Over the Hills and Far Away: Macroprudential Policy and Firm Foreign Exchange Exposure

Drishan Banerjee*

[click here for latest draft]

November 2026

Abstract

Macroprudential policy that shores up the domestic financial system may leave firms more exposed to external risk. I document this trade-off using balance sheet data for Indian non-financial firms. When macroprudential measures tighten the supply of domestic credit, bank-dependent firms face sharp credit rationing and substitute toward external borrowing in foreign currency. This exposes firms to exchange rate fluctuations. Firms that hold more foreign currency debt suffer larger losses, lower profits and a higher likelihood of distress when the rupee depreciates. I build a two-sector model in which firms can replace bank loans with foreign currency debt. The model captures the trade-off between greater resilience of domestic banks and greater fragility of firms due to currency mismatch on their balance sheets, and is used to quantify the welfare consequences of macroprudential regulations and derive their optimal stringency. Calibrated to India, the welfare-maximizing capital requirement is close to 7.6%. The results highlight the importance of considering cross-market and currency substitution when designing macroprudential policy in emerging economies.

Keywords: Macroprudential Policy, Foreign Currency Debt, Bank Capital Requirements

JEL Codes: E44, F34, G28, G32

*UC Santa Cruz. drbanerj@ucsc.edu. I am grateful to Galina Hale, Alonso Villacorta, Kenneth Kletzer, Joel Flynn and Pascal Michaillat for valuable suggestions. All errors are mine.

1 Introduction

Macroprudential policy aims to reduce systemic risk by strengthening the financial system. The Global Financial Crisis led to a wider use of these policies and renewed interest in their effects (Brunnermeier et al. 2009, Hanson et al. 2011). These tools are now widely regarded as essential instruments for central banks and financial regulators seeking to contain systemic risk.[1] Yet, policies that strengthen banks may not leave the firms that borrow from it equally protected. When regulation restricts domestic bank credit, firms may turn to foreign lenders and borrow in foreign currency. This shifts risk from banks to firms and exposes their balance sheets to exchange rate shocks. This possibility has so far received limited direct attention and has not been closely analyzed in the academic or policy literature. This paper examines whether such substitution takes place, and what it implies for the appropriate stance of macroprudential policy.

Most macroprudential instruments, especially in emerging economies, operate through lenders rather than borrowers. These instruments change the ability of domestic banks to supply credit without directly regulating firms (Cerutti et al. 2017, Yang and Suh 2023). By restricting bank lending, these measures can limit credit growth, reduce the cost of a downturn and reinforce the overall stability of the financial system. But firms may respond by borrowing abroad. Since foreign borrowing is often denominated in foreign currency, a depreciation of the domestic currency raises debt-servicing costs and increases the risk of default.[2] If these defaults cause losses for domestic banks, the policy may create a source of systemic risk even as it strengthens bank balance sheets (Niepmann and Schmidt-Eisenlohr 2022, Kim et al. 2015, Bruno and Shin 2020, Alfaro et al. 2019). Thus, the stability gained by the banking system is in part traded for fragility on the corporate side.

Against this background, the paper asks two questions. First, does macroprudential tightening that restricts bank credit lead firms that depend on banks to substitute toward foreign-currency debt, and does this exposure increase their vulnerability to

[1] Mendoza (2016). See Galati and Moessner (2013) for a comprehensive survey.

[2] Many emerging economies find it difficult to borrow abroad in their own currency, a pattern Eichengreen et al. (2007) call original sin. Many countries with sound fundamentals still suffer from it and it is governed mainly by country size and the structure of global portfolios where international borrowing is concentrated in a few major currencies (Eichengreen et al. 2007, Hausmann and Panizza 2003). Several middle-income countries have since built local-currency government bond markets but original sin persists and the currency mismatch has shifted within these economies rather than disappeared (Eichengreen et al. 2023). For firms, foreign borrowing remains mostly in foreign currency and greater reliance on it by the corporate sector raises country risk (Du and Schreger 2022).

currency depreciation? Second, how should a regulator set capital requirements to balance the gains from a more resilient financial system against the costs of greater firm fragility?

India provides a useful setting to study this trade-off. It is one of the most active users of macroprudential policy, second only to China in the number of actions taken, and almost all its measures are lender-based. Since banks are the main source of credit for firms, regulations that constrain bank lending can affect firms' access to finance. Indian firms can turn to foreign lenders, but this borrowing is largely denominated in foreign currency. About two-thirds of the firms in my sample with foreign-currency debt owe more in foreign currency than they earn from exports in a year. They therefore have limited natural hedges against exchange rate risk. Hedging through currency derivatives is also costly and constrained by market liquidity (Patnaik et al. 2015, Goel et al. 2025).

I proceed in three steps. First, I use firm-level data from India to test whether firms that depend more on domestic banks shift toward foreign-currency borrowing when macroprudential policy tightens. Second, I examine whether foreign-currency exposure increases firm losses and distress when the rupee depreciates. Third, I build a model of firms and banks that incorporates this substitution channel and use it to determine the welfare-maximising capital requirement. I then calibrate the model to India and compare the implied requirement with the one in place.

For the empirical analysis, I use firm-level balance sheet data for Indian non-financial firms from the Center for Monitoring the Indian Economy's (CMIE) Prowess database together with the macroprudential policy stance measured by the Macroprudential Policy Index (Alam et al. 2019). The analysis begins in 2013, when the implementation of Basel III started to raise capital requirements on bank lending as a whole. Before Basel III took effect in April 2013, India's macroprudential actions were aimed at commercial real estate, and lending against shares and household retail loans, rather than at bank lending to corporations.[3] Also, capital requirement on bank lending had not changed in over a decade. Basel III was the first time the cost of bank lending to firms began to rise. A firm's exposure to bank-specific macroprudential policy depends on how much it relies on bank credit to begin with. Hence, I exploit differences in firms'

[3] Basel III is the set of international standards for bank regulation agreed by the Basel Committee on Banking Supervision after the 2008 crisis. It raised the amount and quality of capital banks must hold, added capital buffers, surcharges on systemically important banks and a leverage ratio, and introduced liquidity standards. The standards are not binding by themselves: each country writes them into its own regulation, as the RBI did from 2013. They set the framework for most of the lender-based macroprudential tools now in use.

initial dependence on bank credit to identify their responses to policy tightening.

The empirical analysis shows that with macroprudential tightening, firms that rely more on domestic banks reduce the share of bank borrowing and increase the share of foreign-currency debt. Their total borrowing remains largely unchanged. The results suggest that firms replace the credit they lose from domestic banks rather than reduce their borrowing. This extends the literature on credit substitution, which has looked at firms substituting across sources of credit rather than scaling back when bank lending contracts (Adrian et al. 2013, Becker and Ivashina 2014, Crouzet 2018). However, this literature has focused on substitution within domestic markets, from bank loans to corporate bonds in advanced economies and says little about substitution into foreign-currency debt. In emerging economies, the shift toward foreign-currency debt matters because it changes the currency composition of firms' liabilities and exposes them to exchange rate risk.

I show that firms with more foreign-currency debt relative to assets incur higher foreign exchange losses when the Indian rupee depreciates and also experience lower profitability and return on assets. They are also more likely to have operating earnings below their interest expenses. For a firm with 10 percentage points more foreign-currency debt relative to assets, a 10 percent depreciation raises foreign exchange losses by about 0.19 percentage points of assets. It also reduces operating profitability and return on assets by close to one percentage point and raises the probability of distress. Taken together, these results link macroprudential tightening to firm fragility through two channels: tightening raises firms' foreign currency exposure, and that exposure turns into losses and distress when the currency depreciates.

Having established this stylized fact, I analyze its consequences for financial stability and for optimal capital requirement. I build a two-period small open economy model of firms and banks. Firms borrow from domestic banks and foreign lenders, while banks lend to firms and finance themselves through deposits. A higher capital requirement raises the cost of domestic credit and induces firms to substitute toward foreign-currency debt. This makes firms more vulnerable when the domestic currency depreciates. If these firms default, domestic banks incur losses on the loans that remain on their balance sheets. The risk created by foreign borrowing therefore feeds back into the banking system that macroprudential policy seeks to protect. This feedback is particularly relevant for emerging market economies, where firms often borrow abroad in foreign currency.[4] At the same time, higher capital requirements leave banks well

[4] Although Latin American and Asian emerging markets launched initiatives to develop local cur-

capitalized and better equipped to withstand a downturn and continue lending at a cheaper price when firms need credit to recover. Hence the downturn is less severe. The benefit of the macroprudential policy is best described as a reallocation of credit across states rather than an increase in it. The policy thus has two opposing effects: it increases firms' exposure to exchange rate risk in normal times by withholding domestic intermediation capacity and it returns the capacity in a crisis when the net worth of both banks and firms have been eroded and firms need credit to recover. The optimal requirement balances these costs and benefits.

The model also captures why banks may hold less capital than is socially optimal. An individual bank has an incentive to lend more in normal times rather than hold capital that could support lending during a future crisis. When a crisis hits, capital is scarce and the banks that still have it can lend at high rates, so no single bank gains from the lower borrowing costs that higher capital across the entire banking system would bring to firms. It does not fully account for the benefits that higher capital across the entire banking system creates for firms when a crisis occurs. A regulator can address this externality by requiring banks to hold capital that they would not choose to hold on their own. But a higher requirement also raises the cost of domestic credit and pushes firms toward foreign-currency borrowing. For the optimal stance of macroprudential policy, the regulator must therefore weigh the gains from credit supplied during a crisis against the loss of credit and the increase in firm fragility during normal times.

The calibration to India shows that the welfare-maximising capital requirement is slightly below the Reserve Bank of India's minimum. The model reproduces the substitution toward foreign-currency debt that is found in the data and also the increase in firm distress when the rupee depreciates. As the capital requirement rises, banks become better able to supply credit after a crisis, but firms become more exposed to exchange rate risk. A requirement above about 3 percent is enough to keep banks solvent in every state, while banks left to their own decisions hold capital of about 5.6 percent. However, preventing bank failure does not by itself maximise welfare. The gains from higher capital continue because banks can supply credit when firms need it most. They stop when these gains are offset by the cost of reduced domestic credit and the fragility created by firms' foreign-currency borrowing. The welfare-maximising

rency sovereign bond markets to address the currency and maturity mismatches of the 1990s, firms however, still borrow abroad largely in foreign currency. Non-financial corporations in emerging Asia and Latin America sharply increased their international debt issuance after 2009, most of it in US dollars and often through overseas subsidiaries (Chui et al. 2014, Bruno and Shin 2017, Du and Schreger 2022)

requirement is about 7.6 percent, compared to the RBI's minimum requirement of 9 percent, which still delivers about three quarters of the welfare gain. A regulator who ignores the shift into foreign currency debt would set the requirement at 12.5 percent, almost 5 percentage points too high.

This paper makes three contributions. First, it brings firm-level evidence to the study of leakage from macroprudential policy. Existing studies show that tighter regulation of domestic banks can shift credit toward foreign lenders or non-bank financial institutions. [5] These studies focus on lenders or aggregate credit and do not trace how firms respond to the change in credit supply. Additionally, leakage is usually seen as a concern when the aim is to slow credit growth, but less so when the aim is a safer banking system, since banks hold more capital either way (Reinhardt and Sowerbutts 2015). I contribute to this literature by showing that the source of replacement credit matters even for the second aim: when firms substitute toward foreign-currency borrowing, the resulting exchange rate risk can feed back into domestic banks through firm defaults.

Second, I show that bank regulation with no currency dimension can still create foreign currency exposure. The closest evidence studies regulations aimed at currency exposure itself. Ahnert et al. (2021) study regulations that directly target bank's foreign currency lending and funding. In contrast, I show that restrictions on domestic bank credit can increase firms' foreign-currency exposure by inducing them to borrow abroad.[6] This identifies domestic regulation as a source of foreign-currency borrowing, which is usually traced to forces outside a country's control.[7] In India, Acharya and Vij (2020) show that firms borrow more abroad when the dollar carry trade is profitable, a pull from global markets. This paper complements their study by showing that domestic macroprudential regulations can act as a push factor.

