

# The Asymmetric Credit Channel of Monetary Policy <sup>\*</sup>

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## Abstract

We show that firm investment and employment respond strongly to contractionary monetary policy but weakly to expansionary policy, and that this pattern can be attributed to an asymmetric credit channel. Financial constraints increase the responsiveness of firms' investment and hiring to contractionary policy surprises but weaken the response to expansionary surprises. Financial constraints tighten and debt flows deteriorate in response to contractionary policy, but barely respond to expansionary policy. We build a model that incorporates earnings-based and collateral constraints to rationalize our findings. The high current share of financially distressed firms in the U.S. suggests that the ongoing tightening cycle might be very effective in reducing investment and employment over time.

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

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*“one cannot push a string. [...], there is very little, if anything that the reserve organization can do toward bringing about recovery”*

Marriner Eccles (1935), Chairman of the Federal Reserve

*“monetary policy had been about as easy as possible yet had produced no tangible benefits to the economy. The attempt to use monetary policy to extricate an economy from a deep depression was often compared to ”pushing on a string.””*

Ben Bernanke (2004), Governor Federal Reserve

*“will require a clearer articulation of the underlying mechanism that leads to such pronounced asymmetries in the relationship between credit spreads and economic activity”*

Jeremy Stein (2014), Governor Federal Reserve

## 1 Introduction

The credit channel is an important transmission mechanism through which monetary policy affects the real economy. An increase in the policy rate reduces borrowers’ net worth and cash flow and results in a deteriorated access to external financing and reduced investment (Bernanke and Gertler, 1995; Kiyotaki and Moore, 1997; Bernanke and Gertler, 1989). Conversely, monetary policy loosening should relax borrowing constraints and increase debt-financed investment. In standard models, the credit channel of monetary policy is assumed to be symmetric: a loosening of policy increases investment to the same extent as a tightening reduces it (Bernanke et al., 1999). As the quotes cited above suggest, policymakers have long suspected, however, that the credit channel of monetary policy is strongly asymmetric, with tightenings having much stronger effects than easings.

In this paper, we explore empirically and theoretically whether the credit channel is asymmetric, and whether it can generate an aggregate asymmetry of the effects of tightening versus easing shocks on economic activity. We show empirically that the credit channel of monetary policy is indeed asymmetric: while financial constraints amplify the negative impact of contractionary policy on debt funding, employment, and investment, financial constraints instead *dampen* the positive effect of accommodative shocks. The stronger response of constrained firms to contractionary shocks combined with the weaker response of constrained firms to accommodative policy generates an aggregate asymmetry of monetary policy, making the aggregate effects of tightening shocks on investment and hiring stronger than those of easing shocks. We build a model with two types of financial constraints, i.e. earnings-based and collateral-based constraints, that can rationalize these findings. While contractionary monetary policy shocks tighten firms’ binding constraints, reducing their borrowing capacity of firms, accommodative shocks do not relax the binding constraint sufficiently to increase firms’ borrowing capacity. In aggregate, our results imply that in the current environment characterized by a high share of financially constrained firms, a restrictive monetary

policy stance may contribute to a marked slowdown in investment and employment. In contrast, a high share of financially constrained firms weakens the expansionary effects of accommodative monetary policy.

Testing for the asymmetric credit channel of monetary policy is challenging, as monetary policy and credit are inextricably interlinked. Monetary policy tends to be expansionary when credit contracts and contractionary when credit expands. We overcome this challenge in several ways. We use monetary policy shocks, measured using the high-frequency event-study approach around monetary policy decisions, and controlling for information about the state of the economy that might be disclosed through the policy action. We then decompose these shocks into those that are contractionary and those that are accommodative. This allows us to differentiate the state-dependent impact of monetary policy from the asymmetric effects, as the policy innovations we use are, by construction, orthogonal to the state of the economy. However, identifying state-independent monetary policy shocks is not sufficient to identify the asymmetric credit channel of monetary policy. Under this channel, the effect of monetary policy is not only stronger when monetary policy tightens, but also when the share of firms that are close to constraints is higher. In contrast to monetary policy, it is more difficult to find exogenous time-series variation in the share of firms that are close to their constraint; in times of recession, the share of firms close to constraints is high and vice versa. To address this empirical challenge, we exploit cross-sectional heterogeneity in firms’ financial constraints and trace their response to monetary policy tightenings and loosening, respectively. We use firms’ distance to default based on [Merton \(1974\)](#) to measure their degree of financial constraints, as firms close to default have been shown to face relatively inelastic debt and equity supply curves and are thus likely constrained ([Farre-Mensa and Ljungqvist, 2016](#)). Exploiting cross-sectional heterogeneity across firms allows us to compare firms in a given industry-time cell with each other and to rule out time-specific characteristics that are correlated with firms’ constraints that could contaminate our results.<sup>1</sup>

We first show that financially constrained firms—proxied by those that are close to default—reduce their investment significantly more, on average, in response to contractionary shocks than their unconstrained counterparts. The opposite is the case for expansionary shocks: firms close to their constraint increase investment by less. More specifically, we find that the capital stock of firms that are constrained—defined as those below the 25<sup>th</sup> percentile of the distance to default distribution—declines, on average, by about 4% two years after a one standard deviation *contractionary* monetary policy shock. We estimate a 3% decline in the capital stock after the same contractionary shock in the unconstrained group of firms, those above the 25<sup>th</sup> percentile of distance to default. In response to *accommodative* monetary policy shocks, investment increases by 3% for unconstrained firms, but remains unchanged for constrained firms. In sum, contractionary shocks “pull” financially constrained firms “with a string”, while expansionary shocks resemble “pushing

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<sup>1</sup>For instance, in times of recessions, more firms are likely financially constrained, and thus the effect of monetary policy on the real economy may not be influenced as much by the share of firms that are financially constrained, but rather because monetary policy is state-dependent.

financially constrained firms with a string”. The fact that firms’ financial constraints strengthen the transmission of monetary policy tightenings and weaken the transmission of monetary policy loosening would generate, *ceteris paribus*, an overall asymmetric effect of monetary policy. A similar pattern as the one found for investment is found for employment.

Our results are able to explain the well-documented asymmetric effects of monetary policy in the macro-econometric literature (Barnichon et al., 2017; Angrist et al., 2018; Debortoli et al., 2020; Jordà et al., 2020; Barnichon et al., 2022). We confirm the asymmetric effects of monetary policy in our data: investment, employment, and net corporate debt issuances respond more to interest rate surprise increases than to decreases. The asymmetric effects of monetary policy can occur for various reasons, which are difficult to disentangle in the time-series data. Our empirical estimates allow us to perform a back-of-the-envelope calculation for the contribution of financial constraints to the aggregate asymmetry. We calculate the degree of the aggregate asymmetry in our data in the partial equilibrium counterfactual scenario under which no firms are financially constrained. Compared to an economy without financial frictions, the effect of a tightening decreases from 3 to 2.5%, and the effect of loosening increases from 1.5% to 2%. Hence, financial frictions can account for  $\frac{3-2.5}{3} = 17\%$  of the tightening and subtract  $\frac{0.5}{2} = 25\%$  of the loosening. In aggregate, contractionary monetary policy shocks are two percentage points stronger than accommodative shocks, of which almost half can be attributed to the role of financial constraints.

For this financial constraint channel to be an important driver of these differential responses of investment, one would expect that firms’ borrowing follows a similar pattern. To assess this, we explore the heterogeneous response of borrowing across firms with a differential degree of ex-ante default probabilities in response to tightening and loosening shocks. The results mirror those of investment: when monetary policy tightens unexpectedly, firms that are ex-ante already close to default strongly reduce their borrowing—suggesting they hit their borrowing constraint—, while the borrowing of safer firms does not respond to contractionary monetary policy. The magnitudes are similar to investment: total debt of firms in distress declines, on average, by about 6% three years after a one standard deviation contractionary monetary policy shock. We again find that, in response to accommodative monetary policy shocks, borrowing does not respond for either distressed or healthy firms. Taken together, these results suggest that tighter monetary policy increases the severity of financial constraints for firms already close to their constraints, preventing them from borrowing to finance their investment.

What is the mechanism underlying the asymmetric credit channel of monetary policy? The underlying assumption of how accommodative monetary policy improves the real economy is that the financial constraints loosen, improving their access to external finance. We test this assumption in the data and explore whether the effect of monetary policy on constraints is asymmetric. We find evidence that contractionary monetary policy shocks tighten firms’ constraints. With a given level of firms close to their constraint, the marginal tightening of constraints pulls firms into a region where they are unable or unwilling to borrow, reducing their debt issuance, employment,

and investment. In contrast, an accommodative monetary policy does not relax firms’ constraints sufficiently. Firms that are being constrained do not get pushed out of this region, enabling them to borrow, invest, and employ. Monetary policy unsuccessfully aims to push these firms with a string out of their constraint region.

To formalize this channel and explore its implications, we introduce a model in which firms have to satisfy both earnings-based and collateral-based financial constraints (EBCs and CBCs, respectively). Consistent with the evidence (Greenwald, 2019; Lian and Ma, 2021), in equilibrium, we obtain that young and small firms face binding CBCs, middle-aged and medium-sized firms face binding EBCs, and old and large firms are financially unconstrained. While EBCs—which limit borrowing to a fraction of the present value of future earnings—are very sensitive to interest rate changes, CBCs—which limit borrowing to a fraction of the present value of capital—are relatively less sensitive. This means that, after an increase in rates, the borrowing capacity under EBCs drops sharply and becomes the binding constraint for many firms. However, after a decrease in rates, the sharp increase in borrowing capacity under EBCs does not benefit firms because the largely unchanged CBC becomes the binding constraint for most financially constrained firms.<sup>2</sup> As a result, the borrowing and investment of financially constrained firms drop sharply after a policy tightening, but do not respond strongly to a policy easing. Financially unconstrained firms, on the other hand, respond similarly to shocks and, if anything, more strongly to easing shocks. Our results carry important aggregate implications. First, the distribution of net worth determines the prevalence of financial constraints and the strength of the asymmetric effects of monetary policy. With a realistic share of firms facing financial constraints, the asymmetric credit channel translates into strong economy-wide asymmetric effects of monetary policy. Second, applying our findings to the current context, the high share of financially constrained firms suggests that the recent policy tightening is likely to be particularly effective in softening economic activity.

