Debt Covenants, Investment, and Monetary Policy

Özgen Öztürk*
European University Institute
Ozgen.Ozturk@eui.eu

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Abstract

This paper studies the macroeconomic implications of firms' debt covenants. Traditional approach in the macro-finance analyses is to formulate firms' borrowing constraints based on the liquidation value of asset stocks. However, recent studies show that the type of debt covenant determines how firm debt limits are calculated, and further, prevalent form of debt covenants constrain firms' total debt by employing a measure of cash flow. To provide microfoundation for the coexistence of different forms of debt covenants and their implied borrowing constraints, I develop a heterogeneous firm, macro finance model with financial frictions featuring asset based and cash flow based debt covenants. In the model, debts are subject to limited enforceability, therefore lenders determine the terms of asset based and cash flow based debt contracts and restrict the borrowing amount. In line with the recent empirical literature, model predicts that —most of the time— small, young, highly leveraged firms have asset based debt covenants; while older, larger and low leveraged firms mostly borrow with cash flow based debt covenants. This initial set of results about the coexistence of these different debt covenant forms suggest a novel channel on the monetary policy transmission. This channel implies that as the firm's borrowing capacity itself is heterogeneously affected by monetary policy shocks, firm heterogeneity in terms of debt covenants plays a strong role on the tightness of borrowing constraints, and thus shapes the monetary policy transmission.

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

JEL classification codes: E22, E32, E44, E52

*European University Institute, Department of Economics, Villa La Fonte, Via delle Fontanelle 18, I-50014 San Domenico di Fiesole (FI) - Italy. (Email: Ozgen.Ozturk@eui.eu).

1 Introduction

How are firms' balance sheet features and their debt covenants are correlated? And further, what impact do debt covenants have on transmission mechanism of monetary policy? In this paper, to explain the impact of balance sheet features on the form of debt covenants, I develop a heterogeneous firm, macro finance model with financial frictions and endogenous debt limits. In line with the recent empirical findings (Cloyne, Ferreira, Froemel, and Surico, 2018; Lian and Ma, 2021), model predicts that —most of the time— small, young, highly leveraged firms have asset based debt covenants; while older, larger and low leveraged firms mostly borrow under cash flow based debt covenants. This initial set of results suggest a novel channel, in which firm heterogeneity in terms of debt covenants plays a strong role on the severity of financial frictions, thus shaping the monetary policy transmission.

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

Financial accelerator theories indicate that firms' borrowing and investment are more sensitive if they borrow against a collateral of which value is highly responsive to monetary policy surprises. The conventional approach in the literature is to model a firm's borrowing

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

To address these issues, and explain which micro features (*i.e.* size, age, leverage, liquidity position) are impactful on covenant choice, and further to illustrate how different forms of debt covenants lead to different forms of borrowing constraints, and introduce novel channels about financial covenants, and examine their macroeconomic implications, I construct a heterogeneous firm model with endogeneous debt limits and various debt covenants. In the near future, I will also compare the monetary policy transmission channels which are triggered via different types of debt covenants (asset-based contracts and cash flow-based contracts).[2]

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

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

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

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

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

Initial results reveal that, in line with the empirical evidences presented in Lian and Ma (2021), the model well captures the fact that cash flow-based borrowing is the prevalent method for most of the states. Some underlying dynamics are as follows. As the firm becomes more productive, its ability to generate cash flow increases, and thus provides looser borrowing constraints. Furthermore, for a given level of capital, as debt stock increases, most firms rely on asset based borrowing. It is due to the fact that higher debt directly translates into lower pledgeable cash flow. Therefore expecting an increase in the firm's likelihood of reneging from its promise of payment, lenders tighten the borrowing constraints and steer firms to sign asset based contracts. In terms of leverage, model shows that low leveraged firms mostly prefer cash flow based borrowing, in line with empirical evidences presented in Cloyne et al. (2018). Moreover, as the firms' available internal funds increase, then firms do not borrow and use their own funds to finance their investment spendings in order to avoid the costs that comes with external funding—whichever the underlying covenant is.

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

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

investment as a response to a contractionary monetary policy shock.

In the spirit of financial acceleration, if a firm borrows using its asset stock as collateral, then traditional channels suggested by Kiyotaki and Moore (1997) and Bernanke et al. (1999) are still at work.[5] However, if a firm borrows against its earnings, then the traditional channels regarding the financial accelerator mechanism do not operate. For such firms, the only active channel is indirect, that is increasing interest rates suppress the aggregate demand which decreases the firm's cash flow. Therefore, we can deduce financial acceleration mechanisms conduct asymmetrically across firms, suggesting aggregate implications. In terms of monetary policy transmission, if the financial accelerator is effective on a firm (*i.e.* if the firm borrows against its asset stock), then a contractionary monetary policy shock translates into sharper contraction in borrowing capacity and subsequently a decline in net debt issuance and investment. Consequently, this set of results suggest that financial frictions effect monetary policy transmission more severely when more firms borrow against their asset stock.

Short-term Outlook. The dataset I will employ is the merged DealScan and Compustat.[6] In the near future, first I provide empirical evidence about how firm's balance sheet structure affects their covenant choice in corporate borrowing practices.[7] Second, I illustrate having asset-based or cash-flow based borrowing contracts is considerably impactful on the financial variables that influence firms' investment dynamics on the margin. Third, by employing local projections method à la Jordà (2005), I estimate the investment response of firms to a monetary policy surprise. This exercise shows that firms with asset based covenants exhibit relatively sharper contraction of debt issuance and investment.