Third, I incorporate this substitution channel into a model of optimal capital requirements. The model builds on the financial accelerator of Bernanke et al. (1999) and on Villacorta (2018), in which both firms and banks are financially constrained and banks need net worth to lend because their loans carry aggregate risk. Existing mod-

[5] Foreign bank branches in the United Kingdom made up about a third of the drop in lending that followed higher capital requirements on domestic banks (Aiyar et al. 2014). Borrowing from foreign banks rises after capital and reserve requirements tighten (Reinhardt and Sowerbutts 2015, Avdjiev et al. 2016, Cerutti et al. 2017), and credit moves toward non bank lenders (Cizel et al. 2019).

[6] In advanced economies, firms replace bank loans with bonds instead. Crouzet (2018) shows that this leaves them more exposed to distress, and leaves open the question, whether changes in bank regulation would have the same effect.

[7] These include original sin, global liquidity and the carry trade (Eichengreen et al. 2003, Bruno and Shin 2015).

els such as Elenev et al. (2021) weigh the benefits of bank resilience against the cost of reduced credit, but they study this in a closed economy. Falasconi et al. (2024) study capital requirements in a small open economy, but there the banks borrow abroad: safer banks get cheaper foreign funding and take on more of it. In contrast, in my model, firms, not banks, borrow in foreign currency. When higher capital requirements raise the cost of domestic credit, firms turn to foreign lenders. If the rupee depreciates, these firms may default, transmitting losses to domestic banks. Tighter capital requirements therefore create a cost that closed-economy models overlook. The regulator must weigh this cost against the benefit of better-capitalised banks being able to sustain credit during a crisis. Overlooking this cost is itself costly. A regulator who ignores the shift into foreign currency debt overestimates how much bank capital supports investment after a crisis, sets too high of a requirement.

Section 2 describes the data and the institutional framework, Section 3 presents the empirical specification and stylized facts, Sections 4 to 6 presents the model and its results, Section 7 concludes .

2 Data and Institutional Setting

This section describes the data and the setting in which macroprudential policy operates in India. The analysis combines four sources. Macroprudential policy actions are from the integrated Macroprudential Policy Database (iMaPP) compiled by the IMF, and firm balance sheet data from Centre for Monitoring the Indian Economy (CMIE) Prowess database. The rupee-dollar exchange rate and India's monetary policy rate comes from FRED, and the asset quality of Indian banks from the RBI's Handbook of Statistics on the Indian Economy. I first describe India's macroprudential framework and how the Reserve Bank of India (RBI) has used it over the sample period. I then explain how I build the measure of the policy stance from the iMaPP records. Finally, I describe the firm sample, the borrowing and control variables for the empirical analysis.

2.1 India's Macroprudential Framework

India provides a well-suited environment to study the effect of macroprudential policy on firm borrowing. The RBI has used macroprudential instruments actively and continuously since the early 2000s. Their macroprudential framework is overwhelm-

ingly lender based. Of the 102 actions taken by the RBI since 2003, all but 7 actions are lender based. The principal tools used by the central bank are capital buffers and capital requirements, reserve and liquidity requirements and sectoral risk weights. These measures operate on the balance sheets of lenders (in this case, banks), affecting the supply of loanable credit rather than on borrowers directly. This design is central to the identification strategy of the paper because the instruments act on bank lending capacity and not on firms. The policy stance can be treated as exogenous to any individual borrower and its effect on firms operates through the supply of domestic credit.

Before 2013, the RBI's macroprudential actions either targeted particular sectors or managed liquidity. Table A. 1 lists the 42 actions taken in this period. More than half are changes in the cash reserve ratio, which the RBI moved together with the monetary policy rate through the capital inflow boom of the mid 2000s and the 2008 crisis.[8] The countercyclical measures between 2004 and 2007 raised risk weights and provisions on commercial real estate, capital market exposures and personal household and consumer loans, all of which were reversed in November 2008. None of these actions changed the capital banks must hold against their lending as a whole and there were no capital buffers, systemic surcharges or leverage ratio restrictions.

This changed with Basel III, which the RBI implemented from April 2013. The 9 percent minimum capital requirement stayed in place, but the RBI changed what banks must hold on top of it and in what form. Over the next nine years, the minimum common equity requirement rose in steps,[9] a capital conservation buffer was phased in from 2016, the largest banks became subject to surcharges as domestic systemically important banks,[10] and a minimum leverage ratio came into force, with each requirement set above the Basel III minimum.

The RBI also added its own rules on lending to large firms. From 2017, bank lending beyond a normally permitted level to firms with very large credit limits from the banking system carried additional provisions and higher risk weights. From 2019, the Large

[8] The cash reserve ratio requires banks to keep a share of their net demand and time liabilities as cash balances with the RBI. The statutory liquidity ratio, on the other hand, requires them to hold a share in cash, gold or approved securities. Both change how much of banks' funds is free to lend, so the RBI has used them to manage liquidity alongside the policy rate. In November 2008, for example, it cut the policy rate, the cash reserve ratio and the statutory liquidity ratio in the same announcement to ease liquidity after the global financial crisis.

[9] Common equity tier 1 capital consists mainly of paid-up common shares, share premium and disclosed reserves, net of regulatory deductions. It is the capital that absorbs losses first while a bank continues to operate.

[10] Domestic systemically important banks are banks whose failure would disrupt the banking system as a whole because of their size and links to other institutions. The RBI identifies them each year and requires them to hold additional common equity.

Exposures Framework capped what a bank could lend to a single borrower or group. Table A. 2 groups the actions of this period. The years from 2013 to 2022 therefore capture the rules that changed what banks must hold against their corporate lending.

2.2 Macroprudential Policy Data

I measure the RBI's regulations using the integrated Macroprudential Policy (iMaPP) database of Alam et al. (2019), which records the timing and direction of macroprudential actions across all sets of policy instruments. Each action is coded +1 for a tightening and -1 for a loosening. I build a cumulative index as the running sum of net actions. I construct two measures. The headline measure counts the actions that raise the capital or provisioning charge on bank loans to firms. This contains regulations on bank capital as a whole,[11] loan loss provisioning and rules aimed directly at corporate lending such as the large borrower and large exposure limits. The second measure is broader, containing the instruments in the headline measure as well as regulations that bind on all bank lending and not just on corporate loans. This includes the cash reserve ratio and statutory liquidity requirements.[12].

Both measures leave out three groups of lender-based actions–rules on retail household loans and housing credit (3 actions), rules on non-bank lenders that do not bind on banks (1 action) and limits on foreign exchange positions (3 actions). The first two do not directly affect the banks corporate loan book and the third acts on the foreign currency exposure itself, which is the outcome I study. These affect the firm's foreign currency borrowing by design rather than through the supply of domestic bank credit and hence moves the outcome variable mechanically. Of the 46 actions in this period, my measure accounts for 39. Figure 1 shows the actions by fiscal year from 2013 with the onset of Basel III norms to 2022. The specific variable used in the empirical analysis is the net annual change in the index over each firm's fiscal year.

2.3 Firm Data

The firm level data are drawn from the Centre for Monitoring the Indian Economy's (CMIE) Prowess database. I use balance sheets of non-financial firms for the years 2013

[11] minimum requirements, the capital conservation buffer, countercyclical provisions, surcharges on systemically important banks and the leverage ratio

[12] Liquidity coverage ratio and statuatory liquidity ratio.

to 2022 and extend the sample back to 2003 as a robustness check.[13] From the balance sheet, I focus on four borrowing related variables: bank borrowings, foreign currency borrowings, borrowings from other financial institutions and total borrowings. The outcomes of interest are the composition of firm debt – the share of borrowing denominated in foreign currency, share of borrowing from banks and share of borrowing from NBFCs. [14] I also take standard firm level controls commonly used in the corporate finance literature such as firm size, measured as the logarithm of total assets, leverage measured as total borrowings as a share of assets, profitability measured as profit after tax relative to assets, and asset tangibility measured as net fixed assets relative to assets.

A firm's exposure to lender based policy depends on how much it relies on bank credit to begin with. I capture this with a predetermined measure of bank dependence, fixed at the initial level of a firm's bank debt to assets. This reflects the firm's initial reliance on domestic credit from banks and is held constant so that it is unaffected by any later policy induced adjustment that can introduce endogeneity. Because the ability to substitute toward foreign currency requires access to foreign credit markets in the first place, the analysis focuses on firms that borrow in foreign currency at some point in the sample, for which the substitution margin is actually available.[15]

Table 1 reports summary statistics for firms in the sample. Firms with access to foreign-currency debt are larger and more profitable than firms without such access. The median firm in this group holds several times the assets of the median firm without access to foreign credit and has a larger fixed capital base. Yet these firms also rely on domestic banks. Bank loans account for the largest share of their borrowing. This makes them well placed to substitute toward foreign credit when domestic bank lending tightens: they have both a substantial stock of bank debt to replace as well as access to foreign credit markets.

Table 2 looks more closely at the foreign currency borrowing of these firms. Among

[13] Observations are aligned to each firm's fiscal-year-end rather than the calendar year. The panel is cleaned to one observation per firm-year, retaining firms with positive reported assets. I exclude financial firms since they are one of the sources that firms turn to when bank credit tightens. A tighter regulation that pushes firms to non-banking financial companies or NBFCs raises their lending and their borrowing too. If NBFCs are included, their foreign borrowing will respond to the substitution by other firms itself. Additionally, their balance sheets are not comparable to non-financial firms.

[14] Debt ratios are expressed in percentage points and winsorized at the 1st and 99th percentiles.

[15] This sample retains firms with demonstrated access to foreign-currency funding while excluding those whose absence of FX borrowing is mechanical. Within it, roughly thirty percent of firms carry positive foreign-currency debt primarily in the form of external commercial borrowings, providing ample within-firm variation.

firms that hold foreign-currency debt, the median share of this debt is close to 30% of total borrowing and 9% of assets. This exposure is not matched by export earnings. Nearly half of these firms report no export revenue, and the median export share of sales among firms with foreign-currency debt is only 1%. As a result, about two-thirds of these firms owe more in foreign currency than they earn from exports in a year. This suggests that their export earnings provide little natural hedge against exchange rate risk. A depreciation therefore raises the domestic-currency burden of their debt without a corresponding increase in export revenue. This currency mismatch makes the shift toward foreign-currency borrowing a source of firm-level risk.

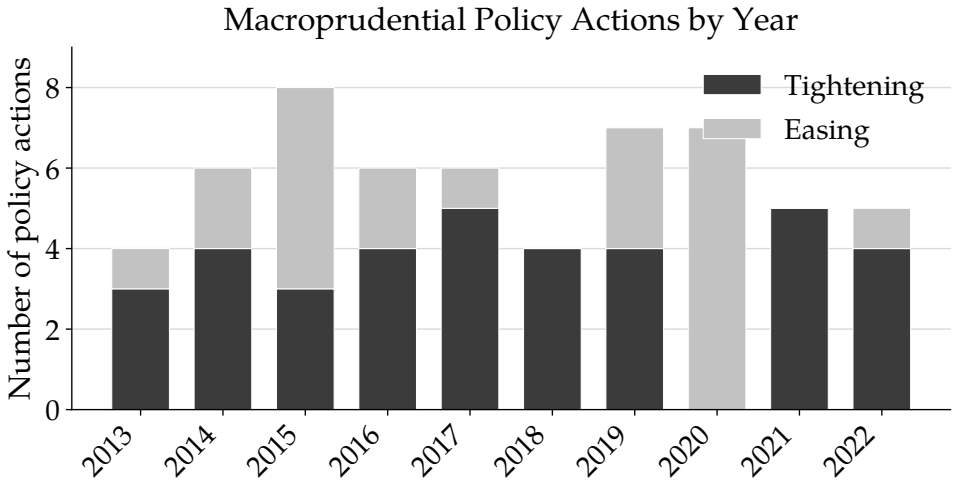


Figure 1: Macroprudential Policy Actions by Year

Notes: Number of macroprudential policy actions taken by India in each year between 2013 and 2022, from the iMaPP database (Alam et al. 2019). Each bar is separated into tightening (dark) and easing (light) actions, summed across the instruments recorded in the database. The figure counts all recorded actions. Source: iMaPP database.