The remainder of the paper is structured as follows. Section 2 reviews the literature. Section 3 explains the data we use. Section 4 describes the empirical strategy. Section 5 presents the empirical results. Section 6 introduces and analyzes the theoretical framework. Section 7 concludes.

## 2 Literature Review

Monetary policy tightening shocks tend to transmit more strongly into aggregate spending and employment than easing shocks, as shown in studies using aggregate time series data (Barnichon et al., 2017; Angrist et al., 2018; Debortoli et al., 2020; Jordà et al., 2020; Barnichon et al., 2022).<sup>3</sup> Papers in this literature typically point to two mechanisms to explain this pattern of asymmetry: downward nominal rigidity in prices and wages (Debortoli et al., 2020) and financial factors (Stein,

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<sup>2</sup>Note that this mechanism is very general and does not rely specifically on EBCs being more rate-sensitive than CBCs, but on the two constraints having different sensitivities to rate changes.

<sup>3</sup>Tenreyro and Thwaites (2016) shows that US monetary policy is less powerful in recessions.

2014). Some evidence has been provided on the first mechanism (Debortoli et al., 2020), which turns on the idea that when monetary policy tightens, nominal wages do not adjust downward, leading to large declines in output. Instead, when monetary policy loosens, prices and wages rise, mitigating the changes in output. We consider both mechanisms to be complementary. The focus of this paper is on the second mechanism, and we are the first to study such a mechanism formally.

At the same time, studies exploiting cross-sectional variation in firm-level data show that financial frictions significantly affect firms' response to monetary policy, although these studies do not distinguish between the effects of tightening and easing policy actions (Gertler and Gilchrist, 1994; 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 are distressed, and that this heterogeneity explains the asymmetric effects of monetary policy documented in the macro-econometric literature.

A large empirical literature studies how firms' financial conditions affect their response to monetary policy. Monetary policy rates and credit spreads tend to comove (Gertler and Karadi, 2015; Gilchrist et al., 2015; Caldara and Herbst, 2019), and the comovement is significantly stronger for more financially distressed firms (Anderson and Cesa-Bianchi, 2020; Palazzo and Yamarthy, 2022). The sales, inventory, and debt of small financially distressed firms are more responsive to a monetary policy tightening (Gertler and Gilchrist, 1994; Caglio et al., 2021), perhaps because they have less flexibility to shift toward alternative forms of financing after banks contract their lending supply when monetary policy tightens (Becker and Ivashina, 2014).

The evidence on the role of heterogeneous firm financial conditions on the response of investment is mixed. Some studies show that more financially distressed public firms react less to (expansionary) 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.

The macro-financial literature using firm-level data often uses event-study methodologies around big contractionary credit shocks such as the global financial crisis to trace the impact of financial factors for the employment (Chodorow-Reich, 2014), investment (Almeida et al., 2011), and productivity (Duval et al., 2020). Manaresi and Pierri (2022) show that contractionary firm-level credit availability shocks have negative productivity consequences, but positive credit supply shocks have limited effects. We contribute to this literature by exploiting cross-sectional firm-level variation in financial conditions to assess the role of financial factors in explaining this pattern.

A recent, small literature has focused on the distinction between EBCs and CBCs. Lian and

Ma (2021) find that, in the U.S., EBCs are more prevalent among large, old firms and that EBCs are much more common than CBCs. Similar in spirit to our work, Greenwald (2019) explores how the presence of two different constraints (in his case, two types of EBCs) affect the response of economic activity to monetary policy. His focus is on the state-dependence of the relevance of each constraint and on the impact of this state-dependence for the state-dependence of the effectiveness of monetary policy. Finally, Drechsel (2023) argues that macroeconomic models featuring EBCs deliver dynamics that are empirically more relevant than the ones delivered by models featuring CBCs and that models with EBCs, moreover, generate different conclusions about the relative importance of different shocks in explaining macroeconomic dynamics.

### 3 Data

Our sample consists of U.S. firms covered by Compustat at a quarterly frequency between 1990 and 2021, excluding utilities (Standard Industry Classification (SIC) codes 4900–4949) and financials (SIC codes 6000–6999). We remove observations with negative revenues, missing information on total assets or capital, or a value of total assets under \$10 million in 2012 U.S. dollar value. We winsorize all variables at the 1% level to remove outliers. Firms in the sample are required to be active for at least five years after the monetary policy shock occurs, to cover the length of the horizon of the effects we study and ensure that effects are not driven by firm samples being different at short and long horizons. We refer to investment as the log difference in the capital stock, following Ottonello and Winberry (2020). Employment is not available at a quarterly frequency from Compustat. We use the annual Compustat data and linearly interpolate the employment data to study the effect of quarterly monetary policy shocks on employment.

One of our key firm-level variables is the distance to default, which captures the likelihood of default over the near-term horizon. It is our baseline proxy for financial distress, as it is less likely to be affected by endogeneity concerns (Farre-Mensa and Ljungqvist, 2016). Distance to default is computed using Compustat and CRSP data following the Merton distance to default model, which takes as inputs the firm’s equity valuations and leverage.

Our proxies for monetary policy shocks borrow from the work of Miranda-Agrippino and Ricco (2021) and Jarociński and Karadi (2020). These authors follow a well-established literature that uses high-frequency financial market surprises around key monetary policy announcements to identify unexpected variations in monetary policy. The innovative aspect of their approach is that they can separately identify exogenous monetary policy shocks from shocks about new information from the Federal Reserve regarding the state of the economy. These monetary policy shocks are therefore orthogonal to shocks to firms’ investment opportunities. We compute the monetary surprise by adding up the monthly monetary policy shocks at the quarterly frequency. 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, the [Miranda-Agrippino and Ricco \(2021\)](#) on the run 2-year wide surprises, we have 62 contractionary and 56 accommodative shocks. The average size of the contractionary (accommodative) shock is 5 (6) basis points with a standard deviation of 4 (5) and a maximum of 20 (29). We standardize the monetary policy shocks so that one unit is equal to a one standard deviation shock.

## 4 Empirical Strategy

We provide evidence on how exogenous changes in interest rates, identified with surprise changes in the monetary policy rate, have a different impact on the investment of firms with different degrees of financial constraints. We do so by estimating the path of the cumulative growth rate of the firm-level stock of real capital using the following [Jordà \(2005\)](#) local projection specification as our baseline estimation framework:

$$\begin{aligned} \Delta_h \log K_{i,t+h} = & \underbrace{\beta_1 MP Shock_t}_{\text{Aggregate MP loosening}} + \underbrace{\beta_2 MP Shock_t * Constraint_{i,t}}_{\text{MP loosening constrained}} + \underbrace{\beta_3 MP Shock_t * \mathbb{1}Tightening_t}_{\text{Aggregate Differential Effect of Tightening}} \\ & + \underbrace{\beta_4 Constraint_{i,t} * MP Shock_t * \mathbb{1}Tightening_t}_{\text{Differential Effect of Tightening constrained}} + \mathbf{X}'\gamma + \epsilon_{i,t} \end{aligned} \quad (1)$$

where  $\Delta_h \log K_{i,t+h}$  is the change in the log of the real stock of capital  $K$  between the end of quarter  $t - 1$  and the end of quarter  $t + h$  and  $MP Shock_t$  is the monetary surprise in quarter  $t$ .  $Constraint_{i,t}$  is defined as the proximity to default.  $\mathbb{1}Tightening_t$  is a dummy that is positive if  $MP Shock_t$  is positive and zero otherwise. Our main coefficient of interest is  $\beta_4$ , which measures whether more constrained firms respond differentially to tightening than to a loosening relative to their unconstrained counterparts. A negative coefficient  $\beta_4$  indicates that constrained firms decrease their investment more to a tightening than they increase their investment to a loosening relative to less constrained counterparts. On its own, the coefficient, however, is not indicative of whether constrained firms respond more to tightenings relative to unconstrained firms. It is possible that constrained firms always respond more, both to tightenings and to loosening, but the response to tightenings is stronger than that of loosening.  $\beta_2$  tests whether monetary policy loosening increases investment differentially for constrained relative to less constrained firms.  $\beta_2 > 0$  implies that a monetary policy loosening increases investment less for a more constrained firm. To test whether constrained firms respond more to tightenings relative to unconstrained firms,  $\beta_2 + \beta_4$  needs to be negative. Since all variables are demeaned,  $\beta_1$  is the effect of monetary policy tightening for the average firm. A negative sign of  $\beta_1$  indicates that a monetary policy loosening increases investment.  $\beta_3$  tests whether tightenings have a differential effects than loosening for the average firm. A negative  $\beta_3$  implies that tightenings of monetary policy have a stronger negative effect on



investment than loosening have a positive effect on investment for the average firm. The total effect of monetary policy tightening is therefore given by the sum of  $\beta_1 + \beta_3$  for the average firm.

## 5 Results

### 5.1 Baseline Results

We start by estimating Equation 1 for  $h = 8$  to evaluate the effect of monetary policy two years out. Note that in this equation we are interested in the difference in the response between firms that are more constrained relative to those that are less constrained.  $MP Shock_t$  is the Miranda-Agrippino and Ricco (2021) monetary policy shock, reflecting positive values for contractionary shocks and negative values for accommodative shocks.  $Constrained_{i,t}$  is the demeaned negative value of distance to default, where higher values reflect being more constrained, with a mean of zero.  $Contr_t$  is a dummy that takes the value 1 if the shock is contractionary and 0 if it is accommodative. The vector  $\mathbf{X}$  includes variables such as the uninteracted regressors, double interactions including aggregated controls interacted with constrained as well as various fixed effects, but we vary  $\mathbf{X}$  depending on the specification.

