Monetary Policy Under Multiple Financing Constraints *

Ander Perez-Orive† Yannick Timmer‡ Alejandro Van der Ghote§

Abstract

We revisit the credit channel of monetary policy when firms face multiple financing constraints, a common feature of corporate financing we document empirically. Our theory shows that the multiplicity of constraints dampens the transmission of expansionary policy to firm borrowing and investment notably but amplifies the transmission of policy tightening. This asymmetry arises because, when policy tightens (eases), the most (least) responsive constraint binds. Using U.S. firm-level data and exploiting a quasi-natural experiment, we find strong support for these predictions and for our proposed channel. Embedding the mechanism into a New Keynesian framework, we find that the drop in investment after contractionary shocks is twice as large as its increase following equally-sized expansionary shocks, thus providing an explanation for why monetary policy tightenings have stronger effects than easings, a longstanding puzzle in monetary economics. Moreover, our analysis implies that the effectiveness of monetary policy is strongly determined by the distribution of financial constraints across firms and that similar asymmetries likely characterize the transmission of other macroeconomic shocks.

Keywords: Monetary policy, asymmetry, firm heterogeneity, investment, financial frictions

JEL Classification Codes: D22, D25, E22, E44, E52

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†Federal Reserve Board. Email: ander.perez-orive@frb.gov

‡Federal Reserve Board. Email: yannick.timmer@frb.gov

§European Central Bank. Email: alejandro.van_der_ghote@ecb.europa.eu

1 Introduction

The firm credit channel is an important transmission mechanism of monetary policy (Bernanke and Gertler, 1995; Gertler and Karadi, 2015). While standard theoretical frameworks of the credit channel impose only one type of constraint on firms' access to external finance (Bernanke and Gertler, 1989; Bernanke et al., 1999; Gertler and Karadi, 2011; Christiano et al., 2014), financial constraints in practice can take many forms, such as collateral, earnings-based, or leverage constraints, among other types (Lian and Ma, 2021; Drechsel, 2023). We revisit the credit channel in a more realistic setting in which each firm's borrowing capacity may be restricted at a point in time by several different occasionally binding constraints.[1] What are the implications of multiple simultaneous constraints for the transmission of monetary policy? We show theoretically and empirically that the multiplicity of constraints can account for a large part of the well-documented—but, so far, unexplained—muted response of economic activity to monetary easings and its strong response to tightenings. This insight has important implications for macroeconomic fluctuations more broadly.

We first develop a simple model of firm borrowing and investment in which firms face multiple occasionally binding constraints on their total borrowing, and in which at least some of those constraints are tight (i.e., close to binding). In the model, policy-induced changes in interest rates affect the tightness of each constraint differently. Following a contractionary policy action, which tightens all constraints but to varying degrees, the constraint that is most likely to bind after the rate hike is the *most* rate-sensitive one; i.e., the one that tightened the most. As a result, firms that face multiple tight constraints tend to experience large drops in borrowing and investment after a rate increase compared to firms that only face one tight constraint. In contrast, following a policy easing, which relaxes all constraints but to varying degrees, the constraint that is most likely to bind after the rate cut is the *least* rate-sensitive one; i.e., the one that eased the least. It follows that firms that face multiple tight constraints tend to display a muted response to policy easings. Combined, these results imply that the effects on monetary policy transmission of financial constraints in the presence of multiple constraints are asymmetric: constraints amplify the effects of tightenings and dampen the effects of loosenings. Importantly, this mechanism operates in addition to, and potentially enhances, any underlying nonlinearity that might already exist in any individual constraint.

[1] Firms often discuss how their overall borrowing capacity is limited by different sources of financial constraints. For example, in a prospectus for a note exchange offer in 2018, Diamondback Energy warns investors that its "*substantial level of indebtedness could adversely affect our financial condition and prevent us from fulfilling our obligations under the notes and our other indebtedness*" (a debt overhang constraint), that "*restrictive covenants ... may limit our ability to respond to changes in market conditions or pursue business opportunities*" (covenant restrictions that often take the form of leverage constraints, earnings-based constraints, or interest coverage constraints), that "*factors that will affect our ability to raise cash through an offering of our capital stock or a refinancing of our debt include financial market conditions, the value of our assets and our performance at the time we need capital*" (respectively, borrowing costs, collateral constraints, or earnings based constraints), and that "*we cannot assure you that an active trading market will develop for the Exchange Notes*" (a market liquidity constraint).

Next, we take the testable predictions of this simple model to our database of U.S. publicly listed firms. To do so, we require a measure of the number of tight borrowing constraints firms face. While measuring the number, type, and tightness of credit constraints is challenging (Farre-Mensa and Ljungqvist (2016)), debt covenant data can help overcome this challenge (Lian and Ma (2021)). Corporate bonds and loans typically feature financial covenants that specify a threshold for a financial variable that, if breached, typically results in a transfer of control rights to the creditors. A large empirical corporate finance literature finds that covenant violations are frequent and that these violations typically result in large reductions in borrowing, investment, and employment.[2] This literature argues, moreover, that covenants on outstanding debt are an important way through which financial constraints affect firm policies, including the ability to access new external financing.

We consider a covenant to be tight if the firm has a very high likelihood of violating the covenant in the next quarter, based on the estimated properties of the underlying financial variable, and construct a measure for the number of tight constraints each quarter, equal to the count of tight covenants. In addition to tight covenants as proxies for financial constraints, we add another potential constraint, following Farre-Mensa and Ljungqvist (2016) and Ottonello and Winberry (2020), which is the firm's distance to default. This is a distinct constraint and captures the inability to borrow due to financial distress, lack of additional debt capacity, and debt overhang. We sort firms into those that are unconstrained, those with a single tight constraint, and those with multiple tight constraints. In our sample, a large fraction (63%) of firms have multiple constraints, and this fraction is countercyclical.

We collect well-identified monetary policy shocks—i.e., measured using a high-frequency event-study approach around policy decisions and controlling for information about the state of the economy that might be disclosed through the policy action—and decompose them into contractionary shocks and accommodative shocks. This strategy allows us to control for the state-dependent impact of monetary policy, given our interest in sign-dependence, as the policy innovations we use are, by construction, orthogonal to the state of the economy. We exploit cross-sectional heterogeneity in firms' number of tight constraints and trace the response of their external funding flows and their investment to monetary policy tightenings and loosenings.

We show that financially constrained firms reduce their external funding and investment notably more, on average, in response to contractionary shocks than their unconstrained counterparts. The opposite is the case for expansionary shocks: firms with at least one tight constraint increase external funding and investment substantially less in response to lower interest rates. Our key empirical insight is that this very muted response to easings and very strong response to tightenings of constrained firms is almost entirely driven by firms facing multiple tight constraints, as our theory predicts. Firms with multiple constraints display a significantly stronger asymmetry in their response of external finance and investment to policy shocks than single-constraint or unconstrained

[2]See, e.g., Roberts and Sufi (2009), Chava and Roberts (2008), Falato and Liang (2016), and Acharya et al. (2020).

firms. Moreover, the asymmetry grows considerably with the number of tight constraints. Our results suggest that contractionary shocks "pull" financially constrained firms "with a string," while expansionary shocks resemble "pushing" financially constrained firms "with a string."[3] Importantly, our results can explain the well-documented finding that monetary policy tightenings have, on average, notably stronger effects on economic activity than policy easings (Tenreyro and Thwaites, 2016; Angrist et al., 2018; Debortoli et al., 2020; Jordà et al., 2020; Barnichon et al., 2022).

The number of tight constraints firms face is determined endogenously and, as a result, the estimates in our baseline estimation might suffer from biases. To mitigate this concern, we take advantage of an accounting rule change—ASC 842—that, we argue, introduces exogenous variation in the tightness of leverage-based covenants. The Financial Accounting Standards Board (FASB) announced in 2016 that it would start requiring in 2019 that operating leases, which were off-balance-sheet items at the time, be included as financial liabilities on U.S. firms' balance sheets. While this rule modification did not directly alter firms' fundamentals, the addition of leases to financial reports worsened many debt-based financial ratios included in covenants and effectively tightened these debt-based covenants. Indeed, we find that firms with a high ratio of estimated operating lease liabilities over total assets pre-ASC 842 are more likely to see their accounting debt rise post-shock and suffer an increase in the tightness of debt-based covenants, compared to firms with low lease ratios. In a difference-in-differences setting, we show that firms with a high lease ratio pre-ASC 842 suffered a large increase post-ASC 842 in the degree of asymmetry in their response to policy shocks. We discard potential confounding factors that could drive our results, including non-random selection into lease usage. This evidence provides a compelling validation of our earlier results and of our theoretical predictions.

Finally, we develop a quantitative version of our simple model with three goals. First, we seek to introduce a framework in which multiple occasionally binding constraints arise naturally. Second, we rationalize the possibility that, for many firms, these multiple constraints can be simultaneously binding. Third, we explore the extent to which the presence of multiple financial constraints generates a quantitatively meaningful asymmetry in the responses of firm borrowing and investment with respect to the sign of the change in the monetary policy rate. We achieve these goals by introducing a New Keynesian theoretical framework with firm heterogeneity and firm investment subject to multiple financing constraints. Firms intrinsically differ in their likelihood of exiting product markets, featuring heterogeneity in their subjective time discount rate and in their marginal value of retaining earnings to reinvest. In addition, firms face limits to external financing: specifically, they must satisfy both an earnings-based constraint and a collateral constraint, the two most common categories of financing constraints. In equilibrium, the distribution of net worth across firms is endogenous, as is the population share of firms facing no binding constraint, one binding constraint, or two simultaneously binding financing constraints. Importantly, the latter

[3]This language echoes the analogy expressed by the first Chairman of the Federal Reserve, Marriner Eccles, in 1935: "...one cannot push a string. [...], there is very little, if anything that the reserve organization can do toward bringing about recovery...".

group may be non-negligible and even economically significant. The reason is that marginal access to external finance, as a function of net worth, exhibits a discontinuity at the point where the two constraints intersect. This discontinuity translates into a jump in the marginal value of retaining earnings to reinvest. As a result, at the level of net worth where the two constraints bind simultaneously, a wide range of firm types—with differing exit probabilities—may prefer to distribute dividends rather than retain earnings and continue reinvesting and accumulating net worth. We calibrate the model to match key moments in the data concerning the distribution of the number and intensity of binding financing constraints across firms. In the calibrated model, an unanticipated tightening in the monetary policy rate generates a response of aggregate cumulative investment relative to the steady state that is approximately 2 times stronger, in absolute value, than the response generated by an unanticipated easing in the monetary policy rate of the same size.

Literature Review Several studies using aggregate time-series data have shown that, compared to easing shocks, monetary policy tightening shocks tend to transmit more strongly into aggregate spending and employment (Tenreyro and Thwaites, 2016; Barnichon et al., 2017; Angrist et al., 2018; Jordà et al., 2020; Barnichon et al., 2022). Papers in this literature typically hypothesize that there are two mechanisms that might explain this pattern of asymmetry: downward nominal rigidity in prices and wages (Debortoli et al., 2020) and financial factors (Stein, 2014). Some evidence has been provided on the first mechanism (Debortoli et al., 2020), which is based on the idea that when monetary policy tightens, nominal wages do not adjust downward, leading to large declines in output. The focus of this paper is on the second mechanism, and we are the first to study such a mechanism formally.

On the theoretical front, standard macroeconomic models of monetary policy transmission with firm financial constraints tend to deliver either roughly symmetric responses to monetary policy shocks (Bernanke and Gertler, 1989; Bernanke et al., 1999)—even if solved nonlinearly (González et al., 2024)—or ambiguous predictions about the sign and magnitude of any asymmetry (Ottonello and Winberry, 2020). In this paper, instead, financial constraints are at the source of a strongly asymmetric response of borrowing and investment to expansionary and contractionary monetary policy actions.

Importantly, the mechanism introduced in this paper is not specific to monetary policy and the asymmetries we identify are relevant in the presence of other structural shocks; i.e., the multiplicity of constraints is likely to dampen (amplify) the effects of most nonmonetary expansionary (contractionary) shocks, relative to a single-constraint benchmark. As such, our paper contributes to a small but influential theoretical literature that introduces mechanisms that drive asymmetric responses to a variety of shocks, mostly by drawing a sharp distinction between normal and crisis times (e.g. Brunnermeier and Sannikov (2014); Mendoza (2010); Guerrieri and Iacoviello (2017); Karadi and Nakov (2021); Van der Ghote (2021); Akinci et al. (2023)). Those frameworks are

in general not suitable for the analysis of macroeconomic fluctuations outside of rare crisis times. Moreover, these models tend to feature symmetric responses within crisis states, delivering strong investment responses in crisis states regardless of the sign of the shock hitting the economy in those states.

Turning to microeconomic evidence, studies exploiting cross-sectional variation in firm-level data show that financial frictions significantly affect the response of firms' financial and real policies to monetary policy, although these studies do not distinguish between the effects of tightening and easing policy actions (Anderson and Cesa-Bianchi, 2020; Palazzo and Yamarthy, 2022; Gertler and Gilchrist, 1994; Caglio et al., 2021; Becker and Ivashina, 2014; Cloyne et al., 2023; Ottonello and Winberry, 2020). We contribute to these literatures by showing that the differential effects of monetary policy tightening and easing on firm spending dynamics depend on whether firms face multiple financial constraints or not, and that this heterogeneity explains the asymmetric effects of monetary policy documented in the macroeconometric literature.

The evidence on the role of heterogeneous firm financial conditions on the response of investment has been subject to a debate in the literature. Some studies show that more financially distressed public firms react less to monetary policy (Ottonello and Winberry, 2020), while others show this is not the case for small private firms (Caglio et al., 2021), for certain sample periods (Lakdawala and Moreland, 2021), and over longer horizons (Jeenas, 2019). Moreover, some authors argue that firm-level measures of financial distress are highly endogenous and capture other factors; for example, the effect of leverage on monetary policy sensitivity disappears when controlling for firm age and dividend-payer status (Cloyne et al., 2023). We contribute to this literature by reexamining this evidence separately for easing and tightening shocks and showing that this decomposition clarifies important controversies in this literature.

A recent, small literature has focused on the distinction between earnings-based constraints and collateral-based constraints. Lian and Ma (2021) find that, in the U.S., earnings-based constraints are more prevalent among large, old firms, and that earnings-based constraints are much more common than collateral-based constraints. Greenwald (2019) explores how two specific earnings-based debt covenants (interest coverage and debt to earnings covenants) affect the response of borrowing and investment to monetary policy. Finally, Drechsel (2023) argues that macroeconomic models featuring earnings-based constraints deliver dynamics that are empirically more relevant than the ones delivered by models featuring collateral-based constraints and that models with earnings-based constraints, moreover, generate different conclusions about the relative importance of different shocks in explaining macroeconomic dynamics.

Our paper is also related to the literature that investigates why firms face financing constraints. At a broad level, this literature highlights agency problems between firms and financiers as the underlying frictions limiting access to external financing. Some notable problems identified in the literature include moral hazard (Myers, 1977; Dewatripont and Tirole, 1994; Holmström and Tirole, 1998), asymmetric information (Townsend 1979), incomplete contracting (Hart and Moore, 1994),

and costly enforcement of contracts (Grossman and Hart, 1986; Kehoe and Levine, 1993). In this paper we motivate the presence of multiple financing constraints by noting that firms generally face several of these problems simultaneously. This approach is consistent with theoretical investigations that explicitly model the presence of multiple frictions and typically obtain that the restrictions imposed by each generically differ (e.g., Prescott and Townsend 1984, Laffont and Tirole 1986, Bolton and Scharfstein 1990, Bolton and Scharfstein 1996). It is also consistent with a large array of conditions on individual debt contracts typically stipulated in practice—usually referred to as debt covenants—which are generally required to be satisfied simultaneously.[4] The specification adopted in the quantitative version of our model is also in line with the set of incentive-compatibility constraints derived by Grossman and Hart (1986), who, in an incomplete contracting framework, rationalize why contracts cannot prevent firms from threatening default at different points in the production cycle—notably before or after production takes place. Our specification is further consistent with the set of credible contracts derived by Hart and Moore (1994), who, based on the principle of the inalienability of human capital, obtain that upon default before production only tangible assets can be seized, whereas after production a share of the firm's earnings can also be seized (but not the human capital used to generate them).

Layout The paper is organized as follows. Section 2 develops a simple model of firm investment in which firms face multiple financing constraints and derives three testable implications of the model. Section 3 describes the data used to test the implications, Section 4 lays out the empirical strategy, and Section 5 explains the empirical results. Section 6 enriches the simple model to provide quantitative support to the main implications. Section 7 concludes.

2 A Simple Model

In this section, we introduce a stylized model of firm investment subject to multiple occasionally binding financing constraints. The objective of this section is to argue that when firms face multiple binding financing constraints, their borrowing and investment response to expansionary monetary policy actions is weaker than their response to contractionary actions. This simple model is extended in Section 6 to rationalize why some firms may face multiple occasionally binding financing constraints, to allow for constraints to be tight but not necessarily binding, and to quantify the macroeconomic importance of our proposed channel.

Consider a competitive firm that lives for two periods, $t = 0, 1$. There is no uncertainty. At time $t = 0$, the firm invests in physical capital $k \geq 0$, and at time $t = 1$, it produces an output good $y \geq 0$. To produce, the firm allocates the invested capital to a standard production technology

[4] Covenant violations are waived sometimes (see e.g., Acharya et al. 2020), which affects the number and type of *effective* financing constraints, but generally does not reduce ex post debt contracts to ones consistent with a single type of agency problem or financing constraint.

with decreasing marginal returns,

$$y = F(k), \tag{1}$$

with $F(0) = 0$, $F'(\cdot) > 0$, and $F''(\cdot) < 0$. Physical capital fully depreciates after production takes place.