This paper shows how particular channels of how asset-based and cash-flow based covenants affect the firm behavior on the margin through their influence on financial variables. This follows from investigating whether the firm's borrowing limit is implied by the liquidation value of physical assets or by cash flows. Then, I argue that different forms

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

[6] I follow Chava and Roberts (2008) while linking the firm level balance sheet items and covenant information. The linking algorithm is generously provided freely by the authors.

[7] Lian and Ma (2021) explains how legal infrastructure shape the corporate borrowing practices. Cash flow-based lending is much more emanating than asset-based lending if the following conditions hold: (*i*) legal infrastructure facilitates verifiability of firms' cash flows in a given time period, (*ii*) liquidation values of physical assets are limited or not easily verifiable (due to high asset specificity, highly volatile markets, and lack of legal foundation).

of debt covenants coupled with limited enforcement is a crucial mechanism explaining how monetary policy surprises have heterogeneous impacts on firms' investment decisions. This paper proposes a novel channel, in which firm heterogeneity in terms of debt covenants plays a strong role on the severity of financial frictions, thus shaping the monetary policy transmission.

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

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

Third, there is a relatively new strand of literature about the debt covenants. Lian and Ma (2021) empirically presents that debt covenants are often written as asset based or cash flow based while the latter is more dominant. Sharing the similar findings, Drechsel (2018) develops a representative firm New Keynesian model to study the implications of investment shocks by comparing the two economies with either asset based or cash flow based prevailing. Greenwald (2019) focuses on an environment in which only earnings based covenants exist and study the transmission of monetary policy shocks. I contribute to this literature branch by providing a rationale for the coexistence of different types of debt covenants. Further, I derive these borrowing limits from first principles, instead of imposing *ad hoc* functional forms, hence developing a microfoundation for the different forms of borrowing constraints.

In spirit, this paper is closely related to Jeenas (2018), Cloyne et al. (2018), Anderson

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

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

Road Map. The rest of the paper is organized as follows. Section 2 explains the data, describes the various identification strategies of monetary policy surprises, and presents micro-level evidence about the pervasive use of cash flow-based covenants, and also provides empirical evidence about heterogeneity in debt covenants leads to varying degrees of firm-level sensitivity to monetary policy shocks. Section 3 develops the heterogeneous firm model, discusses selected equilibrium properties and the calibration strategy. Section 4 provides findings about firm behavior and discusses that model's predictions are consistent with the empirical facts of Section 2. Section 5 presents the firms' heterogeneous sensitivity to monetary policy shocks. Section 6 provides a road map for the near future.

2 Empirical Framework

In this section, I discuss the empirical strategy employed in this paper, corresponding firm-level data and micro level evidence from the existing literature. In Section 2.1, I discuss the methodology of extracting monetary policy surprises, along with some ideas about future robustness checks. In Section 2.2, I briefly describe the datasets I use in my empirical analyses. In Section 2.3, I present a number of descriptive statistics from Lian and Ma (2021) which show cash-flow based lending is the prevalent method for US nonfinancial large firms. Section continues with the discussion about which firms tend to be the asset-based borrowers, mostly. In Section 2.4, I present some results from Cloyne et al. (2018), suggesting that collateral values decline for both young and old firms after an increase in interest rates, however this decline in collateral values only translate into lower investment for young firms. This finding suggests that young firms experience worse financial conditions. Finally in Section 2.5, I discuss my further work in the empirical analyses. As a final notice, since I haven't carried out my own regressions yet, Section 2.3 and 2.4 should not be seen as the final versions. In time, when I do my own empirical exercises, I will fill these sections with my own results. So, Section 2.3 and 2.4 serve as a road map rather than a complete section.

2.1 Identification of Monetary Policy Shocks

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

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

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

Since FOMC meetings are held 8 times in a year, the frequency of monetary policy shock

is higher than quarterly. Therefore, to obtain quarterly monetary policy shock, ε_t^m, I aggregate the high-frequency measures of monetary policy shocks. Process involves summing ϱ_{τ_j} up within quarter t, as presented below:

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

where $\tau_{j,1}$ and $\tau_{j,2}$ exact dates of the beginning and the ending of quarter t, and τ_j corresponds to the exact date at which FOMC press release is issued.[8] Note that monetary policy shocks are normalized in a way that a positive value for ε_t^m corresponds to a surprise increase in the fed funds futures rate.

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

2.2 Data Description

In this work, I work on firm-level data from Compustat and syndicated loan data from DealScan datasets to carry out empirical analyses. By employing the linking file provided by Chava and Roberts (2008), I connect the identifiers of both datasets. Compustat contains firm-level variables of interest, and DealScan contains information of loan covenants for syndicated loans. I classify the loans into different covenant categories and construct variables of interest to have micro level firm-information and covenants.

2.3 Micro-level Evidence on Debt Covenants from the Existing Literature

In this section, I explain debt covenants and their various features relevant to macroeconomics literature. I also provide some empirical findings about the relation between firm

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

characteristics and debt covenants from the recent works of Lian and Ma (2021) and Cloyne et al. (2018)

Definition of Debt Covenants. The contracts that both lenders and borrowers agree on the borrowing terms are called debt covenants. Covenants state terms for the firm to fulfill. These terms may include limits on financial ratios and also the consequences in case of a breach. Although there are various types of covenants in these contracts, the focus of this paper is loan covenants.[9] Loan covenants mandate that throughout the life of loan agreement, firms must satisfy some financial ratios —most prominently, debt-to-assets or debt-to-EBITDA. More details can be found in Appendix D.