Column (1) reports a specification with only firm fixed effect to control for time-invariant observable and unobservable firm characteristics. The coefficient  $\beta_4$  is our main coefficient of interest. It tests whether, in response to contractionary monetary policy shocks, firms that are more constrained react more relative to less constrained firms, relative to their response to accommodative shocks. In Table 1 we report that this is indeed the case. The remaining coefficients are also of interest. First, given that our measure of  $Constrained_{i,t}$  is demeaned in this specification, the coefficient  $\beta_1$  on  $MP Shock_t$  can be interpreted as the effect of the monetary policy action if it is accommodative. The negative and significant estimate indicates that the effect is negative, meaning that monetary policy easing ( $MP Shock_t < 0$ ) increases investment. The coefficient  $\beta_2$  tests whether easing shocks are transmitted more strongly into higher investment for firms that are more constrained. The positive coefficient suggests this. A more accommodative shock ( $Shock < 0$ ) for firms that are more constrained decreases the response to the easing shock. This finding is consistent with Ottonello and Winberry (2020), who document that financially constrained firms respond less than financially unconstrained firms. The difference between  $\beta_2 < 0$  and the Ottonello and Winberry (2020) result is that, in our context, we only find the stronger response of less constrained firms for accommodative shocks but not for contractionary ones.

The estimate of  $\beta_3$  tests the hypothesis of whether, for the average firm, contractionary shocks have stronger effects than accommodative shocks. The negative interaction coefficient indicates that this hypothesis cannot be rejected. Lastly, and as described above, the triple interaction is negative and statistically significant, indicating that, in response to contractionary shocks, firms that are more constrained respond more, *relative* to their response to accommodative shocks. This

negative coefficient, however, does not indicate whether firms that are riskier respond more strongly than their less constrained counterparts. For this, we need to test whether the sum of  $\beta_2$  and  $\beta_4$  is positive and statistically different from zero. The last row of [Table 1](#) reports the p-value for a t-test for,  $\beta_4 + \beta_2 = 0$  and shows that the hypothesis that the sum is equal to zero can be rejected at the 5% level. Overall, this result shows that firms that are more constrained respond more to monetary policy contractions and less to monetary policy easings.

When making the cross-sectional comparison instead of focusing on the time series component, the inclusion of time-fixed effects is possible. In the previous specification, we could not include time-fixed effects because we estimated the effect of the monetary policy shock on investment separately. Column (2) includes time-fixed effects in the specification to control for time-specific characteristics, such as GDP growth, inflation, and aggregate uncertainty that could bias the result. Column (3) additionally saturates the specification with industry-quarter fixed effect to account for sector-specific cyclicalities. Lastly, column (4) includes *industry*  $\times$  *time* fixed effect, which controls not only for aggregate time series but also for time-variant sector-specific characteristics, such as the average investment in the sector in a given period, and only exploits the heterogeneity across firms with differential degrees of constraints at a given point in time. Note that when including these fixed effects,  $MP\ Shock_t$  and  $MP\ Shock_t \times Contr_t$  are collinear with the fixed effects so that the coefficients cannot be interpreted anymore in columns (2)-(4).

Next, we estimate [Equation 1](#) for every quarter after the monetary policy shock to test for the dynamic effects of monetary policy. [Figure 1 a](#) plots the coefficient of the triple interaction  $\beta_4$ . The coefficient is negative and statistically significant across time. [Figure 1 b](#) plots the coefficient  $\beta_2$ , which is the effect of financial constraints for easing shocks. Instead, the coefficient is positive and significant. These two results show that financial constraints weaken the positive effect of accommodative monetary policy and strengthen the negative effects of monetary policy. [Figure 1 c](#) plots the sum of the two coefficients, which is negative, indicating that for contractionary shocks firms with tighter constraints reduce investment more than firms with looser constraints.

To evaluate the impact for firms that are financially constrained vs. those that are not financially constrained, we use our coefficient estimates of [Equation 1](#) and plug in respective values for the size of the monetary policy shock, a dummy of whether it is a tightening or a loosening shock, and values for financially constrained vs. financially unconstrained firms. We define firms that are financially constrained as those that are at the 75th percentile of the constraint, and those that are financially unconstrained as the 25th percentile of the constraint. We choose a monetary policy shock size of one standard deviation and differentiate between loosening and tightening for financially constrained and financially unconstrained firms, delivering four graphs.

[Figure 2](#) shows a large degree of heterogeneity of their investment response in response to tighter monetary policy across firms that are close and far away from default. Firms that are constrained, see [Figure 2 a](#), reduce their investment in response to a tighter monetary policy stance in a statistically significant way, while firms that are financially unconstrained reduce their investment less,

see [Figure 2 b](#). Economically, a one standard deviation tightening shock is associated with an around 4% lower capital stock after two years for firms that are financially constrained relative to a counterfactual in which monetary policy would not have tightened, while the effect on the capital stock of firms that are financially unconstrained is less than 3%. The bottom panel shows the effect of monetary policy loosening. A one standard deviation monetary policy loosening (a negative shock) increases investment for financially unconstrained firms by around 2%, see [Figure 2 d](#). In contrast, when focusing on the firms that are financially constrained we do not detect a significant impact of monetary policy loosening on investment, see [Figure 2 c](#).

The fact that contractionary shocks lead to a decline in investment for both constrained and unconstrained firms, while a monetary policy loosening only increases investment for financially unconstrained firms, suggests that the overall effect of monetary policy tightenings is stronger than that of monetary policy easings.

In fact, when we plot the response of tightenings and loosening for the average firm, we see that monetary policy tightening shocks have stronger effects on investment in our sample, confirming the earlier results in the literature. [Figure 3](#) displays the estimate of the average dynamic response of investment to a one standard deviation surprise increase in the interest rate across all firms in our sample using the monetary policy shocks obtained from [Miranda-Agrippino and Ricco \(2021\)](#). The left panel reports the effect of contractionary shocks and shows that they generate a strong and statistically significant drop in investment: a one standard-deviation surprise increase in interest rates is associated with a cumulative drop in investment of about 3 percent of the initial capital stock after 2 years. The right panel, instead, reports the effect of expansionary shocks and shows that investment only increases by 1.25% in response to a one standard deviation shock.<sup>4</sup>

How much of the aggregate asymmetry is driven by financial constraints? To make this back-of-the-envelope calculation, we can use [Equation 1](#) and compute a counterfactual response of tightening shocks if all firms were unconstrained and compare the counterfactual to the effect of monetary policy tightenings that we observe in the data. [Figure 4](#) shows the results. For tightening shocks even the financially unconstrained firms (blue bars) reduce investment, but financial constraints add to the negative effect of tightenings on investment (red bars). At 8 quarters the contribution of financial constraints to the aggregate tightening is  $\frac{3-2.5}{3} = 17\%$ . [Figure 4 b](#) shows the same results for loosening. The blue bars show a strong response of investment to loosening shocks. The red bars are positive, implying that financial constraints subtract from the positive effect of loosening monetary policy on investment, as financially constrained firms do not respond much to monetary policy loosening. If there were no financially constrained firms, monetary policy loosening would be  $\frac{0.5}{2} = 25\%$  stronger. [Figure 4 c](#) shows the aggregate asymmetry. With the actual share of constrained firms, the aggregate asymmetry is negative, meaning that overall tightening effects are stronger than the effect of loosening. Since financial constraints weaken the effect of loosening

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<sup>4</sup>In unreported results, we show that this evidence is robust to considering alternative monetary policy shocks such as [Jarociński and Karadi \(2020\)](#)

and strengthen the effect of tightenings, the contribution of financial constraints to the aggregate asymmetry is the sum of the contributions: Financial constraints contribute half to the aggregate asymmetry, while the other half is due to other factors, which could include forces such as downward nominal wage rigidities, as proposed by [Debortoli et al. \(2020\)](#).

## 5.2 Employment

In this subsection, we study the asymmetric effects of monetary policy through financial constraints on employment. [Table 3](#) replicates [Table 1](#) for employment instead of capital. The estimated specification is analogous to [Equation 1](#) and tests formally whether the effect is different between contractionary and accommodative monetary policy shocks for firms that are more constrained. In the first column, we see again that monetary policy accommodation is associated with an increase in employment. The interaction between the shock and the contractionary monetary policy shock dummy tests whether the effect of monetary policy is stronger for contractions than for easings. We can see that accommodative monetary policy shocks are less effective in stimulating employment than contractionary monetary policy shocks are in curtailing employment, shown by  $MP\ Shock \times Tightening < 0$ . Across all columns and consistent with the previous results, this effect becomes even stronger when firms are more constrained. Column (2)-(4) further saturate the specification with additional fixed effects and confirm the result.

Overall, this result suggests that monetary policy, as for investment, monetary policy is successful in reducing the workforce due to the credit channel of monetary policy by tightening firms' constraints. However, monetary policy is less effective in increasing employment with accommodative monetary policy, as financially constrained firms are unable to increase their workforce.

## 5.3 Borrowing

When monetary policy is being loosened unexpectedly, one would expect firms to increase their borrowing due to the lower interest rates and increase their investment.

However, so far, our results suggest that accommodative shocks do not seem to translate into higher investment for firms that are financially constrained. These results suggest that a more accommodative monetary policy stance is unlikely to enable constrained firms to borrow more to invest.

In [Table 2](#) we test this proposition. Firms that are financially constrained reduce their borrowing significantly in response to a surprise tightening of monetary policy. When the monetary policy stance becomes more contractionary, firms that are constrained face a tighter borrowing constraint and are, therefore, unable to keep borrowing. In terms of economic magnitudes, after two years, a one standard deviation tightening shock reduces the debt of firms that are financially constrained by around 5%, while the same shock reduces the debt of firms that are far financially unconstrained by around 2.5%.

