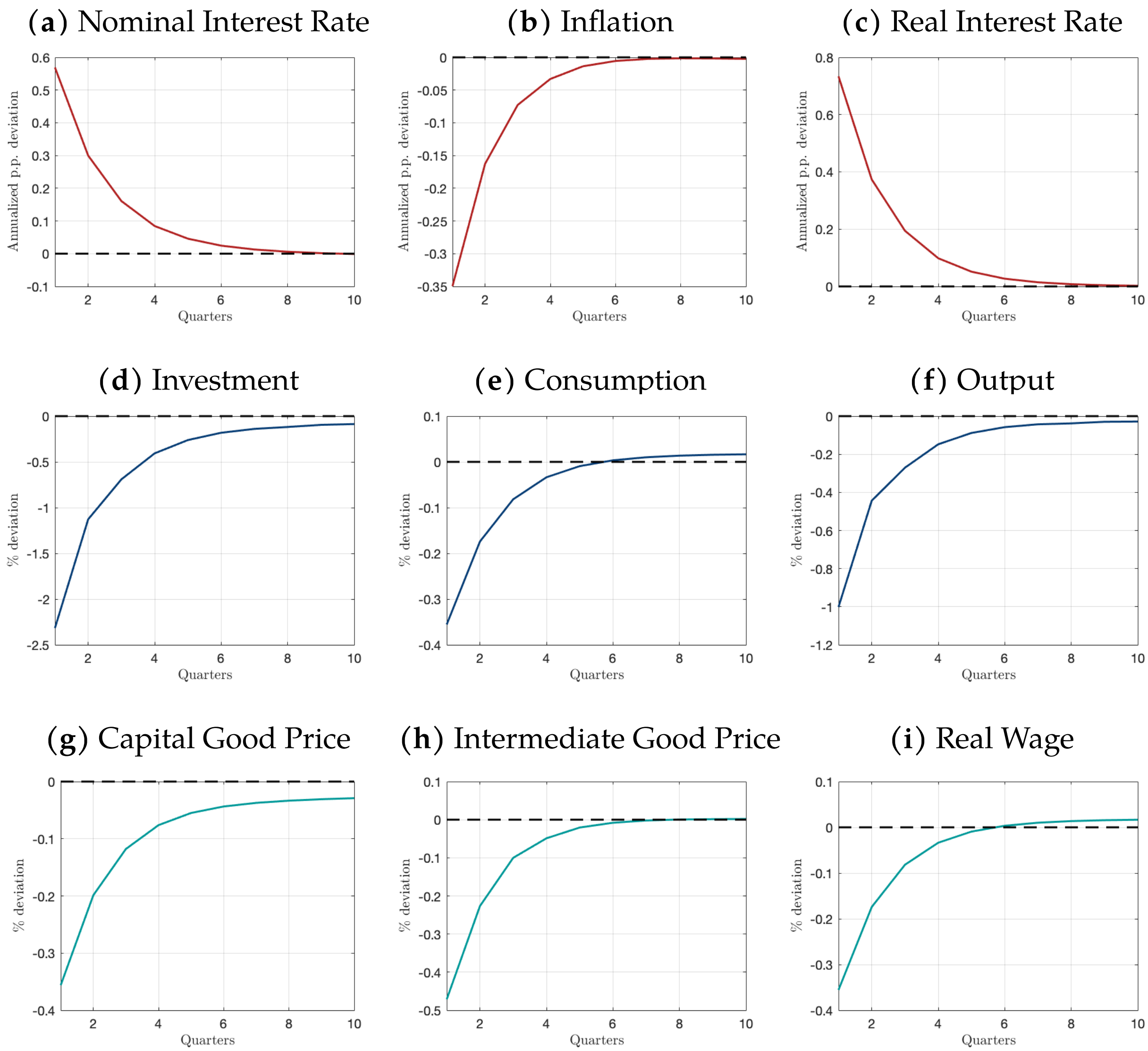
In the next section, I decompose the total effect of the monetary shock on aggregate investment and borrowing. To do so, through the lens of the methodology developed in Section 2, I compute the impulse responses of these aggregate variables among asset-based and cash flow-based borrowing firms.

6.2 Heterogeneous Responses to Monetary Policy

This section presents the model's estimation results on firms' heterogeneous responses to the monetary policy shock experiment. To observe the model's internal dynamics while

[30] Here, note that in Kaplan et al. (2018), a major part of the response to monetary policy shock originates from indirect channels. However, since the heterogeneous household is beyond the scope of this paper, the model relies on the conventional intertemporal substitution channel.

Figure 4
Aggregate Impulse Responses



Note. Aggregate impulse response functions following a contractionary monetary policy shock. The shock is applied as an unexpected innovation to the Taylor rule (23). The monetary policy shock series starts with $\epsilon_t^m = 0.0025$ and continue as $\epsilon_{t+1}^m = 0.5 * \epsilon_t^m$. The responses are computed as the perfect foresight transition path.

keeping the comparability to the empirical pattern of Section 2, on the simulated data I estimate (28) which is a variant of empirical specification (5).

$$y_{j,t+h} - y_{j,t-1} = \alpha_j^h + \delta_t + \beta^h \left(\epsilon_t^m \mathscr{I}_{j,t-1}^{Asset}\right) + \gamma^h \epsilon_t^m + \sum_{p=1}^{P_Z} \Gamma_p \mathbf{Z}_{j,t-p} + e_{j,t+h} \tag{28}$$

$h = 0, 1, ..., H$ represents the time horizon where $H = 8$ quarters. Dependent variable of interest, $y_{j,t+h}$ is investment and borrowing. α_j^h is the firm fixed effect, ϵ_t^m is the quarterly monetary policy shock. $\mathcal{I}_{j,t-1}^{Asset} = 1$ is the indicator variable when firm j use asset-based borrowing contract at time t (otherwise zero).

Regression yields β^h which captures the relative impulse response of asset-based borrowers (compared to cash flow-based borrowers) to a contractionary monetary shock. To prevent contamination from the firm initial distribution assumption, I only consider the firms surviving at least 28 quarters.[31] Similar to (5), firm-level controls include firm size (k), age, and leverage (b), while the macro controls are excluded here, and instead a time fixed effect, δ_t, is employed.[32]

I compare the model output and the data by focusing on the interaction coefficient of indicator variable $\mathcal{I}_{t-1}^{Asset}$ and the monetary shock ϵ_t^m. Dependent variables of interest are firm-level investment and borrowing. The estimation horizon is 8 quarters.[33] I present the model impulse responses as the point estimates of the interaction coefficient β_x^h along with their 90% error bands.

Investment and Borrowing Response Figure 5 depicts the relative impulse responses of investment and borrowing in Panel (A) and Panel (B), respectively. Given that both asset-based and cash flow-based borrowers respond by reducing their investment and borrowing, a negative value indicates that the response of asset-based borrowers is larger in magnitude.

Panel (A) depicts that asset-based borrowers decrease their investment relatively more after a contractionary monetary policy shock than cash flow-based borrowers. Panel (B) exhibits that a similar pattern holds for firm borrowing. The differential impulse response is significant, meaning asset-based borrowers cut back on borrowing considerably

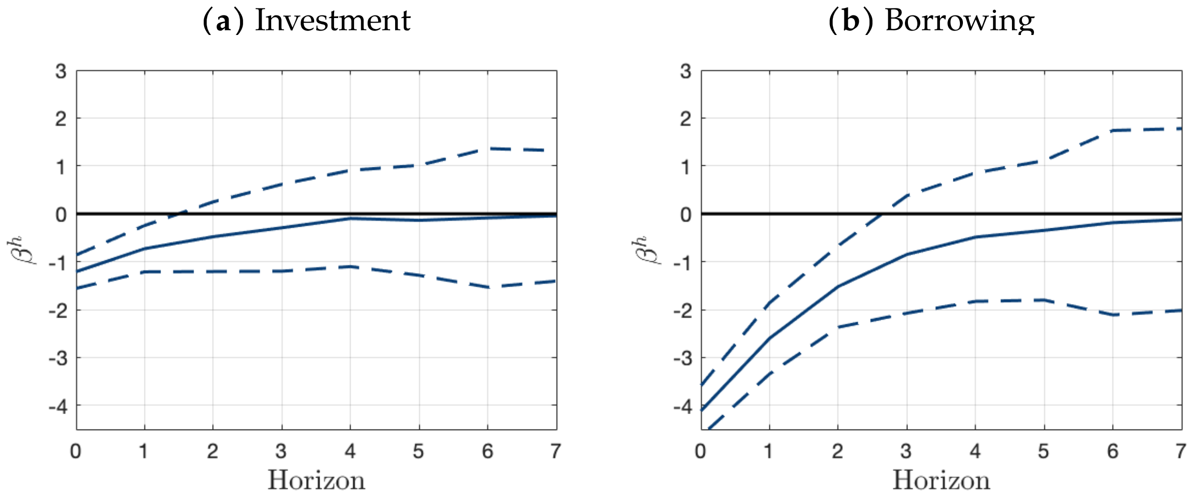
[31] Excluding the earlier periods of firms is a common practice in the literature (Ottonello and Winberry, 2020). The model's results are robust to the cutoff choice.

[32] Here note that (5) also includes current assets ratio and Tobin's Q as firm-level controls, but excluded here since these two variables are beyond the scope of the model.

[33] The horizon of the impulse responses on the simulated data is shorter than the actual data. It is because the model does not feature aggregate impedance mechanisms to generate a sluggish response of variables. Therefore, the impact of the shock survives at shorter horizons compared to the data; thus, running the regressions at longer horizons is unnecessary.

Figure 5

Differential Impulse Responses: Investment and Borrowing



Note. Average impulse response functions for the investment and borrowing to contractionary monetary policy shock. The responses are estimated with a variant of the local projection specification given by (5). Monetary policy shock is interacted with indicator variable based on the firm borrowing status. The dashed lines display 90 percent confidence intervals.

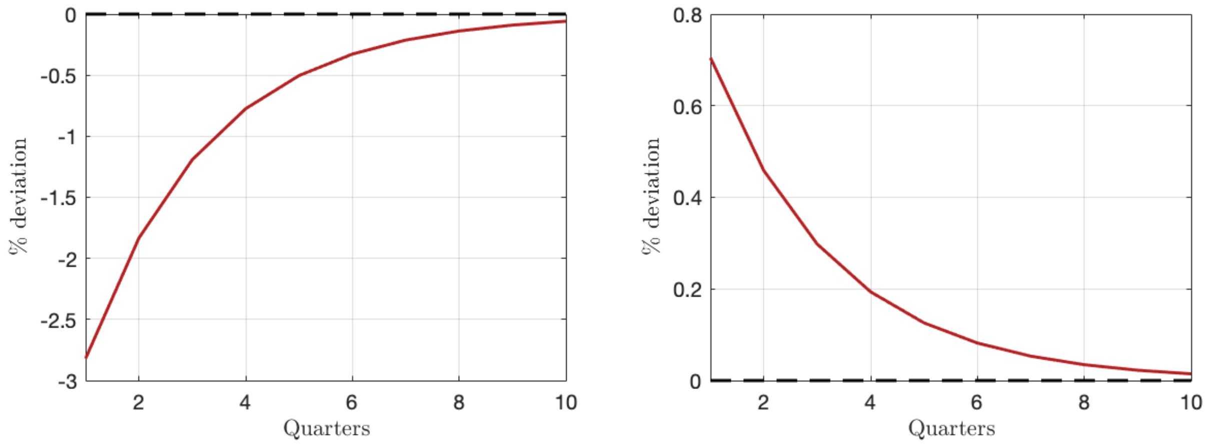
more than cash-flow-based borrowers.

Compositional Changes Following a similar approach to Section 2, I also run an experiment about endogenous changes in group composition. Figure 6 shows that indeed, in line with the empirical evidences in Section 2, firms respond to a contractionary monetary policy shock by switching from asset-based contracts to cash flow-based contracts. This finding about switching supports the paper's main idea that asset-based borrowers are affected more than cash flow-based borrowers. The magnitudes of compositional changes explain another aspect. If there had not been limited commitment, then we would have seen a much larger switch, but through the limited commitment mechanism, asset-based borrowers only switch to cash flow-based debt contracts if they are able to do so. Here note that since the model does not include portfolio adjustment costs to produce dampened dynamics, the responses are larger than their empirical counterparts (3% in the quantitative model vs 1.2% in the data).