Covenant Types. In essence, the main determinant of covenant type is the resolution of default. If in a covenant, creditors have the right to seize the firm's assets, then the borrowing limit is determined by the liquidation value of physical assets. This type of covenants are referred to asset-based covenants. Moreover, if creditors' have the right to take over the management of the firm, then borrowing is calculated via the firm's going-concern cash flow value. This type of covenants are called cash flow-based (or earnings-based covenants).[10] Furthermore, the disscussion about asset-based versus cash flow-based covenants should not be confused with the discussion about secured versus unsecured debt. Both covenant types are secured, and thus creditors have priority in case of bankruptcy.

Prevalence of Cash flow Based Covenants. To illustrate which form of covenant is prevalent, I borrowed Figure 1 from Lian and Ma (2021). As Figure 1 shows, (median) share of asset-based lending is less than 20% while cash flow-based is slightly over 80%, and the shares are steady over time. The sample set consists of US large non-financial firms of which the total debt of these firms constitute over 96% of debt outstanding among Compustat firms. Therefore, the authors argue that Figure 1 well represents the total debt composition in Compustat.

Firm Heterogeneity by Covenant Type. As shown by (Lian and Ma, 2021; Cloyne et al., 2018) covenant types are strongly correlated with some firm characteristics. For instance,

[9] Depending on the sector operated, firms have a variety of covenants. These covenants may include **[GIVE SOME EXAMPLES HERE]**

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

small or young firms generate limited cash flows from their continuing operations and thus creditors cannot rely on the firm's cash flow to seize in case of default. Therefore, small or young firms have to rely on their asset stock as collateral. On the contrary, cash flow based covenants are more common practice among larger or older companies, since these firms are able to generate stable cash flows over time.[11]

Another group of firms that particularly rely on cash flow based lending is the firms operating in services and technology (*e.g.* software) sectors. In these sectors, firms mostly rely on 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).

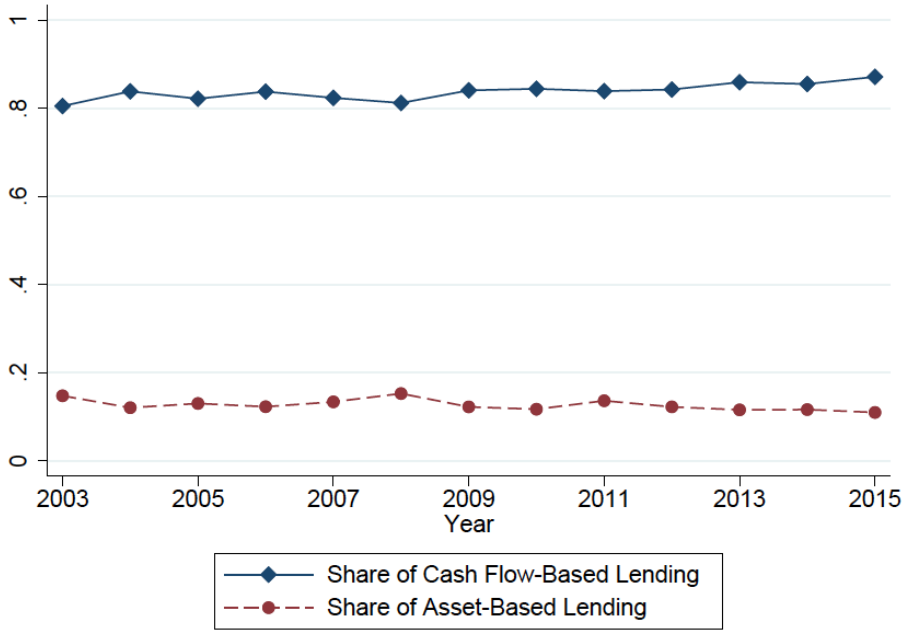


FIGURE 1
Shares of Asset-Based and Cash Flow-Based Lending
Source: Lian and Ma (2020)

[11] Apart from these facts, despite the fact that being mostly large, firms in the airplane industry predominantly employ asset-based lending due to having substantial amounts of standardized transferable assets (aircrafts). On the other extreme, in sectors that mostly employ intangible assets, firms also rely on cash flow-based debt even if they are small.

How are the borrowing limits determined? In cash flow-based covenants, due to its verifiability, borrowing limits are calculated based on a cash flow measure called EBITDA.[12] Lenders impose limits on firm's borrowing capacity by explicitly stating that total debt cannot exceed a certain ratio of debt-to-EBITDA.[13] Note that cash flow-based covenants restricts not only the loan amount but firm's total debt stock. Therefore, cash flow-based covenants also have implications for firm's bond issuance. Further discussion about loan borrowing versus bond borrowing can be found in Appendix D.

2.4 Heterogenous Sensitivity to Monetary Policy Shocks

Figure 2 shows that collateral values decrease for both younger non-dividend and older-dividend paying firms, but translate into lower borrowing for only younger non-dividend paying firms. In the framework of this paper, Figure 2 suggests that only asset based borrowers —which are mostly younger firms— are affected from decreasing collateral values. Therefore, mostly asset-based borrowers respond to an interest rate increase.