Table 1: Descriptive statistics: all firms, and firms with and without access to foreign credit

	All Firms			Firms with Access to Foreign Credit			Firms without Access to Foreign Credit		
Variable	Mean	SD	Med.	Mean	SD	Med.	Mean	SD	Med.
Total assets (Rs. mn)	4,630	16,749	392	15,140	30,416	3,159	3,494	14,058	307
Capital employed (Rs. mn)	2,675	9,091	230	9,274	17,261	2,118	1,953	7,334	177
Net worth (Rs. mn)	1,443	5,317	102	4,634	9,498	960	1,093	4,500	80
Tangible net worth (Rs. mn)	1,381	5,159	98	4,463	9,223	936	1,044	4,366	76
Net fixed assets (Rs. mn)	1,092	4,110	58	4,143	8,167	818	702	3,032	41
Total borrowings (Rs. mn)	1,676	5,699	151	5,064	10,495	899	1,151	4,289	113
Sales (Rs. mn)	3,285	9,639	422	9,738	17,262	2,738	2,351	7,508	307
Log assets	5.81	2.60	5.97	8.12	1.89	8.06	5.56	2.54	5.73
Leverage, borrowings/assets (%)	59.5	127.0	35.0	42.5	68.6	33.2	62.1	133.6	35.4
Bank-debt share of borrowings (%)	66.6	31.8	75.1	47.1	27.9	48.0	67.9	31.7	77.3
FI/NBFC share of borrowings (%)	26.7	30.5	13.6	12.5	16.8	5.9	28.5	31.4	15.3
FX debt / assets (%)	0.5	2.8	0.0	5.0	7.7	0.0	0.0	0.0	0.0
Profitability, PBDITA/assets (%)	7.0	16.5	7.1	10.1	12.8	10.4	6.6	16.9	6.6
Tangibility, NFA/assets (%)	24.4	25.4	15.8	32.4	22.3	29.5	23.3	25.6	13.9
Firms		42,590			3,658			38,932	
Firm-years		334,601			32,635			301,966	

Firms with access to foreign credit are those that borrow in foreign currency at some point in the sample. Levels are in Rs. million and ratios in percent. For firms with access to foreign credit, the bank-debt and FI/NBFC shares of borrowings are computed over the firm-years that carry foreign-currency debt; other statistics use every firm-year. Ratios are winsorized at the 1st and 99th percentiles for means and standard deviations; medians are raw. Differences between the two groups are significant at the 1% level.

Table 2: Foreign-currency debt intensity among firms with access to foreign credit

Statistic	Mean	Median	p25	p75
Share of firm-years with foreign-currency debt > 0 (%)	33.1			
Foreign-currency debt share of total borrowings (%)	42.5	32.6	11.8	72.9
Foreign-currency debt / assets (%)	15.7	9.2	3.4	20.6
Export earnings / sales (%)	17.9	0.3		
Firms with zero export revenue (%)	48.7			
Net foreign-currency short: FX debt exceeds annual exports (%)	67.4			
Firms holding foreign-currency debt		3,658 firms		

Rows 2 to 6 are conditional on holding foreign-currency debt. "Net foreign-currency short" means foreign-currency debt exceeds the firm's annual export earnings. Shares are winsorized at the 1st and 99th percentiles for means; medians and percentiles are raw.

3 Empirics

This section tests whether macroprudential tightening pushes bank dependent firms towards foreign currency debt. I first set out the local projection specification and show how the composition of firm borrowing responds to a tightening and what this means for firms' borrowing costs, followed by a set of robustness checks. Finally, I ask whether foreign currency exposure is costly by looking at how the exposed firms fare when the rupee depreciates.

3.1 Empirical Specification

I estimate the response of firm borrowing to a macroprudential tightening using the local projection method of Jordà (2023). A firm's exposure to lender-based macroprudential policy is not random. It depends on the firm's initial reliance on domestic bank credit. To exploit this heterogeneity within firms, I allow the response to a macroprudential tightening to differ with each firm's initial dependence on banks. For each horizon $h = 0, ..., 4$ I estimate

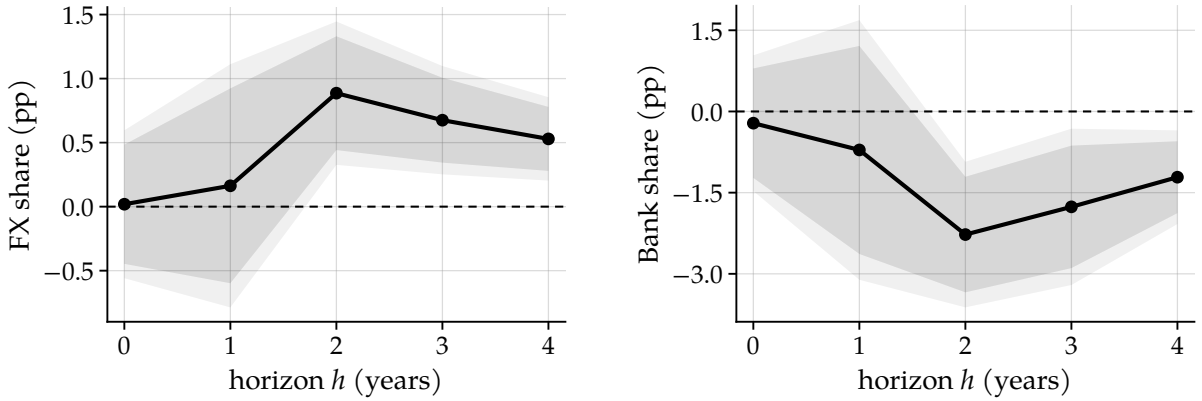
$$y_{i,t+h} = \alpha_i + \delta_{jt} + \beta\big(\text{MaPP}_t \times D_i\big) + \gamma\big(\text{MaPP}_t \times X_i\big) + \Lambda' Z_{i,t-1} + \varepsilon_{i,t+h}, \qquad (1)$$

Where y_{it+h} is the borrowing outcome for firm i in year $t+h$, MaPP_t is the net change in the macroprudential index over the firm's fiscal year t which runs from April to March. D_i is the firm's initial bank-debt-to-assets ratio, standardized. The term X_i contains the firm's initial size, leverage and exporter status, each interacted with the shock. This ensures that β is isolated from the differences in firm size, leverage and exporting status. Z_{it-1} is a set of firm level controls namely size, leverage, profitability, tangible capital and lagged dependent variable. α_i is the firm fixed effect that captures all time-invariant differences across firms. δ_{jt} is the industry-time fixed effect that absorbs conditions common to all firms in the same industry j in a given year. It captures the main effect of $MaPP_t$ as well as any shock specific to an industry in that year, such as a sector specific change in bank lending. The coefficient of interest is β. It measures how much more a firm's borrowing responds to a one-unit tightening in the macroprudential policy index for each one-standard-deviation increase in its initial bank dependence, relative to a firm with no initial bank debt. The effect is expressed in percentage points of the outcome variable. Standard errors are clustered by industry

and year.

3.2 Firm's Debt Composition

Figure 2 plots how the composition of firm debt responds to a macroprudential tightening. The left panel shows the share of a firm's total borrowing in foreign currency and the right panel shows the share from banks. After a tightening, more bank dependent firms raise the foreign currency share of their borrowing and reduce the bank share. The foreign currency share rises by up to about 0.9 percentage points, against an average of 11 percent, and remains higher four years after the tightening. Bank debt moves the other way. The bank share falls by up to about 2.3 percentage points and is still about 1.2 percentage points lower after four years.



(a) Foreign Currency Debt Share

(b) Bank Debt Share

Figure 2: Response of Debt Composition to Macroprudential Tightening

Notes: The figure plots the response of the foreign currency debt share (a) and the bank debt share (b) following a macroprudential tightening shock that raises the capital or provisioning requirement on banks. All regressions include firm and 3-digit industry by year fixed effects. Standard errors are two-way clustered by industry and year. Darker shaded regions denote 90% and lighter shaded regions 95% confidence intervals.

Total borrowing however, barely moves as shown in Figure 3. Across all horizons, the response of total borrowing is close to zero and never statistically different from zero. This is consistent with firms having their financing needs tied to investment plans set well in advance, carried out over a long horizon. Consequently, it is costly for a firm in the middle of a planned project to contract borrowing when bank lending tightens. So it seeks to replace debt rather than forego profitable investments.

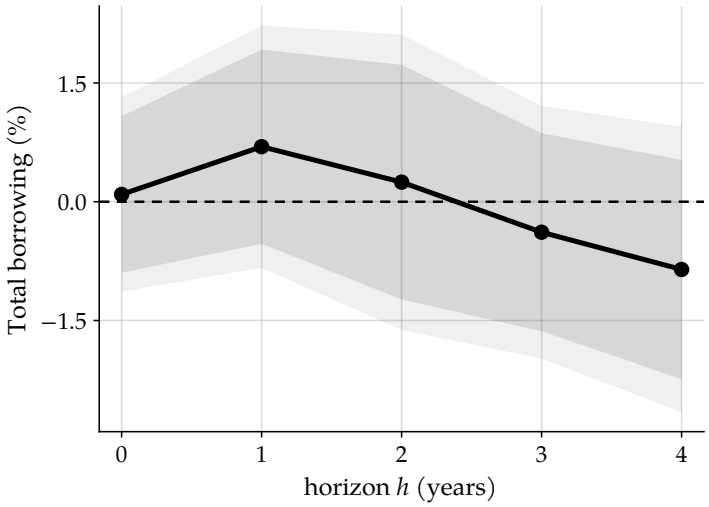


Figure 3: Response of Total Borrowings to a Macroprudential Tightening

Notes: The figure plots the response of the log of total borrowings (in percent) of a firm following a macroprudential tightening shock that raises the capital or provisioning requirement on banks. All regressions include firm and 3-digit industry by year fixed effects. Standard errors are two-way clustered by industry and year. Darker shaded regions denote 90% and lighter shaded regions 95% confidence intervals.

Substitution Away from Banks: A natural alternative source of financing for Indian firms are non-bank financial companies(NBFC) which lent heavily to firms in years when banks were weighed down by non-performing assets. Hence, I estimate the same specification with the NBFC share of borrowing as the outcome variable in figure 4. The NBFC share of borrowing rises by up to about 1.4 percentage points and remains higher after four years. Together with the foreign currency debt share, this accounts for almost all of the drop in the bank share. Non bank credit, however, is a small part of these firms' borrowing. It accounts for about 6 percent of borrowing at the median, compared to about a third for foreign currency debt among the firms that hold it and nearly half for bank debt. More importantly, non-bank credit is denominated in rupees. The shift into foreign currency is the part of the substitution that changes the risk on firm balance sheets.