As a bottom line, Figure 5 shows that asset-based borrowers are affected from an unexpected interest rate increase more than cash flow-based borrowers. The compositional change also favors cash flow-based debt contracts. These responses resemble their empirical counterparts and suggest that the quantitative model well captures the empirical patterns.

Figure 6
IMPULSE RESPONSES: SHARES
ASSET-BASED VS. CASH FLOW-BASED

(a) **Share:** Asset Based (b) **Share:** Cash-flow Based



NOTE. Aggregate impulse response functions for the shares of contracts following a contractionary monetary policy shock. The shock is applied as an unexpected innovation to the Taylor rule (23). The monetary policy shock series starts with $\epsilon_t^m = 0.0025$ and continue as $\epsilon_{t+1}^m = 0.5 * \epsilon_t^m$. The responses are computed as the perfect foresight transition path.

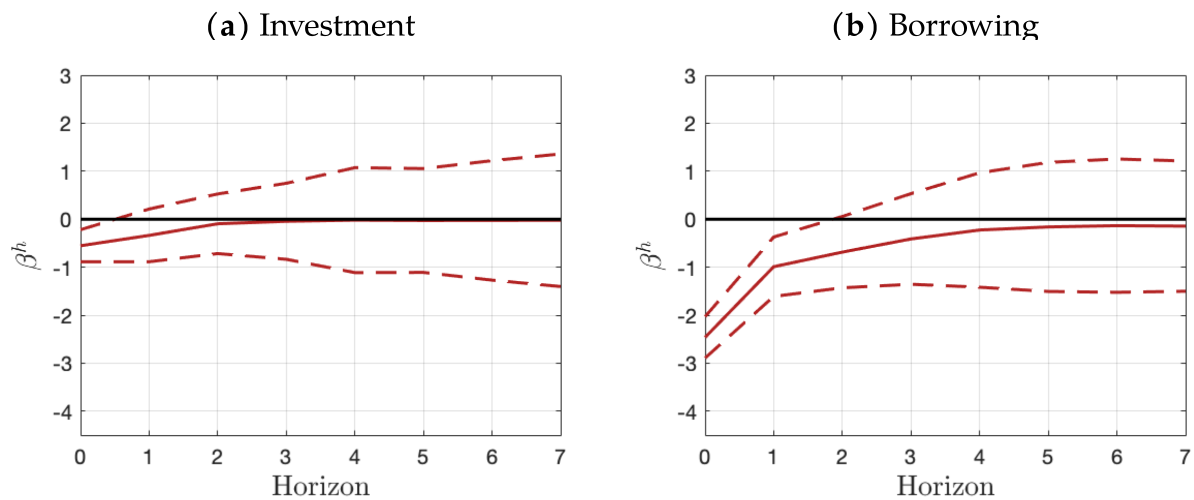
At this point, it is worth repeating the primary mechanism in mind. The firms issuing new debt with asset-based contracts have to rely on their capital stock to serve as collateral. Therefore, by reducing the capital price, contractionary monetary policy shocks tighten the borrowing constraint for these firms and force them to cut back on borrowing and investment. Whereas the firms with cash flow-based debt contracts do not have a capital price in their borrowing constraint formulations, therefore, are not affected by the decreasing values of capital price. I assess the relevance of this capital price channel in the next section by switching it off and comparing the differential responses.

6.3 Heterogeneous Responses to Monetary Policy in the Absence of Capital Price Movements

This section discusses why asset-based borrowers are more sensitive to a contractionary monetary shock. The results emphasize that a conventional framework with asset-based borrowing constraint (Kiyotaki and Moore, 1997; Bernanke et al., 1999; Khan and Thomas, 2013) is inadequate to capture the salient aspects of the findings reported in Section 2.

In order to show the impact of capital price movements on monetary policy transmission, I compare the impulse responses with and without capital price movements. To shut off the capital price movements, in (20) I set the convex adjustment cost parameter $\phi = \text{Inf}$, which yields flexible capital adjustment and time-invariant capital price, $\bar{q} = 1$. Therefore, the collateral constraint of asset-based borrowers is not affected by the extra response of capital price from a monetary shock.

Figure 7
Impulse Responses without Capital Price Movements: Investment and Borrowing



Note. Average impulse response functions for the investment and borrowing to contractionary monetary policy shock. The responses are estimated with a variant of the local projection specification given by (5). Monetary policy shock is interacted with indicator variable based on the firm borrowing status. The dashed lines display 90 percent confidence intervals.

On the one hand, if another factor (instead of the asset price channel) is the primary driver of the heterogeneous responses of investment and borrowing, there should be no difference between the results obtained in this section and Section 6.2. On the other hand, if the asset price channel is the only driver producing the heterogeneous responses, then the differential responses must be immediately shut off. Figure 7 shows that the actual model responses are in between, and thus when the asset price channel is off, the differential response of investment is dampened by approximately 60%. Similarly, the borrowing response difference between these groups is decreased by 50%. The underlying reason about why we don't see a total elimination of differential responses is the general equilibrium effects. More elaborately, by making capital price time-invariant, the indirect channel over the borrowing constraints in the asset-based contracts is shut off. However, for the cash flow-based borrowers, the indirect channel over their borrowing constraint is still effective, as a contractionary monetary shock can still affect the cash flows via aggregate demand.

As a bottom line, this experiment supports the idea that change in asset prices is the primary channel explaining the larger response of asset-based borrowers. This finding is consistent with the proposed primary mechanism, as the debt limits become more stringent when facing a contractionary monetary shock for firms with asset-based borrowing contracts. On the other hand, results indicate that even in the absence of capital price movements, there are still differences between the asset-based and cash flow-based borrowers' responses. This calls for additional analysis and possible model extensions, which is beyond the scope of this paper.

6.4 Implications for Financial Accelerator

In the previous parts of this section, I have shown that by incorporating the coexistence of asset-based and cash flow-based borrowing contracts into an otherwise conventional heterogeneous firm model, I explain the empirical findings of Section 2. That is, firms with asset-based borrowing contracts exhibit a larger response of investment and borrowing following an unexpected change in interest rates. Furthermore, when the asset price channel is shut off, the difference between the responses of asset-based and cash flow-based borrowers dampens. In the following, I discuss the implications of these findings from the macro perspective by focusing on the financial accelerator mechanism.

A broad literature has investigated the roles of firm balance sheets and their interplay with financial frictions in amplifying the effects of monetary policy. The key trait in these papers is that asset price response triggers a reinforcing channel in monetary policy transmission. However, this mechanism depends on the fact that borrowing constraints (Kiyotaki and Moore, 1997) or equity values (Bernanke et al., 1999) are functions of the liquidation value of tangible assets. The introduction of cash flow-based borrowing constraints to an otherwise conventional macrofinance model shows that the effectiveness of the asset price channel actually depends on the contract type the firm hold.

To illustrate the relevance of asset price channel for the financial accelerator mechanism, Table 5 depicts the aggregate responses of various economies relative to the baseline case. Each column represents a different model. The first column, w/o Δq, corresponds to the case when both types of contracts are available in the economy, but as in Section 6.3, capital price is fixed and does not respond to monetary policy shocks. Under this specification, investment is 28% lower, and borrowing is 41% lower than the baseline case. The results are in line with Section 6.3, as the absence of asset price responsiveness (*i.e.* collateral channel) leads to less responsive investment and borrowing. This finding supports that the financial accelerator channel is strong and works through the collateral channel.

Table 5
DEPENDENCE OF AGGREGATE RESPONSE ON CONTRACT TYPE

	w/o Δq	**AB**	**CfB**
Investment	-28.2	35.8	-47.1
Borrowing	-41.4	53.3	-61.5

NOTE. This table shows the aggregate responses of investment and borrowing under various modeling assumptions. The responses are calculated as the discounted percentage changes in borrowing and investment over the forecast horizon. The results presented here are relative to the baseline economy. The baseline case includes when both asset-based and cash flow-based contracts are available in the economy, and asset prices are responsive to monetary policy shocks. **w/o** Δq**:** Both asset-based and cash flow-based contracts are available in the economy but asset prices are time-invariant. **AB:** Only asset-based contracts are available in the economy. **CfB:** Only cash flow-based contracts are available in the economy.

Column 2, presents the model results when only asset-based contracts are available in the economy. Compared to the baseline case, investment and borrowing responses are larger in magnitude, 35.8%, and 53.3%, respectively. Column 3 belongs to an economy with only cash flow-based contracts. The responses are remarkably smaller compared to the baseline economy. Because, in this economy, the borrowing constraints firms face is not a function of capital price, and thus financial accelerator channel is mostly ineffective.

All in all, the three alternative economies' results indicate the collateral channel's active role in the strength of the financial accelerator. As opposed to asset-based contracts, in cash flow-based contracts borrowing limit is not a direct function of the liquidation value of capital. Therefore, cash flow-based borrowers are not vulnerable to the traditional collateral value channel of the financial accelerator mechanism through asset price fluctuations. As the asset price channel is still influential on asset-based borrowers, this implies that the strength of the financial accelerator depends on the share of asset-based borrowers in an economy. Given that most firms borrow using cash flow-based debt contracts, the overall effectiveness of the financial accelerator mechanism may be overstated in the macrofinance models with traditional collateral constraints.

6.5 Heterogeneous Transmission of Quantitative Tightening

Since the Great Recession, many central banks have widely used Quantitative Easing (QE) policy tool, which involves the central bank purchasing securities from the open market to reduce longer-term interest rates. The operation injects more liquidity into the banking system, thus stimulates lending and investment. Several studies investigate the macro implications of such large-scale asset purchase programs. Swanson (2021) discusses that large-scale asset purchases have significant effects on asset prices. Curdia and Woodford (2011), Gertler and Karadi (2011), and Boeckx, Dossche, and Peersman (2014) indicates that –as a policy tool– central bank asset purchases is effective in stimulating economy. On the other hand, in the aftermath of Covid-19, most central banks start to sell the assets they hold and thus contract their balance sheet, the operation known as Quantitative Tightening (QT).

This section presents the discussion of the QT transmission by demonstrating the heterogeneous responsiveness of asset-based and cash flow-based contract holders in the data.[34] To do so, I run the local projections regression in a similar fashion to the baseline empirical framework in Section 2.4. (29) presents the baseline empirical specification.

$$y_{j,t+h} - y_{j,t-1} = \alpha_j^h + \gamma_1^h \left(\epsilon_t^q \mathcal{I}_{j,t-1}^{Asset} \right) + \gamma_2^h \left(\epsilon_t^q \mathcal{I}_{j,t-1}^{Cash} \right) + \sum_{p=1}^{P_Z} \Gamma_p \mathbf{Z}_{j,t-p} + \sum_{p=1}^{P_X} \Gamma_p \mathbf{X}_{t-p} + e_{j,t+h} \quad (29)$$

$h = 0, 1, ..., H$ represents the active time horizon where $H = 20$ quarters. $y_{j,t+h}$ is the dependent variable of interest at horizon h: investment and borrowing. α_j^h is the firm fixed effect, ϵ_t^q is the quarterly quantitative tightening policy surprise. The identified QT policy shocks are obtained from Swanson (2021).[35] The empirical framework controls for a rich set of idiosyncratic and aggregate factors that may simultaneously affect dependent variables and borrowing method. γ_1^h and γ_2^h are the regression coefficients of interest capturing the impulse responses among subgroups, asset-based and cash-flow-based, respectively.

Figure 8 presents the estimated impulse responses using (29). The top and bottom rows are for investment and borrowing, respectively. The shaded areas denote the 90 percent confidence intervals based on two-way clustered standard errors at firm and quarter. Impulse response functions are estimated over 20 quarters period.