Denote the gross real interest rate by $R \geq 1$, and assume for simplicity a constant price of physical capital normalized to 1. Then, the unconstrained optimal investment scale solves

$$\max_{k \geq 0} \left\{ -k + \frac{1}{R} F(k) \right\}, \tag{2}$$

which delivers an optimal value of capital $k_* \geq 0$, with

$$F'(k_*) = R. \tag{3}$$

Let $n \geq 0$ denote the net worth of the firm at time $t = 0$. We assume $n < k_*$. This implies that the firm does not have sufficient internal equity to finance the unconstrained optimal scale of investment. The firm can issue debt $b \geq 0$ and, thus, can finance a leveraged investment scale of $k = n + b$. However, the firm faces many different restrictions on issuing debt,

$$b \leq G_j(n; R) - n, \text{ for } j = 1, 2, ... \tag{4}$$

which ultimately limits investment by

$$k \leq \min_j G_j(n; R) \tag{5}$$

where $j = 1, 2, ...$ indexes the restrictions, and $G_j(n; R)$ indicates the limit implied by each restriction j as a function of net worth and the real interest rate. The minimum operator implies that all restrictions must be simultaneously satisfied. As discussed, we interpret each restriction as a different type of financing constraint. As we argue in the literature review, as the more natural framework, we consider the idea that all restrictions must be simultaneously satisfied so that the borrowing capacity of the firm is the minimum, and not the maximum, of the borrowing limits determined by each constraint.

For the moment, we remain agnostic about the nature and number of the financing constraints, and we impose on them only the following general properties. First, the associated limits on the investment scale relax when net worth increases. Formally, $\partial G_j(n; R)/\partial n > 0$. Second, the limits tighten when the real interest rate rises—that is, $\partial G_j(n; R)/\partial R < 0$. Lastly, the limits feature in general different sensitivities to the real interest rate. Mathematically, $\partial G_j(n; R)/\partial R \neq \partial G_{j'}(n; R)/\partial R$ in general for any $j \neq j'$.

The constrained optimal investment scale is given by $k_{**}(n;R) \geq 0$, with

$$k_{**}(n;R) = \min\left\{k_*\,,\ \min_j G_j(n;R)\right\}. \tag{6}$$

Multiple financing constraints are binding if

$$G_j(n;R) = G_{j'}(n;R) = \min_j G_j(n;R) < k_* \text{ for at least two different } j \neq j'. \tag{7}$$

Below we study the extent to which the number of binding financing constraints influences the response of firm borrowing and firm investment to a marginal change in the interest rate.

Proposition 1 (Condition for asymmetry). *If multiple financing constraints are binding, borrowing and investment respond more aggressively to a marginal increase in the interest rate than to a marginal decrease of equal size. By contrast, if a single constraint is binding, the responses are symmetric.*

We only prove the proposition for investment. If the firm is financially constrained, investment responds to a marginal increase and a marginal decrease in the interest rate, respectively, according to

$$\left|\lim_{h\to 0^+}\frac{k_{**}(n;R+h)-k_{**}(n;R)}{h}\right| = \max_{j\in\mathcal{B}}\left\{\left|\frac{\partial}{\partial R}G_j(n;R)\right|\right\}, \tag{8}$$

and

$$\left|\lim_{h\to 0^-}\frac{k_{**}(n;R+h)-k_{**}(n;R)}{h}\right| = \min_{j\in\mathcal{B}}\left\{\left|\frac{\partial}{\partial R}G_j(n;R)\right|\right\}, \tag{9}$$

where $\mathcal{B}$ is the set of binding financing constraints. This holds because all of the constraints must always be simultaneously satisfied. If multiple constraints are binding, following a marginal increase in the interest rate, investment contracts according to the binding constraint that tightens the most. Following a marginal decrease, instead, investment expands according to the binding constraint that relaxes the least. This naturally implies an asymmetric response of investment with respect to the sign of the change in the interest rate. By contrast, if a single constraint is binding, the response of investment is symmetric, because the minimum and the maximum responses coincide in absolute terms.[5]

Proposition 2 (Strength of asymmetry). *If multiple financing constraints are binding, the larger the number of binding financing constraints, the stronger the asymmetry in the responses of borrowing and investment to a marginal change in the interest rate.*

[5]Note that these results would naturally hold if constraints were tight (i.e. close to being binding) but not binding and the interest rate change was discrete rather than infinitesimal. The key property that generates asymmetry is that the constraint that is binding after an easing shock is different from the one that is binding after a contractionary shock, regardless of whether the firm was unconstrained before the change in the interest rate.

This proposition follows directly from (8) and (9). It holds because the maximum operator is, all else being equal, increasing in the number of its arguments, while the minimum operator is decreasing in the number of its arguments. Proposition 2 naturally implies an intensive margin: as the number of binding financing constraints increases, the asymmetry in borrowing and investment responses becomes stronger.

Proposition 3 (Symmetry of unconstrained response). *If no financing constraint is binding, the responses of investment to a marginal increase and a marginal decrease in the interest rate of equal size are symmetric.*

This proposition is only stated for investment because the firm could be issuing no debt. If it were issuing debt, the borrowing responses would be symmetric as well. The proposition directly follows from differentiating investment scale k_* in equation (3) with respect to interest rate R. Formally, one gets

$$\left| \frac{\partial}{\partial R} k_* \right| = \left| \frac{1}{F''(k_*)} \right|, \tag{10}$$

which implies a symmetric response of investment with respect to the sign of the marginal change in the interest rate.

3 Data

We use quarterly data on U.S. firms from Compustat spanning 1990 to 2024 to assess the empirical validity of Propositions 1, 2, and 3. We exclude firms in the utilities (SIC codes 4900–4949) and financial (SIC codes 6000–6999) sectors. Observations with negative revenues, missing data on total assets or capital, or total assets below $10 million (in 2012 dollars) are dropped. All variables are winsorized at the 1% level to mitigate the influence of outliers. To ensure comparability across time horizons, we restrict the sample to firms that remain active for at least five years following a monetary policy shock. Investment is measured as the log change in the capital stock, following Ottonello and Winberry (2020), and debt growth is defined analogously as the log change in total debt.

We complement the Compustat data with information from Refinitiv's Loan Pricing Corporation DealScan database, which contains detailed data on syndicated loan originations, including loan terms and financial covenants. Financial covenants typically require borrowers to maintain specific financial ratios within predefined thresholds, and DealScan reports these covenant levels. We merge the covenant data with firm-level accounting information from Compustat using a linking file developed by Chava and Roberts (2008). The resulting Compustat-DealScan merged dataset covers a large portion of the U.S. corporate sector. Syndicated loans constitute a significant share of commercial lending, representing roughly one-third of business loans held on the balance sheets of large U.S. banks (Ivashina et al., 2022). We restrict our analysis to loans originated in 1996 or

later, the period during which DealScan began reporting high-quality data on covenant structures.

Our key firm-level variable is the number of "tight" financial constraints a firm faces. Conceptually, while only one constraint might be binding at any point in time, it is possible that multiple constraints are close to binding and might become binding following a large enough shock, such as a large monetary policy shock. A constraint is considered "tight" if the probability that it binds in the near future (in the next quarter, in our case) is above a certain threshold. We operationalize this idea by requiring that the distance to violation of a particular covenant is below two standard deviations of quarterly changes in the underlying financial ratio. Our results, as we discuss below, are robust to other thresholds.

In addition to covenants as proxies for financial constraints, we add another potential constraint, the firm's distance to default, which captures the likelihood of default over the near-term horizon. This is a distinct constraint and captures the inability to borrow due to financial distress, lack of additional debt capacity, and debt overhang. We include this constraint following the evidence in (Farre-Mensa and Ljungqvist, 2016) that the firm characteristic that they can most clearly associate in the data with credit-constrained behavior is closeness to default (and not other characteristics, such as not being dividend payers, being young or small, having low leverage, or no credit rating). Distance to default is computed as in Gilchrist and Zakrajšek (2012), using Compustat and CRSP data following the Merton distance-to-default model, which takes as inputs the firm's equity valuations and leverage. A firm is considered facing a financial distress constraint if its distance to default is below two (where distance to default is expressed in standard deviations of the firm asset value distribution).

Table 1 presents the summary statistics for key firm characteristics across three groups based on their financial constraint status: *Multiple Constraints*, *Single Constraint*, and *Unconstrained*. The table reports the mean and standard deviation (*sd*) for each variable in the sample, offering insights into the differences between constrained and unconstrained firms.

The first variable, *Size*, measured as the natural logarithm of total assets, shows that unconstrained firms tend to be the largest, with a mean value of 7.883 and a standard deviation of 1.547. Firms with a single constraint have an average size of 7.372, while firms with multiple constraints are the smallest, with an average size of 6.762. These results suggest that larger firms are less likely to face financial constraints, consistent with the notion that firm size is correlated with better access to capital markets.

Leverage, defined as the ratio of total debt to total assets, varies across the three groups. Firms with multiple constraints exhibit the highest leverage ratio (0.338), while firms with no constraints have the lowest leverage ratio (0.174). This finding aligns with the expectation that financially constrained firms rely more heavily on debt financing, which may reflect their limited ability to generate internal funds or access external equity markets.

The table also reports *Sales Volatility*, measured as the standard deviation of sales growth over the past three years. Constrained firms, particularly those facing multiple constraints, exhibit

greater sales volatility (0.272), compared to firms with a single constraint (0.242) and unconstrained firms (0.205). This suggests that firms experiencing more uncertainty in their revenue streams are more likely to face financial constraints.

In contrast, cash holdings relative to total assets, tangibility, the ratio of tangible assets to total assets, investment growth, and sales growth do not differ vastly across groups.

By definition, a notable difference across groups emerges in *Distance to Default*, a measure of financial health and creditworthiness. Unconstrained firms exhibit the highest distance to default (9.636), while firms with multiple constraints have a much lower mean value (4.626).

The sample consists of 81,030 firm observations for the multiple-constraints group, 33,271 observations for the single-constraint group, and 13,621 observations for the unconstrained group.

Figure 1 provides a detailed look at the prevalence of various financial covenants across firms. Each bar represents the number of firms for which a specific covenant is tight. The horizontal axis lists the types of covenants, ranging from debt-related ratios to liquidity and leverage ratios, while the vertical axis indicates the number of firms.

The chart shows that some covenants, such as the debt-to-EBITDA ratio, are tight for a large number of firms, reflecting the common use of this metric by lenders to assess a firm's ability to meet its debt obligations. For instance, the debt-to-EBITDA covenant restricts a firm's total debt relative to its earnings before interest, taxes, depreciation, and amortization, and it is often used to prevent overleveraging. Similarly, the interest coverage ratio covenant, which measures a firm's ability to cover interest expenses with its earnings, is also frequently introduced by lenders, indicating its importance in ensuring that firms can service their debt even under adverse conditions. The fixed charge coverage ratio, another critical measure of a firm's financial health, is also commonly used, further illustrating the prevalence of stringent financial constraints in corporate lending agreements.

Figure 2 presents a histogram that illustrates the distribution of the number of binding constraints across firms. The horizontal axis represents the number of constraints, ranging from zero to eight, while the vertical axis shows the fraction of firms that fall into each category.

The histogram reveals that approximately 50 percent of firms face multiple binding constraints, with some firms experiencing as many as eight different constraints simultaneously.[6] The most common scenario involves firms with one or two binding constraints, but there is a substantial proportion of firms that deal with a higher number of constraints. This distribution indicates that it is not uncommon for firms to operate under multiple financial restrictions, which could significantly impact their investment decisions and responses to monetary policy.

The fact that a sizable fraction of firms faces several constraints simultaneously underscores the complexity of their financial environments. When firms are subject to multiple binding constraints, their financial flexibility is significantly reduced, making them more vulnerable to external shocks, including changes in monetary policy. This multifaceted financial pressure can lead to more pronounced and potentially asymmetric responses to monetary policy interventions, as firms struggle

[6]Note that this differs slightly from the final sample.

to navigate the combined restrictions on their operations.

To construct our measure of monetary policy shocks, we follow the methodology proposed by Miranda-Agrippino and Ricco (2021). This approach aims to isolate the pure policy shock by controlling for the information effect, where market participants may react to both the policy action and the underlying economic conditions signaled by the central bank. We identify monetary policy shocks around FOMC meetings as exogenous shifts in the market prices that are unforecastable and not due to the central bank's systematic response to its own assessment of the macroeconomic outlook. Those monetary policy shocks are constructed by projecting market-based monetary surprises on their own lags and the central bank's information set, as summarized by Greenbook forecasts. These monetary policy shocks are therefore orthogonal to shocks to firms' borrowing and investment decisions.

We first focus on high-frequency changes in financial market variables around the time of policy announcements. Specifically, we utilize 10-minute pre-announcement and 20-minute post-announcement windows to capture immediate market reactions. The variables included in our analysis are the 3-month Federal Funds Rate Futures (FF4), the 3-month Treasury Yield (ONRUN3M), the 2-year Treasury Yield (ONRUN2Y), the 5-year Treasury Yield (ONRUN5Y), and the 10-year Treasury Yield (ONRUN10Y).

Subsequently, we aggregate the high-frequency data for each quarter, calculating the sum of the shocks within each quarter. We then employ principal component analysis to extract the first principal component from these quarterly aggregated shocks across instruments. This principal component represents a composite measure of monetary policy shocks, capturing the common variation across different financial market variables. Lastly, we separate the shock series into accommodative and contractionary shocks, which takes the value of the original shock if the shock is negative and positive, respectively, and value 0 otherwise.

For our baseline monetary policy shock, we have 61 contractionary and 58 accommodative shocks. The average size of contractionary and accommodative shocks is similar, with an average size of 4 and 5 basis points, respectively. We standardize the monetary policy shocks so that one unit is equal to a one standard deviation shock.

4 Empirical Strategy

We test the propositions derived in Section 2 by evaluating how shocks to the monetary policy rate impact the external financing flows and the investment of firms depending on the number of tight financing constraints they face. We first implement a strategy in which we directly measure the number of constraints that firms face using data on financial covenants. We next introduce a quasi-natural experiment that provides exogenous variation in the number of tight constraints that firms face and mitigates potential endogeneity concerns in our results.

4.1 Baseline Strategy

To estimate how shocks to the policy rate affect external funding and investment, we estimate the following Jordà (2005) local projection specification as our baseline framework:

$$\begin{aligned}\Delta_{h+1}Y_{i,t+h} =& \beta^h_{c,m}(\text{Contr. MP Shock}_t * \text{Mul. Constraint}_{i,t}) + \beta^h_{a,m}(\text{Acc MP Shock}_t * \text{Mul. Constraint}_{i,t}) \\ & \beta^h_{c,s}(\text{Contr. MP Shock}_t * \text{Single Constraint}_{i,t}) + \beta^h_{a,s}(\text{Acc MP Shock}_t * \text{Single Constraint}_{i,t}) \\ & \beta^h_{c,u}(\text{Contr. MP Shock}_t * \text{Unconstrained}_{i,t}) + \beta^h_{a,u}(\text{Acc MP Shock}_t * \text{Unconstrained}_{i,t}) \\ & + \mathbf{X}'\gamma + \epsilon_{i,t}\end{aligned} \tag{11}$$

where $\Delta_{h+1}Y_{i,t+h}$ is the dependent variable and can be either $\Delta_{h+1}ExFin_{i,t+h}$, the cumulative debt and equity financing flows between the end of quarter $t-1$ and the end of quarter $t+h$ over total assets, or $\Delta_{h+1}\log K_{i,t+h}$, the change in the log of the real stock of capital K between the end of quarter $t-1$ and the end of quarter $t+h$.[7] *MP Shock*$_t$ is the monetary surprise in quarter t. The variables *Mul. Constraint*, *Single Constraint*, and *Unconstrained* are dummy variables that take value 1 if firm i in quarter t faces multiple tight financing constraints, only one tight financing constraint, or none, respectively, and they are 0 otherwise. The variable $\mathbf{X}'_t$ contains various control variables, including leverage, size, and sales volatility (at the firm level) and GDP growth and inflation (at the macroeconomic level).

The β coefficients in specification (11) trace impulse responses at horizon h of external financing flows or investment for each subgroup of firms to tightening versus easing shocks. While we expect all of them to have a negative sign, our theory has clear predictions for the size of some of these elasticities. In particular, our theory predicts that the response of multiple-constraint firms to easing shocks ($\beta^h_{a,m}$) should be weaker than the response of single-constraint firms ($\beta^h_{a,s}$) and, moreover, that the response to tightening shocks of multiple-constraint firms ($\beta^h_{c,m}$) should be stronger than for single-constraint firms ($\beta^h_{c,s}$). In other words, our theory predicts that the response of multiple-constraint firms is strongly asymmetric; that is, $|\beta^h_{c,m}| - |\beta^h_{a,m}| > 0$.

4.2 A Quasi-Natural Experiment: The 2019 Leverage Accounting Rule Change in the U.S. (ASC 842)

To mitigate concerns that the number of constraints is endogenous, we exploit the introduction of ASC 842, which required operating leases to be capitalized on balance sheets beginning in 2019. The reform mechanically increased reported leverage without altering firms' real fundamentals, thereby tightening leverage-based covenants in a plausibly exogenous manner.

[7] Our results go through using a measure of financing flows that only considers debt flows. As Ottonello and Winberry (2020) point out, including equity issuance in the measure of financing flows is appropriate because it is a common source of external funds for firms.