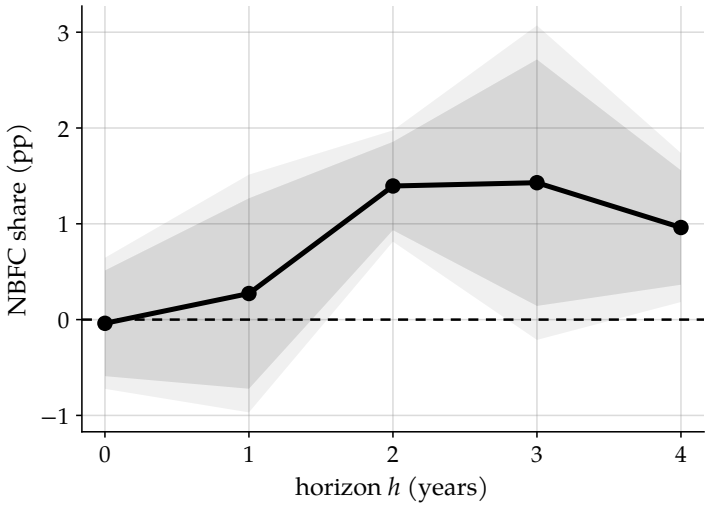
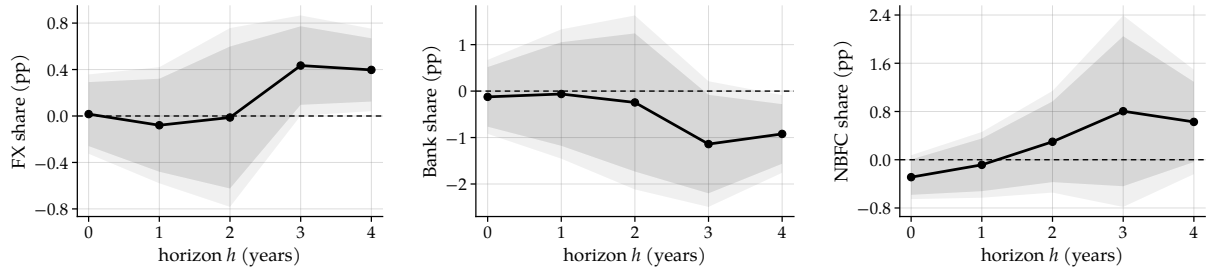


Figure 4: Debt from Non-Bank Financial Corporations (NBFC)

Notes: This figure plots the response of the NBFC debt share of a firm following a macroprudential tightening shock that raises the capital or provisioning requirement on banks. All regressions include firm and 3-digit industry by year fixed effects. Standard errors are two-way clustered by industry and year. Darker shaded regions denote 90% and lighter shaded regions 95% confidence intervals.

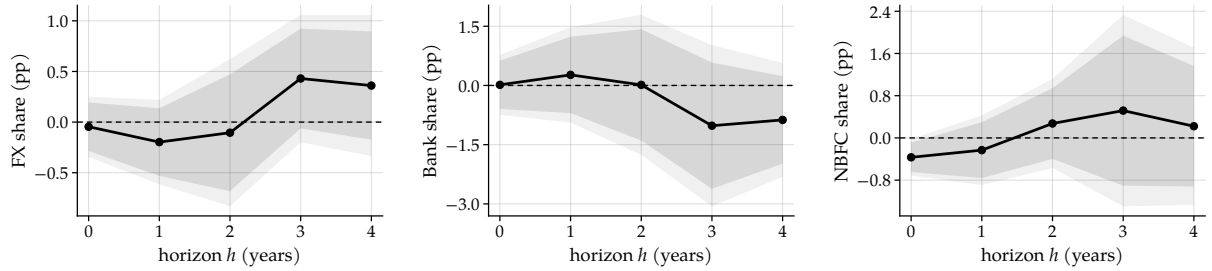
Which Policies Move the Debt Mix: The headline measure counts the actions that raise the capital or provisioning charge on bank loans to firms. I widen it in two steps. The first adds reserve and liquidity requirements, which bind on all bank lending, corporate loans included. Figure 5 shows that the substitution pattern holds with these instruments in the measure: the foreign currency share rises, the bank share falls, and borrowing from NBFCs moves up. The second step uses all 46 macroprudential actions, so it also includes the rules on household credit and on non-bank lenders. Figure 6 shows responses in the same direction, though smaller per action. This is what one would expect if the substitution is driven by the actions that act most directly on the cost of bank lending to firms. Reserve and liquidity requirements work through bank funding, much like monetary policy, and household rules can move bank lending toward firms as well as away from them. Adding them dilutes the measure rather than overturning the result.



(a) Foreign Currency Share (b) Bank Debt Share (c) NBFC Debt Share

Figure 5: Debt Composition: Adding Reserve and Liquidity Requirements

Notes: This figure plots the responses of the firms share of foreign currency debt (a), bank debt (b) and debt from non-bank financial corporations (c) following a macroprudential tightening shock that raises the capital or provisioning requirements on banks along with reserve and liquidity requirements. All regressions include firm and 3-digit industry by year fixed effects. Standard errors are two-way clustered by industry and year. Darker shaded regions denote 90% and lighter shaded regions 95% confidence intervals.



(a) Foreign Currency Share (b) Bank Debt Share (c) NBFC Debt Share

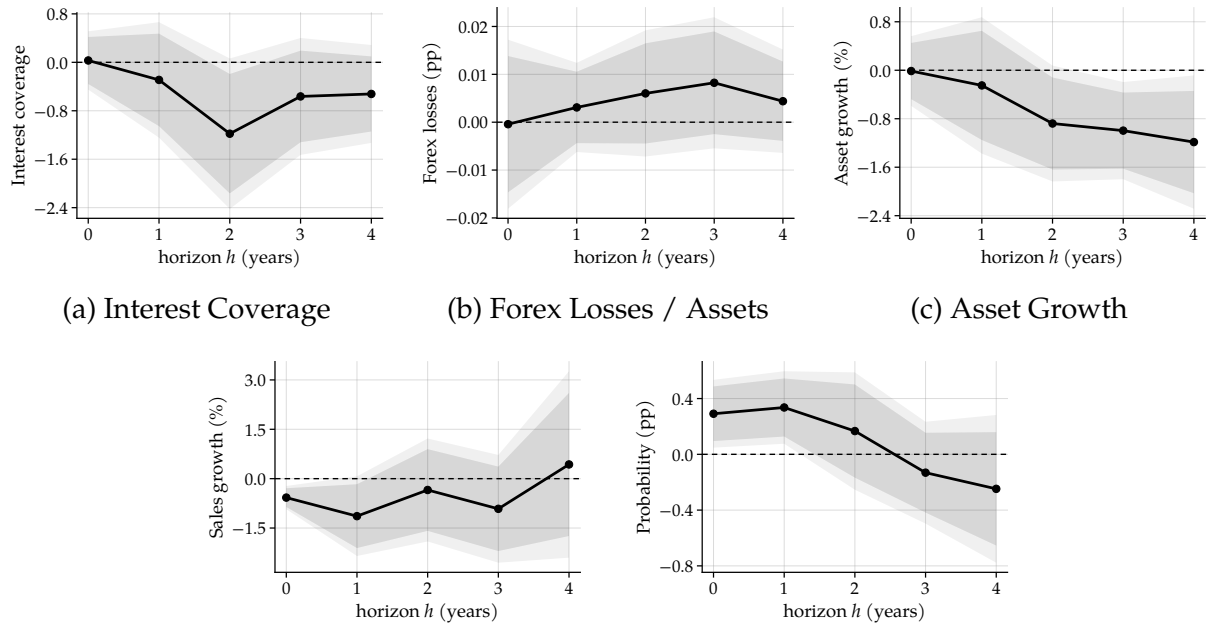
Figure 6: Debt Composition: All Actions

Notes: This figure plots the responses of the firms share of foreign currency debt (a), bank debt (b) and debt from non-bank financial corporations (c) following a macroprudential tightening shock comprising of all lender-based actions. All regressions include firm and 3-digit industry by year fixed effects. Standard errors are two-way clustered by industry and year. Darker shaded regions denote 90% and lighter shaded regions 95% confidence intervals.

Costs of Substitution: The substitution is not free, and its cost shows up on the balance sheets of firms. Figure 7 plots the response of interest coverage, foreign exchange losses relative to assets, asset growth, sales growth and the probability of negative net worth. Interest coverage, measured as operating profit divided by interest expense, indicates how many times a firm's operating earnings cover its interest payments. As the ratio falls, a larger share of operating earnings goes toward interest payments. Following a macroprudential tightening, the interest coverage ratio of more bank-dependent

firms falls by about 1.2 points, from an average of about 13. Foreign exchange losses relative to assets also rise, suggesting that the foreign-currency debt these firms take on, exposes them to exchange rate risk, though the estimates are imprecise. The next subsection tests this link directly.

These firms also experience slower growth. Sales fall by about 0.6% in the year of the tightening and by about 1.1% the following year. Asset growth slows by about 1 percentage point a year, consistent with a squeeze on working capital, which firms in India largely finance through bank credit. Finally, more bank-dependent firms are more likely to end up with negative net worth. These results are robust to using the broader measure of macroprudential tightening, which also includes reserve and liquidity requirements (Figure B.1 in the appendix).



(a) Interest Coverage (b) Forex Losses / Assets (c) Asset Growth

(d) Sales Growth (e) P(Negative Net Worth)

Figure 7: Costs of Substitution

Notes: Responses of the interest coverage ratio measured by PBDITA over interest (a), forex transaction losses as a ratio of firm assets (b), the cumulative growth of total assets (c), the cumulative growth of sales (d) and the probability of negative net worth in percentage points (e) of a firm following a macroprudential tightening shock that raises the capital or provisioning requirement on banks. All regressions include firm and 3-digit industry by year fixed effects. Standard errors are two-way clustered by industry and year. Darker shaded regions denote 90% and lighter shaded regions 95% confidence intervals.

3.3 Exposure to Exchange Rate Fluctuations

The substitution towards foreign currency debt leaves firms more exposed to exchange rate fluctuations. Since the late 2000s, the rupee has depreciated against the US dollar, with sharp declines during the Global Financial Crisis, the Taper Tantrum, the COVID-19 pandemic and the US interest rate hikes of 2022-23. As mentioned earlier, nearly half of the firms with foreign-currency debt in my sample, report no export revenue, and about two-thirds owe more in foreign currency than they earn from exports in a year.

Since most rupee depreciation occurs during a few episodes, averaging outcomes across all years after a macroprudential tightening would dilute the effects of these episodes. Moreover, any single tightening changes a firm's exposure only modestly. A direct test of whether the exposure created by macroprudential policy makes firms more vulnerable during periods of depreciation may therefore have limited statistical power.[16]

I therefore separate the argument into two steps. The first links macroprudential tightening to greater foreign-currency exposure, as shown in the preceding section. The second examines whether firms with greater foreign-currency debt fare worse when the rupee depreciates, using variation in exposure across all firms rather than only the variation induced by policy. Neither step alone establishes that tightening leaves firms more fragile. Together, they support this conclusion, provided that foreign-currency debt taken on after a tightening is exposed to rupee depreciation in the same way as other foreign-currency debt.

$$y_{i,t} = \gamma\big(\mathrm{FX}_{i,t-1} \times \mathrm{Dep}_t\big) + \theta \cdot \mathrm{FX}_{i,t-1} + \phi \log A_{i,t} + \alpha_i + \delta_{jt} + \varepsilon_{i,t} \tag{2}$$

Where $\mathrm{FX}_{i,t-1}$ is the firms foreign-currency borrowing relative to assets at the end of the previous fiscal year, measured in percent. Dep_t is the depreciation of the rupee over the firms fiscal year. A_{it} is total assets and I also have firm and industry by year fixed effects represented by α_i and δ_{jt} respectively.

The interaction terms are divided by 10 so that γ captures the effect of a 10-percentage-point increase in foreign-currency debt relative to assets when the rupee depreciates by 10%. It can therefore be interpreted as the cost of foreign-currency exposure. A 10-percentage-point exposure is close to the sample median, while rupee depreciation

[16] I also estimate this direct version, adding to the local projection a triple interaction of the shock, bank dependence, and the depreciation in the outcome year. The estimates are imprecise and change sign across horizons, as expected when a small policy-induced change in exposure is multiplied by the change in exchange rate.

of 10% or more occurred during major episodes, including the Global Financial Crisis, the Taper Tantrum, the COVID-19 outbreak and the subsequent period of aggressive US interest rate hikes.