## 5.4 Channel

Monetary policy affects access to external financing. Monetary policy loosening is supposed to loosen the financial constraints of firms and make access to finance easier. Contractionary monetary policy tightens financial constraints and reduces access to external financing. To test whether there is an asymmetry between the effect of monetary policy tightenings and loosening in affecting financial constraints, we use our measure of constraints and regress its change on monetary policy easings and tightening shocks, respectively. Figure 5 shows a binned scatter plot between monetary policy shocks and our measure of constraints and a linear fit between those two, allowing for a differential fit between stress and contractionary and accommodative monetary policy shocks. For contractionary monetary policy shocks (right of the vertical dotted line at 0) there is a strong positive relationship between the strength of the tightening shock and to what extent constraints tighten. The linear fit between the size of the shock and the constraint is flat for accommodative shocks. Accommodative monetary policy shocks are ineffective in reducing firms' constraint and hence improve their access to financing.

## 6 Theory

Standard models with a collateral constraint tend to deliver either roughly symmetric responses to policy shocks, even if solved nonlinearly, or ambiguous predictions about the sign and magnitude of any asymmetry. In this section, instead, we introduce two types of constraints, a collateral constraint and an earnings-based constraint in an otherwise standard theoretical framework, and find that our model delivers strong theoretical predictions about the sign of the asymmetry. Intuitively, as the earnings-based constraint is more sensitive to monetary policy than the collateral constraint, contractionary monetary policy tightens the earnings-based constraint and makes it binding, reducing firms' capacity to invest. An accommodative monetary policy shock relaxes the earnings-based constraint, but as the collateral constraint is less sensitive to changes in monetary policy, the collateral constraint becomes binding and prevents firms from expanding the investment.

### 6.1 Environment

Consider a closed economy populated by a standard representative household and a continuum of competitive entrepreneurs of unit size. The household has linear preferences over consumption of an output good, which implies that in a competitive equilibrium, the real interest rate is pin down by her subjective time discount rate. From now on, therefore, we denote the real interest rate by  $r_t \geq 0$ , which is exogenous, but allowed to vary over time  $t \in \mathbb{R}$ .<sup>5</sup>

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<sup>5</sup>Time is continuous and unbounded. From now on, upper dots over variables indicate their differentials with respect to time.

Entrepreneurs operate a production technology with decreasing marginal returns that transforms physical capital into flows of an output good according to

$$y_t = k_t^\alpha, \quad (2)$$

where  $k_t \geq 0$  is physical capital,  $y_t \geq 0$  is the output good, and  $\alpha \in (0, 1)$  indicates the returns of scale of the technology. For the moment, we abstract from adjustment costs on physical capital away, and throughout, for simplicity, we assume an investment technology that instantaneously transforms the output good into physical capital at a unitary return. Thus, letting  $k_{*,t} \geq 0$  denote the unconstrained optimal scale, one gets that the scale is determined as follows

$$\alpha k_{*,t}^{\alpha-1} - \delta = r_t \Leftrightarrow k_{*,t} = \left( \frac{\alpha}{r_t + \delta} \right)^{\frac{1}{1-\alpha}}, \quad (3)$$

where parameter  $\delta \geq 0$  is the depreciation rate of capital. As a remark, note that, everything else fixed, the unconstrained optimal scale is inversely related to real interest rate  $r_t$ .

Entrepreneurs may not operate at the unconstrained optimal scale, nonetheless, because they are subject to financing constraints. We assume both a collateral- and an earnings-based type of constraint. The collateral constraint limits debt  $b_t \geq 0$  by holdings of physical capital according to

$$b_t \leq \lambda k_t, \quad (4)$$

where parameter  $\lambda \in [0, 1]$  is interpreted as the fraction of collateralized capital. The earnings constraint instead does so by the present discounted value of future output flows, according to

$$b_t \leq \gamma \int_t^{+\infty} \exp \left\{ - \int_t^s r_u du \right\} \tilde{y}_s ds, \quad (5)$$

where parameter  $\gamma \in [0, 1]$  is interpreted as the share of pledgeable output, and  $\tilde{y}_s \equiv [e^{-\delta(s-t)} k_t]^\alpha \geq 0$  is the output generated at time  $s \geq t$  given no subsequent adjustment on capital investment  $k_t$ . We assume both constraints must be satisfied to align the incentives of entrepreneurs with those of debt holders. Thus, capital holdings are effectively restricted by

$$k_t \leq \min \left\{ \frac{1}{1-\lambda} n_t, k_{e,t}(n_t) \right\}, \quad (6)$$

where  $n_t \geq 0$  is net worth and  $k_{e,t}(n_t) \geq n_t$  is implicitly determined as follows

$$k_{e,t}(n_t) - \gamma \Lambda_t [k_{e,t}(n_t)]^\alpha = n_t, \quad (7)$$

with  $\Lambda_t \geq 1$  being recursively defined as<sup>6</sup>

$$\dot{\Lambda}_t = -1 + (r_t + \alpha\delta) \Lambda_t . \quad (8)$$

The micro-foundation behind these constraints is as follows. At any time instant, entrepreneurs can declare in bankruptcy and, in principle, walk away with their assets and their license to operate the production technology without repaying their debt. However, if they do so, debt holders can attempt to seize the assets or the license as well as can accept a final renegotiation offered by entrepreneurs to resolve their dispute. If during the renegotiation entrepreneurs do not lock the capital into the technology, the holders can subsequently seize a fraction  $\lambda \in [0, 1]$  of it and sell it in the market. If instead entrepreneurs lock it in, debt holders cannot seize or adjust the capital anymore, but nonetheless can seize the license to operate the technology and subsequently extract a fraction  $\gamma \in [0, 1]$  of the generated output. Upon bankruptcy declaration and the resulting renegotiation process, entrepreneurs will thus only offer the minimum of the two possible values associated with the seizures, which from an ex ante perspective gives rise to effective financing constraint (6).<sup>7</sup>

The constrained optimal capital scale is then given by  $k_{o,t}(n_t) \geq 0$ , with

$$k_{o,t}(n_t) = \min \left\{ \frac{1}{1-\lambda} n_t, k_{e,t}(n_t), k_{*,t} \right\} . \quad (9)$$

Decreasing marginal returns in the production technology implies that there exists a net worth level  $n_{**,t} > 0$ , with

$$n_{**,t} \equiv (1-\lambda) \left( \frac{\gamma \Lambda_t}{\lambda} \right)^{\frac{1}{1-\alpha}} , \quad (10)$$

such that the following holds:

$$k_{e,t}(n) \begin{cases} > \frac{1}{1-\lambda} n & \text{if } n < n_{**,t} \\ = k_{**,t} \equiv \left( \frac{\gamma \Lambda_t}{\lambda} \right)^{\frac{1}{1-\alpha}} & \text{if } n = n_{**,t} \\ < \frac{1}{1-\lambda} n & \text{if } n > n_{**,t} \end{cases} . \quad (11)$$

As shown by [Figure 6](#), then lowly capitalized producers are financially constrained by the collateral-based limit, average capitalized producers are instead constrained by the earnings-based limit, and highly capitalized producers are financially unconstrained. Put differently, small producers (i.e., those with a small scale) are collateral-based constrained, midsize producers are earning-based constrained, and large producers are unconstrained. The distance of the constrained capital holding

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<sup>6</sup>Effective financing constraint (6) follows from combining constraint (4) and constraint (5) with budget constraint  $k_t + b_t = n_t$ . Law of motion (8) follows from differentiating  $\Lambda_t \equiv \int_t^{+\infty} \exp \left\{ - \int_t^s (r_u + \alpha\delta) du \right\} ds$  with respect to time  $t$ .

<sup>7</sup>[Drechsel \(2023\)](#) provides a comprehensive review of the typical micro-foundations used for rationalizing earning-based financing constraints. The micro-foundation in this paper is consistent with the one adopted by [Drechsel \(2023\)](#).



to the unconstrained optimal scale indeed provides a natural measure of the degree of financially constraint.

The capital holdings of entrepreneurs naturally influence the dynamics and the distribution of their net worth. To obtain a competitive equilibrium with both financially constrained and financially unconstrained entrepreneurs, we assume the following dividend payout rule and individual life cycle.

During their lifetime, entrepreneurs distribute dividends to the household, only when they expect the marginal return on their net worth not to exceed a given excess return  $\phi \geq 0$  over the interest rate going forward. Formally, entrepreneurs stop accumulating net worth and start distributing dividends when their net worth reaches level  $n_{\phi,t} > 0$ , with

$$n_{\phi,t} \equiv \min \left\{ n \geq 0 : \left[ \alpha [k_{c,s}(n)]^{\alpha-1} - (\delta + r_s) \right] k'_{c,s}(n) \leq \phi \ \forall s \geq t \right\}. \quad (12)$$

As an example, if  $\phi = 0$  and  $r_t = r$  is constant, then  $n_{\phi,t} = n_*$  is determined by

$$\min \left\{ \frac{1}{1-\lambda} n_*, k_e(n_*) \right\} = k_* , \quad (13)$$

since in this case, as shown by [Figure 6](#), entrepreneurs cannot anymore accrue positive excess returns once they attain the unconstrained optimal scale. Parameter  $\phi$  is interpreted as an additional excess return tied to an outside and off-balance sheet investment opportunity in parallel available to entrepreneurs. For convenience, we assume there are two types of entrepreneurs, one with  $\phi = 0$  and the other one with a positive  $\phi > 0$  such that

$$\phi \in \left[ \frac{\frac{\alpha\lambda}{\gamma\Lambda} - (\delta + r)}{1 - \alpha\lambda}, \frac{\frac{\alpha\lambda}{\gamma\Lambda} - (\delta + r)}{1 - \lambda} \right], \quad (14)$$

where  $\Lambda = 1/(r + \alpha\delta)$  and  $r \geq 0$  is the interest rate in steady state (i.e., the stationary competitive equilibrium). Condition (14) states that in steady state—as well as around neighborhood of it—entrepreneurs with high-return outside opportunities stop accumulating net worth once their collateral-based constraint becomes slack and their earnings-based constraint becomes binding. Formally, at point  $n = n_{**}$ . At that juncture, their marginal excess return on net worth falls in a discrete manner, as shown by [Figure 6](#), since the earnings-based constraint reduces leverage on the marginal unit of net worth by more than what the collateral-based constraint does. In what follows, we parameterize the population share of entrepreneurs with low-return outside opportunities with  $\beta \in (0, 1)$ .<sup>8</sup>

Regarding the life cycle, we assume entrepreneurs retire stochastically, according to an idiosyn-

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<sup>8</sup>Condition (14) is derived by evaluating marginal excess return  $\left[ \alpha [k_c(n)]^{\alpha-1} - (\delta + r) \right] k'_c(n)$  at  $n = \underline{n}$ . The interval in the condition has positive length because  $k'_c(n)$  is discontinuous at that point. To derive  $k'_c(\underline{n}^+)$  we apply the Implicit Function Theorem on (7).

cratic Poisson process with common arrival rate  $\theta > 0$ . Retired entrepreneurs transfer their net worth to the household and immediately afterward are replaced by identical newcomers who receive a share  $\varphi \in (0, 1)$  of their aggregate capital stock as initial endowment. At any time instant, therefore, the population density of entrepreneurs who started at time instant  $s \leq t$  is  $p_{s,t} \in (0, 1)$ , with

$$p_{s,t} = \theta e^{-\theta(t-s)} , \quad (15)$$

and the initial endowment of each of those entrepreneurs was  $n_{s,s} = \varphi K_s$ , where  $K_t \geq 0$  is the aggregate capital stock.