In particular, the number of tight constraints that firms face is determined endogenously and, as a result, the estimates in our baseline estimation might suffer from biases. For example, firms facing multiple constraints might be riskier, more opaque, or face more serious agency frictions, and all of these characteristics could themselves lead to asymmetric responses to monetary policy. To mitigate this concern, we take advantage of an accounting rule change that, we argue, introduces exogenous variation in the tightness of leverage-based constraints.

The FASB announced in 2016 that it would start requiring operating leases, which were off-balance-sheet items at the time, to be included as financial liabilities on U.S. firms' balance sheets. This accounting rule change, dubbed ASC 842, became effective at the beginning of 2019 for public firms. While this rule modification did not directly alter firms' fundamentals in any way, the addition of leases to financial reports did, from a legal and contractual standpoint, worsen many debt-based financial ratios included in debt covenants. Absent specific provisions about this event, or absent a decision by lenders to costlessly waive any violations induced by the rule change, this accounting change effectively tightened debt-based covenants.[8] Prior literature has shown that changes to accounting standards can substantially influence firm behavior through their effects on compliance with covenants on existing debt at the time the change in standards occurred (Demerjian, 2011; Moser et al., 2011; Lian and Ma, 2021; Zhu, 2024).

We first compute the estimated liabilities associated with off-balance-sheet operating leases as the present value of projected future lease payments disclosed by firms in their financial reports, following Jung and Scarlat (2024). We discount these projected leases using a 10% discount rate as an approximation, although our results are robust to other reasonable discount rate choices. We next compute the ratio of the estimated liabilities over total assets in 2016 and consider this ratio to be the measure of the exposure to the accounting change shock; we test whether, as we conjecture, firms with a higher lease ratio before the accounting rule change (the "shock", which occurred in 2019) are more likely to see their accounting debt rise post-shock and suffer an increase in the tightness of covenants based on the accounting debt measure.

We address the concern that firms could anticipate the 2019 accounting rule change since its announcement in 2016 by fixing 2016 as the date in which we measure lease exposure. This choice ensures that most leases used for our measure were signed before the accounting change was announced that same year, while retaining enough statistical power because many of these leases would still be outstanding in 2019 and beyond.

[8] At the time of the transition to the new accounting regime for leases, accounting advisory firms warned their customers of the potential consequences for covenant violations. For example, *CPA Practice Advisor* warned that "*even though a company's operations and results haven't changed, adding leases to financial statements ... may adversely affect those ratios. The result can be a debt covenant violation.*" Accounting firm *KatzAbosch* issued a similar warning, stating that "*If you have financial covenants in your long-term debt agreements, implementing the standard may impact those calculations and cause you to violate the covenants. Covenant violations result in default of the debt agreement and give the lender the legal right to terminate the debt agreement and demand immediate repayment of the entire loan. While lenders will frequently provide written waivers for covenant violations, this is not without cost as lenders will usually require a waiver fee be paid. Plus, covenant violations could damage your relationship with your lender.*"

Evidence of the relevance of our strategy to identify variation in leverage (and, thus, in the number of constraints) is found in Figures 3 and 4. Figure 3 shows the lease share was negatively associated with balance sheet leverage pre-shock. This negative relationship is intuitive given that operating lease liabilities share many similarities with financial leverage, and a high share of operating leases might limit the capacity or the need for higher financial leverage. This negative relationship disappears post-shock, suggesting that firms with higher operating lease burdens grew their leverage relative to this with low operating lease volumes. Consistent with this observation, Figure 4 shows the effect of the lease share on the number of constraints over time and makes it clear that the lease share became a statistically significant determinant of the number of tight constraints following the shock.

The empirical specification for this quasi-natural experiment builds on specification (11) and extends it to a difference-in-differences framework. We start by restricting the sample to firm-quarter observations with at least one tight financial constraint, and, within financially constrained firms, we use the operating liabilities share as an instrument for the change in the number of tight constraints that firms face between the pre-shock and post-shock periods. The testable prediction is that firms with a higher burden of operating liabilities are more likely to display an increase in their asymmetric response to monetary policy post-shock, because they are more likely to see their leverage increase, their debt-based covenants tighten, and their number of tight constraints increase.

More specifically, we run the following specification:

$$\begin{aligned}\Delta_{h+1} Y_{i,t+h} =& \beta_c^h (\text{Contr. MP Shock}_t * \text{High Lease}_{i,t}) \\ &+ \beta_a^h (\text{Acc MP Shock}_t * \text{High Lease}_{i,t}) + \eta_{st} + \mathbf{X}_t' \gamma + \epsilon_{i,t},\end{aligned} \tag{12}$$

where *High Lease* is a dummy variable that takes value 1 if the share of operating lease liabilities over total assets exceeds the median and η_{st} is a sector-time fixed effect. We run specification (12) in the pre-shock sample and in the post-shock sample and compare the degree of asymmetry in the response to policy shocks, $\beta_c^h - \beta_a^h$, in both samples. The testable prediction of our simple model is that the asymmetric response should be stronger following the accounting change.

5 Results

5.1 Baseline Results

The results of estimating specification (11) using external financing flows are found in Figure 5. We first focus on external financing flows as the primary outcome variable because they provide the most direct measure of the underlying mechanism proposed in our model: the effect of monetary policy on firms' ability to borrow when facing multiple tight financial constraints. While changes in the capital stock reflect investment outcomes, they are a more distant manifestation of the credit

channel and can be influenced by a range of other factors, including adjustment costs, depreciation rates, and internal cash flows. In contrast, external financing flows—debt and equity issuance—are immediately and mechanically affected by changes in the capacity to access external financing, making them a more precise indicator of constraint tightness. Since our mechanism hinges on how multiple binding constraints asymmetrically limit borrowing in response to monetary shocks, external financing flows offer a cleaner and more sensitive test of our theoretical predictions.

The response of external funding to changes in the policy rate for unconstrained firms is symmetric. The cumulative drop in debt and equity financing eight quarters after a one standard deviation rate increase is around 4% of total assets when the shock is contractionary (top-right panel), and the corresponding cumulative increase in debt and equity financing when the policy rate drops (bottom-right panel) is also around 4%. The response of constrained firms that only face one tight constraint (the middle panels) displays a small degree of asymmetry. Firms with only one tight constraint have a similar response to policy tightenings than unconstrained firms but a modestly weaker response to easings. Firms that face multiple constraints, in contrast, display a strong asymmetry (left panels). While their response to tightenings (top-left panel) is stronger than that of single-constraint or unconstrained firms, their response to policy easings (bottom-left panel) is essentially muted.

To provide robustness to our results, we test for the stability of our estimates under different specifications in Table 2. In that table, we display the response of the external financing flows of single- and multiple-constraint firms relative to unconstrained firms, in response to contractionary and accommodative shocks. To do so we estimate,

$$\begin{aligned}\Delta_8 \text{ExFin}_{i,t+7} = \beta_1 \textit{Contr. Shock}_t \times \textit{Single Constraint}_{i,t} + \beta_2 \textit{Contr. Shock}_t \times \textit{Mult. Constraints}_{i,t} \\ + \beta_4 \textit{Acc. Shock}_t \times \textit{Single Constraint}_{i,t} + \beta_6 \textit{Acc. Shock}_t \times \textit{Mult. Constraints}_{i,t} + \mathbf{X}_t'\gamma + \epsilon_{i,t}\end{aligned}$$

Our results remain stable regardless of whether we include firm fixed effects, additional firm controls, or macroeconomic controls. After two years, single-constraint firms display a response of funding flows to tightening shocks that is statistically insignificantly different from unconstrained firms' average response, while their response to accommodative shocks is modestly weaker, by around 1 percentage point, in some specifications. Multiple-constraint firms display a notably stronger response to tightenings (between 1.7 and 3.6 percentage points), as shown by the negative coefficient, and a notably weaker response to easings, as shown by the positive coefficient, (between 2 and 3 percentage points) relative to unconstrained firms. These results are consistent with those found in Figure 5 and Proposition 1.

Proposition 2 predicts that asymmetry increases in the number of constraints, which we confirm in Figure 6. Figure 6 illustrates the relationship between the number of financial constraints a firm faces and its responsiveness to monetary policy shocks. The x-axis represents the number of constraints, while the y-axis depicts the predicted effect of monetary policy on external financing.

The blue line and markers represent the response to an accommodative shock, while the red line and markers represent the response to a contractionary shock. Error bars indicate the standard errors at the 90% confidence interval. For firms with no constraints, the effect of contractionary and accommodative monetary policy shocks is symmetric. However, the negative impact of contractionary shocks increases in the number of financial constraints the firm faces. This suggests that financially constrained firms are particularly vulnerable to tightening monetary policy. In contrast, the response to accommodative shocks weakens as the number of constraints increases, suggesting that monetary policy may have a limited impact on stimulating external financing and investment for firms with a large number of financial constraints.

In Table 3 we repeat the exercise of Table 2 for the response of investment, replacing external financing flows with changes in the capital stock as the outcome variable to examine how investment responds to monetary policy shocks across firms with different levels of financial constraint. Our results mirror those of external financing flows. After two years, the cumulative investment of single-constraint firms displays, again, a response to tightening shocks that is statistically insignificantly different from unconstrained firms' average response, while the response to accommodative shocks is modestly weaker by around 1 percentage point in some specifications. Multiple-constraint firms display a moderately stronger investment response to tightenings (between 0.8 and 2.2 percentage points) and a markedly weaker response to easings (between 1.1 and 2.4 percentage points) relative to unconstrained firms. While external financing flows provide the cleanest test of our mechanism by directly capturing changes in borrowing capacity, examining the response of investment is also important because it connects our theory to aggregate economic outcomes. Investment is the primary channel through which firm-level financing constraints translate into macroeconomic fluctuations, and the asymmetry we document in financing behavior should ultimately manifest in firms' investment decisions. By showing that firms with multiple constraints not only adjust their financing flows asymmetrically, but also adjust their investment in a similarly asymmetric fashion, we provide further validation of the economic relevance of our mechanism and strengthen the link between financial frictions and macro-level outcomes.

5.2 The 2019 Leverage Accounting Rule Change (ASC 842): Results

Table 4 presents the summary statistics for firm characteristics based on firms' lease status, measured as the share of leasing in total assets in 2016. Firms are categorized into two groups, *High Leases* and *Low Leases*, split by the median value of lease usage. The table reports the mean and standard deviation (sd) for each variable in the sample, allowing for a comparison between firms that rely heavily on leasing and those that do not. The total sample comprises 30,881 firm observations for the high lease group and 30,840 firm observations for the low lease group.

The results in Table 4 suggest that firms with high and low lease usage tend to be quite

similar, providing a good experiment to track their response to monetary policy shocks. Firms with high lease exposures appear to have a very similar size, risk profile, capital structure, liquid asset holdings, asset tangibility, and growth rates. This reduces concerns that the results of our quasi-natural experiment are driven by a selection effect of which firms have operating leases. The results of our estimation based on the 2019 leverage accounting rule change ASC 842 are found in Table 5. The left panel displays the estimates *pre*-shock of the interaction of *High Lease* with, respectively, contractionary policy shocks (β_c^h) and easing shocks (β_a^h). The right panel displays the estimates *post*-shock of the interaction of *High Lease* with, respectively, contractionary policy shocks ($\beta_c^h + \beta_{cp}^h$) and easing shocks ($\beta_a^h + \beta_{ap}^h$).

The results show that, post-shock, the external financing flows of firms with high pre-shock operating leases are significantly more responsive to contractionary shocks than those of low-lease firms, and they are significantly less responsive to easing shocks. In stark contrast, pre-shock, the external financing flows of firms with high pre-shock operating leases are about equally sensitive to contractionary or accommodative shocks than low-lease firms. A potential concern could be that high-lease firms are concentrated in specific sectors (for example retail and transportation) and may have faced distinct sector shocks around 2018–2019 (tightening financial conditions in late 2018), which could generate spurious "post" patterns even absent any ASC mechanism. We address this directly by including industry-time fixed effects, which absorb any common shocks at the industry-quarter level. Results are also stable and robust to the presence of time fixed effects, firm fixed effects, firm controls, or macro controls.

Quantitatively, the external financial flows decline by between 4.2 and 8.6 percentage points more in response to a contractionary monetary policy shock for firms that have high leases before the lease accounting change, while they increase by between 4.3 and 7.5 percentage points *less* in response to an accommodative monetary policy shock.

We replicate those results for investment in Table 6 and find qualitatively similar results, especially that firms with more leases before the accounting change are less responsive to accommodative monetary policy.

These results provide further support to the predictions of our simple model. As we showed in Section 4.2, the firm-level operating lease share pre-ASC 842 helps identify variation in the total number of tight constraints firms face, because these firms are more likely to see their leverage increase and their debt-based covenants tighten. We, thus, interpret the results in Tables 5 and 6 as providing strong support for the role of the multiplicity of constraints in explaining why financially constrained firms display a weak response to monetary easings but a strong response to monetary contractions.

In sum, because ASC 842 mechanically altered reported financial constraints without changing fundamentals, these findings provide causal evidence that an exogenous increase in the number of tight constraints amplifies contractionary transmission and attenuates expansionary transmission.

5.3 Response of Financial Constraints to Monetary Policy Shocks

The simple model assumes that the tightness of different financial constraints exhibits different sensitivities to monetary policy shocks. In this section, we test which constraints exhibit a weaker or stronger sensitivity to monetary policy shocks. To do so, we estimate the following set of regressions:

$$\Delta_h Constraint^X_{i,t+h} = \beta^h_X \text{MP Shock}_t + \mathbf{X}'_t\gamma + \epsilon_{i,t}$$

where $Constraint^X_{i,t+h}$ are the constraint measures based on the current ratio, the quick ratio, the senior leverage ratio, the tangible net worth ratio, the leverage ratio and debt-to-equity ratio, the debt-to-EBITDA ratio, the senior debt-to-EBITDA ratio, the cash interest coverage ratio, the interest coverage ratio, the fixed charge coverage ratio, or the distance to default. *MP Shock*$_t$ is defined as the Miranda-Agrippino and Ricco (2021) monetary policy shock. After obtaining the sensitivity for each constraint at each horizon, we average the response for each constraint across a two-year horizon. Then we group those two-year responses into the following groups: leverage (current ratio, quick ratio, senior leverage ratio, tangible net worth ratio, leverage ratio, and debt-to-equity ratio), debt to earnings (debt-to-EBITDA ratio, senior debt-to-EBITDA ratio), interest coverage (cash interest coverage ratio, interest coverage ratio, fixed charge coverage), and distance to default (negative of distance to default).

Figure 7 illustrates the average responsiveness of the tightness of leverage, interest coverage, debt to earnings, and distance-to-default constraints to a monetary policy shock. All types of constraints tighten in response to a contractionary monetary policy shock. However, the strength of the response varies strongly. Distance to default is most strongly affected by monetary policy shocks, which is not surprising, given it is a market-based financial constraint. As stock prices move strongly in response to monetary policy, firms become closer to their financial constraint, based on the Merton metric, as shown by the positive response of the distance to default (for which the sign is flipped). The blue bar shows that interest coverage ratios are also strongly affected by monetary policy shocks, which is intuitive, given that the interest rate directly enters the constraint definition, and consistent with Greenwald (2019). In contrast, debt to earnings and leverage constraints are less affected by monetary policy shocks, as they are more slow moving.

Having provided a theoretical microeconomic foundation for our proposed mechanism and robust evidence in support of its predictions for the cross-sectional behavior of firms in response to contractionary and accommodative monetary policy, we next turn to exploring the macroeconomic implications of the multiplicity of constraints.

6 Quantitative Model

We now present a macroeconomic model with firm investment and multiple occasionally binding financing constraints to provide quantitative support to the mechanisms proposed in Section 2. This more realistic quantitative framework serves two additional goals. First, we seek to introduce a framework in which multiple occasionally binding constraints arise naturally. Second, we rationalize the possibility that, for many firms, these multiple constraints can be simultaneously binding.

Following Ottonello and Winberry (2020), the model is presented in three blocks: an investment block, which captures the extent to which the number of binding financing constraints influences the response of firm investment to disturbances to the monetary policy rate; a New Keynesian block, which incorporates stickiness in nominal prices and, thus, enables real effects from monetary policy in the short term; and a representative household block, which closes the economy. Time, captured by $t = 0, 1, 2, ...$, is discrete and unbounded, and there is no aggregate uncertainty.

6.1 Investment Block

Technology. This block is composed of a continuum of competitive firms of unit measure. Firms produce an intermediate good $y_t = A_t l_t^{\alpha_l} k_{t-1}^{\alpha_k} \geq 0$, combining labor hours $l_t \geq 0$ and physical capital $k_{t-1} \geq 0$, according to a production technology with productivity $A_t > 0$ and decreasing returns to scale $\alpha_l + \alpha_k < 1$. Additionally, firms accumulate physical capital over time, according to a storage technology that transforms a final consumption good into physical capital one-to-one. Physical capital is a predetermined variable when production takes place and depreciates over time at a constant rate $\delta > 0$.