Figure 8 shows that foreign-currency exposure is costly for firms. Foreign exchange losses rise by 0.19 percentage points of assets, roughly doubling the losses of a typical firm. Profitability and return on assets also fall. Firms are more likely to experience financial distress. The share of firm-years in which operating earnings fall short of interest payments rises from 18.6% to 21.4%, while the share reporting a loss increases from 28.7% to 32.3%. These results imply that each form of distress becomes 12–15% more likely.

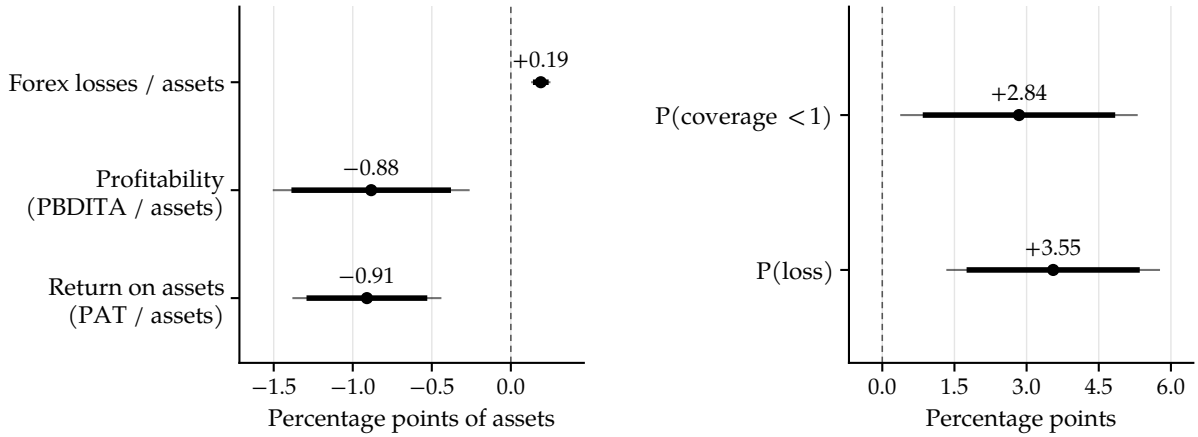


Figure 8: Firm losses when Rupee depreciates

Notes: Each point is the coefficient γ for one outcome, per 10 percentage points of foreign-currency debt to assets times 10 percent fiscal-year depreciation of the rupee. The left panel shows forex losses, operating profitability (PBDITA over assets), and return on assets (profit after tax over assets), in percentage points of assets. The right panel shows the probability that operating earnings fall short of interest expense and the probability of a loss, in percentage points. All regressions include firm and industry by year fixed effects, and standard errors are two-way clustered by industry and year. Thick bars denote 90% and thin bars 95% confidence intervals.

Taken together, the results link macroprudential policy to firm fragility through two channels. First, tighter restrictions on bank lending push bank-dependent firms toward foreign-currency debt. Second, this debt raises losses and the risk of distress when the rupee depreciates.

This effect is stronger for policies that raise the capital or provisioning requirements on bank loans to firms. These measures were introduced mainly through the phase-in of Basel III and the RBI's rules on lending to large borrowers. Reserve and liquidity

requirements also constrain bank lending, but they work by raising the cost of bank funding, much like monetary policy. Including these measures in the policy index preserves the main result, but weakens it.

The policies excluded from both measures are less likely to generate this form of leakage and may even work in the opposite direction. Regulations on retail and household lending, as well as those targeting non-bank lenders, do not directly constrain bank lending to firms. The results suggest that these policies may instead redirect bank credit toward firms.

3.4 Robustness checks

Monetary policy: Macroprudential tightening may coincide with a monetary tightening, which could itself induce firms to turn abroad. A monetary tightening that impacts bank-dependent firms can therefore confound the result. To account for this, I include change in the weighted average call rate, interacted with firms' initial bank dependence, alongside the macroprudential term. Figure B.2 shows that the macroprudential coefficients are essentially unchanged. The foreign currency share of firm borrowing still rises, the bank borrowing share falls and the NBFC share rises by nearly the same amount, while total borrowing remains unchanged and statistically insignificant. This shows that the substitution is a response to macroprudential policy and not to the monetary policy stance.

Bad loans: During the period from 2016 to 2018, Indian banks were saddled with a large stock of non-performing assets (NPA) or bad loans. Banks under stress may cut lending to bank-dependent firms even without regulatory tightening, leading to a similar shift in firms' debt mix. To control for this, I add the annual change in the gross NPA ratio of banks, interacted with firms' initial bank dependence. This interaction captures the extent to which borrowing by bank-dependent firms adjusts when bank stress rises, separating the effects of bank distress from those of regulation. Figure B.3 shows that the results are robust: the responses of foreign-currency borrowing, the NBFC debt share and the bank debt share are almost identical to the baseline, while total borrowing remains unchanged.

Fixed cohort of firms: To check that late entrants do not drive the results discussed in the preceding sections, I restrict the sample to firms already present in 2013. Figure B.4 shows that the estimates are nearly identical to the baseline. The foreign currency

share rises by about 0.9 percentage points and the bank debt share falls by about 2.3 percentage points two years after the tightening, the NBFC debt share rises, and total borrowing does not move.

Longer sample: Finally, I extend the sample from 2003 to 2022. The longer sample includes the years before Basel III, when the index captures only the sector-specific provisions introduced between 2005 and 2008 and their subsequent reversal. Figure B.5 shows that the results remain qualitatively similar. The share of bank debt falls, while the share of foreign-currency debt rises, with the latter effect becoming statistically significant four years after tightening. Total borrowing remains unchanged. The estimated responses are smaller and less precisely estimated. This is expected because the index now includes measures that did not raise the cost of bank lending to firms across the board.

4 Model

The empirical results show that macroprudential tightening shifts bank-dependent firms from bank credit toward foreign-currency debt, which exposes them to distress when the rupee depreciates. This shift is driven mainly by policies that raise the capital or provisioning requirements on bank loans to firms, most of which were introduced during the phase-in of Basel III. These policies raise the capital that banks must hold against their lending. This is one side of the policy trade-off.

The other side is the benefit of a better-capitalised banking system. Such a system is less likely to become insolvent during a downturn and can sustain lending when firms need credit most. Since these benefits extend across the economy, assessing the trade-off requires a framework that accounts for aggregate effects. The costs may also exceed those captured by the firm-level estimates: when firms default, some of their losses are passed back to the banks that the policy was intended to protect. Evaluating the trade-off therefore requires accounting for both channels.

To study this trade-off, I develop a two-period small open economy model in which firms borrow from domestic banks and foreign lenders.The model builds on the financial accelerator of Bernanke et al. (1999) and on Villacorta (2018), where both firms and banks need net worth to borrow and lend. A macroprudential tightening, modeled as a higher bank capital requirement, raises the cost of domestic credit. The model shows how the regulator trades off the credit preserved by better-capitalised banks during a

crisis against the credit forgone and the firm fragility created in normal times. I use this framework to determine how these costs and benefits shape the optimal capital requirement.

4.1 Environment

I consider a two-period economy, $t = 1, 2$, with a firm or entrepreneurial sector and a bank or financial sector. A continuum of firms borrow from domestic banks and from foreign lenders to buy capital and produce a final good. A continuum of banks raise deposits from households who supply them elastically at a gross real rate R and lend to firms. Foreign lenders supply funds denominated in foreign currency elastically at a gross real rate R^* to firms.

4.1.1 Aggregate shocks

At the end of each period an aggregate state $\omega = \{e', A\}$ realizes where e' is the end of period exchange rate (domestic units per \$) [17] and A is an aggregate productivity shock. For simplicity, I assume both are two-point and have mean = 1:

- $e' \in \{e_L, e_H\}$ built from log-shocks $+/-\sigma_e$ rescaled so $E[e'] = 1$ exactly.
- $A \in \{1 - \sigma_A, 1 + \sigma_A\}$, so $E[A] = 1$ exactly.

I assume that the correlation between the two shocks is 0. Shocks are i.i.d across periods so the realized ω enters the future only through the net-worth stocks it leaves behind; it is not itself a state variable.

4.1.2 Idiosyncratic Shock

Each firm draws an idiosyncratic productivity shock $z \sim \text{LogNormal}(\mu_z, \sigma_z^2)$, with $\mathbb{E}[z] = 1$, which implies $\ln z \sim \mathcal{N}(\mu_z, \sigma_z^2)$ and $\mu_z = -\frac{\sigma_z^2}{2}$.

$\Phi_N(\cdot)$ is the cumulative distribution function (CDF) of the standard normal distribution. I define $\bar{z}$ as the threshold value of z below which the firm falls short of its debt obligations and defaults for a given state ω. Then the probability of firm's default can be defined as:

$$F(\bar{z}) = \Phi_N\left(\frac{\ln \bar{z} - \mu_z}{\sigma_z}\right) \tag{3}$$

[17] so a rise corresponds to depreciation

And the expected productivity over the default region is given by:

$$G(\bar{z}) = \int_0^{\bar{z}} z\, dF(z) = \Phi_N\left(\frac{\ln \bar{z} - \mu_z - \sigma_z^2}{\sigma_z}\right) \tag{4}$$

Following Bernanke et al. (1999), I define the fraction of the project value accruing to lenders before default costs as

$$\Gamma(\bar{z}) = G(\bar{z}) + \bar{z}\big(1 - F(\bar{z})\big) \tag{5}$$

And the fraction retained by firms is therefore:

$$1 - \Gamma(\bar{z}) = \int_{\bar{z}}^{\infty} (z - \bar{z})\, dF(z) \geq 0 \tag{6}$$

4.2 The Firm

4.2.1 Technology and balance sheet

Each firm enters the period with net worth n^F. It uses the net worth, together with debt, to acquire capital k. The firm can borrow in two ways: from domestic banks in domestic currency, b_d, and from foreign lenders in foreign currency, b_f. It makes these choices at the start of the period, before the aggregate state ω and its own productivity z are realized.

At the end of the period, a firm with capital k and productivity z earns $zAR^K k$ in state ω, where R^K is the gross return per unit of capital and depends on the total stock of capital at the aggregate level. The payoffs are proportional to the firms' individual capital and so each firm operates with constant returns to scale. Further, since each firm is small, they take R^K as given.

The firm finances its capital with its net worth and debt. Foreign debt is denominated in foreign currency, so its value in domestic units depends on the exchange rate e at which it is taken on. The balance sheet of the firm is

$$k = n^F + b_d + e\, b_f, \tag{7}$$

so total debt, measured in domestic units, is $b_d + e\, b_f = k - n^F$. I normalize the exchange rate at the time of borrowing to $e = 1$.

The share of domestic currency debt is given by,

$$s = \frac{b_d}{b_d + e\, b_f}, \tag{8}$$

so that $1 - s$ is the share of foreign currency debt. The firm's financing choice can then be summarized by two numbers: how much it borrows in total, and how it splits that borrowing between the two currencies.

The split matters because the two debts are repaid at different exchange rates. Domestic debt is repaid in domestic currency, so its burden does not depend on the exchange rate. Foreign debt is repaid at the end-of-period rate e'. If the currency depreciates, so that $e' > e$, the firm owes more in domestic units on its foreign debt. This is the source of the firm's currency risk.

4.2.2 Entry and exit

At the end of period 1, a fraction τ_x^F of firms exit. An exiting firm pays out its wealth and consumes it. New firms enter with total net worth equal to a fraction ξ^F of aggregate firm net worth N^F. Since firms' choices do not depend on their size (as shown below), only aggregate firm net worth matters, not the number of firms.

This assumption plays two roles. First, it keeps firm net worth stationary. Without exit, firms would carry all of their earnings into period 2, and firm net worth would grow even if no shock occurred. With exit and entry, any difference between period 2 and period 1 comes from the aggregate shock alone. With exit and entry, any difference between period 2 and the steady state comes from the aggregate shock alone. Banks face the same assumption. Second, it determines how much the firm cares about period 2. With probability τ_x^F the firm exits and consumes its wealth at the end of period 1, and only with probability $1 - \tau_x^F$ does that wealth stay in the firm and earn a return in period 2. The exit rate therefore sets the weight the firm places on period 2 when it makes its choices in period 1. Entry does not affect this weight, since the net worth of entrants goes to new firms.