2.5 Further Work in the Empirical Part

Prevalence Among Firm Groups. Demonstrate the prevalence of each covenant form among many firm groups: *size* (small/large), *age* (young/old), *balance sheet liquidity* (short-term/long-term debt), and *capital type* (tangible/intangible). By utilizing these findings, create a mapping of sectoral variations in reliance on covenants.

Sensitivity of Net Debt Issuance to Earnings. I will carry out the following regression to show how asset based borrowers and earnings based borrowers react to EBITDA.[14] It is expected that for asset based borrowers EBITDA produces β values close to zero.

In order to isolate the impact of contemporaneous EBITDA, I include control variables related to internal funds. These control variables are size, cash holdings, Q, book leverage, property, plant and equipment, depreciation rates, and lagged EBITDA.

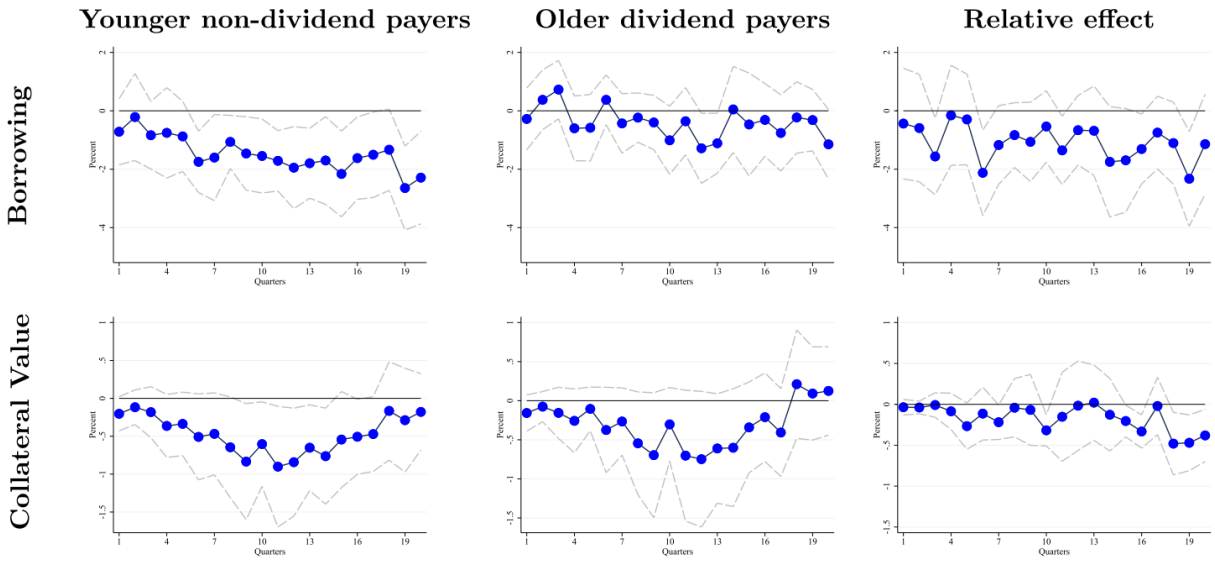
$$Y_{i,t} = \alpha_i + \eta_t + \beta \text{EBITDA}_{it} + X'_{it}\gamma + e_{it} \tag{3}$$

In this regression, the dependent variable $Y_{i,t}$ is net debt issuance and $X_{i,t}$ is the set of controls mentioned above.

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

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

[14] Lian and Ma (2021) performs a similar regression among the following groups: (i) large firms with cash flow-based covenants, (ii) large firms without cash flow-based covenants, (iii) small firms, (iv) young firms, (v) airline firms. They find that only the first group has a significant coefficient on EBITDA



Notes: This figure shows the IRFs for the investment rate following a 25bps increase in the one year interest rate. We run separate regressions per each row. The first row shows the response of total real debt growth (annualized). The second row shows the response of real collateral value growth (market value). The market value of collateral is constructed using the change in the book value of corporate real estate assets and using state house price variation as discussed in the data appendix. Young refers to less than 15 years since incorporation. The relative effect column refers to separate specifications where the IRFs are estimated relative to older firms paying dividends. The IRFs are estimated using the local projection IV approach described in the text. Dotted lines are 90% standard error bands. Standard errors are computed using the Driscoll-Kraay method, clustering by firm and time, which is robust to very general forms of cross-sectional and temporal dependence.

FIGURE 2
Response of Firm Finance: Borrowing and Collateral Value
Source: Cloyne et al. (2018)

Sensitivity of Net Debt Issuance to Asset Prices. (4) will be run to observe that asset based borrowers have significant β coefficients while cash flow based borrowers do not.

In addition to controls employed in 4, I now include EBITDA at time t to isolate the potential indirect channels that may be effective on net debt issuance.

$$Y_{it} = \alpha_i + \eta_t + \beta \mathrm{RE}_{it} + X'_{i,t}\gamma + e_{it} \tag{4}$$

The dependent variable $Y_{i,t}$ is net debt issuance, RE is the price of pledgeable assets which will be obtained by following Cloyne et al. (2018) and Lian and Ma (2021).

Link between Micro-data and National Statistics. Estimate the average effect of monetary policy shocks on investment at the firm-level. Then estimate the effect of a monetary policy shock on aggregate investment (aggregate data obtained from national statistics). Finally show these two sets of results are plausibly close to each other.