Let $p_t > 0$ denote the price of the intermediate good in units of the final consumption good, and let $w_t > 0$ denote the real wage. We set the final good as the numeraire. The profit maximization problem of firms is static and given by

$$\max_{l_t \geq 0} \left\{ p_t A_t l_t^{\alpha_l} k_{t-1}^{\alpha_k} - w_t l_t + (1-\delta) k_{t-1} \right\} . \tag{13}$$

The quantity of labor that maximizes profits is

$$l_t = \left(\frac{\alpha_l}{w_t} p_t A_t \right)^{\frac{1}{1-\alpha_l}} k_{t-1}^{\frac{\alpha_k}{1-\alpha_l}} , \tag{14}$$

and the maximized profits as a function of physical capital are $\zeta_t (k_{t-1}) \geq 0$, with

$$\zeta_t (k_{t-1}) \equiv (1-\alpha_l) \left[\left(\frac{\alpha_l}{w_t} \right)^{\alpha_l} p_t A_t \right]^{\frac{1}{1-\alpha_l}} k_{t-1}^{\frac{\alpha_k}{1-\alpha_l}} + (1-\delta) k_{t-1} . \tag{15}$$

After production takes place, an exogenous event may force firms to exit product markets and permanently cease operations. The event is idiosyncratic to each firm, and its likelihood is given

by $\theta \in [0,1]$. The likelihood is firm-specific, and its cross-sectional distribution across firms is given by cumulative distribution function $F(\theta) \in [0,1]$. As shown by Lemma 1 below, in general, heterogeneity in firm exit rates is essential for obtaining an endogenous cross-sectional distribution of firms in which some face no binding financing constraint, some face a single binding financing constraint, and the remaining face multiple binding financing constraints. This heterogeneity can be more generally interpreted as differences in subjective time discount rates across firms, as implied by the objective in problem (20). Exiting firms are replaced by identical newborns, whose initial endowment is given by $\kappa > 0$ units of physical capital.

Financing. Conditional on not exiting product markets and continuing to operate, firms must decide the dividends d_t to distribute, the amount of physical capital to carry to the next period, $k_t \geq 0$, and the amount of debt to issue to finance those expenditures, $b_t \in \mathbb{R}$. The debt is assumed to mature after one period.

Financial constraints are captured by an inability to issue equity ($d_t \geq 0$) and by the fact that debt must simultaneously satisfy several constraints. For simplicity, we restrict attention to an earnings-based constraint and an asset-based constraint, two constraints usually considered in the literature (Lian and Ma (2021), Drechsel (2023), Giovanni et al. (2022)).

Let $n_t = \zeta_t(k_{t-1}) - (1+r_t)b_{t-1} \geq 0$ denote the net worth of (continuing) firms, where $r_{t+1} \in \mathbb{R}$ is the real interest rate. Firms face a standard budget constraint,

$$d_t + k_t = n_t + b_t\,, \tag{16}$$

where the price of physical capital is set to 1 because of the one-to-one technology to transform consumption goods into capital. The earnings-based financing constraint limits debt issuance according to

$$(1+r_{t+1})\, b_t \leq \lambda_e\, \zeta_{t+1}(k_t)\,, \tag{17}$$

where parameter $\lambda_e \in (0,1)$ is the share of profits that can be pledged. The asset-based constraint instead does so according to

$$(1+r_{t+1})\, b_t \leq \lambda_a q_{t+1} k_t\,, \tag{18}$$

where $\lambda_a \in (0,1)$ is the share of physical capital that firms can pledge, and $q_t \in [0,1]$ is the price at which debt holders can liquidate the capital. The dynamics of the liquidation price of capital are not fully micro-founded, and, for simplicity, we assume q_t to inversely depend on the real interest rate r_t. Firms must respect both financing constraints and, thus, are effectively subject to the following borrowing constraint:

$$(1+r_{t+1})\, b_t \leq \min\{\lambda_e\, \zeta_{t+1}(k_t)\,, \lambda_a q_{t+1} k_t\}\,. \tag{19}$$

Constraint (19) is central to our proposed mechanism. A simple micro-foundation for this

constraint is that firms can declare default on their debt without incurring any costs either before or after production takes place, but always before they may exit product markets. If they do so before, debt holders get the right-hand side of (18), while if they do so after, debt holders get the right-hand side of (17). Assuming a debt renegotiation process following default declaration in which firms can make a single take-it-or-leave-it offer, debt holders can only secure for themselves the worst of the two payoffs, hence the minimum operator.

Let $V_{\theta,t}(n_t) \geq 0$ denote the value of a firm with net worth n_t and likelihood of exiting θ. The objective of firms is to maximize the present discounted value of dividend distributions. Thus, their problem can be recursively represented using the value as follows:[9]

$$\begin{aligned} V_{\theta,t}(n_t) = \max_{d_{\theta,t},k_{\theta,t}\geq 0} & \left\{ d_{\theta,t} + \frac{1-\theta}{1+r_{t+1}} V_{\theta,t+1}(n_{t+1}) \right\} \\ & \text{subject to:} \\ & n_{t+1} = \zeta_{t+1}(k_{\theta,t}) - (1+r_{t+1})\, k_{\theta,t} + (1+r_{t+1})(n_t - d_{\theta,t}) \\ & k_{\theta,t} \leq \min\{k_{e,t}(n_t - d_{\theta,t}), k_{a,t}(n_t - d_{\theta,t})\} \end{aligned} \tag{20}$$

where the first condition in the set of restrictions to the problem describes the law of motion of net worth, and where earnings- and asset-based limits on physical capital, $k_{e,t}(\cdot)$ and $k_{a,t}(\cdot)$, are respectively given by

$$k_{e,t}(n) = n + \frac{1}{1+r_{t+1}} \lambda_e \zeta_{t+1}[k_{e,t}(n)] \tag{21}$$

and

$$k_{a,t}(n) = \frac{1+r_{t+1}}{1+r_{t+1}-\lambda_a q_{t+1}} n\,. \tag{22}$$

Optimal Choices. To solve this problem, we postulate that if the marginal value of net worth equals 1, then the marginal value in the next period equals 1 as well. Formally,

$$\text{if } V'_{\theta,t}(n) = 1, \text{ then } V'_{\theta,t+1}(n) = 1\,, \tag{23}$$

[9] To recap, the timing of events underlying the dynamic program within any given time period is the following: First, before production takes place, firms can declare a default on their debt, and, if they do so, a debt renegotiation process takes place. This gives rise to the asset-based constraint. Second, after production takes place, firms have another opportunity to declare a default on their debt, and, if they take it, the same debt renegotiation process as in the first event follows. This generates the earnings-based constraint and the resulting, effective borrowing constraint. Third, if before they did not declare default, firms must repay their debt. Fourth, firms may be forced in probability to exit product markets. If they do not have to exit, they choose their dividend distributions, the amount of physical capital to carry to the next period, and the amount of debt to issue to finance those expenditures. Additionally, they continue to the next period. Otherwise, firms must permanently cease their operations, without before having the opportunity to distribute dividends. One could interpret such a sudden exit as being triggered by an exogenous, obsolescence shock to the stock of capital held by the firm. In the general equilibrium version of the model with the three blocks, for simplicity, any net worth of exiting firms not distributed as dividends is collected by the household. Equivalently, the obsolete capital is picked up by the household, who recycles it and makes it again operative.

where note that $V'_{\theta,t}(n) \geq 1$, because the marginal value of distributing dividends always equals 1. Naturally, this conjecture holds in steady state—i.e., a stationary environment in which aggregate variables are constant over time. The conjecture specifies that in nonstationary environments, the investment opportunity set of firms does not significantly change over time, in the sense that if for a given level of net worth the firm finds it optimal to distribute dividends in the current period, then it also finds it optimal to do so in the next period. When considering nonstationary environments—among which we restrict attention to small perturbations around steady state—we verify the conjecture numerically.

Lemma 1. *Under conjecture (23) the optimal distribution of dividends and reinvestment of physical capital are respectively given by*

$$d_{\theta,t}(n) = \max\{n - \bar{n}_{\theta,t}, 0\} \tag{24}$$

and

$$k_{\theta,t}(n) = \min\{k_{e,t}(n), k_{a,t}(n), \bar{k}_{\theta,t}\}, \tag{25}$$

where targets for net worth $\bar{n}_{\theta,t} \geq 0$ and physical capital $\bar{k}_{\theta,t} \geq 0$ are given by

$$\bar{n}_{\theta,t} = \begin{cases} n_{e,t}(\theta) & \text{if } \theta \leq \bar{\theta}_{e,t} \\ n_{a,e} & \text{if } \theta \in (\bar{\theta}_{e,t}, \bar{\theta}_{a,t}) \\ n_{a,t}(\theta) & \text{if } \theta \geq \bar{\theta}_{a,t} \end{cases} \text{ and } \bar{k}_{\theta,t} = \begin{cases} k_{e,t}(\bar{n}_{\theta,t}) & \text{if } \theta \leq \bar{\theta}_{e,t} \\ k_{a,e} & \text{if } \theta \in (\bar{\theta}_{e,t}, \bar{\theta}_{a,t}) \\ k_{a,t}(\bar{n}_{\theta,t}) & \text{if } \theta \geq \bar{\theta}_{a,t} \end{cases}, \tag{26}$$

with net worth functions $n_{j,t}(\theta) \geq 0$ for $j \in \{e, a\}$ being implicitly characterized by

$$1 = \frac{1-\theta}{1+r_{t+1}} \left\{ \left\{ \zeta'_{t+1}\left[k_{j,t}\left[n_{j,t}(\theta)\right]\right] - (1+r_{t+1}) \right\} k'_{j,t}\left[n_{j,t}(\theta)\right] + (1+r_{t+1}) \right\}, \tag{27}$$

thresholds $\bar{\theta}_{j,t} \geq 0$ being such that

$$n_{j,t}\left(\bar{\theta}_{j,t}\right) = n_{ae,t}, \tag{28}$$

and $n_{ae,t} \geq 0$ and $k_{ae,t} \geq 0$ being jointly determined by

$$k_{e,t}(n_{ae,t}) = k_{a,t}(n_{ae,t}) = k_{ae,t}. \tag{29}$$

The lemma is shown in the Appendix.[10] The intuition behind the lemma is as follows.

Firms face a tradeoff between distributing dividends and retaining equity to reinvest in physical capital. If they have a net worth below target $\bar{n}_{\theta,t}$, they prefer not to distribute dividends and to retain all their equity. Otherwise, they prefer to distribute $n - \bar{n}_{\theta,t}$ and retain only $\bar{n}_{\theta,t}$. Target $\bar{n}_{\theta,t}$ is such that firms are indifferent on the margin between the two alternatives.

[10] The lemma assumes $k_{ae,t} < k_{*,t}$, where $k_{*,t} \geq 0$ is defined by (30).

A key determinant of the target is the likelihood of exiting product markets. To understand its determination, it is useful to classify firms in four groups as follows: patient—i.e., those with exiting likelihood $\theta = 0$; mildly impatient—those with $\theta \in \left(0, \bar{\theta}_{e,t}\right)$; moderately impatient—firms with $\theta \in \left[\bar{\theta}_{e,t}, \bar{\theta}_{a,t}\right]$; and highly impatient—those with $\theta \in \left(\bar{\theta}_{a,t}, 1\right)$.

For patient firms, the target is any net worth level $n \geq n_{e,t}(0)$ equal to or greater than threshold $n_{e,t}(0)$. The reason is that these firms are as equally patient as the market and thus inherently target the financially unconstrained scale. Formally, $\bar{k}_{0,t} = k_{*,t} \geq 0$, with

$$0 = \zeta'_{t+1}(k_{*,t}) - (1 + r_{t+1}) . \tag{30}$$

Lemma 1 imposes that $\bar{n}_{0,t} = n_{e,t}(0)$ without loss of generality.

For mildly and for highly impatient firms, the target is given by condition (27), with $j = e$ being the single binding financing constraint for the former type of firms, and $j = a$ being the single binding constraint for the latter. The left-hand side on the condition is the marginal value of distributing dividends, while its right-hand side is the marginal value of retaining equity to reinvest, provided that only constraint j is binding. These two types of firms are always financially constrained because they are effectively less patient than the market. As illustrated by Figure 8, before reaching their targets, both types of firms are constrained by the asset-based constraint. Once they reach their target, mildly impatient firms face only a binding earnings-based constraint, while highly impatient firms remain constrained by the asset-based constraint. This happens for two reasons. First, more patient firms prefer to retain more equity to hence target a larger operating scale. Second, and as illustrated by Figure 8 (panel b), the earnings-based constraint is tighter than the asset-based constraint for relatively large levels of net worth, but it is looser for relatively low levels. This naturally follows from decreasing returns to scale.[11]

Lastly, for moderately impatient firms, the target is $\bar{n}_{\theta,t} = n_{ae,t}$. These firms are such that given $n = n_{ae,t}$, they do not prefer on the margin to further accumulate net worth and mildly reinvest according to $k'_{e,t}(n_{ae,t}) < k'_{a,t}(n_{ae,t})$, but neither do they prefer on the margin to further distribute dividends and aggressively disinvest according to $k'_{a,t}(n_{ae,t})$. This discontinuity in preferences results because, in general, multiple financing constraints create discontinuities in the marginal return from retaining equity to reinvest at net worth levels at which the financing constraints intersect.[12] Once they reach their targets, this group of firms faces multiple binding financing constraints, in the sense that if only constraint j were to exist, the firms would choose a target $\bar{n}_{\theta,t} = n_{j,t}(\theta)$ that would generically differ from $n = n_{ae,t}$. Like the other types of firms, as

[11] Formally, $k_{e,t}(n) < k_{a,t}(n)$ for $n > n_{ae,t}$, while $k_{e,t}(n) > k_{a,t}(n)$ for $n < n_{ae,t}$, where $n_{ae,t} > 0$ is the threshold level of net worth at which the two constraints intersect, as defined by (29). In line with (28), and as illustrated in panel a, low-impatience threshold $\theta = \bar{\theta}_{e,t}$ is such that at $n = n_{ae,t}$, the given firm is indifferent on the margin between distributing dividends and retaining equity to reinvest according to the earnings-based constraint, while high-impatience threshold $\theta = \bar{\theta}_{a,t}$ is characterized in the same manner but with respect to the asset-based constraint.

[12] This result holds in general regardless of the number and nature of the individual financing constraints. In particular, it does not require discontinuities in individual constraints.

illustrated by Figure 8, initially in their life cycle—provided that the initial net worth endowment $\kappa < n_{ae,t}$ is sufficiently low—these firms face a single binding financing constraint, which is the asset-based.

All in all, and as corollary of the lemma, the investment block naturally generates a cross-sectional distribution of firms, in which some face no binding financing constraint, some face a single binding financing constraint, and the remaining face multiple binding financing constraints. Condition $k_{ae,t} < k_{*,t}$ is key for the possibility of having firms facing multiple binding financing constraints. This condition guarantees that the two financing constraints intersect at a level of net worth that is below the level required to support the financially unconstrained scale. From now on we assume the condition holds.

6.2 New Keynesian Block

The New Keynesian block closely follows Ottonello and Winberry (2020). There is a continuum of retailers in the unit interval, indexed by $i \in [0,1]$, each of which produces a differentiated variety $\tilde{y}_{i,t} = y_{i,t}$ according to a one-to-one technology using the intermediate good, where $y_{i,t} \geq 0$ is the quantity demanded by retailers of type i of the good. Retailers can set the real price for their variety $\tilde{p}_{i,t} \geq 0$, but to adjust their price, they must pay a quadratic cost $\frac{\varphi}{2}\left(\frac{\tilde{p}_{i,t}}{\tilde{p}_{i,t-1}} - 1\right)^2 Y_t$, where $\varphi \geq 0$ is a parameter and $Y_t \geq 0$ is the aggregate quantity of the final good. This adjustment cost is the source of nominal rigidities. Retailers face a downward-sloping demand curve, which results from a representative final good producer, who uses the varieties to produce the final good according to

$$Y_t = \left(\int_0^1 \tilde{y}_{i,t}^{\frac{\gamma-1}{\gamma}} di\right)^{\frac{\gamma}{\gamma-1}}, \tag{31}$$

where $\gamma > 0$ is the elasticity of substitution across the varieties.

Both retailers and the final good producer maximize the present discounted value of profits. Their combined optimality conditions yield a standard Phillips curve,

$$\ln(1+\pi_t) = \frac{\gamma-1}{\varphi} \ln \frac{p_t}{p_{ss}} + \beta \ln(1+\pi_{t+1}), \tag{32}$$

where $\pi_t \equiv P_t/P_{t-1} - 1$ is the rate of inflation in the price of the final good, $P_t > 0$, and $p_{ss} \equiv \frac{\gamma-1}{\gamma} > 0$ is the price of the intermediate good in steady state. Relative to steady state, an increase in reinvestment boosts demand for the final good and, consequently, it also boosts demands for varieties and for the intermediate good. Because of the costs to adjust prices, the resulting increases in demand exert upward pressure on the price of the intermediate good, which generates inflation in the price of the final good according to the Phillips curve.

A monetary authority can set the nominal interest rate $i_t \geq 0$. The Fisher equation relates the nominal and the real interest rates as follows: $1 + r_{t+1} = (1+i_t)/(1+\pi_{t+1})$. We assume the

monetary authority sets the nominal interest rate according to

$$\ln(1+i_t) = \ln(1+r_{ss}) + \varphi_\pi \ln(1+\pi_t) + \varepsilon_t\,, \tag{33}$$

where $r_{ss} \in \mathbb{R}$ is the real interest rate in steady state, $\varphi_\pi > 0$ is the weight of inflation in the response of the Taylor rule, and $\varepsilon_t \in \mathbb{R}$ is an unanticipated disturbance to the rule.