4.2.3 Default threshold

The contractual interest rates that the firm faces on both kind of debts are fixed when it borrows. Let R_d and R_f denote the gross rates on domestic and foreign debt. At the end of the period, after the shocks are realized, the firm owes $R_d b_d$ on its domestic debt

and $e' R_f b_f$ on its foreign debt. Its total debt service in domestic units is therefore,

$$R_d\, b_d + e' R_f\, b_f.$$

The firm repays if its project value $zAR^K k$ covers this amount and defaults otherwise. It therefore defaults when its productivity falls below the threshold

$$\bar{z}(\omega) = \frac{R_d\, b_d + e' R_f\, b_f}{AR^K k}. \tag{9}$$

The threshold depends on the aggregate state through e' and A. A depreciation raises e' and with it the domestic value of the foreign debt, while low productivity lowers the project value. Both raise $\bar{z}$, so more firms default. Since the cutoff is homogenous of degree 0, the threshold depends on the proportions of the balance sheet and not the size.[18]

4.2.4 Lenders

Lenders are risk neutral and competitive. Domestic banks fund their loans at the cost $R(1+\tau)$, where τ is the macroprudential policy wedge created by the capital requirement. I take τ as given here and derive it from the banks' problem in the subsequent section. Foreign lenders fund their loans at the world rate R^*.

If a firm repays, each lender receives what they are owed. If a firm defaults, its lenders recover a fraction κ of the project value, and this amount is shared between them in proportion to their claims. Foreign lenders, however, keep only a fraction $\varepsilon(s)$ of their share which falls as the firm borrows more abroad. So they recover less of each additional unit they lend. Foreign creditors are likely to face higher costs when recovering their claims from distressed firms in India. Domestic creditors tend to know the local legal system better and have greater access to information about the borrower and its assets. This gives them an advantage in monitoring borrowers, negotiating restructuring and enforcing their claims, which can lead to higher recovery. In contrast, foreign creditors may find it harder to navigate India's slow-moving and complex judicial and insolvency resolution system.[19] This friction acts only after a default, so it is

[18] Proof in Appendix C.1

[19] More broadly, $\varepsilon(s)$ is a reduced-form way of capturing anything that makes foreign credit costlier or harder to acquire than domestic credit as a firm borrows more abroad, such as hedging costs, rollover risk, information frictions or regulatory limits on external commercial borrowing. Firms with access to foreign credit hold both domestic and foreign debt rather than borrowing only in the cheaper market.

an ex-post recovery friction, not an ex-ante monitoring cost.

$$\varepsilon(s) = 1 - (1 - s)^{\psi}, \qquad \psi > 1.$$

The more exposed a foreign lender is to a firm, the higher contractual rate they charge because they are likely to recover less. Since $\psi > 1$, the rising marginal cost of foreign debt keeps the firms from moving entirely to foreign debt.

Per unit of debt owed, the expected repayment to each type of lender is

$$\varphi^d(\bar{z}) = \big(1 - F(\bar{z})\big) + \kappa \frac{G(\bar{z})}{\bar{z}}, \qquad \varphi^f(\bar{z}, s) = \big(1 - F(\bar{z})\big) + \varepsilon(s)\,\kappa \frac{G(\bar{z})}{\bar{z}}.$$

The first term is full repayment, received when the firm survives. The second term is the recovery when the firm defaults.[20]

The interest rates are set before the shock, so lenders are compensated to the point where they break even in expectation across the aggregate states.

$$R_d\, \mathbb{E}_\omega\big[\varphi^d(\bar{z}(\omega))\big] = R(1 + \tau), \qquad R_f\, \mathbb{E}_\omega\big[\varphi^f(\bar{z}(\omega), s)\big] = R^*. \tag{10}$$

The exchange rate does not appear in the foreign lenders' condition. They lend and are repaid in foreign currency, so a depreciation does not change the value of what a surviving firm pays them. It matters to them only because it makes default more likely, through $\bar{z}(\omega)$. Given the firm's leverage ($\lambda = k/n^F$) and debt mix (s), these two conditions determine the interest rates R_d and R_f.

4.2.5 The firm's problem

The firm makes its choices at the start of the period, before the shocks are known. Given its net worth n^F, it chooses its domestic and foreign debt, or equivalently, the leverage $\lambda \equiv k/n^F$ and domestic debt share s. These two numbers pin down its capital and its two debts:

$$k = \lambda\, n^F, \qquad b_d = s(\lambda - 1)\, n^F, \qquad b_f = (1 - s)(\lambda - 1)\, n^F.$$

This requires the cost of foreign credit to rise with firm's foreign borrowing, which $\varepsilon(s)$ delivers.

[20] These are the BGG expressions written directly. In the notation of Bernanke et al. (1999), $\varphi^d = \big[\Gamma(\bar{z}) - (1 - \kappa)G(\bar{z})\big]/\bar{z}$, and similarly for φ^f with $\varepsilon(s)\kappa$ in place of κ.

The interest rates R_d and R_f are not fixed and are set by the lenders' conditions as outlined in Section 4.2.4, so they change with the firm's choices: a firm that borrows more is riskier and pays more. The firm takes this into account when it chooses.

After the shocks, a firm with productivity z keeps what is left after paying its debt, or nothing if it defaults.

$$\max\{zAR^K k - (R_d b_d + e' R_f b_f), 0\}$$

Averaging over the firm's own idiosyncratic draws, its wealth at the end of the period in state ω is

$$W^F(\omega) = A(\omega)\, R^K k \left[1 - \Gamma(\bar{z}(\omega))\right], \tag{11}$$

the share of the project value that remains with the firm. Limited liability is built into Γ: a firm that defaults keeps nothing, but never less than nothing. The firm then either exits with probability τ_x^F and consumes its wealth or it keeps its wealth as net worth for the next period. The firm's problem in period 1 is

$$V_1^F(n^F, S) = \max_{\lambda, s} \frac{1}{R}\, \mathbb{E}_\omega \left[\tau_x^F W^F(\omega) + (1 - \tau_x^F)\, V_2^F\left(W^F(\omega),\, S'(\omega)\right)\right] - n^F\, \Phi(\lambda), \tag{12}$$

subject to the two lenders' conditions in equation 10 and the balance sheet identity in equation 7.[21] Here V_2^F is the value of a firm that enters period 2 with net worth n^F. Period 2 is the last period, so the firm consumes all of its wealth at the end of it:

$$V_2^F(n^F, S') = \max_{\lambda', s'} \frac{1}{R}\, \mathbb{E}_{\omega'} \left[W^{F\prime}(\omega')\right] - n^F\, \Phi(\lambda'), \tag{13}$$

where ω' is the aggregate state realized at the end of period 2, and $W^{F\prime}(\omega')$ is end-of-period wealth, defined as in period 1 but with the period-2 choices, the wedge τ' and the return on capital $R^{K\prime}$. The aggregate state is $S \equiv (N^F, N^B)$, aggregate firm and bank net worth. This matters to the firm because it determines the credit wedge and the return on capital. The shock ω is not part of the state. Shocks are independent over time, so once ω has hit balance sheets, it affects the future only through the net worth it leaves behind, $S'(\omega)$.

In the period-1 problem, the first term is the wealth consumed if the firm exits. The

[21] Formally, the expectation runs over both the aggregate state ω and the firm's own draw z. Because the value functions are linear in net worth (shown below), only the firm's average wealth over z matters, which is $W^F(\omega)$.

second is the value of continuing with that wealth as net worth. The last term is a leverage adjustment cost,

$$\Phi(\lambda) = \frac{\chi}{2} \frac{(\lambda - \bar{\lambda})^2}{\bar{\lambda}},$$

which grows as leverage moves away from a reference level $\bar{\lambda}$. The cost captures the idea that firms have a target capital structure and adjust toward it slowly. It limits how much total borrowing responds to the wedge τ, in line with the evidence that firms adjust the mix of their debt more than its size. I set $\bar{\lambda}$ equal to the leverage that firms choose under the current existing capital requirement. At $\lambda = \bar{\lambda}$ the cost and slope is zero and has no effect on firms' choices under the existing policy.

The firm's size does not affect its choices. Technology has constant returns, the balance sheet scales with the firm, the lenders' condition is homogeneous of degree 0 and depend only on the ratios λ and s, and the adjustment cost is proportional to net worth. A firm with twice the net worth can therefore double every quantity, pay the same interest rates, and end each period with twice the wealth. In period 2, which has no continuation, its value is then proportional to its net worth, $V_2^F(n^F, S') = \nu_2^F(S')\, n^F$, where $\nu_2^F(S')$ is the value of one unit of net worth in period 2:

$$\nu_2^F(S') = \max_{\lambda', s'} \frac{1}{R} \mathbb{E}_{\omega'} \Big[A(\omega') R^{K\prime} \lambda' \left(1 - \Gamma(\bar{z}'(\omega'))\right) \Big] - \Phi(\lambda'). \tag{14}$$

Substituting this into the period-1 problem, the same argument gives $V_1^F(n^F, S) = \nu_1^F(S)\, n^F$, with

$$\nu_1^F(S) = \max_{\lambda, s} \frac{1}{R} \mathbb{E}_{\omega} \Big[m(\omega)\, A(\omega) R^K(S)\, \lambda \left(1 - \Gamma(\bar{z}(\omega))\right) \Big] - \Phi(\lambda), \tag{15}$$

$$\text{where, } m(\omega) = \tau_x^F + (1 - \tau_x^F)\, \nu_2^F\big(S'(\omega)\big). \tag{16}$$

The weight $m(\omega)$ is the value of one unit of wealth at the end of the period in state ω. With probability τ_x^F it is consumed and worth one. With probability $1 - \tau_x^F$ it stays in the firm, where it is worth $\nu_2^F(S'(\omega))$. A unit of net worth is worth more than one inside the firm, because it supports more than one unit of capital. How much more depends on credit conditions in period 2, which differ across states. This is what makes the firm forward-looking: it cares not only about how much wealth it ends with, but about which state that wealth arrives in. The period-2 problem is the same problem with $m = 1$ in every state, since all wealth is then consumed. Setting $m = 1$ in period 1 as well gives the static problem of a myopic firm.

Because all firms choose the same leverage and debt mix, aggregate firm net worth at the start of period 2 is

$$N^{F\prime}(\omega) = \Big[(1-\tau_x^F)\, A(\omega) R^K \lambda \left(1-\Gamma(\bar{z}(\omega))\right) + \xi^F\Big] N^F. \tag{17}$$

The first term is the wealth of surviving firms and the second is the net worth of entrants. This is the firm part of next period's state $S'(\omega)$.

4.2.6 Optimality conditions

The firm has two choices, the composition of debt s and leverage λ, so there are two optimality conditions. The cost Φ depends only on leverage, so it appears in the leverage condition and not in the composition condition. The results on currency substitution, which is the main focus of the paper, therefore do not depend on the form of Φ.

Debt composition. Raising s while holding λ fixed replaces a unit of foreign debt with a unit of domestic debt, leaving total debt and capital unchanged. [22] The default threshold can be written as $\bar{z}(\omega) = \frac{\lambda-1}{\lambda} \cdot \frac{D(\omega)}{AR^K}$, where $D(\omega) \equiv R_d\, s + R_f\, e'(1-s)$ is debt service per unit of debt. The composition condition is

$$\mathbb{E}_\omega\Big[m(\omega)\left(1-F(\bar{z}(\omega))\right)\frac{\partial D(\omega)}{\partial s}\Big] = 0. \tag{18}$$

The firm shifts its debt mix until a weighted average of the change in debt service is zero. Each state is weighted by the value of wealth there, $m(\omega)$, and by the probability that the firm survives, $1-F(\bar{z}(\omega))$.