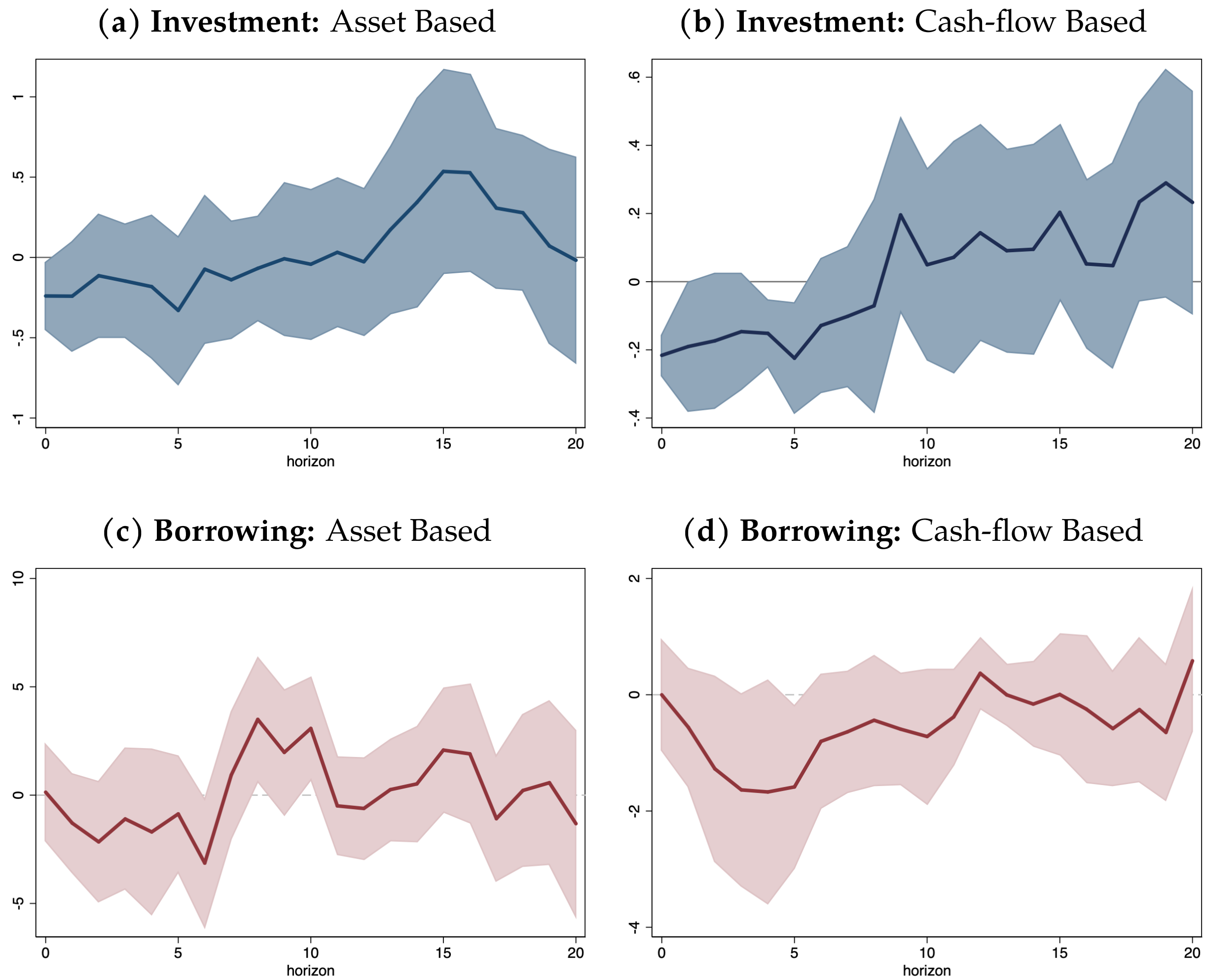
The results about the QT shock resemble the conventional contractionary monetary policy shock findings as depicted in Section 2.4. The magnitude of the impulse responses

[34] I am grateful to Edouard Challe for suggesting to investigate the QT implications of debt contracts.

[35] Swanson (2021) identifies the QT shocks by extending Gürkaynak et al. (2005)'s high frequency approach. After calculating the asset price responses (within a 30-minute window) to each FOMC announcement, the author estimates the first three principal components of these asset price responses. To do so, the author chooses the three factors which offer the strongest explanatory power for high-frequency asset price movements. Then, the author identifies the factors as the first factor corresponds to changes in the federal funds rate, the second factor to changes in forward guidance, and the third factor to changes in large-scale asset purchases (*i.e.* QE).

Figure 8

Impulse Responses to a Quantitative Tightening Shock:
Asset-based vs. Cash flow-based



Note. Average impulse response functions for the investment and borrowing following a QT shock. The responses are estimated with the local projection specification given by (29). QT policy shock is interacted with indicator variable based on the firm borrowing status. The shaded areas display 90 percent confidence intervals. Standard errors are clustered two-way clustered at firm and quarter.

of investment and borrowing among asset-based borrowers is larger than cash flow-based borrowers. However, unlike the responses to an unexpected interest rate increase, the impulse response of asset-based borrowers is not statistically significant. At this point, it is worth mentioning that Krishnamurthy and Vissing-Jorgensen (2013) points out the role of the expectations channel in QE transmission. The underlying mechanism is that since QE means purchasing assets with long maturities, the value of long-term assets is mainly affected by expectations about future policy stance. Therefore, the authors conclude that the transmission mechanism of QE relies heavily on managing these expectations, namely the announcement (i.e. communication to the investors) of QE policies is effective rather than actual purchasing operations. Given that in the last decade (excluding the Covid-19 period), there were a few announcements of QE policy, the reason behind the insignificant impulse responses may be the insufficient number of announcements).

Finally, in Appendix D, motivated by the empirical evidence about heterogeneous QT transmission, I conduct a QT experiment with the model and present the model-produced impulse responses on firms' heterogeneous responses to a quantitative tightening shock.[36] Note that the exercise is designed to see the effect of QT on investment through the collateral channel, not how QT interventions move asset prices. Therefore, the latter mechanism is taken as given. In the experiment, what is measured in the exercise is the impact of an unexpected decrease in capital prices –possibly triggered by QT– on investment and borrowing when there are both asset-based, and cash flow-based contracts, and switching between these debt contract types is allowed. The key mechanism –as in Section 6– works through the heterogeneous responses of borrowing constraints.

Regarding QT, an interesting extension of the model in Section 3 could be incorporating borrowing constraints which depend on not the future but today's values. As Krishnamurthy and Vissing-Jorgensen (2013) points out, the aim is to disentangle the channels, namely investigating which channel is more effective: through altering expectations about future asset prices or actual asset sales. Although interesting, investigating expectations channel through the different timings of borrowing constraints is beyond the scope of this paper.

[36]Since the effect of a QE shock is symmetric to a QT shock within the model, the results in this section also shed light on the impact of a QE shock.

7 Conclusion

In this paper, I investigate the interactions between the nature of debt contracts and monetary policy transmission to firm-level investment. On the empirical side, by employing loan-level data, firm-level balance sheet data, and stock return data, I first show that firms with more pledgeable assets and high stock beta tend to sign asset-based debt agreements, while more profitable firms with high Jensen's alpha usually opt for cash flow based debt contracts. Second, I show that following a contractionary monetary policy shock, firms with asset-based borrowing contracts cut their investment and borrowing significantly more than firms with cash flow-based debt contracts. Third, despite constituting only a tiny portion of the total investment, the majority of investment *response* to monetary policy shocks are initiated by asset-based borrowers.

To interpret the results about why firms choose one contract over the other and to understand the channels driving the heterogeneous sensitivity to monetary policy shocks, I set up a heterogeneous firm macrofinance model. The model is able to explain the cross sectional heterogeneity on the firm's contract type choice through state contingent borrowing limits. The quantitative results suggest that the traditional collateral channel through asset prices causes this heterogeneous sensitivity as the cash flow-based borrowers are less vulnerable to asset price fluctuations. As for the aggregate implications, the findings suggest that the financial accelerator mechanism is effective, and its strength is tied to the collateral channel and may diminish as more firms in the economy hold cash flow-based contracts.

The results of this paper are of crucial interest to monetary policymakers as these results contribute to understanding how monetary policy transmits to firm investment and borrowing. Furthermore, long-term economic growth requires a healthy rate of birth and death of businesses because it promotes the emergence of new, productive ideas. However, my results show that, while cooling down the economy via increasing rates –through the financial accelerator mechanism– contractionary policy will asymmetrically harm the asset-based borrowing firms, which are already fragile. As the asset-based borrowers are mostly young and small firms, increasing interest rates may have adverse side effects as being detrimental to business dynamism. My results imply that there is room for fiscal policy intervention to asset-based borrowing firms while conducting the monetary policy to fulfill its mandate of keeping inflation steady.

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Online Appendix
"Debt Contracts, Investment, and Monetary Policy"
by Özgen Öztürk

A Data Appendix

In this section, I elaborate the steps taken in data process. Section A.1, A.2, and A.3 discusses the selection/construction of the variables of interest from Compustat, DealScan, and CRSP datasets, respectively. Section A.4 details the merging procedure of the datasets: Compustat, DealScan, and CRSP. Data appendix continues with the discussion of macro variables, as Section A.5 presents each macro time series utilized in the analyses, and Section A.6 elaborates the sources of the identified monetary policy shocks. Figure A.1 shows the comprehensive picture of the finalized data set.

A.1 Firm-level Data

This subsection describes the firm-level, quarterly Compustat variables used in the empirical exercises of the paper. The variable definitions and their implied role in the analyses along with the sample selection procedure closely follow standard practices in the literature (Cloyne et al., 2023; Jeenas, 2023; Ottonello and Winberry, 2020). Briefly, if a variable is defined as a ratio, it is directly used as they are in Compustat. However, if the variable is in levels, then it is deflated by the aggregate GVA deflator. Some Compustat variables are reported as cumulative values within the firm's fiscal year. To convert these variables to quarterly series, I take the first difference of these variables within each fiscal year. Furthermore, if there is only one missing observation in the data series, I estimate it by linear interpolation, however, if there is more than one missing variable in the consecutive periods, then no data imputation is involved. All Compustat variables are deseasonalized by regressing them on quarter-dummies, and using the residuals in the actual exercises. Table A.1 briefly presents the variable definitions and corresponding Compustat variable codes, but below I present further details about these variables.

Investment. Following the literature which works with Compustat data (Mongey and Williams, 2017; Jeenas, 2023; Ottonello and Winberry, 2020), I employ perpetual inventory method to calculate the investment variable which is defined as $\Delta\log(k_{j,t+1})$. Due to being sparsely populated, level of gross plant, property, and equipment (`PPEGTQ`) cannot be used directly. Instead for each firm, I track the earliest observation of PPEGTQ in Compustat and record it as the first value of $k_{j,t+1}$. Then, by consecutively adding the changes of net plant, property, and equipment (PPENTQ) in each period, I obtain the series $k_{j,t+1}$. Note that the variable is PPENTQ is well populated and reported (from the source) as the net of depreciation. However, if a firm has only one missing observation of PPENTQ, I estimate that missing observation by linear interpolation. If there are more than one missing observation in the consecutive periods, I do not impute the values

Leverage. I measure leverage as the ratio of total debt (DLCQ and DLTTQ) to total assets (ATQ).

Size. I define size as the log of total real assets (ATQ), deflated by the aggregate GVA deflator.

Liquidity. I measure liquidty as the ratio of cash and short-term investments (CHEQ) to total assets (ATQ).

Cash flow. I define cash flow as EBITDA OIBDPQ deflated by the aggregate GVA deflator.

Dividend. I calculate dividend DVQ by taking the first difference of DVY within the firm's own fiscal year. Then deflate resulting DVQ by the aggregate GVA deflator.

Cash receipts. Following Lian and Ma (2021), cash receipt is defined as the ratio of the sum of cash flows from operations (OANCFQ) plus interest and related expenses (XINTQ) to the firm size (ATQ). Here, I calculate the cash flows from operation (OANCFQ), by taking the first difference of OANCFY within the firm's own fiscal year.