6.3 Household Block

Lastly, the household block includes only a representative household, who consumes the final good and supply labor hours, and whose preferences over consumption $C_t \geq 0$ and labor supply $L_t \geq 0$ are given by

$$\sum_{t=0}^{+\infty} \beta^t \left(\ln C_t - \chi L_t\right)\,, \tag{34}$$

where $\beta \in (0,1)$ is its time discount factor and $\chi > 0$ is its disutility weight from labor supply. The household faces a sequence of budget constraints,

$$C_t - B_t = w_t L_t + \Gamma_t - (1+r_t)\, B_{t-1}\,, \tag{35}$$

where $-B_t \in \mathbb{R}$ are holdings of firm debt and $\Gamma_t \in \mathbb{R}$ are net transfers received from firms and retailers. We assume the household is the residual claimant of the dividends distributed by firms and of the profits accrued by retailers. Additionally, we assume the household finances the initial endowment of the new entrant firms and appropriates for itself the net worth of the exiting firms.

The household maximizes utility (34) subject to budget constraints (35). The optimality conditions of its problem are

$$w_t = \chi C_t \tag{36}$$

and

$$1 = \beta \left(\frac{C_{t+1}}{C_t}\right)^{-1} (1+r_{t+1})\,. \tag{37}$$

6.4 Equilibrium

Let $n_{\theta,t}(a) \geq 0$ denote the net worth of (continuing) firms with age $a \in \{0,1,2,...\}$ and likelihood of exiting θ. Naturally, the net worth is exogenous at the initial period. For any positive exiting rate, the density distribution across age is set to $z_\theta(a) = \theta(1-\theta)^a$. This corresponds to the stationary age distribution for the fixed $\theta > 0$. For the null exiting rate, the corresponding cumulative distribution is set to $Z_0(a) = \mathbf{1}_{a \geq \bar{a}}$, where $\bar{a} > 0$ is a sufficiently large number. This is done to interpret firms with $\theta = 0$ as the financially unconstrained. Note that those firms can accumulate sufficient internal equity to implement their desired target—since they are infinitely lived—and that their desired target is $\bar{k}_{0,t} = k_{*,t}$.

An equilibrium is a set of firm decision rules $\{d_{\theta,t}(n), k_{\theta,t}(n)\}$, a distribution of firm net worth $\{n_{\theta,t}(a)\}$, quantities $\{l_{\theta,t}(a), L_t, K_t, Y_t, C_t\}$, and prices $\{p_t, \pi_t, i_t, w_t\}$ such that:

1. $\{d_{\theta,t}(n), k_{\theta,t}(n)\}$ are consistent with Lemma 1;

2. $n_{\theta,t}(a)$ evolves according to

$$n_{\theta,t+1}(a+1) = \zeta_{t+1}\left[k_{\theta,t}\left[n_{\theta,t}(a)\right]\right] - (1+r_{t+1})\, k_{\theta,t}\left[n_{\theta,t}(a)\right] + (1+r_{t+1})\left[n_{\theta,t}(a) - d_{\theta,t}\left[n_{\theta,t}(a)\right]\right],$$

with $n_{\theta,t}(0) = \kappa$;

3. $l_{\theta,t+1}(a+1)$ is given by (14), with $k_t = k_{\theta,t}\left[n_{\theta,t}(a)\right]$;
$L_{t+1} = \int \sum_{a\geq 0} z_\theta(a)\, l_{\theta,t+1}(a+1)\, dF(\theta)$ is consistent with firm aggregation;
$K_t = \int \sum_{a\geq 0} z_\theta(a)\, k_{\theta,t}\left[n_{\theta,t}(a)\right] dF(\theta)$ idem to L_{t+1};
$Y_{t+1} = A_{t+1} \int \sum_{a\geq 0} z_\theta(a) \left[l_{\theta,t+1}(a+1)\right]^{\alpha_l} \left[k_{\theta,t}\left[n_{\theta,t}(a)\right]\right]^{\alpha_k} dF(\theta)$ idem to L_{t+1};
$C_{t+1} + K_{t+1} - (1-\delta) K_t = Y_{t+1} - \frac{\varphi}{2}\pi_{t+1}^2 Y_{t+1}$ is consistent with market clearing;

4. $\{p_t, \pi_t, i_t\}$ satisfy {(32), (33), (37)}, with $1 + r_{t+1} = (1+i_t)/(1+\pi_{t+1})$;
w_t satisfies (36).

A steady state is an equilibrium in which aggregate variables are constant over time. We restrict our attention to the steady state and to small perturbations around the steady state. The perturbations are triggered by temporary monetary disturbances $\varepsilon_t \neq 0$ and consequently feature nonstationary dynamics that eventually revert back to steady state. We solve nonstationary dynamics numerically assuming perfect foresight. The next subsection details the parametrization of cumulative distribution function $F(\theta)$ and of liquidation price q_t and the values of the parameters in the baseline calibration.

6.5 Parametrization and Parameter Values

We take the values for the parameters from other studies or set them to match key variables in steady state to data. The time frequency is quarterly.

Productivity $A_t = 1$ is kept constant over time and is normalized to 1. The share of output of labor in the production of the intermediate good is set equal to $\alpha_l = 0.64$, and the corresponding share of physical capital is set equal to $\alpha_k = 0.21$. This implies returns to scale of $\alpha_l + \alpha_k = 0.85$. These values are consistent with Ottonello and Winberry (2020). Physical capital depreciates at a rate of $\delta = 0.035$, which is consistent with Khan and Thomas (2008). The elasticity of substitution in the production of the final good is set equal to $\gamma = 10$ to generate a markdown in the price of the intermediate good in steady state of 10%. Note that as in Ottonello and Winberry (2020), $\gamma = 10$ and $\alpha_l = 0.64$ combined imply a share of output of labor in the production process of the

final good of $\frac{\gamma-1}{\gamma}\alpha_l \simeq 0.58$, which is also consistent with Karabarbounis and Neiman (2014). The parameter in the adjustment cost of the prices for varieties is $\varphi = 90$ to generate a slope in the Phillips curve of 0.1. This value is consistent with Kaplan et al. (2018). The coefficient on inflation in the Taylor rule is set equal to $\varphi_\pi = 1.5$, which is a common value in the literature.

The discount factor of the household is $\beta = 0.99$. This value implies an annualized real interest rate in steady state of 2%. The disutility weight from supplying labor hours is set equal to $\chi = 1$ to match an aggregate quantity of labor in steady state of 1/3 per unit of time.

The cumulative distribution function of exiting rates is parametrized as follows:

$$F(\theta) = \begin{cases} \mu_0 & \text{if } \theta = 0 \\ \mu_0 + \frac{\theta}{\bar{\theta}_e}\mu_1 & \text{if } \theta \in \left(0, \bar{\theta}_e\right) \\ 1 & \text{if } \theta \geq \bar{\theta}_e \end{cases}, \tag{38}$$

where $\mu_0 \in (0,1)$ and $\mu_1 \in (0,1)$ are constants. Assigning cumulative probability mass $1-(\mu_0+\mu_1)$ differently among moderately impatient firms $\theta \in \left[\bar{\theta}_{e,t}, \bar{\theta}_{a,t}\right]$ does not significantly affect the quantitative results. This is because all those firms target the same operating scale $\bar{k}_{\theta,t} = k_{ae,t}$. We do not consider specifications that assign positive probability mass to firms with $\theta > \bar{\theta}_{a,t}$, in order to interpret firms facing multiple binding financing constraints as the most severely financially constrained, as measured by $|\bar{k}_{\theta,t} - k_{*,t}|$.[13]

Parameter $\mu_0 = 10.6\%$ is set to directly match the population share of the financially unconstrained firms in our database. Parameters $\{\mu_1, \kappa, \lambda_e, \lambda_a\}$ are jointly set to match the population share in our database of the firms facing a single binding financing constraint (26% in both model and data), the relative size as measured by employment using the Business Dynamics Statistics database of the firms with age less than one year (2% in the model, while 3% in the data), the average leverage (i.e., debt over assets) in our database (31% in both), and the corresponding average leverage across the financially constrained firms (32% in both). The target for the relative size is consistent with Ottonello and Winberry (2020), and those for the average leverages are consistent with Crouzet and Mehrotra (2020). The latter reports an average leverage for a similar sample of firms of approximately 34%. The implied population share of firms facing multiple binding financing constraints is 63.4%. To match these targets, we set a liquidation price of physical capital equal to $q_{ss} = 1$, a point on which we elaborate below.

The liquidation price of physical capital is parametrized as follows:

$$q_t = \left(\frac{r_{ss}}{r_t}\right)^{\epsilon}, \tag{39}$$

where $\epsilon \geq 0$ is the elasticity of the price to the real interest rate and $r_{ss} = 1/\beta - 1$ in steady state.

[13] Regardless of the exiting likelihood, the financially unconstrained optimal scale is given by $k_{*,t}$. This is because absent financial frictions (i.e., $\lambda_e = \lambda_a = +\infty$), firms could sell a claim to their future profits to thus distribute dividends in the current period, according to $n_t - k + \frac{1}{1+r_{t+1}}\zeta_{t+1}(k)$.

This implies an asset-based constraint more sensitive than the earnings-based constraint to the real interest rate for firms facing multiple binding financing constraints. Put formally,

$$\left|\frac{\partial}{\partial r_{t+1}}k_{a,t}\left(n\right)\right|_{n=n_{ae,t}} > \left|\frac{\partial}{\partial r_{t+1}}k_{e,t}\left(n\right)\right|_{n=n_{ae,t}}, \tag{40}$$

even for $\epsilon = 0$. The elasticity is set equal to $\epsilon = 1$ to match the sensitivity of the distance-to-default constraint to the interest rate in our database (1% in the data, while 1.4% in the model).

6.6 Impulse Responses to Monetary Disturbances

Figure 9 shows the impulse responses of firm borrowing and firm cumulative investment (i.e., percentage deviation of accumulated capital stock from steady state) to a positive and a negative monetary disturbance of equal size. The size is set to $|\varepsilon_0| = 0.25\%$. The positive disturbance is interpreted as an unanticipated tightening in monetary policy relative to steady state, while the negative disturbance is interpreted as an unanticipated monetary easing.

A monetary disturbance has a positive effect on the real interest rate. This is because of sluggishness in price setting. The positive effect on the real rate negatively impacts firm borrowing and firm investment through two channels. First, it increases the user cost of physical capital and, thus, reduces the willingness to borrow and reinvest. This force materializes as downward pressure over financially unconstrained scale $k_{*,t} \leq k_{*,ss}$. Second, it increases the costs of servicing debt and, consequently, triggers a tightening of financing constraints. This force reduces the ability of firms subject to binding financing constraints to reinvest regardless of the identity and number of those constraints.

All else being equal, the strength of the former (i.e., willingness) channel is not influenced by the sign of the monetary disturbance. This is because, as implied by equation (30), financially unconstrained scale $k_{*,t}$ is differentiable in real interest rate r_{t+1}. By contrast, and in line with Proposition 1, the strength of the latter (i.e., ability) channel depends on the sign of disturbance, provided that multiple financing constraints are binding. Specifically, for firms facing multiple binding financing constraints in steady state, following a monetary easing, the earnings-based constraint—which, in our simulations, is the least sensitive to the interest rate—becomes the single binding constraint. Following a monetary tightening, that role is instead taken by the asset-based constraint, the more sensitive of the two. The difference in the sensitivity between the two constraints—in line with Proposition 1—naturally generates larger responses of borrowing and investment in absolute terms to the monetary tightening (panels f and i). The differences in the responses are persistent and extend throughout the simulation horizon.

The responses of the other firms are significantly influenced by those of the initially multiple-constraint firms (panels d, e, g, and h). This is because the model features a general-equilibrium effect that operates through the real wage. Specifically, to fix ideas, a large contraction in investment

by a significant group of firms exerts downward pressure on the aggregate demand of labor, which in turn exerts downward pressure on the real wage. Everything else the same, a fall in the real wage boosts the real return on physical capital, which stimulates the willingness of financially unconstrained firms to reinvest as well as relaxes earnings-based financing constraints. This general equilibrium effect explains the smaller responses of borrowing and investment in absolute terms to the monetary tightening for the firms facing in steady state either no or a single binding financing constraint. Absent the general equilibrium effect, as shown by Proposition 1, the responses of those firms would instead be symmetric with respect to the sign of the change in the policy rate. The general equilibrium effect is not highly persistent, nonetheless, as in the simulations it almost vanishes after the eighth quarter.

Lastly, panel c of Figure 9 reports impulse responses of aggregate investment. These responses are primarily influenced by those of the initially multiple-constraint firms. This is mainly because of the large population share of those firms in the baseline calibration. The aggregate investment response features asymmetry throughout the simulation horizon. The asymmetry is quantitatively significant. For instance, at the eighth quarter, the response of aggregate investment following the tightening is approximately two times larger in absolute terms than that following the easing. As shown by Figure 10, a 0.5 point change in the interest-rate elasticity of the liquidation price affects the strength of the asymmetry at the eighth quarter by approximately 20%, while a 0.1 point change in the population share of firms facing multiple financing constraints—as implied by $\mu_1 \in \{0.16, 0.36\}$—does so by approximately 10%.

7 Conclusion

In this paper, we revisit the credit channel of monetary policy by examining the implications of multiple firm financial constraints on firm borrowing, a well-documented feature of firm financing. Our research addresses a critical gap in the literature, moving beyond the standard theoretical frameworks that typically impose only a single constraint on firms' access to external finance.

We first introduce a simple theoretical model that predicts an asymmetric response of borrowing and investment to monetary policy: following a contractionary policy action, the most interest rate sensitive constraint becomes binding, leading to significant reductions in borrowing and investment; conversely, under policy easings, the least sensitive constraint remains binding, resulting in a muted response. To test these predictions, we construct a novel measure of the number of tight constraints faced by firms, leveraging detailed debt covenant data and distance-to-default estimates. We find strong empirical support for the predictions of our theoretical model. Moreover, we exploit an accounting rule change in 2016 that effectively tightened debt-based covenants and provides quasi-exogenous variation in the number of tight constraints to provide further support to our predictions. Finally, we show in a realistically calibrated medium-scale New Keynesian framework that our proposed credit channel leads to strong economy-wide asymmetric effects of monetary policy.

Our results carry an important policy implication: the effectiveness of monetary policy depends on the aggregate distribution of financial conditions in nonfinancial firms. In particular, the effects of monetary policy easings are dampened when a large share of firms faces multiple tight constraints, while the impact of monetary tightening is amplified.

Our results also suggest that monetary policy transmission might be state-dependent. For example, following a period of sustained monetary expansion, the firm financial constraints that are relatively rate-insensitive are more likely to be dominant, and rate-sensitive ones are likely to be slack. In that situation, any monetary policy action—expansionary or contractionary—becomes somewhat ineffective. We leave these avenues for future research.

More broadly, the main insight in this paper has important implications for macroeconomic fluctuations beyond those that are caused by monetary policy. The multiplicity of constraints is likely to dampen the effects of most nonmonetary expansionary shocks (such as positive shocks to financial market sentiment or positive aggregate demand shocks), relative to a single-constraint benchmark. Conversely, the multiplicity of constraints is likely to amplify the effects of most contractionary shocks. We also leave this exploration for future research.

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Appendix

The proof of Lemma 1 is as follows:

The problem of firms is

$$\begin{aligned} V_{\theta,t}\left(n_t\right) = & \max_{d_{\theta,t},k_{\theta,t}\geq 0}\{d_{\theta,t}+\frac{1-\theta}{1+r_{t+1}}V_{\theta,t+1}\left(n_{t+1}\right)\} \\ & \text{subject to:} \\ & n_{t+1}=\zeta_{t+1}\left(k_{\theta,t}\right)-\left(1+r_{t+1}\right)k_{\theta,t}+\left(1+r_{t+1}\right)\left(n_t-d_{\theta,t}\right) \\ & k_{\theta,t}\leq \min\{k_{e,t}\left(n_t-d_{\theta,t}\right),k_{a,t}\left(n_t-d_{\theta,t}\right)\} \end{aligned} \tag{41}$$

Define net worth functions $n_{j,t}\left(\theta\right)\geq 0$ for $j\in\{e,a\}$ as

$$1=\frac{1-\theta}{1+r_{t+1}}\left\{\left\{\zeta'_{t+1}\left[k_{j,t}\left[n_{j,t}\left(\theta\right)\right]\right]-\left(1+r_{t+1}\right)\right\}k'_{j,t}\left[n_{j,t}\left(\theta\right)\right]+\left(1+r_{t+1}\right)\right\}, \tag{42}$$

net worth threshold $n_{ae,t}\geq 0$ as

$$k_{e,t}\left(n_{ae,t}\right)=k_{a,t}\left(n_{ae,t}\right)=k_{ae,t}, \tag{43}$$

and firm threshold $\bar{\theta}_{j,t}\in[0,1]$ as

$$n_{j,t}\left(\bar{\theta}_{j,t}\right)=n_{ae,t}. \tag{44}$$

Note that $\bar{\theta}_{e,t}<\bar{\theta}_{a,t}$ because $k'_{e,t}\left(n_{ae,t}\right)<k'_{a,t}\left(n_{ae,t}\right)$. Moreover, note that $n_{j,t}\left(\theta\right)>n_{ae,t}$ for any $\theta<\bar{\theta}_{j,t}$ and that $n_{j,t}\left(\theta\right)<n_{ae,t}$ for any $\theta>\bar{\theta}_{j,t}$.