Heterogeneous Responses to Monetary Policy Shocks. Following Jordà (2005), I will employ local projections method to demonstrate the heterogeneous responses of the asset based and earnings based borrowers to a monetary policy shock. The main empirical specification will be:

$$\Delta \log k_{i,t} = \alpha_i + \alpha_{st} + \beta \varepsilon_t^m + \gamma \varepsilon_t^m \mathrm{DC}_{i,t-1} + X'_{i,t-1}\gamma + e_{i,t} \tag{5}$$

where ε_t^m is the identified monetary policy shock, $k_{i,t}$ is the capital stock, and $\mathrm{DC}_{i,t-1}$ stands for the firm's debt covenant form in the previous period.

3 Model

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

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

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

In a nutshell, the model is developed by following Khan and Thomas (2013) and Cao et al. (2019), and extended to incorporate different forms of debt covenants and a monetary authority.

REMARK: In the current version, model does not incorporate nominal terms or price stickiness mechanism. Therefore, in this version I only investigate the steady state behavior of firms. Adding these components is the very next step.

3.1 Production Firms

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

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

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 (7):

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

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

$$nw = \max_{l} pz(k)^{\theta} l^{\nu} - wl + q(1-\delta)k - b - \Phi \tag{8}$$

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

$$\begin{aligned} v^{\chi}(z,k,b) = \max_{k',b'} \quad & nw - qk' + \mathscr{Q}b' \\ & + \mathbb{E}_{z'|z}\left[\Lambda^{h} v'(z',k',b')\right] \quad \chi \in \{\text{Asset}, \text{Cash}\} \end{aligned} \tag{9}$$

subject to a non-negativity constraint on dividends:

$$nw - qk' + \mathscr{Q}b' \geq 0, \tag{10}$$

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

3.2 Debt Covenants

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

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

Lenders offer two types of debt covenants: asset-based or cash flow-based. Firms choose the optimal debt covenant by comparing them. These covenants differ in terms of default resolution. If the firm opts for asset-based debt covenant, default results in a loss of a fraction of its asset stocks. However, if the firm borrows with cash flow-based debt covenant, then in case of default, the firm loses the management rights. In this case, the firm's contingent value is calculated as the multiple of its cash flow.[15]

In this setup, firm's borrowing decisions have two dimensions. In the extensive margin whether to opt for asset-based covenant or cash flow-based covenant, and in the intensive margin how much to borrow. In the extensive margin, firm's value is governed by the upper envelope of v^{Asset} and v^{Cash} as given below:[16]

$$v\left(z,k,b\right)=\max\left\{v^{Asset}(z,k,b),v^{Cash}(z,k,b)\right\} \tag{11}$$

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

$$v^{Asset}\left(z',k',b'\left(z',k'\right)\right)\geq v^{Asset}\left(z',(1-\Theta)k',0\right)\qquad\text{for all } z'. \tag{12}$$

The interpretation of (12) originates from the fact that in case of a covenant breach firms lose a fraction Θ of their existing asset stock and continue with the remaining portion. It is due to the fact that only a portion of firm's existing capital stock is pledgeable as collateral (Lian and Ma, 2021).[17] As shown in Section 2.5, the fraction of asset stock that is pledgeable

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

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

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

mostly depends on the sector operated. For instance, if a firm operates in a sector then mostly uses highly specific capital, then its share of pledgeable assets will be low (most of the time, only real estate). Therefore, Θ in (12) is idiosyncratic and drawn from its own distribution. However, it is treated as a parameter rather than a shock, because once a firm starts to operate in a sector, then throughout its life time, its share of pledgeable asset stock remains the same (except temporary disturbances).

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

$$v^{Cash}\left(z', k', b'\left(z', k'\right)\right) \geq v^{Cash}\left(z', k', 0\right) - \phi\left(pz'\left(k'\right)^{\theta}\left(l'\right)^{\nu} + wl'\right) \quad \text{for all } z'. \tag{13}$$

Since v is decreasing in b, it can be shown that there is an upper bound on the debt limits, $\bar{b}\left(z', k'\right)$ such that a borrowing constraint can take the form below:[18]

$$b'\left(z', k'\right) \leq \bar{b}\left(z', k'\right) \quad \text{for all } z' \text{ and } k'. \tag{14}$$

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

Ad hoc borrowing constraints. I also run experiments for economies with ad hoc borrowing constraints. First economy does not allow any form of borrowing, thus firms finance their investment only with internal funding.[19] Therefore, borrowing limit is specified as:

$$\bar{b}\left(z, k'\right) = 0 \tag{15}$$

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

$$\bar{b}\left(z, k'\right) = -\kappa k'. \tag{16}$$

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

predominantly use asset-based borrowing.

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

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

formulation for the borrowing limit. For the ease of expositional comparison, I here follow the same specification (Khan and Thomas, 2013; Jeenas, 2018; Ottonello and Winberry, 2020).[20]

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

Sources of funds for investment. Firms have two sources of funds. First, as explained above, they can use external funding subject to the debt covenants. Second source of investment is internal funding. In this case, firms lower dividend payments d_{it} and use retained earnings. Note that dividend payments cannot fall below zero, $d_{i,t} \geq 0$.. This non-negativity constraint on dividend payments captures the fact that firms are not allowed to issue new equity in this economy.[21]

3.3 Financial Intermediary

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

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

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

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

subject to

$$D' - B' \leq (1 + r^B)B - (1 + r^D)D \tag{18}$$

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

3.4 Household

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

$$\mathbb{E}_0 \sum_t^{\infty} \beta^t \left(\log c_t - \Psi l_t\right). \tag{19}$$