Tobin's Q. Following Cloyne et al. (2023), I define Tobin's Q as the ratio of total assets at market value to the total assets. Here market value is calculated as the sum of total assets (ATQ), market value of common shares outstanding (PRCCQxCSHOQ), and deferred taxes and investment tax credit (TXDITCQ) less common equity (CEQQ)[37].

[37] CSHOQ is recorded (at the source) as the actual number of shares and PRCCQ is the acutal level of share price, and therefore both variables are adjusted for stock splits. See Section A.3 for further details about the retroactive adjustment procedure.

Collateral. Following Dinlersoz et al. (2018) and Cloyne et al. (2023), collateral is defined as the ratio of the sum of net property, plant and equipment (PPENTQ), inventory (INVTQ), and receiables (RECTQ) to the total assets (ATQ).

Asset pledgeability. Following Dinlersoz et al. (2018), I define asset pledgeability as the ratio of collateralizable assets to the total assets.

Profitability. Following Dinlersoz et al. (2018), I define profitability as the ratio of net income (NIQ) to the total assets (ATQ).

Table A.1

COMPUSTAT VARIABLE DEFINITIONS

Variable	COMPUSTAT
Total Assets (Book Value)	ATQ
Long-term Debt (Book Value)	DLTTQ
Total Debt (Book Value)	DLCQ + DLTTQ
Leverage (Book Value)	(DLCQ + DLTTQ) / ATQ
Liquidity Ratio (Book Value)	CHEQ / ATQ
EBITDA	OIBDPQ
Interest and Related Expenses	XINTQ
Rent Expense	XRENT
Dividends	D.DVY (within year)
Acquisitions	AQCY / ATQ
Tobin's Q	(ATQ + PRCCQ x CSHOQ - CEQQ +TXDITCQ) / ATQ
Collateral (Book Value, Annual)	PPENT + INVT + RECT
Operating Cash Flow	D.OANCFY (within year)
Cash Receipts	(OANCFQ + XINTQ) / AT

Sample Selection. Before cleansing the data with the given sample selection procedure, following Ottonello and Winberry (2020), I winsorize observations at the top and bottom 0.5% of the distribution to prevent outliers contaminating the results. Then, I impose a set of sample restrictions:

1. Firms not incorporated in the United States are excluded.

2. Firms in the finance, insurance, real estate (FIRE) and public sectors are excluded.

3. Firm-quarter observations with below conditions are dropped.

- Negative capital or assets
- Acquisitions (constructed based on AQCY) larger than 5% of assets.
- Investment rate is in the top and bottom 0.5% of the distribution.
- Investment spell is shorter than 40 quarters.
- Net current assets as a share of total assets higher than 10 or below -10.
- Leverage higher than 10 or negative.
- Quarterly real sales growth above 1 or below -1.
- Negative sales or liquidity

WorldScope Following Cloyne et al. (2023), I construct firm age in two steps. First, I use the incorporation date from WorldScope (INCORPDAT), and second I check the firm's first appeareance in Compustat. Firm age is calculated by taking the earlier one between WorldScope variable and Compustat first appearance.

Furthermore, the regional dummy used in the analyses in Section B.3 is constructed by using the corresponding ZIP code variable in WorldScope.

A.2 Loan-level Data

DealScan is a detailed loan-level database. The unit observation is loan facility. Although the dataset presents information on many other aspects of the loan, in this paper I use the following variables: contract type, start date, end date, covenant type, amount, spread, and maturity. Since, this paper focuses on the firm-quarter observations, before merging DealScan with Compustat, there has to be two aggregation layers involved in the dataset. First layer is package level. Lenders may choose to bundle the loan facilities into one package or create new packages depending on the characteristics of the loan facilities. Therefore, for a given quarter, a firm may have multiple packages and each of these packages may include multiple loan facilities. Following Chava and Roberts (2008), covenant info is aggregated to firm level as follows. As covenants -most of the time- apply to all loan facilities in a package, life of the package starts with the loan with the earliest start date within the package and ends with the ending date of the most recent loan. Related, each of the loan packages firm have could be tied to a different covenant. Following Chava and Roberts (2008) and Nini et al. (2012) it is assumed that for a given quarter, tightness of these covenants are similar. Therefore, while parallel packages may have different debt covenants, such as debt-to-EBITDA, net worth, or interest payment, since the most pertinent to the analysis is the debt-to-EBITDA covenants, among multiple covenants I consider "Max. Debt-to-EBITDA" covenant.

DealScan is a wide format database. Therefore, each row in the dataset denotes a loan facility with information such as start/end date, amount, spread, maturity etc. cross section with different origination dates. Following Chava and Roberts (2008), I transform the dataset into long format with quarterly frequency (not annual). It is because firms are subject to due diligence 4 times a year and have to show their compliance with financial covenants by reporting their balance sheet/income statement details. Therefore, the it is logical to assume that restrictions apply at a quarterly frequency.

Classification. First step of categorization is the determining whether a loan is asset based or cash flow based (or neither). To do so:

- A loan is classified as asset based if
  - Backed by specific physical and other separable assets including equipment, inventory, receivable etc.
  - Specify a *"borrowing base"*,
  - Explicit statements in the notes
- A loan is classified as cash flow based
  - Backed by borrowers' **"all assets"** or **"cash and cash equivalents"**
  - Explicit statement about a lien on the entire corporate entity,
  - Entails financial covenants based on cash flow, mostly **"Max. Debt-to-EBITDA"**,

Second step is determining whether the active borrowing constraint is asset based or cash flow based for a given quarter. Following the corporate finance literature, the key feature is that terms of asset based contracts being loan specific, while the terms of cash flow based contracts are usually blanket liens. Namely, the borrowing constraint is defined as asset based ***iff*** all the packages include asset based contracts exclusively. However, it is enough to have only one cash flow-based contract to define the borrowing constraint as cash flow-based.

Sample Selection. Since the variable about financial covenants was sparsely populated before 1997, sample period starts with 1997 Q1. The ending of the sample period is restricted by the Chava-Roberts link file which is 2017 Q3.

A.3 Security-level Data

The Center for Research in Security Prices (CRSP) is the detailed security level dataset which is widely used in the literature. I use the variables S&P Domestic long term issuer Credit rating (SPLTICRM), stock price variable (PRC), Cumulative Factor to Adjust Prices (CFACPR), and S&P return (SPRTRN). Price variables of interest in CRSP (PRC) and Compustat (PRCCQ) are historically recorded at the source and require further treatment as they have not been retroactively adjusted for splits[38]. But fortunately, both Compustat and CRSP have dedicated split adjustment factor variables. In Compustat, this factor variable is ADJEX and in CRSP it is CFACPR. By using these variables, I retroactively adjust the stock returns for stock splits as follows. In order to retroactively adjust the historical prices for the stock split, I divide PRC by CFACPR. For instance if a stock is priced at 86.92 before the split, and 44.01 after the split, after the adjustment it becomes 43.46 and 44.01, before and after the split.

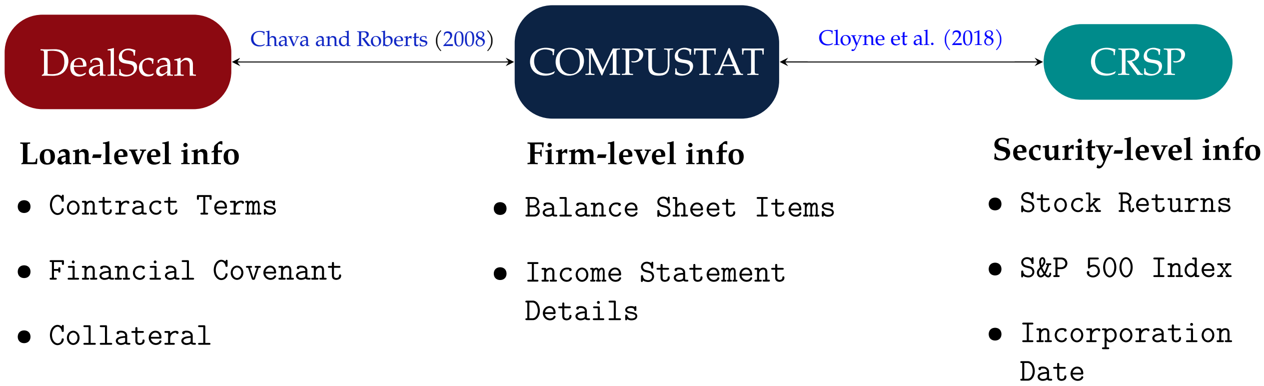
A.4 Dataset Construction

In this subsection I elaborate the merging procedure of Compustat, DealScan, and CRSP. Figure A.1 depicts the final body of the constructed dataset, along with the information about which items come from which dataset. The final version of the merged data set covers more than 60,000 firm-quarter observations for more than 1,000 distinct firms from 1997 to 2018.

Merging Compustat - DealScan. Following Chava and Roberts (2008), I merge Compustat and DealScan by utilizing the identifier link provided publicly by Michael Roberts and is available on Michael Roberts' personal website. Unfortunately, the link file is updated infrequently, and the version used in this paper is April 2018 version. Merging procedure is inner join, namely I drop firms from Compustat that do not appear at in Dealscan data and similarly drop loan observations that if the firm cannot be found in Compustat.

[38]From time to time, a company's share price can increase too much, and becomes unaffordable for some investors. This situation is detrimental to the stock's liquidity. In this case, a firm can undertake a stock split decision to increase the number of shares outstanding by spliting existing shares. This operation does not alter the underlying value of the company. Common split ratios are 2-for-1 and 3-for-1, which means that after the stock split operation an investor who owns the stock will have two or three shares, respectively, for every share held before the split.

Figure A.1
Dataset Construction



Merging Compustat - CRSP. I merge Compustat - CRSP datasets to carry out the analysis in Section B.1. I merge Compustat with CRSP by employing the Compustat/CRSP link-table available in WRDS. The link table maps the firm identifier in CRSP (`CUSIP`) to the firm identifier of Compustat (`GVKEY`).

A.5 Macro Time Series Data

Macro data is obtained from the Federal Reserve Bank of St. Louis (FRED). I closely follow the definitions and interpretations of Cloyne et al. (2023), which builds upon Gertler and Karadi (2015). The GVA deflator series is `B358RG3Q086SBEA`, the Price Index for Gross Value Added (GDP: Business: Nonfarm (chain-type price index)). Aggregate business investment is `PNFI`, Private Nonresidential Fixed Investment. CPI is `CPALTT01USM661S`, Consumer Price Index: Total All Items for the United States. One-year risk free rate is `GS1`, Market Yield on U.S. Treasury Securities at 1-Year Constant Maturity, Quoted on an Investment Basis. Three-months risk free rate is `DGS3MO`, Market Yield on U.S. Treasury Securities at 3-Month Constant Maturity, Quoted on an Investment Basis. Industrial production is `INDPRO`, Industrial Production: Total Index. GDP is `GDPC1`, Real Gross Domestic Product. Unemployment rate is `UNRATE`, Unemployment Rate. Volatility index is `VIXCLS`, CBOE Volatility Index: VIX.

A.6 Monetary Policy Shocks

For the baseline exercises, I use the exact FOMC meeting dates, time stamp of press release from FOMC, and daily shocks in percentage points from Gorodnichenko and Weber

(2016). The data is publicly available and can be downloaded from Michael Weber's personal website. Sample period is from Feb 5, 1997 to Dec 16, 2009.

For robustness check, I use Policy News Shock from Nakamura and Steinsson (2018). Corresponding data, along with the dates are publicly available and can be downloaded from Emi Nakamura and Jon Steinsson's personal websites.