First, consider a firm with $\theta\geq\bar{\theta}_{a,t}$. Consider first a case with $n_t\geq n_{a,t}\left(\theta\right)$. Assume an interior solution for $d_{\theta,t}$ and a corner solution with $j=a$ for $k_{\theta,t}$. Formally, $d_{\theta,t}\in\left(0,n_t\right)$ and $k_{\theta,t}=k_a\left(n_t-d_{\theta,t}\right)\leq k_{ae,t}$. The first-order condition with respect to $d_{\theta,t}$ delivers the following optimality condition: $d_{\theta,t}=n_t-\hat{n}_{a,t}\left(\theta\right)$, with $\hat{n}_{a,t}\left(\theta\right)\geq 0$ defined as

$$1=\frac{1-\theta}{1+r_{t+1}}V'_{\theta,t+1}\left[n_{t+1}[\hat{n}_{a,t}\left(\theta\right)]\right]\left\{\left\{\zeta'_{t+1}\left[k_a\left[\hat{n}_{a,t}\left(\theta\right)\right]\right]-\left(1+r_{t+1}\right)\right\}k'_a\left[\hat{n}_{a,t}\left(\theta\right)\right]+\left(1+r_{t+1}\right)\right\}, \tag{45}$$

where $n_{t+1}[\hat{n}_{a,t}\left(\theta\right)]$ is given by

$$n_{t+1}[\hat{n}_{a,t}\left(\theta\right)]=\zeta_{t+1}\left(k_a\left[\hat{n}_{a,t}\left(\theta\right)\right]\right)-\left(1+r_{t+1}\right)k_a\left[\hat{n}_{a,t}\left(\theta\right)\right]+\left(1+r_{t+1}\right)\hat{n}_{a,t}. \tag{46}$$

Note that $\hat{n}_{a,t}\left(\theta\right)$ does not depend on n_t. Thus, $d_{\theta,t}=n_t-\hat{n}_{a,t}\left(\theta\right)\geq 0$ if and only if $\hat{n}_{a,t}\left(\theta\right)\leq n_t$. From, first, substituting $d_{\theta,t}=n_t-\hat{n}_{a,t}\left(\theta\right)$ and $k_{\theta,t}=k_a\left(n_t-d_{\theta,t}\right)$ into problem (41), and then taking the first-order derivative of $V_{\theta,t}\left(n_t\right)$ with respect to n_t, one gets $V'_{\theta,t}\left(n_t\right)=1\ \forall n_t\geq\hat{n}_{a,t}\left(\theta\right)$. Note that $n_{t+1}[\hat{n}_{a,t}\left(\theta\right)]>\hat{n}_{a,t}\left(\theta\right)$ because $k_a\left[\hat{n}_{a,t}\left(\theta\right)\right]<k_{*,t}$. Thus, from conjecture (23), it follows that $V'_{\theta,t+1}\left[n_{t+1}[\hat{n}_{a,t}\left(\theta\right)]\right]=1$. By definition, then $\hat{n}_{a,t}\left(\theta\right)=n_{a,t}\left(\theta\right)$, which in turn implies that

$d_{\theta,t} = n_t - n_{a,t}(\theta) \geq 0$ is interior and $k_{\theta,t} = k_a(n_t - d_{\theta,t}) = k_a[n_{a,t}(\theta)] \leq k_{ae,t}$ is corner with $j = a$, as initially assumed. If, instead, $n_t < n_{a,t}(\theta)$, then naturally, $d_{\theta,t} = 0$ and $k_{\theta,t} = k_a(n_t) \leq k_{ae,t}$ are optimal. All in all, these derivations imply that $d_{\theta,t} = \max\{n_t - n_{a,t}(\theta), 0\}$ and $k_{\theta,t} = \min\{k_a(n_t), k_e(n_t), k_a[n_{a,t}(\theta)]\}$ are optimal for any firm with $\theta \geq \bar{\theta}_{a,t}$, as stated by the lemma.

Next, consider a firm with $\theta \leq \bar{\theta}_{e,t}$. Proceeding in the same manner as that for a firm with $\theta \geq \bar{\theta}_{a,t}$, but instead imposing $j = e$ in the assumption of the corner solution for $k_{\theta,t}$, one gets that $d_{\theta,t} = \max\{n_t - n_{e,t}(\theta), 0\}$ and $k_{\theta,t} = \min\{k_e(n_t), k_a(n_t), k_e[n_{e,t}(\theta)]\}$ are optimal, as stated by the lemma.

Finally, consider a firm with $\theta \in (\bar{\theta}_{e,t}, \bar{\theta}_{a,t})$. Consider first a case with $n_t \geq n_{ae,t}$. Assume $k_{\theta,t} = \min\{k_a(n_t - d_{\theta,t}), k_e(n_t - d_{\theta,t})\}$. The first-order derivative of the objective in problem (41) with respect to $d_{\theta,t}$ is $\partial O_{\theta,t}/\partial d_{\theta,t}$, with

$$\begin{aligned}\frac{\partial O_{\theta,t}}{\partial d_{\theta,t}} =& 1 - \frac{1-\theta}{1+r_{t+1}} V'_{\theta,t+1}[n_{t+1}(n_t - d_{\theta,t})] \times \\ & \times \left\{ \left\{ \zeta'_{t+1}\left[k_{\hat{j},t}(n_t - d_{\theta,t})\right] - (1+r_{t+1}) \right\} k'_{\hat{j},t}(n_t - d_{\theta,t}) + (1+r_{t+1}) \right\}\end{aligned} \tag{47}$$

where $\hat{j} = \arg\min_{j \in \{a,e\}}\{k_j(n_t - d_{\theta,t})\}$. Note that for $d_{\theta,t} > n_t - n_{ae,t}$, $\hat{j} = a$ and $\partial O_{\theta,t}/\partial d_{\theta,t} < 0$, while for $d_{\theta,t} < n_t - n_{ae,t}$, $\hat{j} = e$ and $\partial O_{\theta,t}/\partial d_{\theta,t} > 0$. Therefore, $d_{\theta,t} = n_t - n_{ae,t}$ is optimal, which in turn implies that $k_{\theta,t} = \min\{k_a(n_t - d_{\theta,t}), k_e(n_t - d_{\theta,t})\} = k_{ae,t}$ is optimal. If, instead, $n_t < n_{ae,t}$, the first-order derivative is

$$\begin{aligned}\frac{\partial O_{\theta,t}}{\partial d_{\theta,t}} =& 1 - \frac{1-\theta}{1+r_{t+1}} V'_{\theta,t+1}[n_{t+1}(n_t - d_{\theta,t})] \times \\ & \times \left\{ \left\{ \zeta'_{t+1}[k_{a,t}(n_t - d_{\theta,t})] - (1+r_{t+1}) \right\} k'_{a,t}(n_t - d_{\theta,t}) + (1+r_{t+1}) \right\}.\end{aligned} \tag{48}$$

Naturally, $\partial O_{\theta,t}/\partial d_{\theta,t} < 0 \ \forall d_{\theta,t} \leq n_t$, and, thus, $d_{\theta,t} = 0$ and $k_{\theta,t} = k_a(n_t) \leq k_{ae,t}$ are optimal. All in all, these derivations imply that $d_{\theta,t} = \max\{n_t - n_{ae,t}, 0\}$ and $k_{\theta,t} = \min\{k_a(n_t), k_e(n_t), k_a(n_{ae,t})\}$ are optimal for any firm with $\theta \in (\bar{\theta}_{e,t}, \bar{\theta}_{a,t})$, as stated by the lemma.

This shows the lemma.

Table 1: Summary Statistics

	Multiple Constraints		Single Constraint		Unconstrained	
	(1)		(2)		(3)	
	mean	sd	mean	sd	mean	sd
Size	6.762	1.489	7.372	1.598	7.883	1.547
Leverage	0.338	0.184	0.276	0.176	0.240	0.157
Sales Volatility	0.272	0.232	0.214	0.207	0.172	0.171
Cash/Assets	0.074	0.098	0.101	0.123	0.115	0.124
Tangibility	0.310	0.245	0.299	0.238	0.293	0.241
Investment	0.012	0.136	0.014	0.105	0.012	0.085
Net Leverage	0.139	0.353	0.066	0.313	0.025	0.273
Sales Growth	0.014	0.271	0.017	0.225	0.015	0.204
Distance to Default	4.626	4.167	7.496	4.702	9.636	5.441
Observations	81030		33271		13621	

This table presents the summary statistics for firm characteristics across three groups based on their constraint status: Multiple Constraints, Single Constraint, and Unconstrained. The variables include Size (log of total assets), Leverage (ratio of total debt to total assets), Sales Volatility (standard deviation of sales growth over the past three years), Cash/Assets (ratio of cash holdings to total assets), and Tangibility (ratio of tangible assets to total assets), Investment (log change in capital), Net Leverage (leverage minus cash), Sales Growth (log change in sales), and Merton's distance to default. Means and standard deviations (sd) are reported for each variable. The sample comprises 81,030 observations for firms with Multiple Constraints, 33,271 observations for firms with a Single Constraint, and 13,621 observations for Unconstrained firms.

Table 2: Response of External Financing Flows to Tightening and Easing Shocks by Number of Constraints

	$\Delta_8 ExFin_{i,t+7}$			
	(1)	(2)	(3)	(4)
Contr. Shock × Single Constraint	-1.521	-0.697	-0.170	-0.293
	(1.203)	(1.152)	(0.676)	(0.738)
Contr. Shock × Mult. Constraint	-3.361***	-2.640**	-2.044***	-1.748***
	(1.196)	(1.141)	(0.751)	(0.654)
Acc. Shock × Single Constraint	0.709	-0.054	0.962***	1.131***
	(1.282)	(1.037)	(0.323)	(0.374)
Acc. Shock × Mult. Constraint	2.963***	2.144***	2.053***	2.339***
	(1.073)	(0.773)	(0.504)	(0.491)
R-squared	0.030	0.030	0.338	0.041
N	106,881	106,881	106,707	100,060
Time FE	✓	✓	✓	✓
Firm FE			✓	
Firm Controls				✓
Macro Controls		✓	✓	✓

This table displays the coefficients from the following estimated equation:

$$\Delta_8 \text{ExFin}_{i,t+7} = \beta_1 \textit{Contr. Shock}_t \times \textit{Single Constraint}_{i,t} + \beta_2 \textit{Contr. Shock}_t \times \textit{Mult. Constraints}_{i,t} + \beta_4 \textit{Acc. Shock}_t \times \textit{Single Constraint}_{i,t} + \beta_6 \textit{Acc. Shock}_t \times \textit{Mult. Constraints}_{i,t} + \mathbf{X}_t'\gamma + \epsilon_{i,t}$$

where $\Delta_8 \text{ExFin}_{i,t+7}$ denotes the cumulative debt and equity financing flows over seven quarters (two years) following the shock. *Contr. Shock*$_t$ is defined as the Miranda-Agrippino and Ricco (2021) monetary policy shock when it is positive, and *Acc. Shock*$_t$ is defined as the same shock when it is negative. *Contr. Shock* × *Single Constraint* captures the differential effect of a contractionary shock for firms with one tight constraint, relative to unconstrained firms, while *Contr. Shock* × *Mult. Constraints* captures the corresponding differential effect for firms with multiple tight constraints. Similarly, *Acc. Shock* × *Single Constraint* reflects the differential effect of an accommodative shock for singly constrained firms, and *Acc. Shock*×*Mult. Constraints* captures the effect for firms with multiple constraints, both relative to unconstrained firms. The controls ($\mathbf{X}_t$) and fixed effects vary across columns. Columns (1)–(4) progressively include Time Fixed Effects, Firm Fixed Effects, Firm Controls, and Macro Controls. Firm controls include leverage, size, and sales volatility. Macro controls include GDP growth and inflation. Standard errors are double-clustered at the firm level and reported in parentheses. Statistical significance is denoted as follows: * for 10%, ** for 5%, and *** for 1%.

Table 3: Response of the Cumulative Change in Capital to Tightening and Easing Shocks by Number of Constraints

	$\Delta_8 Capital_{i,t+7}$			
	(1)	(2)	(3)	(4)
Contr. Shock × Single Constraint	-1.762**	-0.764	-0.364	-0.642+
	(0.726)	(0.558)	(0.336)	(0.417)
Contr. Shock × Mult. Constraint	-2.227***	-1.353**	-0.873*	-0.966**
	(0.842)	(0.657)	(0.523)	(0.473)
Acc. Shock × Single Constraint	1.520	0.615	0.498	1.252***
	(1.154)	(0.904)	(0.537)	(0.459)
Acc. Shock × Mult. Constraint	2.399**	1.542*	1.141	1.757***
	(1.136)	(0.866)	(0.689)	(0.516)
R-squared	0.054	0.054	0.358	0.061
N	111,673	111,673	111,523	101,129
Time FE	✓	✓	✓	✓
Firm FE			✓	
Firm Controls				✓
Macro Controls		✓	✓	✓

This table displays the coefficients from the following estimated equation:

$$\Delta_8 \text{Capital}_{i,t+7} = \beta_1 \textit{Contr. Shock}_t \times \textit{Single Constraint}_{i,t} + \beta_2 \textit{Contr. Shock}_t \times \textit{Mult. Constraints}_{i,t} + \beta_4 \textit{Acc. Shock}_t \times \textit{Single Constraint}_{i,t} + \beta_6 \textit{Acc. Shock}_t \times \textit{Mult. Constraints}_{i,t} + \mathbf{X}_t'\gamma + \epsilon_{i,t}$$

where $\Delta_8 \text{Capital}_{i,t+7}$ denotes the change in firm capital over seven quarters (two years) following the shock. *Contr. Shock*$_t$ is defined as the Miranda-Agrippino and Ricco (2021) monetary policy shock when it is positive, and *Acc. Shock*$_t$ is defined as the same shock when it is negative. *Contr. Shock* × *Single Constraint* captures the differential effect of a contractionary shock for firms with one tight constraint, relative to unconstrained firms, while *Contr. Shock* × *Mult. Constraints* captures the corresponding effect for firms with multiple constraints. Similarly, *Acc. Shock* × *Single Constraint* reflects the differential effect of an accommodative shock for singly constrained firms, and *Acc. Shock* × *Mult. Constraints* captures the effect for firms with multiple constraints—both relative to unconstrained firms. The controls ($\mathbf{X}_t$) and fixed effects vary across columns. Columns (1)–(4) progressively include Time Fixed Effects, Firm Fixed Effects, Firm Controls, and Macro Controls. Firm controls include leverage, size, and sales volatility. Macro controls include GDP growth and inflation. Standard errors are double-clustered at the firm level and reported in parentheses. Statistical significance is denoted as follows: * for 10%, ** for 5%, and *** for 1%.

Table 4: Summary Statistics— Lease Status

	High Leases			
	(1) High Leases		(2) Low Leases	
	mean	sd	mean	sd
Size	7.586	1.291	7.957	1.323
Leverage	0.315	0.181	0.313	0.167
Sales Volatility	0.178	0.171	0.226	0.198
Cash/Assets	0.082	0.088	0.084	0.100
Tangibility	0.281	0.215	0.318	0.260
Distance to Default	7.143	5.018	7.344	4.938
Investment Growth	0.012	0.113	0.012	0.101
Net Leverage	0.132	0.305	0.133	0.280
Sales Growth	0.011	0.240	0.013	0.218
Age	16.306	8.307	16.756	8.470
Sales	1.638	4.106	1.793	4.296
Profits	0.141	0.476	0.199	0.571
Observations	30881		30840	

This table presents summary statistics for firm characteristics across two groups, based on the ratio of operating leases to total assets in 2016. Firms are split at the median into High Lease and Low Lease groups. The variables include Size (log of total assets), Leverage (ratio of total debt to total assets), Sales Volatility (standard deviation of sales growth over the past three years), Cash/Assets (ratio of cash holdings to total assets), Tangibility (ratio of tangible assets to total assets), Investment Growth (log change in capital), Net Leverage (leverage minus cash), Sales Growth (log change in sales), and Merton's Distance to Default, Age is the age of the company, Sales and Profits are in million USD. Means and standard deviations (sd) are reported for each variable. The sample comprises 30,881 observations for firms with High Leases and 30,840 observations for firms with Low Leases.

Table 5: Response of External Financing Flows to Tightening and Easing Shocks by Lease Status

	Pre-Shock				Post-Shock			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Contr. Shock × High Lease	0.059	-0.082	-0.178	-0.892	-5.603**	-8.562***	-8.006**	-6.526***
	(0.639)	(0.705)	(0.702)	(0.743)	(2.174)	(2.958)	(3.082)	(1.982)
Acc. Shock × High Lease	-0.091	0.452	0.534	1.041	5.560**	7.543**	7.282**	5.587**
	(0.158)	(0.510)	(0.543)	(0.705)	(2.482)	(2.722)	(2.884)	(2.126)
R-squared	0.028	0.044	0.053	0.106	0.012	0.029	0.068	0.130
N	34,491	32,811	32,811	32,544	10,467	10,402	10,400	10,316
Time FE	✓	✓	✓		✓	✓	✓	
Industry FE			✓				✓	
Industry x Time FE				✓				✓
Firm Controls		✓	✓	✓		✓	✓	✓
Macro Controls	✓	✓	✓	✓	✓	✓	✓	✓

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

This table displays the coefficients from the following estimated equation:

$$\Delta_8 \text{ExFin}_{i,t+7} = \beta_1 \textit{Contr. Shock}_t \times \textit{High Lease}_i + \beta_2 \textit{Acc. Shock}_t \times \textit{High Lease}_i + \eta_{st} + \mathbf{X}_t'\gamma + \epsilon_{i,t}$$

where $\Delta_8 \text{ExFin}_{i,t+7}$ denotes the cumulative debt and equity financing flows over seven quarters (two years) following the shock. *Contr. Shock*$_t$ is defined as the Miranda-Agrippino and Ricco (2021) monetary policy shock when positive, and *Acc. Shock*$_t$ is defined as the same shock when negative. *Contr. Shock*$\times$*High Lease* captures the differential effect of a contractionary shock for firms with a high share of leases in 2016, relative to those with a low share. Similarly, *Acc. Shock* $\times$ *High Lease* represents the differential effect of an accommodative shock for firms with a high lease share in 2016, relative to those with a low share. The controls ($\mathbf{X}_t$) and fixed effects vary across columns. Firm controls include leverage, size, and sales volatility. Macro controls include GDP growth and inflation. *Pre-Shock* refers to the sample before 2018; *Post-Shock* refers to the sample after 2018. Standard errors are double-clustered at the firm level and reported in parentheses. Statistical significance is denoted as follows: * for 10%, ** for 5%, and *** for 1%.