A competitive equilibrium is a path for the aggregate capital stock such that given the path of the interest rate the market for physical capital clears at every instant. The equilibrium is formally characterized by the following condition:

$$K_t = \int_{-\infty}^t \theta e^{-\theta(t-s)} [\beta k_{c,t}(n_{L,s,t}) + (1 - \beta) k_{c,t}(n_{H,s,t})] ds , \quad (16)$$

where the RHS on (16) is the aggregate demand of physical capital, and where net worth  $n_{j,s,t} \geq 0$  evolved over  $u \in [s, t]$  according to

$$\dot{n}_{j,s,u} = \begin{cases} [k_{c,u}(n_{j,s,u})]^\alpha - (\delta + r_u) k_{c,u}(n_{j,s,u}) + r_u n_{j,s,u} & \text{if } n_{j,s,u} < \bar{n}_{j,u} \\ 0 & \text{if } n_{j,s,u} = \bar{n}_{j,u} \end{cases} , \quad (17)$$

with initial condition  $n_{j,s,s} = \varphi K_s$ , boundary condition  $n_{j,s,u} = \bar{n}_{j,u}$ , and with subscript  $j \in \{L, H\}$  respectively denoting the type of entrepreneur with low- and high-return outside opportunity.

## 6.2 Steady State

Before studying impulse responses to shocks to the interest rate, we illustrate the dynamics and the distribution of net worth by considering a stationary economy with a constant interest rate,  $r_t = r$ . Put simply, the steady state. As it is common practice, in this subsection, we omit time subscript  $t$ .

In steady state, the aggregate capital stock satisfies

$$K = \int k_c(n) [\beta \Phi_L(n) + (1 - \beta) \Phi_H(n)] dn , \quad (18)$$

where  $\Phi_j(n) \geq 0$  is the aggregate distribution of net worth across entrepreneurs with outside opportunity of type  $j$ . These distributions can be computed by simulating the evolution of net worth according to the following law of motion:

$$\dot{n} = [k_c(n)]^\alpha - (\delta + r) k_c(n) + rn , \quad (19)$$

with initial condition  $n_0 = \varphi K$  and boundary conditions  $n_{\infty,L} = \bar{n}$  and  $n_{\infty,H} = \underline{n}$ . The density mass for each net worth  $n_s \in [\varphi K, n_{\infty,j})$  is  $p_s = \theta e^{-\theta s}$  where  $s \geq 0$  indicates the age required to reach each level. The cumulative mass of boundary net worth  $n = n_{\infty,j}$  is  $1 - \int_0^{s_j} \theta e^{-\theta s} ds$  where  $s_j \equiv \min\{s \geq 0 : n_s = n_{\infty,j}\}$ . To guarantee  $k_c(\varphi k_*) < k_*$ , and hence also the existence of financially constrained entrepreneurs in steady state, we impose the following condition:

$$\varphi < \min \left\{ 1 - \lambda, \max \left\{ 1 - \frac{r + \delta}{r + \alpha \delta} \frac{\gamma}{\alpha}, 0 \right\} \right\}. \quad (20)$$

**Figure 7** displays the aggregate distribution of the net worth in steady state. This distribution features positive cumulative mass at points  $n = n_{**}$  and  $n = n_*$  which implies that a large share of entrepreneurs operates at scale  $k = k_{**}$  (i.e., the scale consistent with the intersection between the two constraints) and at the unconstrained optimal scale.<sup>9</sup> The distribution is naturally shaped by the dynamics of individual net worth. These dynamics can be summarized as follows.

A starting entrepreneur initially accumulates net worth relatively fast because both her marginal return on capital investments and her leverage are relatively high and because she does not distribute dividends. The entrepreneur continues accumulating net worth and growing her production scale at a relatively fast pace until she reaches the net worth level at which the collateral- and earnings-based constraints intersect. At that juncture, if the entrepreneur has a high return on outside opportunities, she distributes dividends and stops accumulating net worth and growing her scale. By contrast, if she has a low return, the entrepreneur continues behaving as before reaching the juncture, with the key difference that from that point on, she accumulates net worth and grows her scale relatively slow because both her marginal return on capital investments and her leverage are relatively low. This entrepreneur continues with that behavior until eventually she attains the unconstrained optimal scale, at which point she cannot obtain a higher marginal return than in credit markets, and thus starts distributing dividends and stops accumulating net worth. Regardless of the stage in these dynamics, the entrepreneur retires when it is hit by the Poisson shock, at which point a newcomer re-starts them.

### 6.3 Asymmetric Responses to Shocks to the Interest Rate

We are now ready to study impulse responses to shocks to the interest rate. To do so, we consider a stationary economy that initially is in steady state, until at time  $t_0$ , it is hit by an unanticipated shock to the interest rate. After the shock the interest rate evolves deterministically according to the following  $AR(1)$  process for its deviation from steady state:

$$\dot{r}_t = -\rho(r_t - r) + \varepsilon_t, \text{ for } t \geq t_0, \quad (21)$$

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<sup>9</sup>The former of these two results is indeed robust to a distribution of marginal returns on outside opportunities continuous over interval (14).

where parameter  $1/\rho > 0$  indicates the persistence of shock  $\varepsilon_{t_0} \neq 0$ , and where  $\varepsilon_t = 0 \forall t > t_0$ . We consider both a negative and a positive shock of equal size. These shocks are set sufficiently small not to induce entrepreneurs with high-return outside opportunities to continue accumulating net worth at point  $n = n_{**,t}$ .

On impact, the change in the interest rate only affects the unconstrained optimal scale and the maximum possible scale consistent with the earnings-based constraint. That is,  $k_{*,t}$  and  $k_{e,t}(n_t)$ . Both scales inversely respond to the change in the rate, but in general, if the shock is transitory, the unconstrained optimal scale responds by more, because that scale only depends on the contemporaneous interest rate whereas the other one depends on the entire future path of the interest rate—as shown by formula (3) and (7). Over the subsequent dynamics, the distribution of net worth and the aggregate capital stock do respond to the change in the interest rate. Those two objects are affected with some delay by the previously chosen capital holdings. Moreover, the distribution of net worth is also affected by the capital stock itself (since it determines the initial endowment of newcomers) and by the change on funding costs.

Figure 8 displays impulse responses of capital holdings both at the entrepreneur and the aggregate level for both the negative and the positive shock. On impact, collateral-based constrained entrepreneurs do not respond to either shock while both earnings-based constrained and financially unconstrained entrepreneurs tend to respond more aggressively to the positive (i.e., an increase in the interest rate) than to the negative shock (a decline in the rate). Those earnings-based constrained with net worth around  $n = n_{**}$  tend to respond in such a manner because their collateral-based constraint becomes binding when the interest rate falls whereas their earnings-based constraint remains the binding one when the interest rate increases. Those earnings-based constrained with net worth around  $n = n_*$  and the financially unconstrained entrepreneurs do so instead because only when the interest rate falls the earnings-based constraint prevents them from attaining the new unconstrained optimal scale. Note that none entrepreneur has idle borrowing capacity in steady state and that financing constraints do not impose limits in borrowing reductions. Over the subsequent dynamics, these asymmetries naturally shape the more aggressive response of the aggregate capital stock to the increase in the interest rate.

Perhaps the behavior of the impulse responses not so consistent with the patterns empirically documented is the relatively large decline in the capital holdings of financially unconstrained entrepreneurs following the increase in the interest rate. In the model such a pronounced decline occurs mainly because of a lack of adjustment costs on physical capital. Below we incorporate those costs into model and report the revised impulse responses.

## 7 Conclusion

In this paper, we have shown empirical support for the hypothesis that financial frictions in nonfinancial firms are important to explain why the magnitude of the response of investment to monetary

policy tightening shocks is stronger than the response to easing shocks.

Our results carry an important policy implication, which is that the effectiveness of monetary policy depends on the aggregate distribution of financial conditions in nonfinancial firms. A contractionary monetary policy action might have stronger effects on investment in an environment of poor credit quality and tight financial conditions for nonfinancial firms. However, the effectiveness of expansionary monetary policy does not seem to depend as much on firm financial conditions.

In the current context, as since the beginning of 2022, more firms have moved closer to default, the results in the paper would imply that the potency of the recent interest rate increases by the Federal Reserve has increased.