B Additional Empirical Exercises

B.1 CAPM Regression

In order to measure the profitability (Jensen's Alpha) and return volatility (Beta), I estimate the below single factor CAPM model.

$$r_{j,t-\tau} - r_{f,t-\tau} = \alpha_j^{\tau} + \beta_j^{\tau}\left(r_{m,t-\tau} - r_{f,t-\tau}\right) + e_{j,t-\tau} \tag{B.1}$$

$\tau = 0, 1, \ldots, \mathrm{T}$ represents the active time horizon. Following both the literature and industry tradition, rolling regressions are estimated using a window of 36 months (*i.e.* $\mathrm{T} = 36$). $r_{j,t}$ is the stock return of firm j, $r_{m,t}$ is the $S\&P$ 500 Index and $r_{f,t}$ is the risk free rate. To carry out the analyses I merge Center for Research in Security Prices (CRSP) and Compustat databases via a Compustat/CRSP link-table, which maps the identifier in CRSP (`PERMNO`) to the identifier in Compustat (`GVKEY`). Here note that B.1 does not represent a panel data regression, but instead a separate time series regression is estimated for each firm j. This process yields time series for α_j (**Jensen's alpha**) and β_j (**Stock Beta**) coefficients for each firm j.

B.2 Differential Responses

To investigate more formally whether the differential response between high- and lowleverage firms is statistically significant, we estimate the dynamic effect of monetary policy

To provide a better comparable impulse responses with Section 6.2, I estimate the following regression. The resulting impulse responses are differential, and thus show the relative response of asset based borrowers compared to cash flow based borrowers.

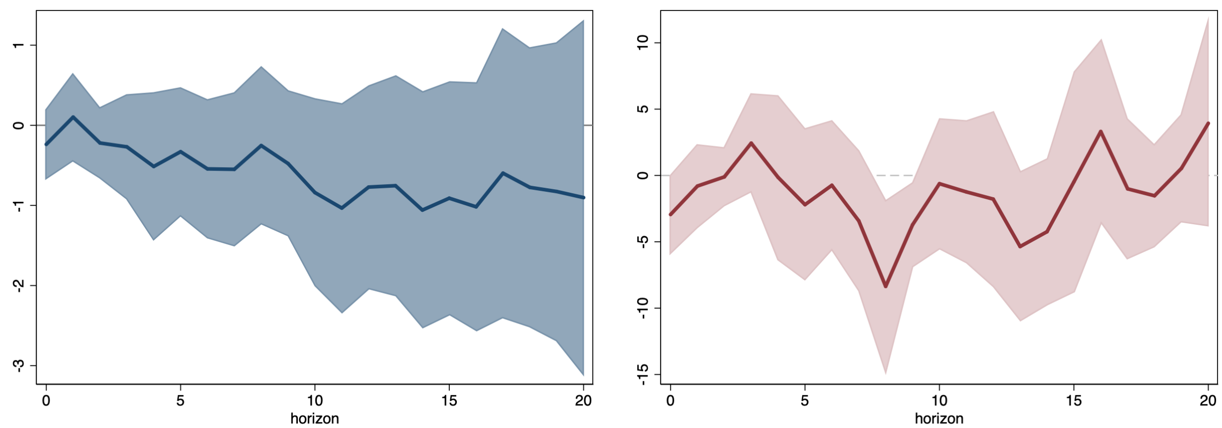
$$y_{j,t+h} - y_{j,t-1} = \alpha_j^h + \gamma^h \mathcal{I}_{j,t-1}^{Asset} \epsilon_t^m + \sum_{p=1}^{P_Z} \Gamma_p \mathbf{Z}_{j,t-p} + \sum_{p=1}^{P_X} \Gamma_p \mathbf{X}_{t-p} + e_{j,t+h} \tag{B.2}$$

$\mathcal{I}_{j,t-1}^{Asset}$ is the dummy variable that equals 1 when the firm j holds an asset based borrowing contract in time $t-1$. γ_h is the coefficient of interest which captures the effect of monetary policy shock on the dependent variable for asset-based borrowers relative to cash flow-based borrowers. h denotes the horizon, with $h = 0, 1, 2, ..., H$.

Figure B.1

Relative Impulse Responses

(**a**) Investment (**b**) Borrowing



Note. Relative impulse responses for the investment and borrowing following a 25 bps increase in 3-month T-bill rate. The responses are estimated with the local projection specification given by (**??**). Monetary policy shock is interacted with indicator variable based on the firm borrowing status. The shaded areas display 90 percent confidence intervals. Standard errors are clustered two-way clustered at firm and quarter.

B.3 Robustness of the Baseline Results

In order to show the robustness of the baseline results, I carry out additional set of empirical exercises presented below.

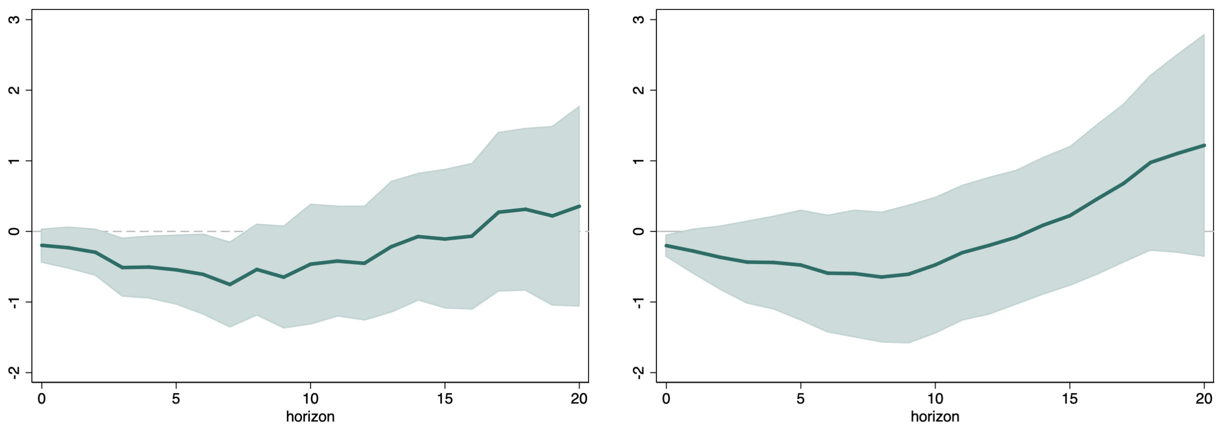
Spread. Anderson and Cesa-Bianchi (2020) stresses the role of credit spread on the firm level investment. The mechanism in their setup is that firms having higher credit spread response cut their investment and borrowing more, therefore responds more to a monetary policy surprise. Therefore, the baseline results in Figure 1, could be driven by spread responses regardless of the underlying borrowing method. To address this concern, I run the same setup as in (1), with the dependent variable being the spread (Dealscan variable *AllInDrawn*).

Figure B.2 reports the results obtained. The point estimates among subgroups are almost identical, therefore the baseline results in Figure 1 cannot be driven by the response of credit spread.

Figure B.2

Impulse Responses: Spread
Asset-based vs. Cash flow-based

(**a**) **Spread:** Asset Based (**b**) **Spread:** Cash-flow Based



Note. Average impulse response functions for the spread 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 (5) with the dependent variable being the spread (Dealscan variable *AllInDrawn*). Monetary policy shock is interacted with indicator variable based on the firm borrowing status. The shaded areas display 90 percent confidence intervals. Standard errors are clustered two-way clustered at firm and quarter.

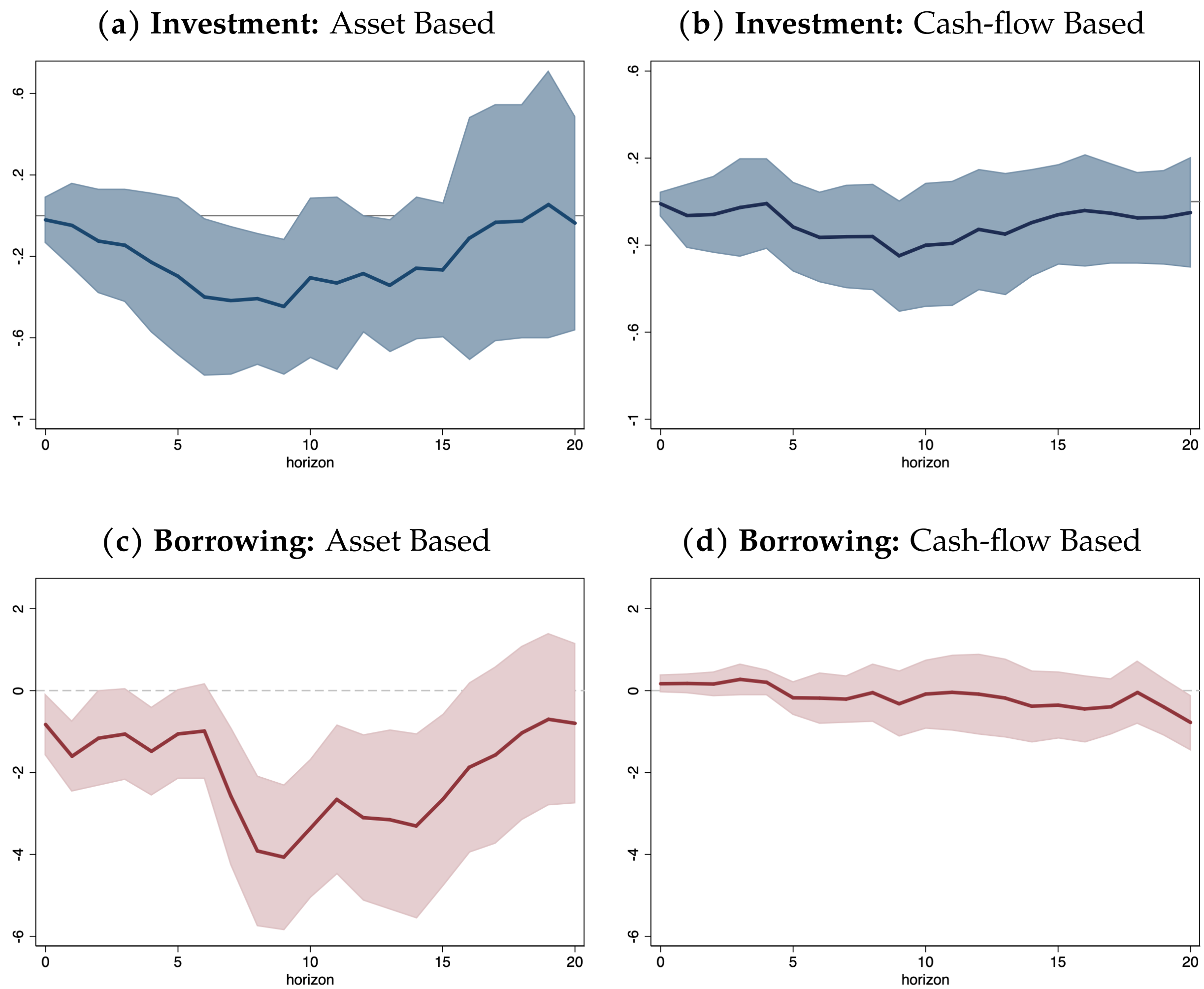
Regional heterogeneity. As documented by Chaney, Sraer, and Thesmar (2012), the value of real estate has considerable impact on firm-level activity through the collateral channel. Further, Bahaj, Pinter, Foulis, and Surico (2019) show that regional heterogeneity plays role in the response of property prices to monetary policy. These two studies suggest that the results depicted in Section 2.4 may simply reflect that some firms reside in areas where real estate prices are more responsive to monetary policy than others. To address this concern, I run a variant of (5) and include regional dummies as shown below

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

$\gamma_{l,s}^h$ is the regional dummy equals 1 for firms that operate in the region l in the quarter-year s and 0 otherwise. Figure B.3 depicts that estimated responses are similar to Figure 1 and still statistically significant.

Figure B.3

Impulse Responses: Regional Heterogeneity
Asset-based vs. Cash flow-based



Note. Average impulse response functions for the investment and borrowing 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 (B.3). Monetary policy shock is interacted with indicator variable based on the firm borrowing status. The shaded areas display 90 percent confidence intervals. Standard errors are clustered two-way clustered at firm and quarter.