This condition has a simple reading. Let $\mathcal{D} \equiv R_d + s\,\partial R_d/\partial s$ be the marginal cost of domestic borrowing and $\mathcal{F} \equiv R_f - (1-s)\,\partial R_f/\partial s$ the marginal cost of foreign borrowing. Each of these marginal costs is the rate on the extra unit plus the change in the rate faced by the debt the firm already has. The condition in equation 18 becomes

$$\mathcal{D} = \hat{e}\,\mathcal{F}, \qquad \hat{e} \equiv \frac{\mathbb{E}_\omega\big[m(\omega)\left(1-F(\bar{z}(\omega))\right)e'\big]}{\mathbb{E}_\omega\big[m(\omega)\left(1-F(\bar{z}(\omega))\right)\big]}. \tag{19}$$

The firm equates the marginal costs of the two debts, converting the foreign cost at $\hat{e}$, a weighted average of the end-of-period exchange rate. Because default is most

[22] In a formulation with b_d and b_f as choice variables, this condition is the difference between the two first-order conditions.

likely after a depreciation, the survival weights are lowest in exactly those states. The firm therefore puts too little weight on the states where foreign debt is most expensive, and $\hat{e}$ lies below the true expectation $\mathbb{E}[e'] = 1$. Limited liability makes foreign debt look cheaper to the firm than it is.

Using the lenders' conditions to replace $\partial R_d/\partial s$ and $\partial R_f/\partial s$ gives the condition in terms of the price gap:

$$\underbrace{R_d - \hat{e}\, R_f}_{\text{price gap}} = \underbrace{(1-s)\,\hat{e}\,\frac{R_f}{\mathbb{E}[\varphi^f]}\,\varepsilon'(s)\,\mathbb{E}\left[\varphi^f_\varepsilon\right]}_{\text{marginal cost of foreign debt}} + \underbrace{s\,\frac{R_d}{\mathbb{E}[\varphi^d]}\,\mathbb{E}\left[\varphi^d_{\bar{z}}\,\frac{\partial \bar{z}}{\partial s}\right] + (1-s)\,\hat{e}\,\frac{R_f}{\mathbb{E}[\varphi^f]}\,\mathbb{E}\left[\varphi^f_{\bar{z}}\,\frac{\partial \bar{z}}{\partial s}\right]}_{\text{repricing of default risk}} \tag{20}$$

where $\varphi^f_\varepsilon = \kappa G(\bar{z})/\bar{z}$ is the effect of ε on foreign recovery and $\varphi_{\bar{z}}$ denotes the derivative of φ with respect to the threshold. The left side is the interest saving from borrowing one more unit in foreign currency. The right side is what that unit costs: there is a worsening in the terms of the loan when a firm becomes more dollarized and face a steeper price, and the change in default risk reprices both debts.[23]

Leverage. The leverage condition is

$$\frac{1}{R}\mathbb{E}_\omega\left[m(\omega)\left\{\underbrace{A(\omega)R^K(1-\Gamma(\bar{z}))}_{\text{return on one more unit of capital}} - \underbrace{(1-F(\bar{z}))\left[\frac{D(\omega)}{\lambda} + (\lambda-1)\frac{\partial D(\omega)}{\partial \lambda}\right]}_{\text{extra debt service, incl. repricing}}\right\}\right] = \Phi'(\lambda) \tag{21}$$

The left side is the value of raising leverage by one unit: the extra capital earns its return, and the extra borrowing raises debt service, including the higher rate on existing debt, in the states where the firm survives. The right side is the marginal cost of adjusting leverage.

How policy enters. The composition condition shows how a tighter capital requirement changes the debt mix. A higher requirement raises the wedge τ, which raises the domestic rate R_d through the domestic lenders' condition and widens the price gap. The firm shifts toward foreign debt until the marginal costs are equal again. This raises its exposure to the exchange rate, so default becomes more likely after a depreciation.

[23] With a single state and $m = 1$, the firm minimizes its default threshold, $\partial \bar{z}/\partial s = 0$, the repricing terms vanish, and the condition reduces to the myopic firm's optimality condition.

The firms take the wedge τ as given. The next subsection turns to the banks, where I show where it comes from.

4.3 The Bank

In the lenders' subsection, domestic banks require an expected return of $R(1+\tau)$ on their loans. This section describes the banks and shows where the wedge τ comes from.

4.3.1 Balance sheet and returns

A bank enters the period with net worth n^B, lends b_d to firms, and funds the rest with deposits $b_d - n^B$ at the gross rate R. Banks lend only in domestic currency, so they carry no exchange rate exposure of their own. Each bank is subject to a capital requirement,

$$n^B \geq \theta\, b_d, \tag{22}$$

which limits how much it can lend per unit of its own net worth. The requirement θ is the macroprudential policy instrument: a tighter policy means a higher θ.

Banks are competitive and take the return on loans as given. Per unit lent, a bank receives R_d from firms that repay and a recovery from firms that default:

$$\rho^B(\omega) = \underbrace{R_d\left(1 - F(\bar{z}(\omega))\right)}_{\text{repayment by surviving firms}} + \underbrace{R_d \cdot \kappa \frac{G(\bar{z}(\omega))}{\bar{z}(\omega)}}_{\text{recovery from defaulting firms}} \tag{23}$$

By the domestic lenders' condition in equation 10, the expected return on a loan is $\mathbb{E}_\omega[\rho^B(\omega)] = R_d\, \mathbb{E}_\omega[\varphi^d(\bar{z}(\omega))] = R(1+\tau)$.

The bank's assets earn $\rho^B(\omega)$ and its deposits cost R, so its wealth at the end of the period is

$$W^B(\omega) = \rho^B(\omega)\, b_d - R\,(b_d - n^B) = b_d\big(\rho^B(\omega) - R\big) + R\, n^B. \tag{24}$$

Deposits are insured, so depositors are repaid in full even if the bank fails.

4.3.2 Exit and entry

Banks face the same structure of exit and entry as firms. At the end of period 1, a fraction τ_x^B of bankers exit and consume their wealth. New bankers enter with total net

worth equal to a fraction ξ^B of aggregate bank net worth in period 1, N^B. In the aggregate, this inflow is equivalent to an outside recapitalization of the banking system, and I calibrate it to the equity injections into Indian banks.

Without exit, bankers would retain all of their earnings, and bank net worth would grow even if no shock occurred. The entry and exit of banks also helps pin down the return on bank equity and the wedge τ as I show below. Like in firms, it sets the weight the banker places on period 2. Entry does not affect this weight, since the inflow goes to new bankers, not to existing ones.

4.3.3 The bank's problem

Let $\lambda^B \equiv b_d/n^B$ denote bank leverage, so the capital requirement becomes $\lambda^B \leq 1/\theta$. A bank chooses its leverage in period 1 to solve

$$V_1^B(n^B, S) = \max_{\lambda^B \leq 1/\theta} \frac{1}{R}\,\mathbb{E}_\omega\Big[\tau_x^B W^B(\omega) + (1-\tau_x^B)\,V_2^B\big(W^B(\omega),\, S'(\omega)\big)\Big] \tag{25}$$

Here V_2^B is the value of a bank that enters period 2 with net worth n^B. Period 2 is the last period, so the bank consumes all of its wealth at the end of it:

$$V_2^B(n^B, S') = \max_{\lambda^{B\prime} \leq 1/\theta} \frac{1}{R}\,\mathbb{E}_{\omega'}\big[W^{B\prime}(\omega')\big], \tag{26}$$

where $W^{B\prime}(\omega')$ is end-of-period wealth, defined as in period 1 but with period-2 leverage, and the period-2 return on loans.

The bank's size does not affect its choices. A bank lends to many firms, so its return per unit lent, $\rho^B(\omega)$, depends only on the aggregate state and not on how much it lends. The deposit rate is the same for every bank, and the capital requirement depends only on the ratio λ^B. A bank with twice the net worth can therefore double its lending and its deposits, keep the same leverage, and end each period with twice the wealth:

$$W^B(\omega) = n^B\big[\lambda^B\big(\rho^B(\omega) - R\big) + R\big] \tag{27}$$

Its value is then proportional to its net worth in both periods. In period 2, which has no continuation, $V_2^B(n^B, S') = v_2^B(S')\,n^B$, where

$$v_2^B(S') = \max_{\lambda^{B\prime} \leq 1/\theta} \frac{1}{R}\,\mathbb{E}_{\omega'}\Big[\lambda^{B\prime}\big(\rho^{B\prime}(\omega') - R\big) + R\Big]. \tag{28}$$

Substituting this into the period-1 problem gives $V_1^B(n^B, S) = \nu_1^B(S)\, n^B$, and the problem becomes

$$\nu_1^B(S) = \max_{\lambda^B \le 1/\theta} \frac{1}{R}\, \mathbb{E}_\omega \Big[m^B(\omega) \left(\lambda^B(\rho^B(\omega) - R) + R \right) \Big], \tag{29}$$

$$\text{where } m^B(\omega) = \tau_x^B + (1 - \tau_x^B)\, \nu_2^B\big(S'(\omega)\big), \tag{30}$$

where, $m^B(\omega)$ is the value of one unit of bank wealth in state ω.

The period-1 objective is linear in λ^B, so the bank either lends as much as the requirement allows or lends less. It lends up to the requirement when the value of one more unit of lending is positive:

$$\frac{1}{R}\, \mathbb{E}_\omega \Big[m^B(\omega) \left(\rho^B(\omega) - R \right) \Big] > 0. \tag{31}$$

Writing the expectation of a product as the product of expectations plus a covariance,

$$\underbrace{\mathbb{E}[m^B]\; \mathbb{E}\big[\rho^B - R\big]}_{\text{lending incentive}} + \underbrace{\mathrm{Cov}\big(m^B(\omega),\, \rho^B(\omega)\big)}_{\text{precautionary motive}} > 0. \tag{32}$$

The first term is the lending incentive. On average, each unit lent earns more than it costs to fund, by $\mathbb{E}[\rho^B] - R = R\tau$, so this term is positive. The second term is the precautionary motive, and it is negative. Loans do worst in the state when the currency depreciates and aggregate productivity is low and many firms default. But this is also when capital is most valuable to a bank: after a crisis, few banks have capital left, so a bank that still has some can lend at high rates. Lending more therefore means losing the most exactly when the bank can least afford to. If this caution outweighs the gain from lending, the bank holds more capital than the requirement asks for. At the calibrated parameters, the gains from lending is greater and so the requirement binds.

4.3.4 The macroprudential wedge

Since every bank lends up to the requirement, aggregate bank net worth at the start of period 2 is

$$N^{B\prime}(\omega) = (1 - \tau_x^B)\, \max\Big\{ \frac{\rho^B(\omega) - R}{\theta} + R,\; 0 \Big\} N^B + \xi^B N^B. \tag{33}$$

The maximum reflects limited liability: a bank whose losses exceed its net worth ends the period with nothing.

I start by assuming the economy at a stationary point: absent any shocks, expected bank net worth stays the same from one period to the next.[24] Let $R^e \equiv \mathbb{E}_\omega[W^B(\omega)]/n^B$ denote the expected gross return on bank equity. When the bank survives in every state, stationarity requires

$$(1-\tau_x^B)\,R^e + \xi^B = 1, \qquad \text{so} \qquad R^e = \frac{1-\xi^B}{1-\tau_x^B}.$$

The return on equity is therefore pinned by the entry and exit of bankers. I calibrate R^e to the long run return on equity of Indian banks and ξ^B to equity injections, and τ_x^B drops out as a residual from this condition.