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

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

$$V(a, \eta) = \max_{c,l,a',\eta'} \quad (\log c - \Psi l) + \beta V(a', \eta') \tag{20}$$

subject to

$$\begin{aligned} c + a' + \int_{\mathbf{S}} \rho\left(z, k', b', \right) \eta'\left(z, k', b'\right) = \\ wl + (1 + r)a + \int_{\mathbf{S}} \rho\left(z^-, k, b\right) \eta\left(z^-, k, b\right) + \int_{\mathbf{S}} div\left(z^-, k, b\right) \eta\left(z^-, k, b\right) + \Upsilon \end{aligned} \tag{21}$$

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

3.5 Equilibrium

In this economy, households own production firms and financial intermediary.[22] Therefore, these entities share the stochastic discount factor of households, obtained from Euler equation of risk-free bonds, which is given below:

$$\Lambda^h = \beta \frac{u_c(c', l')}{u_c(c, l)} \tag{22}$$

Financial intermediary's optimality condition reads:

$$r'_B = r'_D \tag{23}$$

(22) and (23) together yields:

$$\Lambda^h \left(1 + r'_B\right) = 1 \tag{24}$$

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

3.6 Further Work in the Model

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

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

$$\tilde{y}_{j,t} = y_{j,t} \tag{25}$$

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

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

$$Y_t = \left(\int \tilde{y}_{j,t}^{\frac{\gamma-1}{\gamma}} \, \mathrm{d}j\right)^{\frac{\gamma}{\gamma-1}}. \tag{26}$$

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

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

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

Corresponding law of motion for capital

$$K_{t+1} = \Phi\left(\frac{I_t}{K_t}\right) K_t + (1-\delta)K_t \tag{27}$$

where

$$\Phi\left(\frac{I_t}{K_t}\right) = \frac{\hat{\delta}^{1/\phi}}{1-1/\phi}\left(\frac{I_t}{K_t}\right)^{1-1/\phi} \tag{28}$$

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

$$\log R_t^f = \log\frac{1}{\beta} + \varphi_\pi \log \Pi_t + \varepsilon_t^{\mathrm{m}}, \text{ where } \varepsilon_t^m \sim N\left(0, \sigma_m^2\right), \tag{29}$$

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

4 Firm Dynamics at the Steady-State

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

4.1 Corporate Borrowing Form

Figure 3 and 4 show the firms' debt covenant choices in the stationary equilibrium depend on their size of existing asset stock, ability to generate cash flow, current leverage and its

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

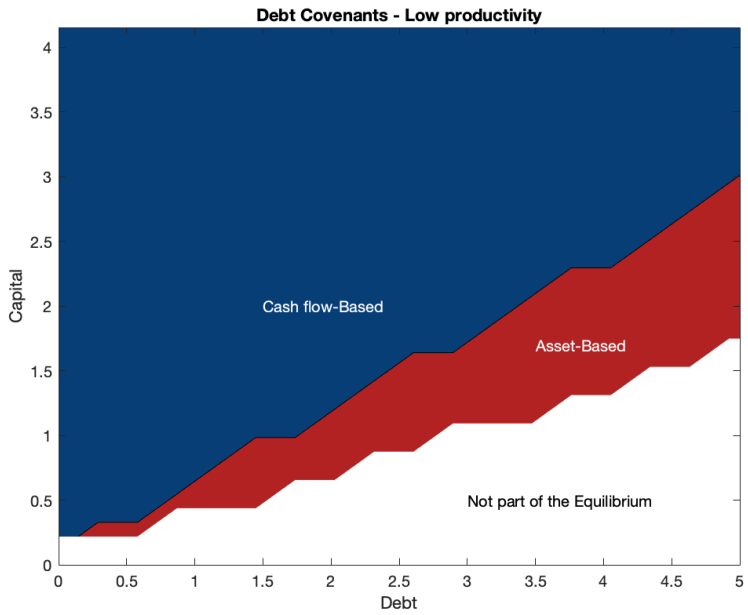


FIGURE 3
Covenant Choices —Low Productivity

Comparing Figure 3 and 4 as low productivity versus high productivity, the area for asset based borrowing is narrower for high productivity case. This is an indication that, as firms have higher productivity, their ability to generate cash flow increases. Furthermore, for a given level of capital, as debt increases red area widens. This is because, higher debt directly translates into lower cash flow, and thus steering firms to borrow against their asset stock. For the white region, in low productivity case, it is larger. The underlying reason is due to the higher productivity, lenders find it easier to offer a contract which ensures the repayment. Note that, both for low and high productivity cases, the southwest region states that if a firm's capital stock is very low, then the firm can only borrow against its cash flow. It makes sense because, if this firm cannot pledge its cash flow, then lenders cannot offer any contract. Thus, there is no tampon of red region between blue and white.