External finance dependence. As originally proposed by Rajan and Zingales (1998), in order to fund their investment expenditures, some firms could be inherently more dependent on the financial sector. This dependence could arise from the sector's frequent investment requirements or simply from the strong link between banks and the firm. Following Rajan and Zingales (1998), I construct a proxy for the external finance dependence as presented below.[39]

$$ExFin = \frac{\text{Capital Expenditures} - \text{Cash Flow from Operations}}{\text{Capital Expenditures}} \tag{B.4}$$

To address this concern, I switch to the " double-sorting" strategy and interact the coefficient of borrowing method with the external finance dependence coefficient. That is, I estimate the following specification

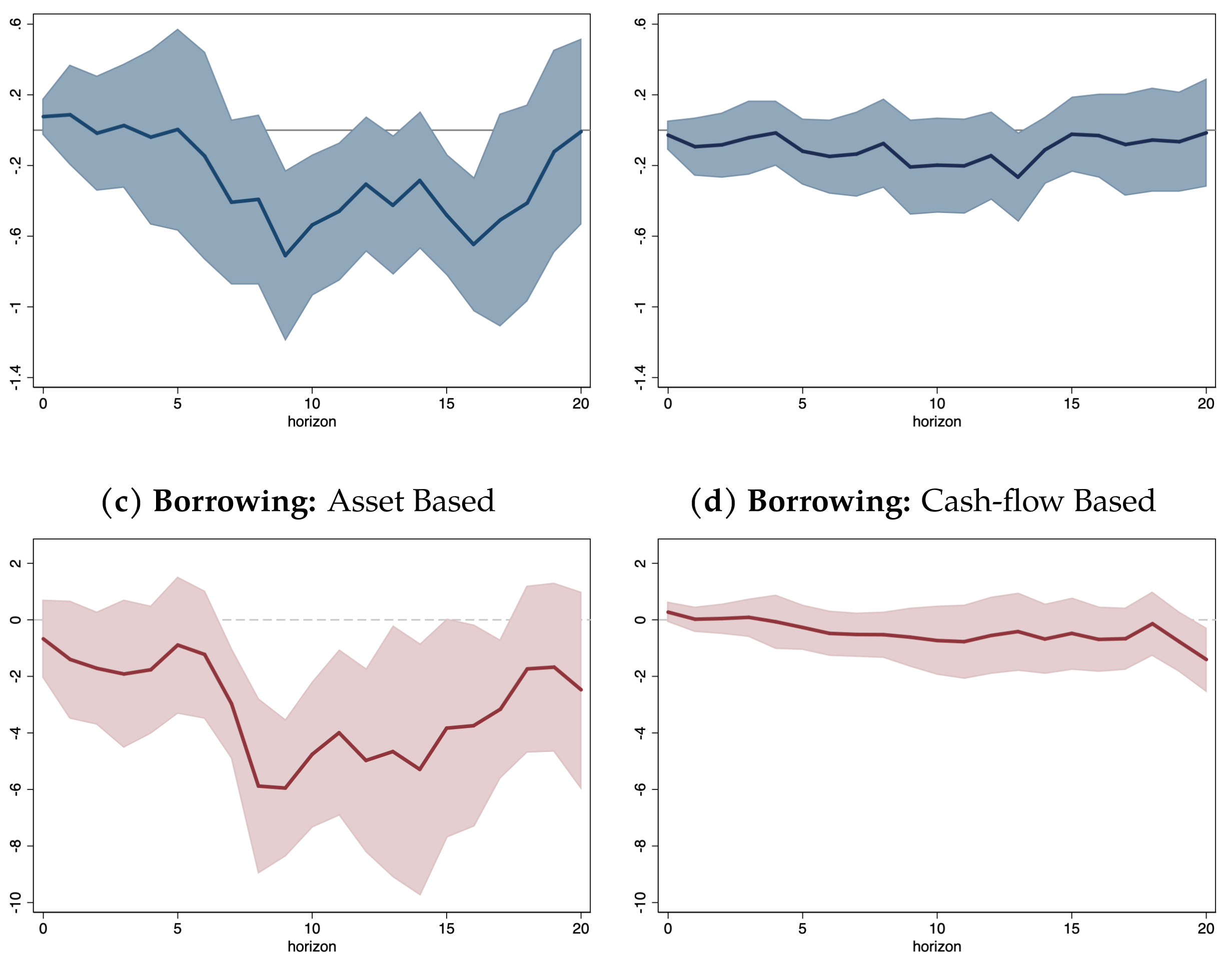
$$\begin{gathered} y_{j,t+h} - y_{j,t-1} = \alpha_j^h + \sum_{x \in \{\chi\}} \beta_x^h \left(\epsilon_t^m \mathcal{I}_{j,t-1}^x\right) + \\ \sum_{p=1}^{P_Z} \Gamma_p \mathbf{Z}_{j,t-p} + \sum_{p=1}^{P_X} \Gamma_p \mathbf{X}_{t-p} + e_{j,t+h}. \end{gathered} \tag{B.5}$$

Figure B.4 and B.5 presents the results for firms of which their external finance dependence is below and above median, respectively. Even after double sorting, the results remain unchanged.

[39] Here Rajan and Zingales (1998) stresses that as being large and publicly traded, most Compustat firms face the least frictions in accessing finance. Thus the amount of external finance used by these Compustat firms is likely to be a good proxy of their demand for external finance.

Figure B.4

IMPULSE RESPONSES: ***LOW*** EXTERNAL FINANCE DEPENDENCE
ASSET-BASED VS. CASH FLOW-BASED



(**a**) **Investment:** Asset Based

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

(**c**) **Borrowing:** Asset Based

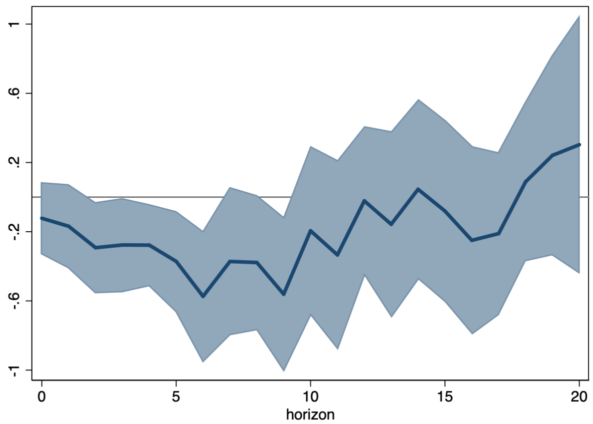
(**d**) **Borrowing:** Cash-flow Based

NOTE. Average impulse response functions for the investment and borrowing following a 25 bps increase in 3-month T-bill rate. The responses are classified into 4 groups: asset-based/low dependence, asset-based/high dependence, and cash flow-based/low dependence, cash flow-based/high dependence. The impulse responses are estimated with the local projection specification given by (B.4). Monetary policy shock is interacted with indicator variable based on the firm borrowing status. The shaded areas display 90 percent confidence intervals. Standard errors are clustered two-way clustered at firm and quarter.

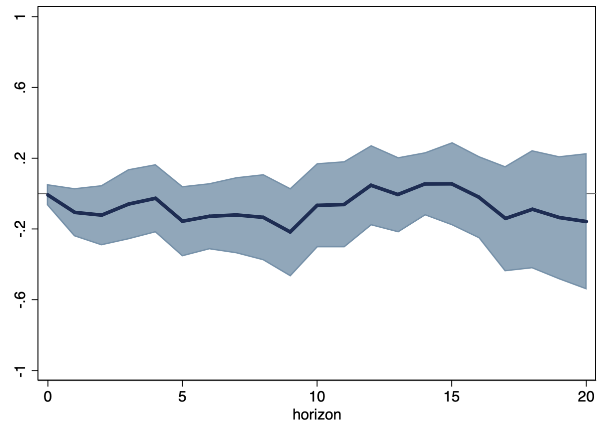
Figure B.5

Impulse Responses: ***High*** External Finance Dependence
Asset-based vs. Cash flow-based

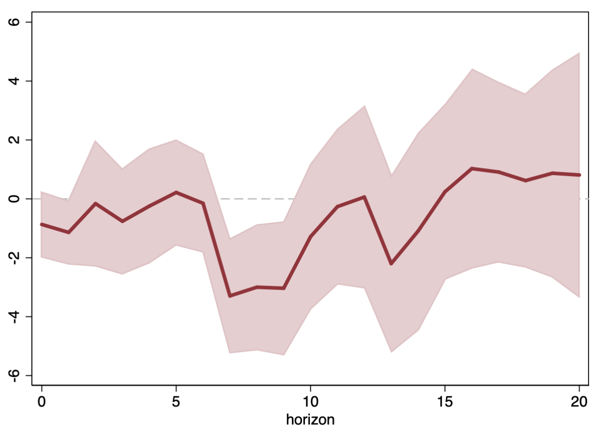
(**a**) **Investment:** Asset Based



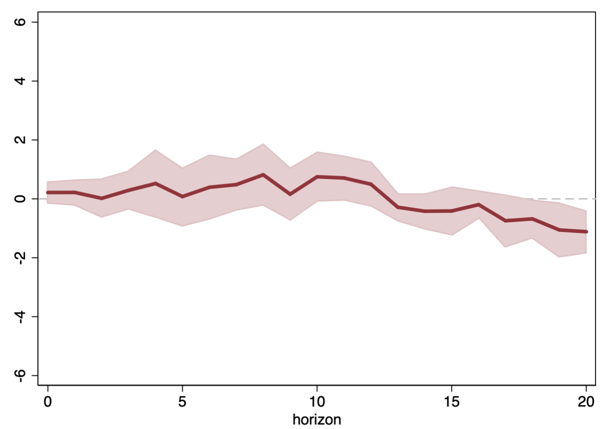
(**b**) **Investment:** Cash-flow Based



(**c**) **Borrowing:** Asset Based



(**d**) **Borrowing:** Cash-flow Based



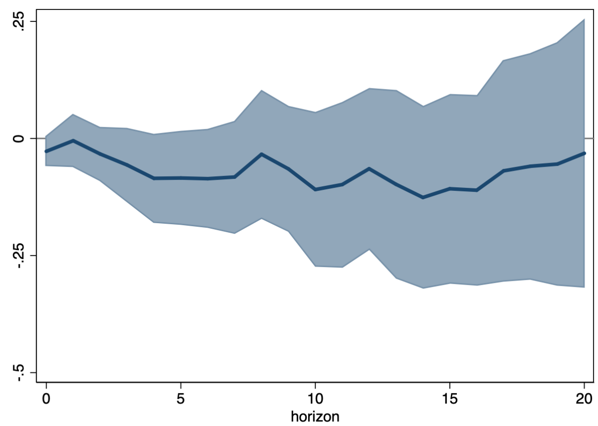
Note. Average impulse response functions for the investment and borrowing following a 25 bps increase in 3-month T-bill rate. The responses are classified into 4 groups: asset-based/low dependence, asset-based/high dependence, and cash flow-based/low dependence, cash flow-based/high dependence. The impulse responses are estimated with the local projection specification given by (B.4). Monetary policy shock is interacted with indicator variable based on the firm borrowing status. The shaded areas display 90 percent confidence intervals. Standard errors are clustered two-way clustered at firm and quarter.