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**Table 1: Differential Capital Response of Tightening Shocks for Constrained Firms to Tightening and Loosening Monetary Policy Shocks**

	$Log(Capital)_{t+8} - Log(Capital)_{t-1}$			
	(1)	(2)	(3)	(4)
MP. Shock	-1.221*** (0.140)			
MP. Shock $\times$ Constrained	0.322*** (0.036)	0.273*** (0.040)	0.265*** (0.039)	0.228*** (0.039)
MP. Shock $\times$ Tightening.	-1.933*** (0.298)			
MP. Shock $\times$ Constrained. $\times$ Tightening	-0.528*** (0.061)	-0.519*** (0.067)	-0.496*** (0.066)	-0.450*** (0.066)
R-squared	0.341	0.377	0.374	0.388
N	242,653	245,261	242,653	242,653
Firm FE	✓	✓	✓	✓
Time FE		✓	✓	
Industry-Time FE				✓
Industry-Quarter FE	✓		✓	
p: $\beta$ [Shock $\times$ Tighten] + $\beta$ [Shock $\times$ Const. $\times$ Tighten]=0	.00001	.000002	.000004	.00001

This table displays the coefficient from the following estimated equation:

$$\begin{aligned}
\Delta_9 Log(K)_{i,t+8} = & \underbrace{\beta_1 MP Shock_t}_{\text{Aggregate MP loosening}} + \underbrace{\beta_2 MP Shock_t * Constraint_{i,t}}_{\text{MP loosening constrained}} + \underbrace{\beta_3 MP Shock_t * 1Tightening_t}_{\text{Aggregate Differential Effect of Tightening}} \\
& + \underbrace{\beta_4 Constraint_{i,t} * MP Shock_t * 1Tightening_t}_{\text{Differential Effect of Tightening constrained}} + \mathbf{X}'\gamma + \epsilon_{i,t}
\end{aligned}$$

where  $\Delta_9 Log(K)_{i,t+8}$  is the difference in log capital between 2 years after the shock and the quarter before the shock.  $Constraint_{i,t} * MP Shock_t * 1Tightening_t$  is the interaction between the proximity of default, based on the negative value of distance to default,  $Constraint_{i,t}$ , the [Miranda-Agrippino and Ricco \(2021\)](#) monetary policy shock  $MP Shock_t$ , and a dummy that is one if the shock is contractionary and zero if it is accommodative,  $1Tightening_t$ .  $\mathbf{X}$  includes controls and fixed effects and vary by column. The p-value displays the p-value for a t-test for  $\beta_4 + \beta_2 = 0$ . Standard errors are in parentheses. Standard errors are clustered at the firm level. The symbols \*, \*\*, and \*\*\* indicate significance at 10%, 5%, and 1% levels, respectively.

**Table 2: Differential Debt Response of Tightening Shocks for Constrained Firms to Tightening and Loosening Monetary Policy Shocks**

	$Log(Debt)_{t+8} - Log(Debt)_{t-1}$			
	(1)	(2)	(3)	(4)
MP. Shock	-3.202*** (0.376)			
MP. Shock $\times$ Constrained	0.549*** (0.110)	0.451*** (0.120)	0.453*** (0.120)	0.423*** (0.122)
MP. Shock $\times$ Tightening	-0.302 (0.726)			
MP. Shock $\times$ Constrained $\times$ Tightening	-0.571*** (0.212)	-0.478** (0.230)	-0.447* (0.231)	-0.413* (0.234)
R-squared	0.294	0.314	0.313	0.318
N	214,804	216,701	214,804	214,804
Firm FE	✓	✓	✓	✓
Time FE		✓	✓	
Industry-Time FE				✓
Industry-Quarter FE	✓		✓	
p: $\beta$ [Shock $\times$ Tighten] + $\beta$ [Shock $\times$ Const. $\times$ Tighten]=0	.89228	.87972	.97407	.95706

This table displays the coefficient from the following estimated equation:

$$\begin{aligned}
\Delta_9 Log(Debt)_{i,t+8} = & \underbrace{\beta_1 MP Shock_t}_{\text{Aggregate MP loosening}} + \underbrace{\beta_2 MP Shock_t * Constraint_{i,t}}_{\text{MP loosening constrained}} + \underbrace{\beta_3 MP Shock_t * \mathbb{1}Tightening_t}_{\text{Aggregate Differential Effect of Tightening}} \\
& + \underbrace{\beta_4 Constraint_{i,t} * MP Shock_t * \mathbb{1}Tightening_t}_{\text{Differential Effect of Tightening constrained}} + \mathbf{X}'\gamma + \epsilon_{i,t}
\end{aligned}$$

where  $\Delta_9 Log(Debt)_{i,t+8}$  is the difference in log debt between 2 years after the shock and the quarter before the shock.  $Constraint_{i,t} * MP Shock_t * \mathbb{1}Tightening_t$  is the interaction between the proximity of default, based on the negative value of distance to default,  $Constraint_{i,t}$ , the [Miranda-Agrippino and Ricco \(2021\)](#) monetary policy shock  $MP Shock_t$ , and a dummy that is one if the shock is contractionary and zero if it is accommodative,  $\mathbb{1}Tightening_t$ .  $\mathbf{X}$  includes controls and fixed effects and vary by column. The p-value displays the p-value for a t-test for  $\beta_4 + \beta_2 = 0$ . Standard errors are in parentheses. Standard errors are clustered at the firm level. The symbols \*, \*\*, and \*\*\* indicate significance at 10%, 5%, and 1% levels, respectively.

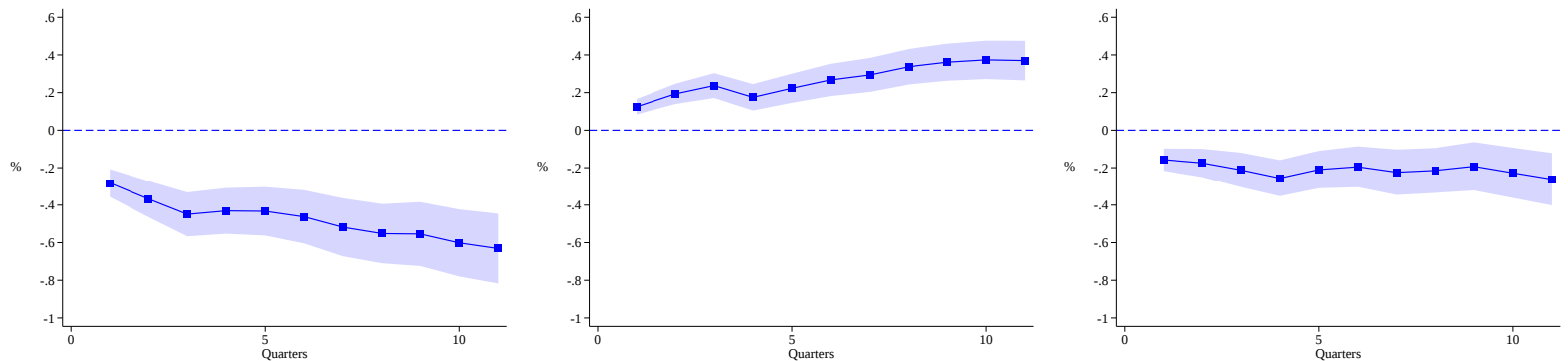
**Table 3: Differential Employment Response of Tightening Shocks for Firms further away from Default**

	$Log(Emp)_{t+8} - Log(Emp)_{t-1}$			
	(1)	(2)	(3)	(4)
MP. Shock	-1.007*** (0.096)			
MP. Shock $\times$ Constrained	0.253*** (0.024)	0.163*** (0.026)	0.160*** (0.025)	0.141*** (0.025)
MP. Shock $\times$ Tightening	-0.867*** (0.216)			
MP. Shock $\times$ Constrained $\times$ Tightening	-0.419*** (0.043)	-0.319*** (0.047)	-0.310*** (0.047)	-0.274*** (0.047)
R-squared	0.363	0.404	0.403	0.413
N	233,270	235,790	233,270	233,267
Firm FE	✓	✓	✓	✓
Time FE		✓	✓	
Industry-Time FE				✓
Industry-Quarter FE	✓		✓	
p: $\beta$ [Shock $\times$ Tighten] + $\beta$ [Shock $\times$ Const. $\times$ Tighten]=0	.000012	.00002	.00004	.00036

This table displays the coefficient from the following estimated equation:

$$\begin{aligned}
\Delta_9 Log(Emp)_{i,t+8} = & \underbrace{\beta_1 MP Shock_t}_{\text{Aggregate MP loosening}} + \underbrace{\beta_2 MP Shock_t * Constraint_{i,t}}_{\text{MP loosening constrained}} + \underbrace{\beta_3 MP Shock_t * 1Tightening_t}_{\text{Aggregate Differential Effect of Tightening}} \\
& + \underbrace{\beta_4 Constraint_{i,t} * MP Shock_t * 1Tightening_t}_{\text{Differential Effect of Tightening constrained}} + \mathbf{X}'\gamma + \epsilon_{i,t}
\end{aligned}$$

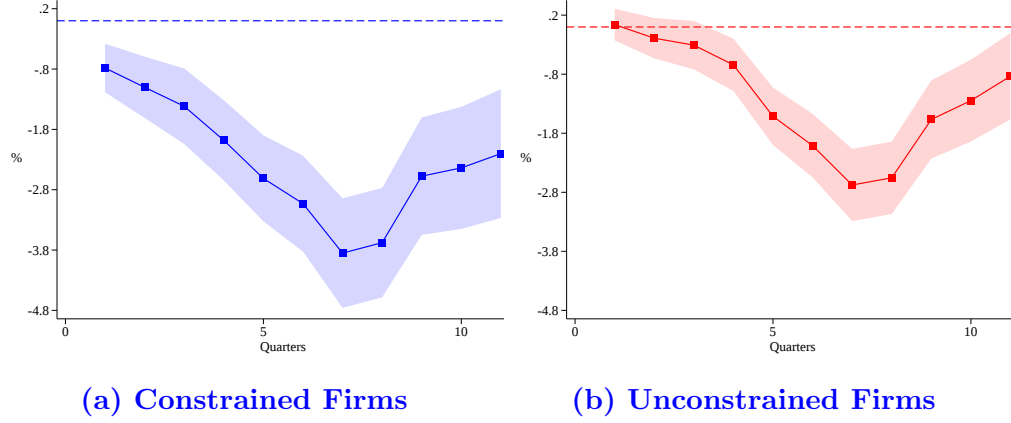
where  $\Delta_9 Log(Emp)_{i,t+8}$  is the difference in log employment between 2 years after the shock and the quarter before the shock.  $Constraint_{i,t} \times MP Shock_t * 1Tightening_t$  is the interaction between the proximity of default, based on the negative value of distance to default,  $Constraint_{i,t}$ , the [Miranda-Agrippino and Ricco \(2021\)](#) monetary policy shock  $MP Shock_t$ , and a dummy that is one if the shock is contractionary and zero if it is accommodative,  $1Tightening_t$ ,  $\mathbf{X}$  includes controls and fixed effects and vary by column. The p-value displays the p-value for a t-test for  $\beta_4 + \beta_2 = 0$ . Standard errors are in parentheses. Standard errors are clustered at the firm level. The symbols \*, \*\*, and \*\*\* indicate significance at 10%, 5%, and 1% levels, respectively.