Table 6: Response of Cumulative Change in Capital to Tightening and Easing Shocks by Lease Status

	Pre-Shock				Post-Shock			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Contr. Shock × High Lease	-0.075	-0.004	-0.091	-0.390	-8.586	-10.351	-9.794	-7.853
	(0.304)	(0.384)	(0.375)	(0.364)	(8.221)	(8.209)	(8.159)	(5.211)
Acc. Shock × High Lease	0.143	0.239	0.323	0.531	16.318**	17.360**	17.016**	12.101***
	(0.469)	(0.555)	(0.576)	(0.547)	(6.320)	(6.247)	(6.231)	(4.274)
R-squared	0.028	0.039	0.055	0.111	0.198	0.212	0.235	0.316
N	41,308	38,072	38,072	37,770	13,361	12,865	12,863	12,807
Time FE	✓	✓	✓		✓	✓	✓	
Industry FE			✓				✓	
Industry x Time FE				✓				✓
Firm Controls		✓	✓	✓		✓	✓	✓
Macro Controls	✓	✓	✓	✓	✓	✓	✓	✓

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

This table displays the coefficients from the following estimated equation:

$$\Delta_8 \text{Capital}_{i,t+7} = \beta_1 \textit{Contr. Shock}_t \times \textit{High Lease}_i + \beta_2 \textit{Acc. Shock}_t \times \textit{High Lease}_i + \mathbf{X}_t' \gamma + \epsilon_{i,t}$$

where $\Delta_8 \text{Capital}_{i,t+7}$ denotes the change in capital over seven quarters (two years) following the shock. *Contr. Shock*$_t$ is defined as the Miranda-Agrippino and Ricco (2021) monetary policy shock when positive, and *Acc. Shock*$_t$ is defined as the same shock when negative. *Contr. Shock* × *High Lease* captures the differential effect of a contractionary shock for firms with a high share of leases in 2016 relative to those with a low share, while *Acc. Shock* × *High Lease* represents the differential effect of an accommodative shock for firms with a high lease share in 2016 relative to those with a low share. The controls ($\mathbf{X}_t$) and fixed effects vary by column specification. Firm controls include leverage, size, and sales volatility. Macro controls include GDP growth and inflation. Pre-Shock refers to the sample before 2018; Post-Shock refers to the sample after 2018. Standard errors are double-clustered at the firm level and reported in parentheses. Statistical significance is denoted as follows: * for 10%, ** for 5%, and *** for 1%.

Table 7: Parameter Values

Parameter	Description	Value	Source / Target
A	Productivity	1	Normalization
α_l	Output share of labor	0.64	Ottonello and Winberry (2020)
α_k	Output share of physical capital	0.21	Ottonello and Winberry (2020)
δ	Depreciation rate of physical capital	0.035	Khan and Thomas (2008)
γ	Demand elasticity	10	Target 10% markdown
φ	Price adjustment cost	90	Kaplan et al. (2018)
φ_π	Coefficient in Taylor rule	1.5	Kaplan et al. (2018)
β	Discount factor of household	0.99	Target 2% (annualized) real rate
χ	Disutility weight	1	Target 2/3 labor hours per period
μ_0	Parameter in $F(\theta)$	10.6%	Target share of unconstrained firms
μ_1	Parameter in $F(\theta)$	26%	Target share of single-constrained firms
κ	Endowment of new entrants	0.4	Target share of employment age < 1
λ_e	Share of pledgeable output	0.30	Target average leverage
λ_a	Share of pledgeable physical capital	0.32	Target average leverage of constrained
ϵ	Interest-rate elasticity of liq. price	1	Target sensitivity of D2D constraint

The time frequency is quarterly.

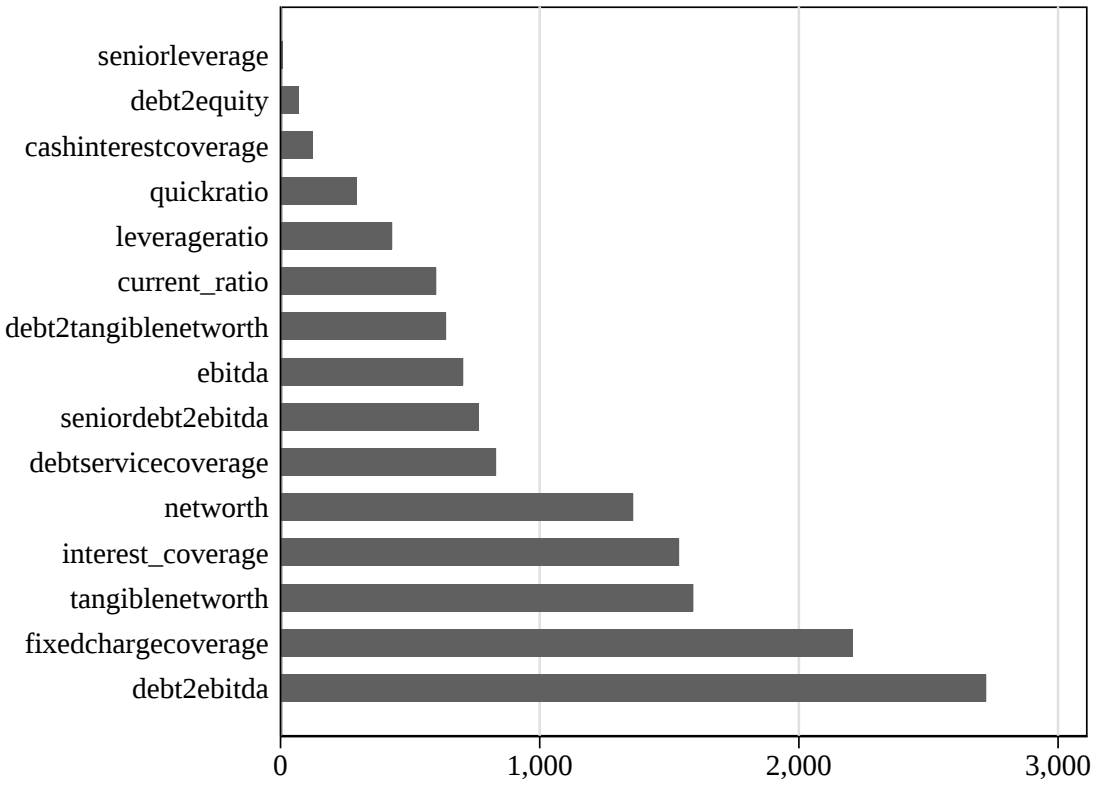


Figure 1: Types and Prevalence of Financial Covenants.

Notes: This chart displays the frequency of various tight financial covenants per firm-quarter observation from 1990 to 2020. A covenant is defined as tight if the firm is within two standard deviations of its binding threshold. Data are sourced from the Compustat and DealScan databases and are based on a sample of publicly traded U.S. firms.

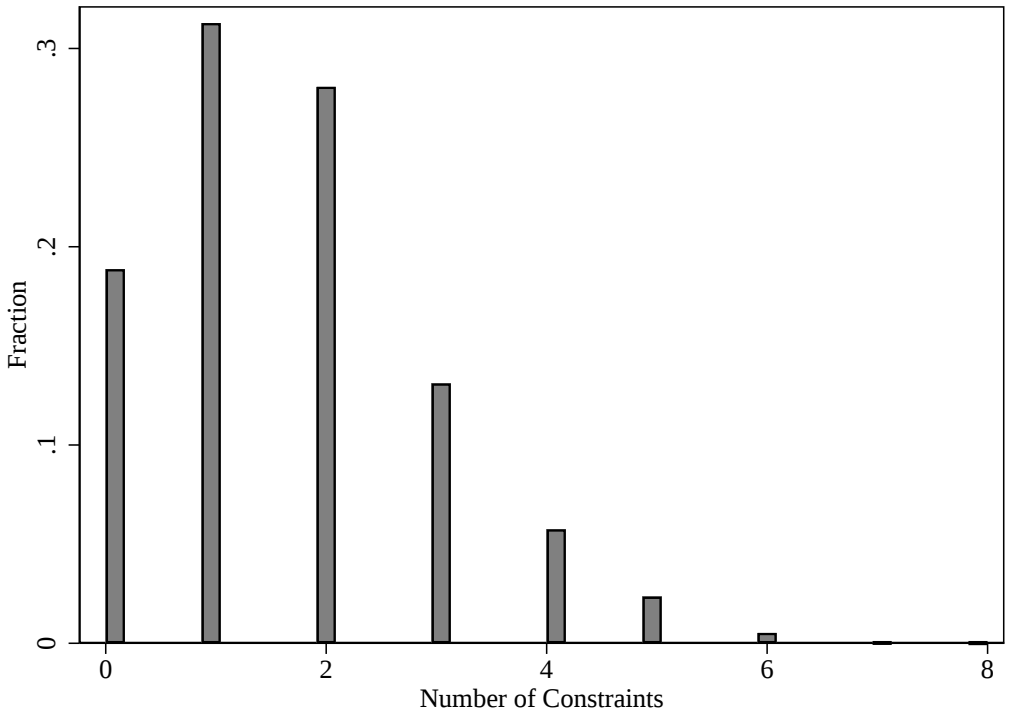


Figure 2: Distribution of the Number of Tight Financial Constraints.

Notes: This chart displays the fraction of firms with a given number of tight financial covenants per firm-quarter observation from 1990 to 2020. A covenant is defined as tight if the firm is within two standard deviations of its binding threshold. Data are sourced from the Compustat and DealScan databases and are based on a sample of publicly traded U.S. firms.



Figure 3: Lease Share and Leverage

Notes: These charts display binscatter plots of firm leverage against the share of leases in 2016. The left panel shows the relationship for the pre-2018 period, while the right panel shows the relationship for the post-2018 period.

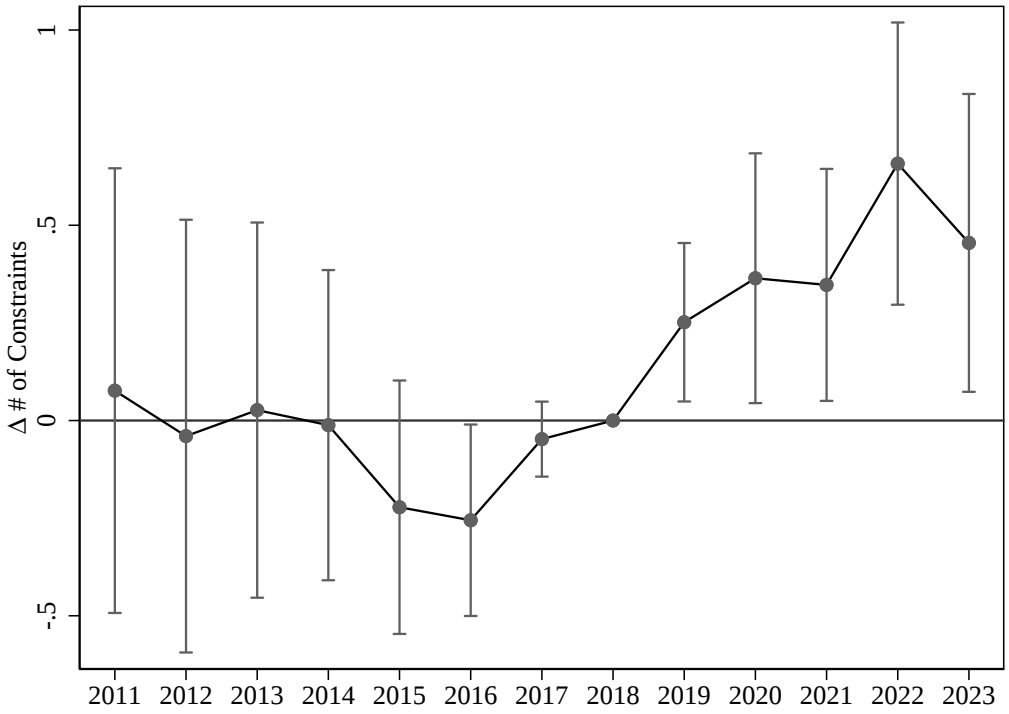


Figure 4: Diff-in-Diff around Lease Treatment Accounting Change.

Notes: This chart presents the estimated impact of lease share on the number of financial constraints using a difference-in-differences approach around the year of the accounting change (2019), based on the following equation:

$$\text{Nr.Constraints}_{i,t} = \beta_0 + \sum_{t \neq 2018} \beta_t(\text{Year}_t \times \text{Lease Share}_{i,2016}) + \alpha_i + \gamma_t + \varepsilon_{i,t}$$

The vertical axis represents the estimated change in financial constraints, and the horizontal axis shows the year. The shaded areas represent 95% confidence intervals. $\text{Nr.Constraints}_{i,t}$ is the number of financial constraints faced by firm i at time t. Year_t are year dummy variables (with 2018 as the omitted base year), and $\text{Lease Share}_{i,2016}$ is the lease share of firm i in 2016. α_i are firm fixed effects, γ_t are time fixed effects, and $\varepsilon_{i,t}$ is the error term. The figure plots the estimated coefficients β_t, which capture the year-specific effect of lease share on financial constraints relative to 2018. Standard errors are double-clustered at the firm and date-quarter levels.

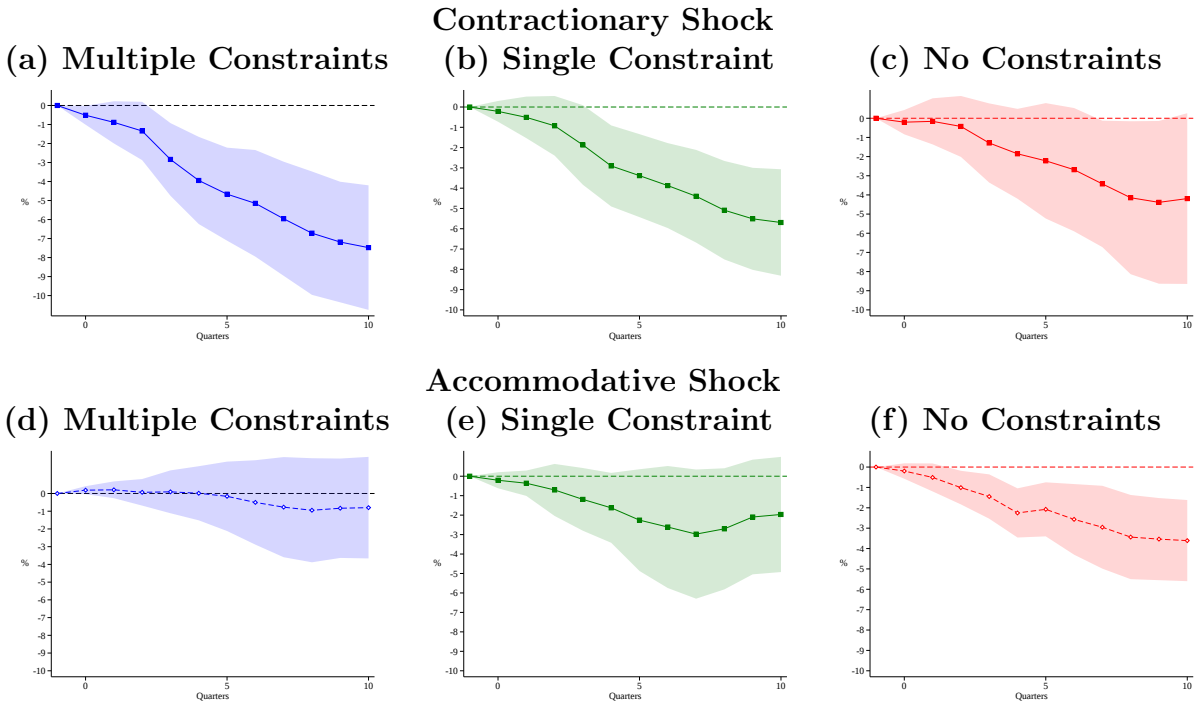


Figure 5: Local Projections: Effect of Tightening and Easing Shocks on External Financing by Constraint Status.