Figure B.6

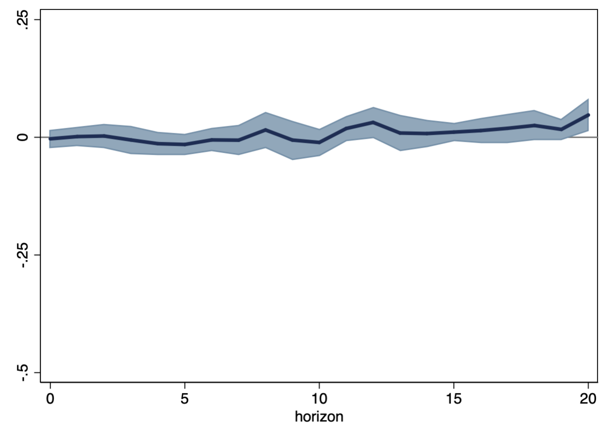
IMPULSE RESPONSES: Nakamura and Steinsson (2018) SHOCKS

ASSET-BASED VS. CASH FLOW-BASED

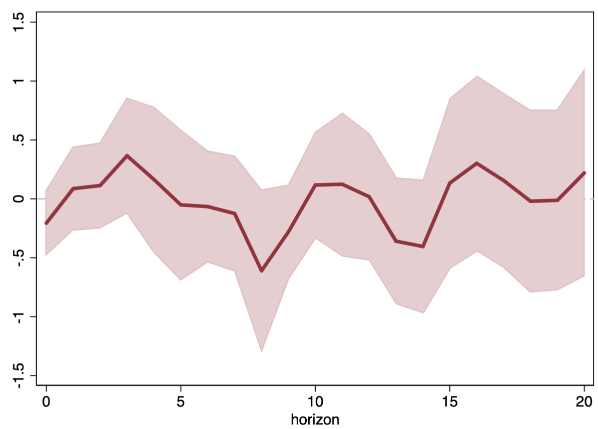
(a) **Investment:** Asset Based



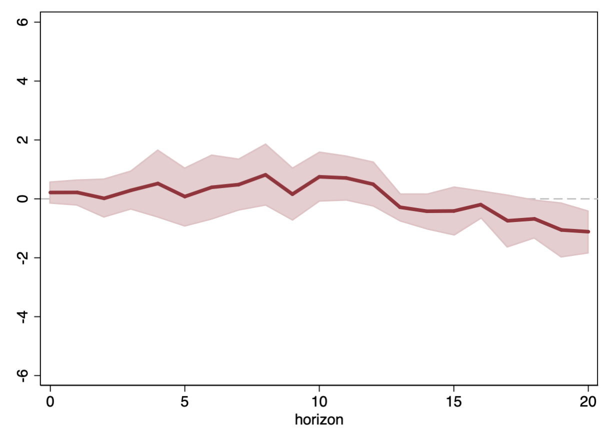
(b) **Investment:** Cash-flow Based



(c) **Borrowing:** Asset Based



(d) **Borrowing:** Cash-flow Based



NOTE. Average impulse response functions for the investment and borrowing following a 25 bps increase in 3-month T-bill rate. The impulse responses are estimated with the local projection specification given by (5). Monetary policy shock is interacted with indicator variable based on the firm borrowing status. The shaded areas display 90 percent confidence intervals. Standard errors are clustered two-way clustered at firm and quarter.

C Model Appendix

C.1 Discussion of Key Assumptions

The following discusses the implications of and rationale behind some of the key modeling assumptions made.

No spread difference between contract types. I employ a simplifying assumption that there is no difference in their spreads between asset based and cash flow based contracts.[40] Empirically, it is obvious that such a spread exits between corporate borrowing rate and risk free policy rates, however from the modeling perspective, as long as there is no spread difference between asset based and cash flow based contracts, model's implications would not have changed, if I had included spread over risk-free rate.

To be able to assume no spread difference between asset based and cash flow based contract types, three conditions must be satisfied. First, empirically the difference between the *level* of spreads has to be small enough. As can be seen from Table 1, at the mean the difference between these two borrowing types is only 0.37 pp, and thus we can accept that this condition is satisfied. Second, the loan maturities have to be close to each other. Otherwise these contracts would have been exposed to different duration risk. Table 1 depicts that at the median maturity of both types exactly equal each other (60 months). Third, the *response* of spread to a common monetary policy shock must be similar. Figure B.2 shows that indeed in terms of point estimates the responses are similar and both asset based and cash flow based borrowers experience similar fluctuations in relevant borrowin rates. Since these three conditions are satisfied, I could assume no spread difference among contract types.

Exogenous exit of firms. A common curse in the macrofinance models is that in the model economy, firms accumulate capital and thus become financially unconstrained very quickly. However, the focus of the paper is to understand how debt contracts and financial constraints shape the monetary policy transmission to firm level borrowing and investment decisions. Therefore, in order to prevent firms from accumulating enough capital that firms do not face a binding borrowing limit forever. This is forestalled by imposing stochastic exogenous exit in the model. Since exiting firms are replaced by en-

[40]By introducing endogenous default mechanism, one can introduce endogenous spread in two aspects: *i*) between the borrowing rate and risk free rates, *ii*) between the borrowing rates of asset based and cash flow based contract holders. Although interesting, this extension is irrelevant to the core mechanism of the paper (*i.e.* asset price channel of monetary policy transmission).

trants which are small by definition, it takes time for new entrants to reach their optimal scale due to the existence of financial frictions.

Non-negative dividends. It is common in the macro finance literature to assume that firms do not raise equity to fund their investment expenditures. First, this assumption is convenient in the sense that it allows for a leaner computational process. Second, the assumption is also backed by empirical studies such that new equity issuance occurs very infrequently and it is lumpy due to its costly nature (Altınkılıç and Hansen, 2000; Bazdresch, 2013).

Pass-through financial intermediary. Following the literature (Jeenas, 2023; Ottonello and Winberry, 2020), I model the financial intermediary as pass-through. It is because the purpose of this paper to explain/interpret firm behavior regarding their debt contract choice and its interaction with a monetary policy surprise. Therefore mechanisms like relationship lending (*i.e.* lenders behave differently to the borrowers they already know) or search friction in the credit markets (*i.e.* borrowers search for a suitable source of funding among lenders and there is nonzero probability of failure to do so) are abstracted from this model. Although interesting, the concept of financial intermediary with such self interests is beyond the scope of this paper.

Aggregate capital adjustment cost. The main point of the quantitative section is to illustrate the main mechanism behind why asset based borrowers are more responsive to monetary policy shocks. As discussed rigorously above it is the collateral channel through asset price fluctations. Therefore, to induce time varying capital price within the model economy, I incorporate separate aggregate capital producer firms subject to convex capital adjustment costs. In a nutshell, by this method, model is able to include financial accelerator mechanism (Bernanke et al., 1999).

C.2 Derivations

Some selected derivations along with further details about the model is provided in this subsection.

Capital Good Producer. Capital good producers operate in a perfectly competitive market, thus take the capital price q_t as given. These firms buy the existing capital stock, K_t

and also purchase I_t units of final good to produce next period's capital stock, K_{t+1}. Capital good producer solves the below problem.[41]

$$\max_{I_t} \quad q_t K_{t+1} - q_t(1-\delta)K_t - I_t \tag{C.1}$$

subject to the production function

$$\Phi\left(\frac{I_t}{K_t}\right) = \frac{\hat{\delta}^{1/\phi}}{1-1/\phi}\left(\frac{I_t}{K_t}\right)^{1-1/\phi} - \frac{\hat{\delta}}{\phi-1} \tag{C.2}$$

and the capital adjustment cost

$$K_{t+1} = \Phi\left(\frac{I_t}{K_t}\right)K_t \tag{C.3}$$

Above profit maximization problem yields the relative price of capital as

$$q_t = \frac{1}{\Phi'\left(\frac{I_t}{K_t}\right)} = \left(\frac{I_t/K_t}{\hat{\delta}}\right)^{1/\phi} \tag{C.4}$$

C.3 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 $\mu_0(z, nw)$ of firms over idiosyncratic states, set of value functions $\left\{v_t(a,\eta), v_t(z,nw), v_t^{Asset}(z,nw), v_t^{Cash}(z,nw), v_I(B,D)\right\}$ and allocations $\{c, l, a', \eta'(z', nw'), B', D', k', b', l'\}$ such that:

1) Production firms. Given the borrowing constraint rules and operating cost $\{\Phi\}$ and prices $\{p, q, \mathcal{Q}, w\}$; allocation $\{k', b', l\}$; the value function $\{v_t(z,nw)\}$ solves production firm's problem governed by (10) - (16)

2) Financial Intermediary. (19) 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 (24), (25). And it satisfies (26) and the in-

[41]Note that, since capital good producers have to buy the entire aggregate capital stock, only choice variable for these firms is how much final good to use to produce new aggregate capital stock.

tratemporal optimality condition $w = \psi c$;

4) Stationary distribution. Stationary distribution of firms

$$\mu(z, nw) = \mu'(z, nw) \tag{C.5}$$

5) Labor market clearing. Labor market clears.

$$l = \int_{\mathbf{S}} l\mu(z, nw)\, d(z, nw) \tag{C.6}$$

6) Equity market clearing. The equity market clears.

$$\eta(z, k', b') = 1 \quad \text{for each firm } (z, k', b') \in \mathbf{S} \tag{C.7}$$

7) Debt market clearing. The debt market clears.

$$B' = \int_{\mathbf{S}} b'\mu(z, nw)\, d(z, nw) \tag{C.8}$$

8) Deposit market clearing. The deposit market clears.

$$D' = a' \tag{C.9}$$

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

$$\begin{aligned} C + &\int_{\mathbf{S}} k'\mu(z, nw)\, d(z, nw) + \int_{\mathbf{S}} \Phi\mu(z, nw)\, d(z, nw) \\ &= \int_{\mathbf{S}} zk^{\theta} l^{\nu}\mu(z, nw)\, d(z, nw) + (1-\delta)\int_{\mathbf{S}} k\mu(z, nw)\, d(z, nw) \end{aligned} \tag{C.10}$$

D Quantitative Tightening as a Model Exercise

Quantitative tightening is conducted by the monetary authority, which affects the capital price q_t through a reduced form formula (D.1). Modeling QT shock (D.1) is not far from the actual channels that QT transmits. Krishnamurthy and Vissing-Jorgensen (2013) indicates that QE mostly transmits through the effect of large-scale purchases on asset prices, and the channel through long-term bond yields is generally ineffective. Therefore, although this is a reduced form approach to modeling quantitative tightening, it may still provide insights into how quantitative tightening transmits to firm-level investment and borrowing through the borrowing constraints.

The steady-state capital price is pinned down as $q_{SS} = 1$.

$$q_t = q_{SS} + \varepsilon_t^q \quad \text{where } \varepsilon_t^q \sim N\left(0, \sigma_q^2\right) \tag{D.1}$$

$\varepsilon_t^{\mathrm{q}}$ is the unconventional monetary policy shock (*i.e.* unexpected asset purchases by the central bank). Similar to the conventional monetary experiment, I assume that the economy is initially in steady state and unexpectedly receives a $\varepsilon_{t=0}^{\mathrm{q}} = -0.25$ percent innovation to the reduced form rule which reverts to 0 according to $\varepsilon_{t+1}^{\mathrm{q}} = \rho_{\mathrm{q}}\varepsilon_{\mathrm{q}}$ with $\rho_{\mathrm{q}} = 0.5$. Given the price path, I compute the perfect foresight transition path of the economy as it converges back to steady state.

To observe the model's internal dynamics via these borrowing constraints while keeping the comparability to the Section 6, I estimate a variant local projection specification (D.2) on the simulated data. Regressions yield the coefficients of interest γ_1^h and γ_2^h which capture the impulse response to a QT shock.