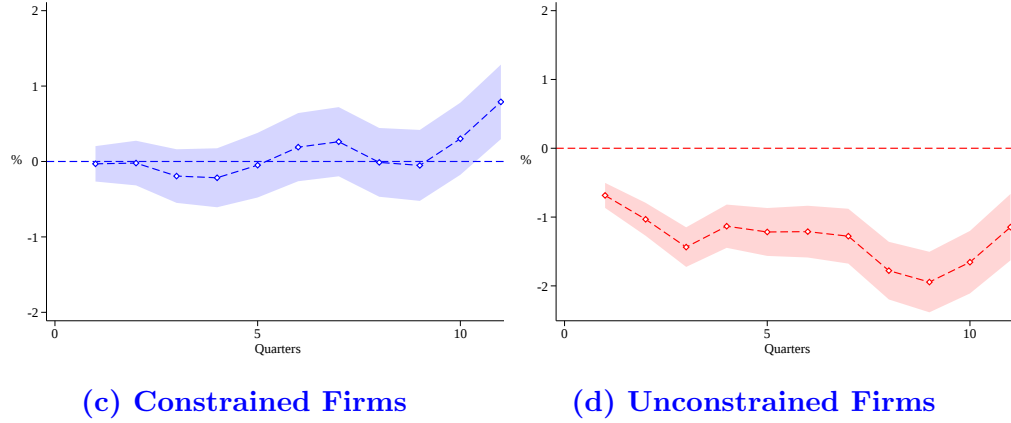
(a) Differential Effect of Constraint (b) Effect of Constraint for Loosening (c) Effect of Constraint for Tightening

**Figure 1: Local Projections: Differential Effects of Constraints to Tightening and Easing Shocks.** The charts display the coefficient estimate measuring the differential effect of constraints to monetary policy tightening or easing shock. Panel (a) shows the coefficient of the triple interaction, measuring the differential effect of constraints for tightening shocks relative to loosening shocks. Panel (b) plots the double interaction measuring the effect of constraints for easing shocks. Panel (c) plots the sum of the double and triple interaction measuring the effect of constraints for tightening shocks. The dependent variable is the difference between the log of total capital in period  $t+h$  and in period  $t-1$ . The monetary surprise in quarter  $t$  is calculated by adding up the monthly monetary policy shocks obtained from [Miranda-Agrippino and Ricco \(2021\)](#). Shaded areas represent the 99% confidence intervals of the estimates.

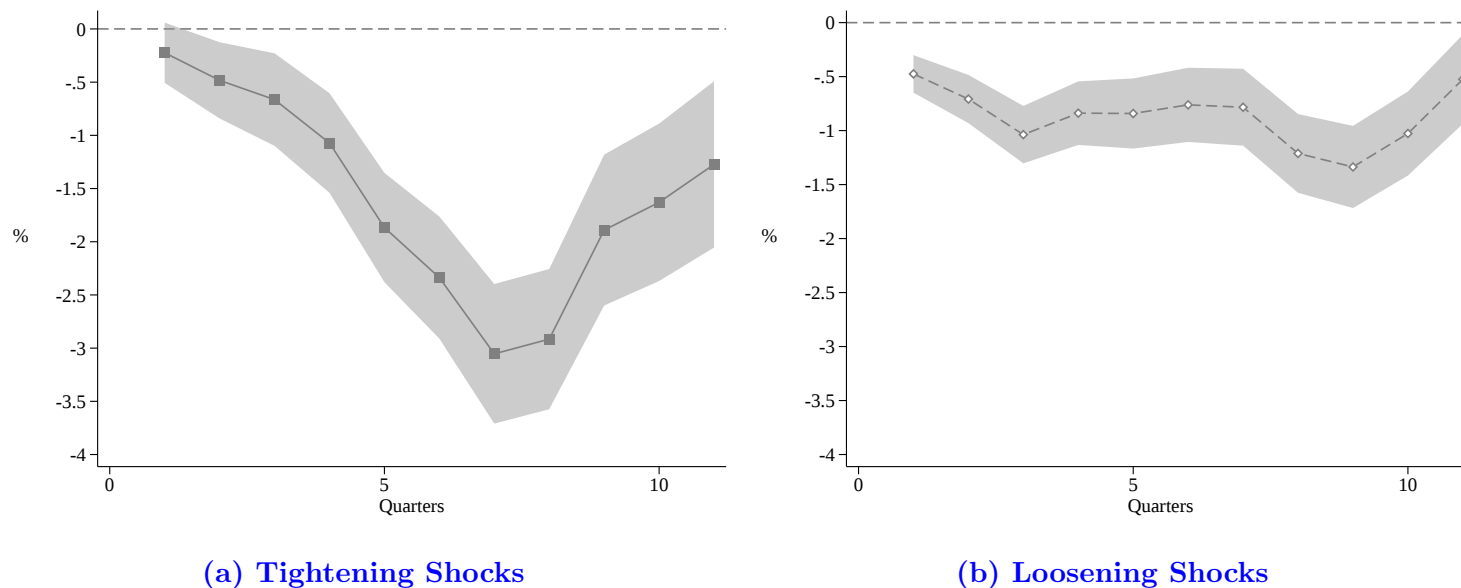
## Tightening Shocks



## Loosening Shocks

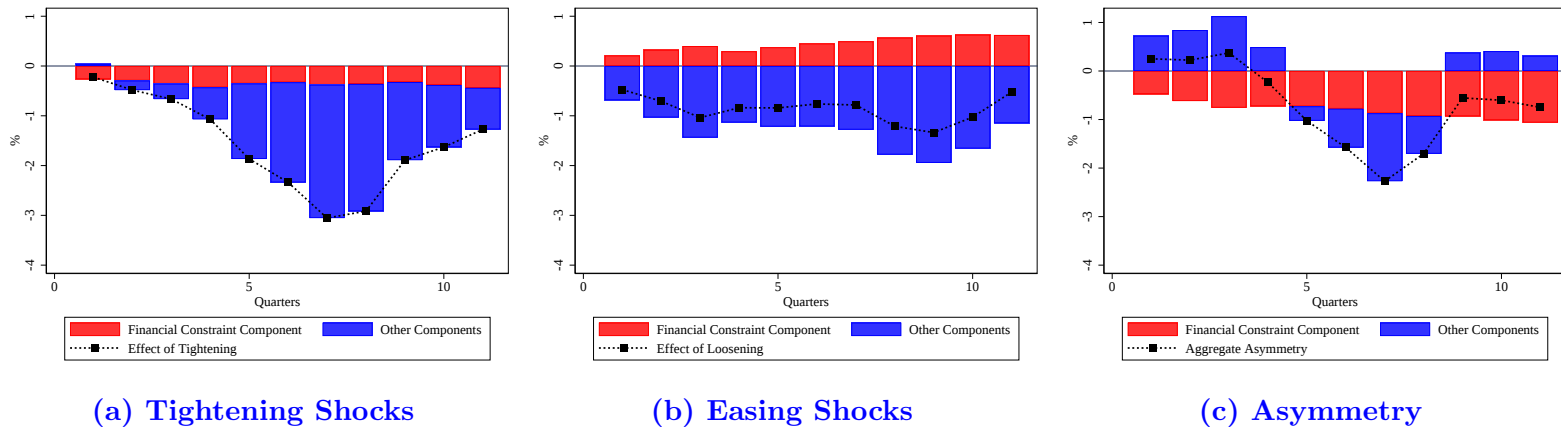


**Figure 2: Local Projections: Response of Investment to Tightening and Easing Shocks by Constraint.** The charts display the estimate of the dynamic response of investment to a one standard deviation monetary policy tightening or easing shock, respectively. Constrained firms are those at the 75th percentile of the constraint, while unconstrained firms are those at the 25th percentile of the constraint. The upper panels show the effect of contractionary shocks while the lower panels report the effect of accommodative shocks. The dependent variable is the difference between the log of total capital in period  $t+h$  and in period  $t-1$ . The monetary surprise in quarter  $t$  is calculated by adding up the monthly monetary policy shocks obtained from [Miranda-Agrippino and Ricco \(2021\)](#). Shaded areas represent the 99% confidence intervals of the estimates.