Figure 5 shows the choice of debt in the capital-debt grid for a given low productivity level, when the asset specificity is zero. In the figure, the northwest triangle belongs to

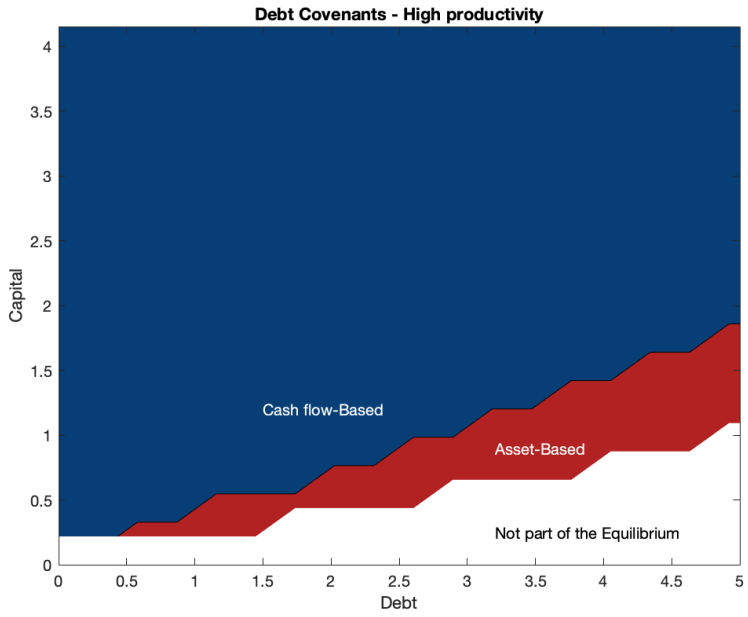


FIGURE 4
Covenant Choices —High Productivity

the no borrowing region, in which firms fund their investment spendings by their own internal funds. However, the southeast triangle, chiming with Figure 3, represents the region which is not part of the equilibrium.

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

Similarly Figure 6 presents the results for a high productive firm. Being able to earn more profits, comparing to Figure 5, no borrowing region is bigger, and no equilibrium region is smaller. In terms of leverage, both 5 and, 6 indicates that low leveraged firms (the left half of the figures) mostly prefer cash flow based borrowing, again in line with empirical evidences presented in Cloyne et al. (2018). Moreover, as the firms' available internal funds increase, then they do not borrow but use their own funds to finance their investment spendings in order to avoid the costs that comes with external funding—whichever the underlying covenant is.

4.2 Life Cycle of an Average Firm

Figure 7 displays the life cycle characteristics of the heterogeneous production firms. It is simulated from an economy which inhabits 1000 firms, and the capital and debt choices corresponds to the average behavior of these 1000 firms. Approximately, for the first 8 peri-

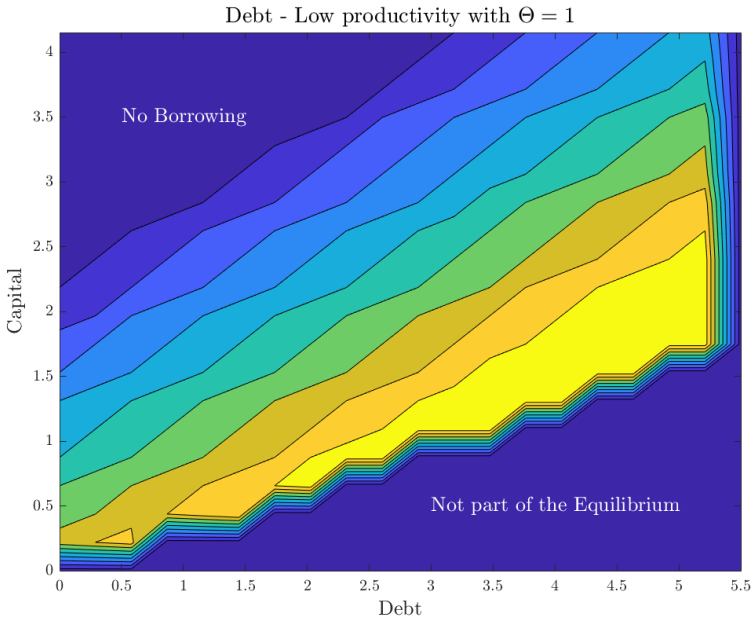


FIGURE 5
Debt Level —Low Productivity

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

5 Quantitative Monetary Policy Analysis

5.1 Aggregate Response to Monetary Policy

5.2 Heterogeneous Responses to Monetary Policy

5.3 Aggregate Implications of Financial Heterogeneity

6 Road Map

Before explaining the future steps, I briefly summarize the work done so far. First, the problem with full commitment assumption is solved. Then, using the results of the firm's problem under full commitment, I solved steady state behavior of firms when firms have endogenous debt limits. In the current version of the production firm's problem, state vari-