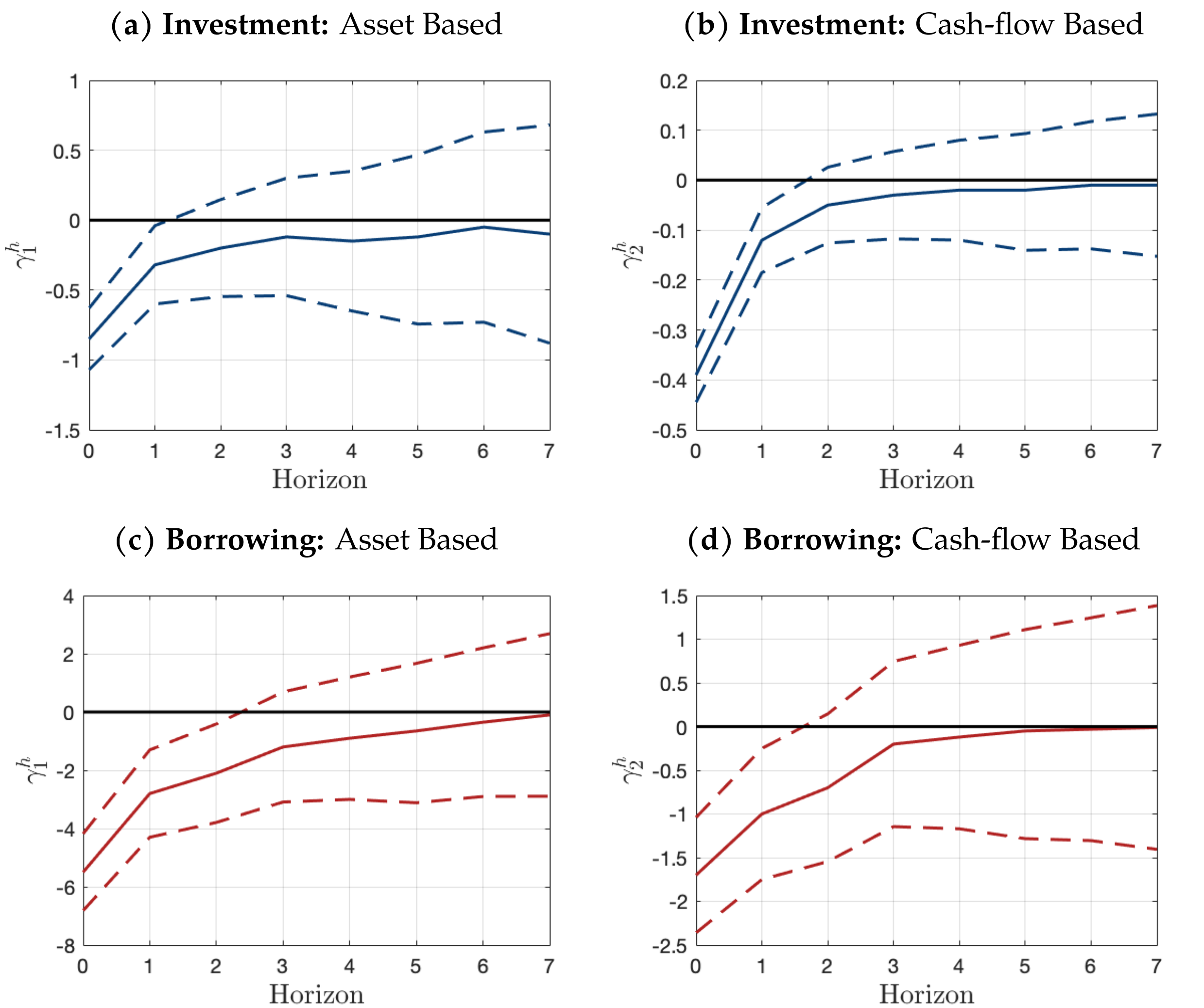
$$y_{j,t+h} - y_{j,t-1} = \alpha_j^h + \delta_t + \gamma_1^h\left(\epsilon_t^q \mathcal{I}_{j,t-1}^{Asset}\right) + \gamma_2^h\left(\epsilon_t^q \mathcal{I}_{j,t-1}^{Cash}\right) + \sum_{p=1}^{P_Z} \Gamma_p \mathbf{Z}_{j,t-p} + e_{j,t+h} \tag{D.2}$$

$h = 0, 1, ..., H$ represents the time horizon where $H = 10$ quarters. $y_{j,t+h}$ is the dependent variable of interest at horizon h: investment and borrowing. α_j^h is the firm fixed effect, ϵ_t^q is the quarterly QT shock. $\mathcal{I}_{j,t-1}^{Asset} = 1$ when firm j use asset-based borrowing practices in the prior quarter of the QT shock (otherwise zero) and $\mathcal{I}_{j,t-1}^{Cash} = 1$ when firm j use cash flow based borrowing practices in the quarter that precedes the QT surprise (otherwise zero). Baseline specification also controls for a variety of idiosyncratic factors and also includes time fixed effect, δ_t to control for the aggregate factors.

Figure D.1 depicts the impulse responses estimated using (D.2) and the dashed lines

Figure D.1

Impulse Responses to a Quantitative Tightening Shock: Asset-based vs. Cash flow-based



Note. Average impulse response functions for the investment and borrowing to a quantitative tightening shock. The responses are estimated with (D.2). Quantitative tightening shock is interacted with indicator variable based on the firm borrowing status. The dashed lines display 90 percent confidence intervals.

denote the 90 percent confidence intervals. The top row, Panel (A) and Panel (B), show that asset-based borrowers' peak investment response is almost double that of cash flow-based borrowers. The bottom row, Panel (C) and Panel (D), show that the borrowing response resembles the investment response, as the magnitude is three times larger for asset-based borrowers (at their peak).

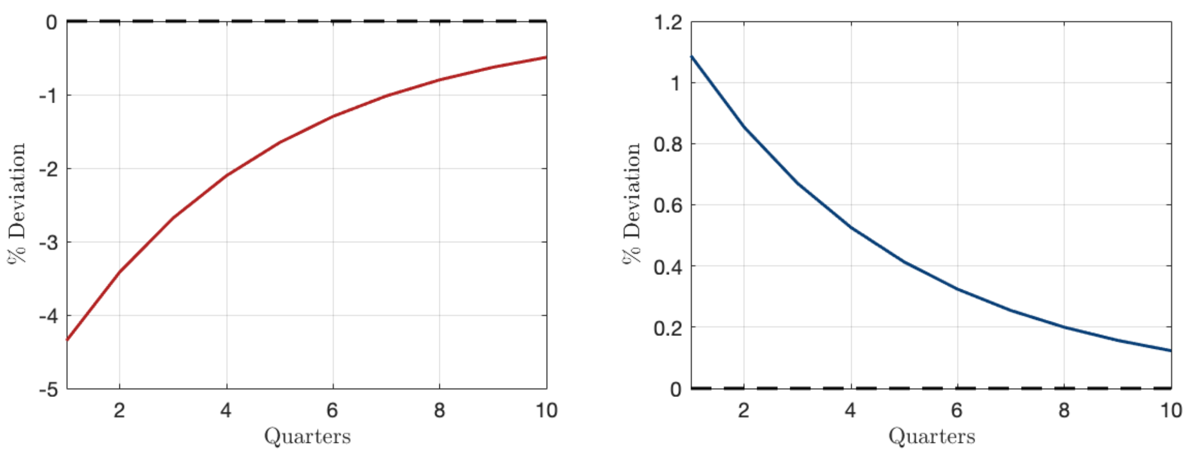
The underlying mechanism also works through the response of borrowing constraints to a change in asset prices. Lower asset prices mean lower collateral value, which leads to tighter borrowing constraints for asset-based borrowers. Since such a channel is not operative on the cash flow-based contracts, we see the heterogeneous transmission of QT shock to the firm-level investment. As for the QE shock, since the effect of a QE shock is symmetric to a QT shock, given that asset-based borrowing firms are affected by changes in asset prices in a straightforward manner, QE programs directly lift the financial situation of these particularly fragile firms.

Figure D.2

Response of Shares to a qt Shock

Asset-based vs. Cash flow-based

(**a**) **Share:** Asset Based (**b**) **Share:** Cash-flow Based



Note. Aggregate impulse response functions for the shares of contracts following a quantitative tightening shock. The shock is applied as an unexpected innovation to the rule (D.1). The shock series starts with $\epsilon_t^q = 0.0025$ and continue as $\epsilon_{t+1}^q = 0.5 * \epsilon_t^q$. The responses are computed as the perfect foresight transition path.

Figure D.2 shows that firms respond to a QT shock by switching from asset-based contracts to cash flow-based contracts. This behavior is in line with the finding in Section 6.3 that the borrowing constraint of asset-based contracts is affected more severely by asset price fluctuations than cash flow-based borrowers. The main mechanism is that to avoid the tightening borrowing constraints, firms with asset-based contracts switch to cash flow-based debt contracts if they are able to do so.[42] One final note about switching behavior is that compared to 6, in Figure D.2 the impulse response is more persistent.

E Discussion About Debt Contracts

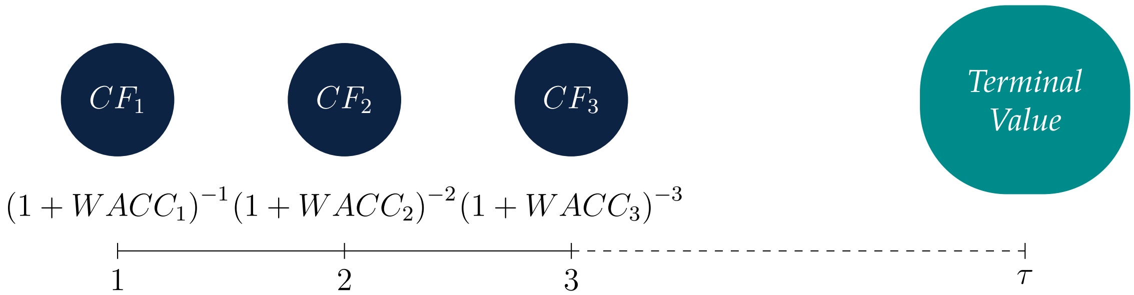
E.1 Valuation Methods

There are two main approaches in business valuation: absolute valuation and relative valuation. Absolute valuation, also called as intrinsic valuation, employs discounted cash flow (DCF) analysis to evaluate a firm's financial worth. DCF method determines a firm's intrinsic value by using its projected cash flows. Figure E.1 depicts a diagram summarizing the DCF analysis. However, using the absolute value analysis poses some challenges such as accurately forecasting cash flows, predicting accurate growth rates, and evaluating appropriate discount rates. First, forecasting the exact cash flow values is nearly impossible given the idiosyncratic and aggregate disturbances firm faces. Second, not only cash flow values but also an appropriate discount rate (i.e. weighted average cost of capital) needs to be forecasted with complete certainty. Third, as can be seen from Figure E.1, the largest chunk that needs to be forecasted is the terminal value. More elaborately, all of the DCF analysis assume that each firm reaches a stable path in their lifecycle in which exhibits a constant growth rate, cash flow and discount rate. The analyst also has to assume the length of time period until its terminal value. Although there are methods to estimate these values from firm's balance sheet and income statement, these estimations are still far from being absolute. Therefore, it is difficult for borrower and lender to agree on any of these estimations given the very sensitive nature of the analysis. The caveats of this approach makes it controversial while forming the contracts.

Given the contractibility issues of absolute valuation, borrowers and lenders employ a much more practical approach. Relative valuation is a business valuation approach in which a firm's value is assessed by using some measures of the firm's competitors or industry peers. In order to evaluate the firm of interest, analysts and investors compare the ratios such as value-to-EBITDA, price-to-earnings, market capitalization etc. to other similar firms. Nevertheless, absolute valuation via DCF method is also used by analysts to support the relative valuation. Therefore one can think of these two approaches as complements rather than substitutes.

[42]Similar to the mechanism in Section 6.2, the limited commitment of debt dampens the number of switching firms. Since financial intermediary ensures repayment in every state of tomorrow, most firms do not find it optimal to switch their contracts.

Figure E.1
DCF Analysis



Note. This figure summarizes the discounted cash flow analysis. $WACC_t$ stands for weighted average cost of capital in period t. Terminal value is defined as $TV = \frac{CF}{WACC-g}$ where CF is the constant cash flow value, WACC is the constant weighted average cost of capital, and g is the constant growth rate of the firm.

Sectoral Heterogeneity. Some sectors exhibit strong preference in one of the debt contract types. Lian and Ma (2021) indicates that firms in the airline industry constitute good example as they predominantly employ asset-based borrowing due to having substantial amounts of standardized, transferable assets such as aircrafts and hangars. Having higher amounts of pledgeable assets makes asset based borrowing ideal for the firms in airline sector. By presenting impact of aircraft collateral and fire sale mechanism in this industry, Pulvino (1998),Benmelech and Bergman (2009) and Benmelech and Bergman (2011) also emphasize the dominance of asset based borrowing in airline sector.

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).

Loan vs 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, even though bonds do not contain such limits on firm's actions, they are still bounded by the loan covenants as a loan covenant limits firm's total debt, regardless the underlying source of the debt (*i.e.* bond issuance or loans).

The underlying reasons behind why firms borrow via loans and comply with the stricter 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 relatively larger.