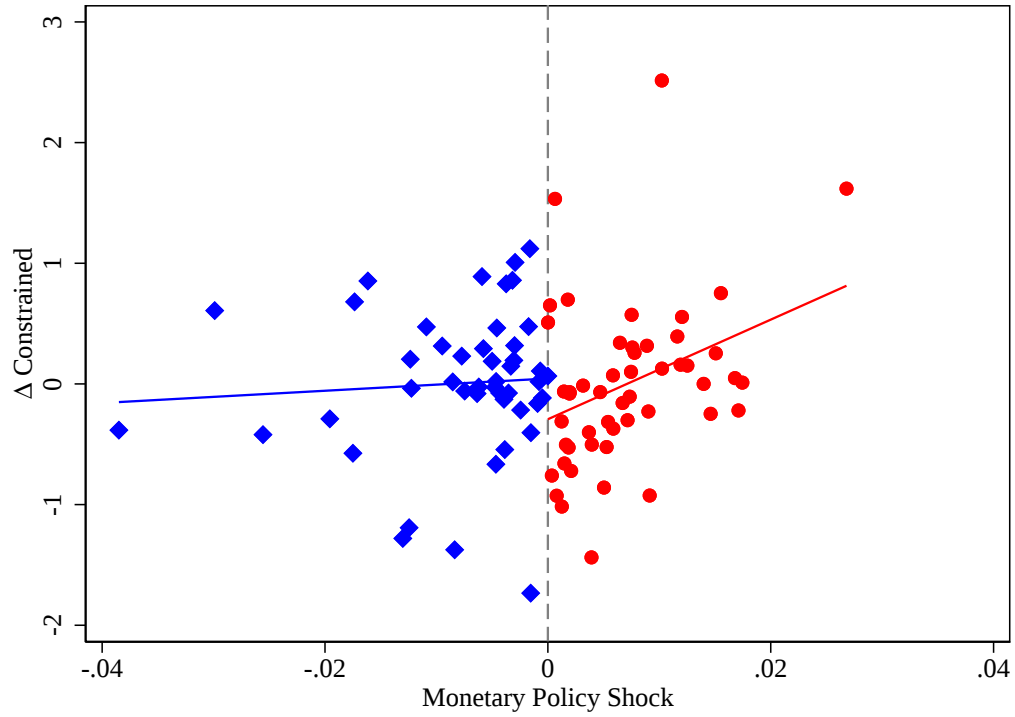


**Figure 3: Local Projections: Average Response of Investment to Tightening and Easing Shocks.** The charts display the estimate of the dynamic response of investment to a one standard deviation monetary policy tightening or easing shock, respectively. The left panel shows the effect of contractionary shocks while the right panel reports the effect of accommodative shocks. The dependent variable is the difference between the log of total capital in period  $t+h$  and in period  $t-1$ . The monetary surprise in quarter  $t$  is calculated by adding up the monthly monetary policy shocks obtained from [Miranda-Agrippino and Ricco \(2021\)](#). Shaded areas represent the 99% confidence intervals of the estimates.

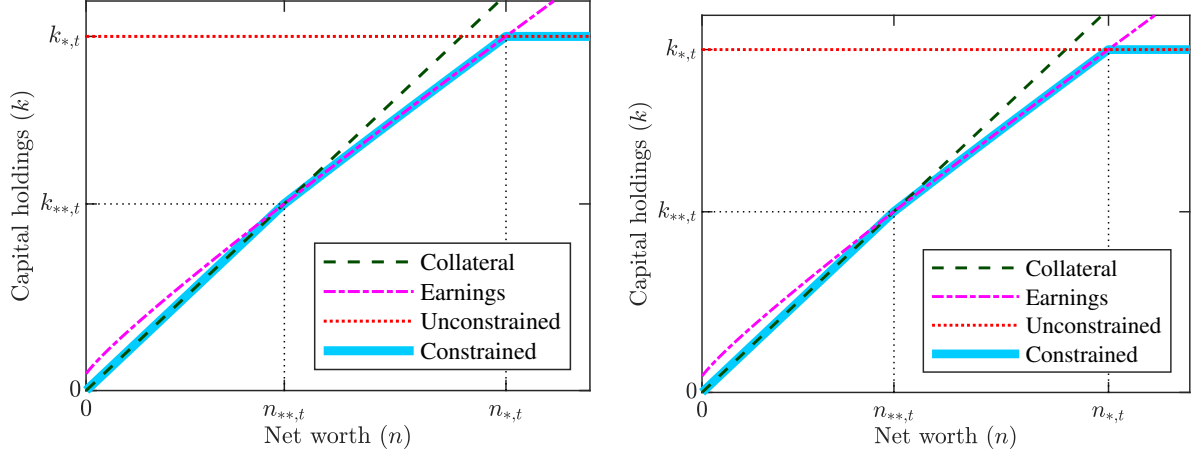




**Figure 4: Local Projections: Decomposition Asymmetry.** The charts display the decomposition of the effect of financial constraints and other factors to monetary policy. The black line shows the tightening shock (a), easing (b), and the asymmetric average effect (c). The red bars show the contribution of financial constraints to the respective average effect. The blue bars show the contribution of other factors to the effects. The dependent variable is the difference between the log of total capital in period  $t+h$  and in period  $t-1$ . The monetary surprise in quarter  $t$  is calculated by adding up the monthly monetary policy shocks obtained from [Miranda-Agrippino and Ricco \(2021\)](#). Shaded areas represent the 99% confidence intervals of the estimates.

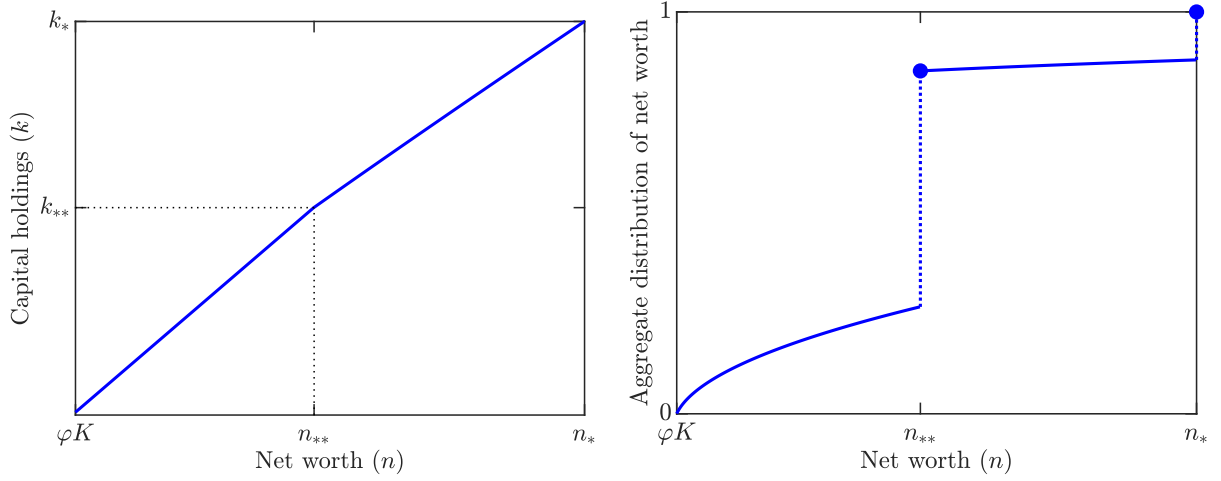


**Figure 5: Response of Financial Constraints to Tightening and Easing Shocks.** The charts display the change in the financial constraint on the vertical axis and the monetary policy shock on the horizontal axis. Positive shocks reflect contractionary monetary policy shocks and negative shocks reflect accommodative monetary policy shocks. The monetary surprise in quarter  $t$ , is calculated by adding up the monthly monetary policy shocks obtained from [Miranda-Agrippino and Ricco \(2021\)](#).



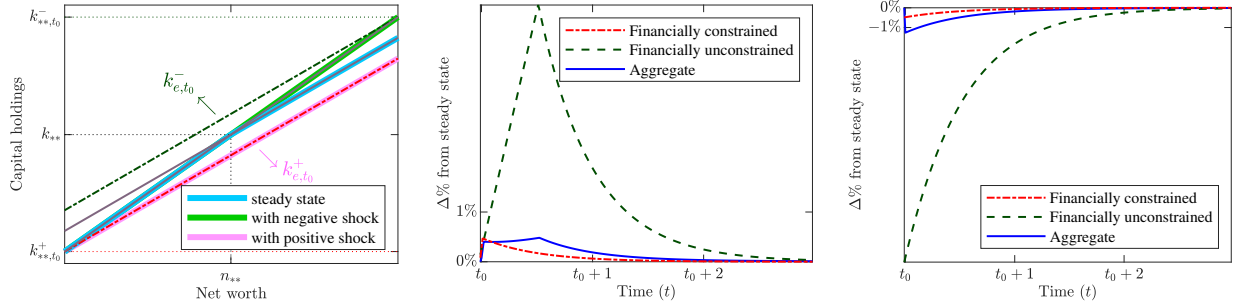
**Figure 6: Holdings of physical capital & Marginal excess return on net worth.**

**Notes:** Parameter values:  $r = 0.02$ ,  $\alpha = 0.5$ ,  $\delta = 0.05$ ,  $\theta = 0.04$ ,  $\lambda = 0.3$ ,  $\gamma = 0.07$ ,  $\varphi = 0.01$ ,  $\beta = 0.2$ .



**Figure 7: Holdings of physical capital & Aggregate distribution of net worth.**

**Notes:** Parameter values:  $r = 0.02$ ,  $\alpha = 0.5$ ,  $\delta = 0.05$ ,  $\theta = 0.04$ ,  $\lambda = 0.3$ ,  $\gamma = 0.07$ ,  $\varphi = 0.01$ ,  $\beta = 0.2$ .



**Figure 8: Impulse responses to shocks to the interest rate.**

**Notes:** The figure in the left panel displays the responses to both a negative and a positive shock to the interest rate for entrepreneurs with net worth levels around the region in which the two financing constraints intersect in steady state. The figure in the middle panel plots the responses over time to a negative shock for financially constrained and financially unconstrained entrepreneurs and for entrepreneurs as a whole. The figure in the right panel plots the same as the middle figure but with respect to a positive shock. Parameter values:  $r = 0.02$ ,  $\alpha = 0.5$ ,  $\delta = 0.05$ ,  $\theta = 0.04$ ,  $\lambda = 0.3$ ,  $\gamma = 0.07$ ,  $\varphi = 0.01$ ,  $\beta = 0.05$ ,  $\rho = 2$ ,  $|\varepsilon| = 0.005$ .