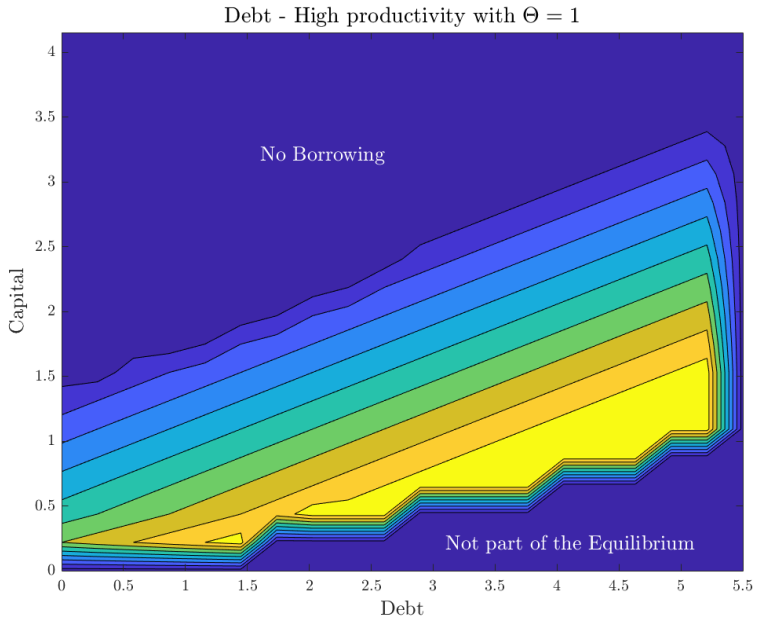


FIGURE 6
Debt Level —High Productivity

ables are idiosyncratic productivity z, capital stock k, and debt stock b. The choice variables are next period's capital k', and next period's debt stock b'. Since the solution algorithm of this problem is inefficient, in the very next step, I am going to define an additional state variable, net worth nw which contains the information of k and b. Reducing state space by one dimension will improve the efficiency of the algorithm. Then, as mentioned in Section 3, stochastic Θ will be introduced.

For the empirical part, future work is roughly presented in Section 2.5. To reemphasize, first, empirical evidence about which firm groups favor which type of debt covenant will be investigated. Therefore, a rough sectoral mapping about the debt covenants will be obtained. This mapping will show which idiosyncratic firm characteristics play the key role while choosing the optimal covenant. Second, I will empirically show financially constrained firms' debt issuance depends on their covenant form. Third, I will employ local projections method to show the heterogeneous sensitivity of different firm groups to a monetary policy shock.

For the model, Section 3.6 provides a guideline about which components will be incorporated. In a nutshell, price stickiness mechanism and a monetary authority which follows a Taylor rule will be introduced. Then, linking the empirical findings and model predictions, I will show the impact of debt covenants on heterogeneous responses to a monetary policy shock.

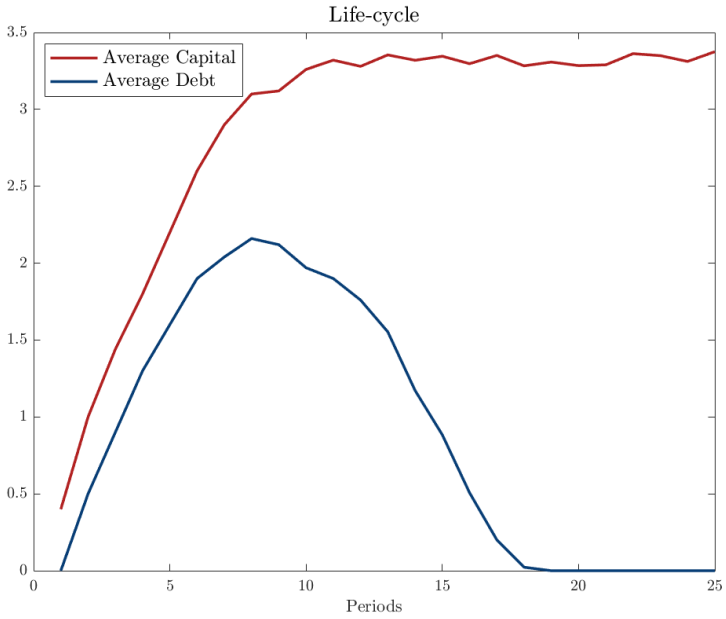


FIGURE 7
Lifecycle of an Average Firm

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Appendix

A Data Appendix

A.1 Dataset Construction

Further treatment about the linking procedure will be explained here.

A.2 Variable Construction

Construction of the variables will be explained here.

B Model Appendix

Further details about the model will be added here.

C Computational Algorithm

Step 1 Solve the problem under full commitment assumption, and obtain the value function $V_{FC}(z,k,b)$ and the policy functions $k'_{FC}(z,k,b)$ and $b'_{FC}(z,k,b)$. Here, full commitment problem refers to maximization of (9) subject to (10) and an optimal debt covenant in which firms are not allowed to walk away from their contracts.

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

- Find the set of b values that imply negative values for (12) and (13) for each point in the capital grid and state of idiosyncratic productivity shock.
- Looking for the loosest of borrowing constraint values in the idiosyncratic productivity process, find the vector of minimum values in z for each possible choice of capital stock.
- Vector $\bar{b}(z',k')$, contains the value of the borrowing constraint evaluated at each point in the capital grid and state of idiosyncratic productivity shock.

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

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

D Discussions About Debt Covenants

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

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

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

E Equilibrium Definition

REMARK: There is no price stickiness mechanism and monetary authority in this definition yet.

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

1) Production firms. Given the borrowing constraint rules and operating cost $\{\Phi\}$ and prices $\{p, q, \mathscr{Q}, w\}$; allocation $\{k', b', l\}$ and the value functions $\left\{v(z,k,b), v^{Asset}(z,k,b), v^{Cash}(z,k,b)\right\}$ solves production firm's problem governed by 8, 9 and 10, by satisfying the optimal choice of debt covenant governed by 11, 12, 13, and 14.

2) Financial Intermediary. 23 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 20, 21. And it satisfies 22 and the intratemporal optimality condition $w = \psi c$;

4) Stationary distribution. Stationary distribution of firms

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

5) Labor market clearing. Labor market clears.

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

6) Equity market clearing. The equity market clears.

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

7) Debt market clearing. The debt market clears.

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

8) Deposit market clearing. The deposit market clears.

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

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

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

F Impact of Volatility on the Firms' Covenant Choice

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