Notes: This figure displays coefficient estimates from the following specification:

$$\begin{aligned}\Delta_h ExFin_{i,t+h} = {} & \beta^h_{c,m}(\text{Contr. MP Shock}_t \times \text{Mult. Constraint}_{i,t}) + \beta^h_{a,m}(\text{Acc. MP Shock}_t \times \text{Mult. Constraint}_{i,t}) \\ & + \beta^h_{c,s}(\text{Contr. MP Shock}_t \times \text{Single Constraint}_{i,t}) + \beta^h_{a,s}(\text{Acc. MP Shock}_t \times \text{Single Constraint}_{i,t}) \\ & + \beta^h_{c,u}(\text{Contr. MP Shock}_t \times \text{Unconstrained}_{i,t}) + \beta^h_{a,u}(\text{Acc. MP Shock}_t \times \text{Unconstrained}_{i,t}) \\ & + \mathbf{X}'_t\gamma + \epsilon_{i,t}\end{aligned}$$

where $\Delta_h ExFin_{i,t+h}$ is the cumulative debt and equity financing flow between the end of quarter $t-1$ and the end of quarter $t+h$, scaled by total assets. *Contr. MP Shock*$_t$ and *Acc. MP Shock*$_t$ denote contractionary and accommodative monetary policy shocks, respectively. The variables *Mult. Constraint*, *Single Constraint*, and *Unconstrained* are dummy variables equal to 1 if the firm in that quarter faces multiple tight constraints, a single tight constraint, or no tight constraints, respectively. Panels (a)–(c) show responses to tightening shocks; Panels (d)–(f) show responses to easing shocks. The monetary surprise in quarter t is constructed by summing the monthly monetary policy shocks from Miranda-Agrippino and Ricco (2021). Shaded areas represent 90% confidence intervals.

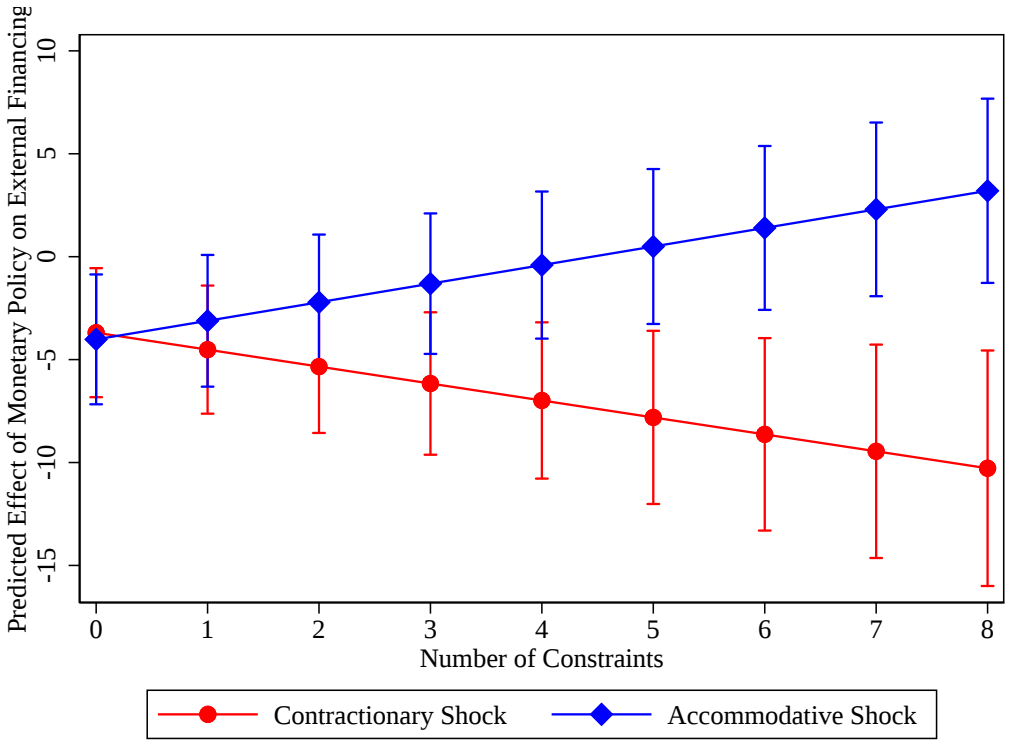


Figure 6: Relationship between Number of Financial Constraints and Responsiveness to Easing and Tightening Shocks.

Notes: This chart plots the marginal effects of a one standard deviation monetary policy shock on the two-year response of external financing, as a function of the number of constraints the firm faces, based on the following equation:

$$\Delta_8 \text{ExFin}_{i,t+7} = \beta_1 \textit{Contr. Shock}_t \times \textit{Nr. Constraints}_{i,t} + \beta_2 \textit{Acc. Shock}_t \times \textit{Nr. Constraints}_{i,t} + \mathbf{X}_t'\gamma + \epsilon_{i,t}$$

where $\Delta_8 \text{ExFin}_{i,t+7}$ denotes the cumulative debt and equity financing flows over seven quarters (two years) following the shock. *Contr. Shock*$_t$ is defined as the Miranda-Agrippino and Ricco (2021) monetary policy shock when positive, and *Acc. Shock*$_t$ is defined as the same shock when negative.

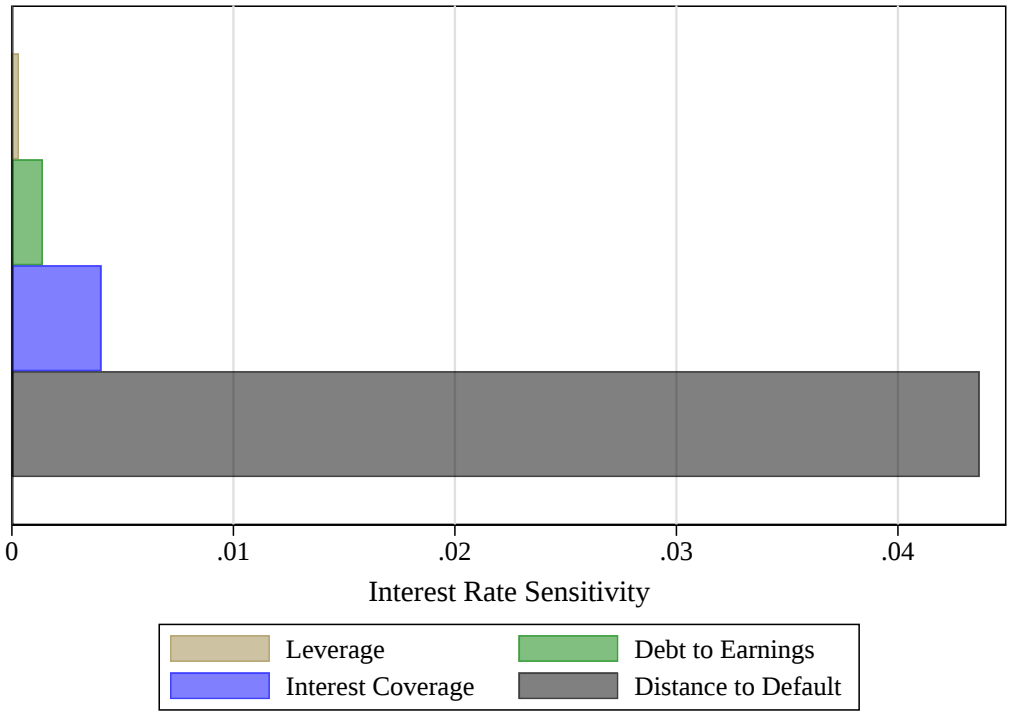


Figure 7: Responsiveness of Financial Constraints to Monetary Policy Shock.

Notes: This chart plots the response of external financing constraint tightness to a one standard deviation monetary policy shock. The estimated equations are:

$$\Delta_h \text{Constraint}^X_{i,t+h} = \beta^h_X \text{MP Shock}_t + \mathbf{X}'_t\gamma + \epsilon_{i,t}$$

where $\text{Constraint}^X_{i,t+h}$ represents one of the following: the current ratio, quick ratio, senior leverage ratio, tangible net worth ratio, leverage ratio, debt-to-equity ratio, debt-to-EBITDA ratio, senior debt-to-EBITDA ratio, cash interest coverage ratio, interest coverage ratio, fixed charge coverage ratio, or the negative of distance to default. *MP Shock*$_t$ is the Miranda-Agrippino and Ricco (2021) monetary policy shock. The estimated sensitivities are averaged over a two-year horizon within the following categories: (i) leverage ratios (current ratio, quick ratio, senior leverage ratio, tangible net worth ratio, leverage ratio, and debt-to-equity ratio), (ii) debt-to-earnings ratios (debt-to-EBITDA ratio and senior debt-to-EBITDA ratio), (iii) interest coverage ratios (cash interest coverage ratio, interest coverage ratio, and fixed charge coverage ratio), and (iv) distance to default (measured as the negative of distance to default).

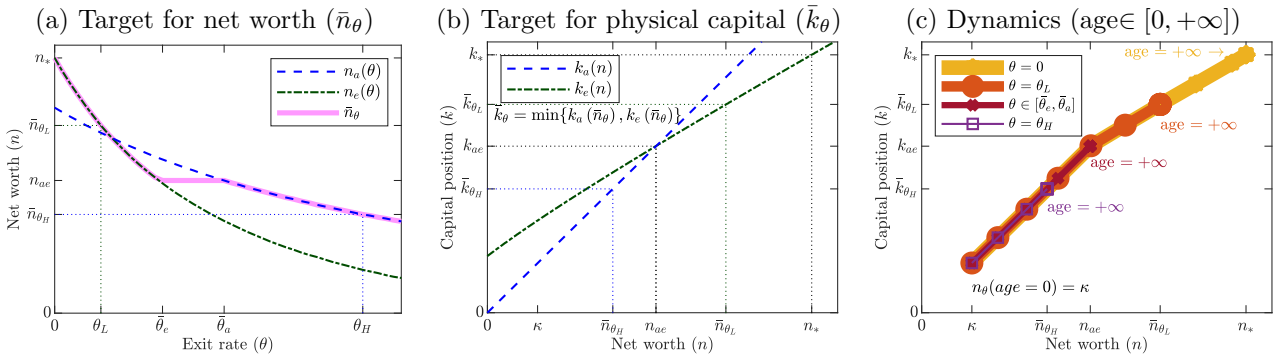


Figure 8: Schematic Representation of Key Targets and of Key Individual Dynamics.

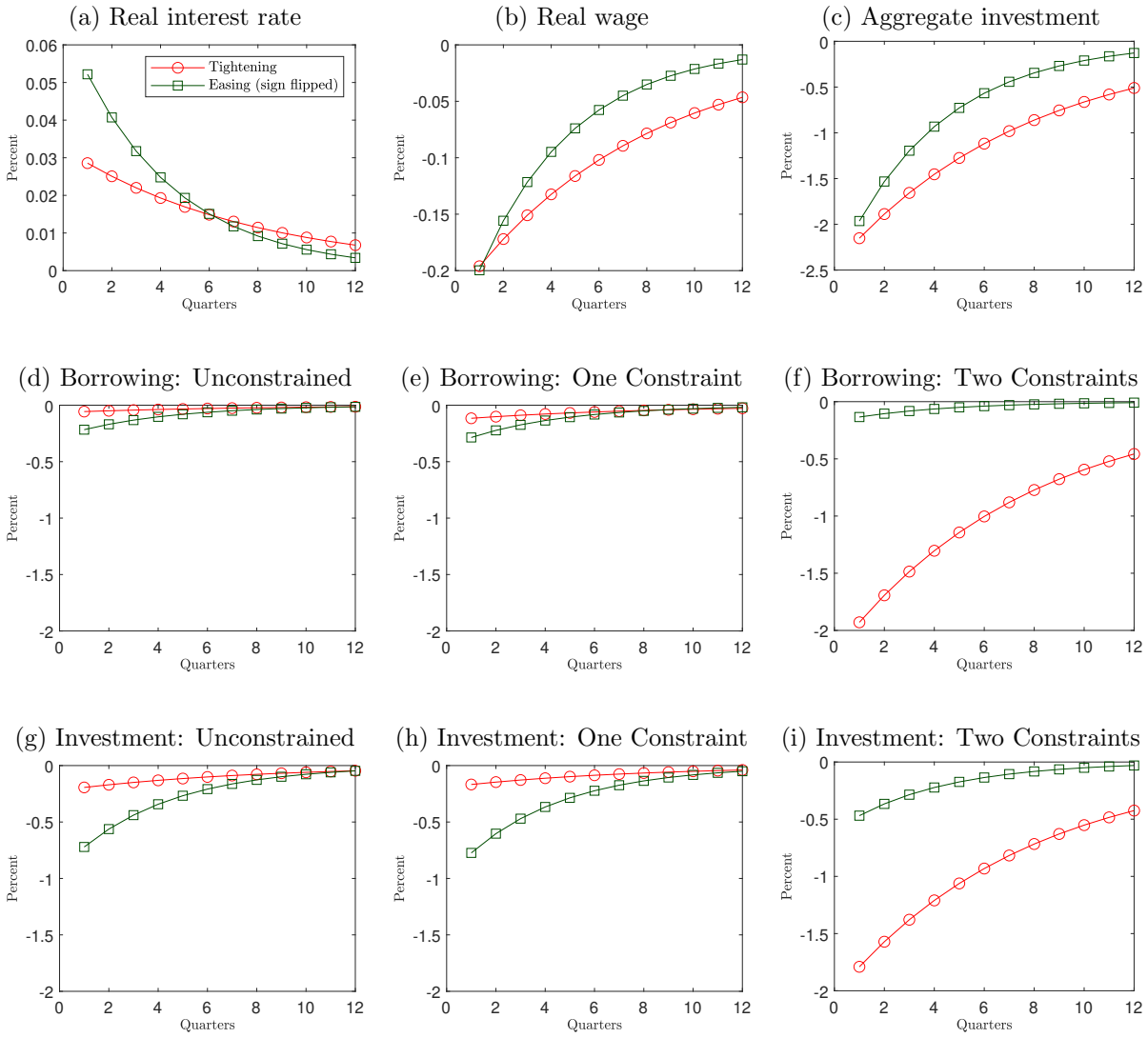


Figure 9: Impulse Responses.

Notes: Impulse responses to a monetary tightening and a monetary easing of 25 basis points. The sign of the responses to the monetary easing is flipped to facilitate comparison between the two cases.

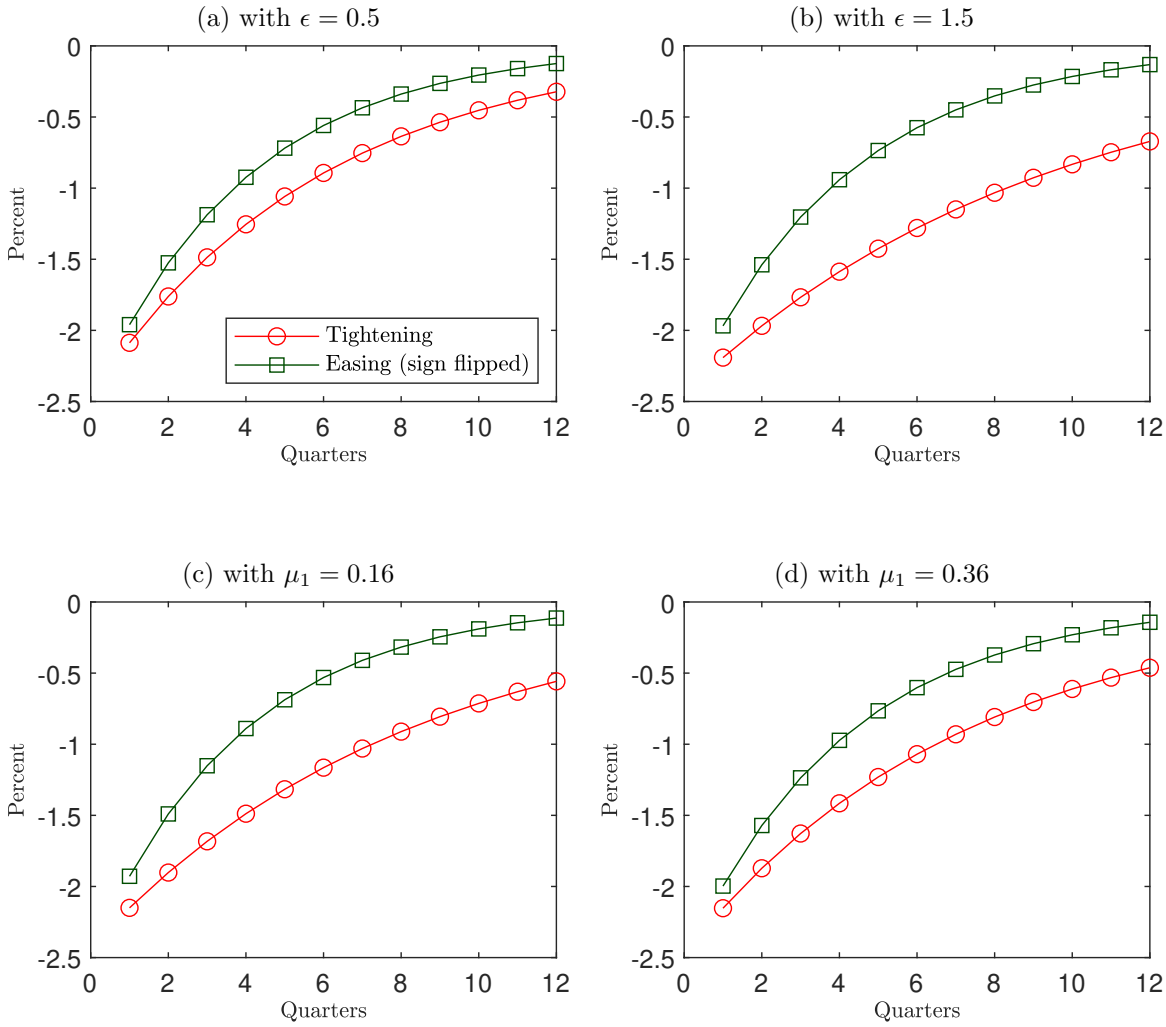


Figure 10: Sensitivity Analysis: Impulse Responses of Aggregate Investment.

Notes: Impulse responses to a monetary tightening and a monetary easing of 25 basis points. The sign of the responses to the monetary easing is flipped to facilitate comparison between the two cases.