The bank's balance sheet gives a second expression for the same return. With $b_d = n^B/\theta$, expected wealth per unit of equity is

$$R^e = \frac{1}{\theta}\Big(\mathbb{E}[\rho^B] - R\Big) + R = R\Big(1 + \frac{\tau}{\theta}\Big).$$

Each unit of equity supports $1/\theta$ units of lending, and each unit of lending earns the margin $R\tau$. Equating the two expressions gives the wedge:

$$\tau = \theta\,\frac{R^e - R}{R}. \tag{34}$$

Equity is more expensive than deposits, by the equity premium $(R^e - R)/R$. Requiring banks to fund a larger share of each loan with equity raises the cost of lending, and the wedge rises in proportion to θ. [25]

4.3.5 Solvency floor

A bank survives state ω if its wealth is not negative, $W^B(\omega) \geq 0$. With $n^B = \theta\, b_d$, this is

$$b_d\big(\rho^B(\omega) - R\big) + R\,\theta\, b_d \geq 0 \quad \Longleftrightarrow \quad \theta \geq 1 - \frac{\rho^B(\omega)}{R}.$$

The condition is hardest to meet in the worst realization of ω, where the return on loans is lowest.

[24] This is equivalent to the long run or steady state in an infinite period model

[25] The wedge depends only on the return on equity, not on how stationarity is split between entry and exit.

Let ω_c denote the worst realization of the state ω. The bank is solvent in every state if and only if $\theta \geq \theta_{\text{floor}}$, where

$$\theta_{\text{floor}} = 1 - \frac{\rho^B(\omega_c)}{R}.$$

Below the floor, the worst realization of ω completely wipes out the bank's equity. Deposit insurance has to then cover the shortfall, $\max\{-W^B(\omega_c), 0\}$, so depositors are repaid in full. I treat this payment as a cost to the government. The regulator never lowers the requirement below this floor.

4.4 The return on capital

Each firm takes the return on capital R^K as given. In the aggregate, it depends on how much capital the economy uses. Capital works with a fixed supply of one unit of labor, so aggregate output is $\mathcal{A}K^\alpha$, where K is aggregate capital, $\alpha \in (0,1)$ is the capital share and $\mathcal{A} > 0$ is a constant. A unit of capital returns itself plus its marginal product:

$$R^K = 1 + \alpha \mathcal{A} K^{\alpha - 1}. \tag{35}$$

Since $\alpha < 1$, each unit of capital earns less when firms as a whole install more.

Capital receives its marginal product, so it gets a share α of output. The rest, a share $1 - \alpha$, goes to labor. Households supply the one unit of labor inelastically and receive

$$w = (1 - \alpha)\, \mathcal{A} K^\alpha. \tag{36}$$

Labor has no other use in the model, so the whole wage bill is income households would not otherwise have. It depends on how much capital firms install. When aggregate capital falls, each unit of capital earns more and the wage falls, and to first order the two changes offset each other exactly:

$$K \frac{\partial R^K}{\partial K} = -(1 - \alpha)\, \alpha \mathcal{A} K^{\alpha - 1} = -\frac{\partial w}{\partial K}.$$

What owners of capital gain from a higher return is what households lose in wages.

Each firm is small, so it takes R^K as given and still operates with constant returns to scale. Only the economy as a whole runs into diminishing returns. Since every firm chooses the same leverage, aggregate capital is $K = \lambda N^F$.

This gives the model a natural recovery force. After a bad shock, firms enter period 2 with less net worth and install less capital, so each unit of capital earns more. Firms coming out of a crisis therefore rebuild faster, and a unit of firm net worth is worth more in that state.

4.5 Timing

Events within the two periods unfold as follows.

Period 1.

1. The economy starts with aggregate firm net worth N^F and bank net worth N^B, under a capital requirement θ.

2. Firms choose their leverage and debt mix. Lenders set the interest rates R_d and R_f and lend based on the contracted rates.Aggregate capital determines the return on capital R^K.

3. The aggregate state $\omega = (e', A)$ is realized, followed by each firm's own productivity z.

4. Firms whose productivity falls below $\bar{z}(\omega)$ default, and lenders recover part of the project value. Banks earn $\rho^B(\omega)$ on their loans. If a bank's losses exceed its net worth, deposit insurance repays its depositors.

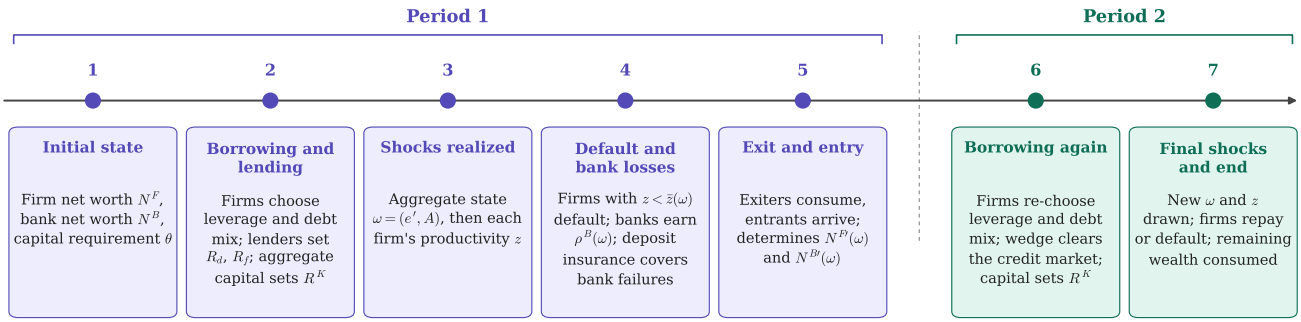
5. Some firms and bankers exit and consume their wealth, and new ones enter. This determines firm and bank net worth at the start of period 2, $N^{F\prime}(\omega)$ and $N^{B\prime}(\omega)$.

Period 2.

6. Firms choose their leverage and debt mix again. The wedge adjusts so that the credit banks can supply equals what firms want to borrow, and aggregate capital determines the return on capital.

7. A new aggregate state and new productivity draws are realized. Firms repay or default, all remaining wealth is consumed, and the economy ends.

The diagram below depicts the timing and flow visually



4.6 What happens after a shock

An adverse shock ω at the end of period 1 damages both banks and firms. At the start of period 2, firms inherit their net worth, $N^{F\prime}(\omega)$ and banks inherit their net worth $N^{B\prime}(\omega)$ following from equations 33 and 17. The wedge τ adjusts to clear the market.

Supply. Banks lend at most what the requirement θ allows, so the credit they can supply is

$$B^{supply}(\omega) = \frac{N^{B\prime}(\omega)}{\theta}.$$

Demand. Each unit of firm net worth borrows $b(\tau')$ from banks, an amount that falls as the wedge rises. Aggregate demand is

$$B^{demand}(\omega) = N^{F\prime}(\omega)\, b\big(\tau'(\omega)\big).$$

A bad shock lowers firm net worth too, so demand for credit falls along with the supply.

Clearing. The wedge $\tau'(\omega)$ adjusts so that demand equals supply. If banks can supply more than firms want even with no wedge, then $\tau'(\omega) = 0$ and banks lend less than the requirement allows. After a mild shock, banks have enough net worth to meet demand at a low wedge or none. The same phenomenon happens if the bank is well capitalized. After a severe shock or if the bank is inadequately capitalized, they fall short, the wedge rises, and firms pay more for domestic credit in period 2.

4.7 Equilibrium

I normalize firm net worth in period 1 to one, $N^F = 1$. Since every choice is proportional to net worth, this is without loss of generality. Households supply deposits elastically at R and foreign lenders supply funds elastically at R^*, so neither market needs a clearing condition.

Definition 1 (Equilibrium)**.** Given a capital requirement θ and a policy regime, an equilibrium consists of

- **allocations:** firm choices (λ, s) and bank leverage (λ^B) in period 1, and, for each aggregate state ω, firm choices (λ', s') and bank leverage $(\lambda^{B\prime})$ in period 2;
- **prices:** interest rates (R_d, R_f), the wedge τ and the return on capital R^K in period 1, and, for each ω, interest rates (R'_d, R'_f), the wedge τ' and the return on capital $R^{K\prime}$ in period 2;
- **aggregate net worth:** bank net worth N^B in period 1, and firm and bank net worth $(N^{F\prime}, N^{B\prime})$ at the start of period 2;
- **values:** the values of firm and bank net worth in each period, ν_1^F, ν_2^F, ν_1^B and ν_2^B,

such that:

1. **Firms** solve the firm's problem in each period, taking prices as given: in period 1 with the weights $m(\omega)$, and in period 2 with $m = 1$.
2. **Banks** solve the bank's problem in each period, taking prices as given, subject to the requirement θ in period 1 and 2.
3. **Interest rates** satisfy the lender's participation condition in equation 10 for each period.
4. **The domestic credit market clears:** the domestic debt firms demand equals the domestic credit banks supply,

$$s(\lambda - 1)\, N^F = \lambda^B N^B \qquad \text{and} \qquad s'(\lambda' - 1)\, N^{F\prime}(\omega) = \lambda^{B\prime}(\omega)\, N^{B\prime}(\omega),$$

   with $\tau'(\omega) \geq 0$.
5. **The return on capital** satisfies equation 35, with $K = \lambda N^F$ in period 1 and $K_2 = \lambda' N^{F\prime}$ in period 2.

6. **The wedge** satisfies equation 34

7. **Net worth** evolves according to equations 17 and 33.

8. **Expectations are consistent:** the values $v_2^F(S'(\omega))$ and $v_2^B(S'(\omega))$ that firms and banks use equal the period-2 values in state ω.

In period 1, the wedge is set by equation 34, so the market clearing condition determines aggregate bank net worth. Once that is set, in period 2, aggregate bank net worth is inherited from period 1, so the market clearing condition determines how steep the wedge is.

4.8 Welfare

All agents are risk neutral, so I measure welfare as the sum of the expected values of the domestic agents that policy affects, in period-1 present value:

$$\begin{aligned}\mathcal{W}(\theta) = \underbrace{v^F N^F}_{\text{firms}} + \underbrace{\tau B_d + \frac{1}{R}\,\mathbb{E}_\omega\left[\tau'(\omega)\, B'_d(\omega)\right]}_{\text{bank owners}} \\ + \underbrace{\frac{1}{R}\,w + \frac{1}{R^2}\,\mathbb{E}_\omega\left[w'(\omega)\right]}_{\text{households}} - \underbrace{\frac{1}{R}\,\mathbb{E}_\omega\left[DI(\omega)\right]}_{\text{cost of bank failure}},\end{aligned} \tag{37}$$

where B_d and $B'_d(\omega)$ are domestic credit in periods 1 and 2, w and $w'(\omega) = (1-\alpha)\mathcal{A}K_2(\omega)^\alpha$ are the wage that households receive in periods 1 and 2 from equation 36, paid at the end of each period, and

The first term is the value of firms. It already includes what firms expect in period 2 and the consumption of firms that exit through the weights $m(\omega)$. The second term is bank rents: what banks earn above their cost of deposits. The third term is households' wage income. A higher requirement can lower the capital firms install. This raises the return on each unit of capital, which firm value counts as a gain, and lowers wages by the same amount. Without the wage term, welfare would count the gain to firms and miss the loss to households. The wedge itself is just a transfer: what firms pay in extra interest, the bank owners receive. However, welfare depends on the wedge through the distortion it creates. A higher wedge pushes firms toward foreign debt, raises their default risk in states where a currency depreciation occurs, and rations credit after a bad shock. The last term is the cost of bank failure. Below the solvency

floor, a crisis state wipes out bank equity, and the deposit insurance becomes active and repays depositors. Covering this shortfall uses public funds, and I count the payout as the cost of bank failure. Above the solvency floor the payout is zero.

Optimal policy. The regulator chooses θ in period 1 to maximize $\mathcal{W}(\theta)$. A tighter requirement has costs: it raises the wedge in period 1, which pushes firms toward foreign debt and raises default after a depreciation. It also has benefits: banks keep more net worth after a bad shock, so less credit is rationed in period 2, and a requirement above the solvency floor rules out bank failure. The optimal requirement balances the two.

5 Calibration

For the calibration, parameters with a direct counterpart in Indian data are set to it. Five parameters without a direct counterpart are chosen so that the model matches the features of Indian firms and banks that drive its mechanism: how much firms borrow, how much of it is in foreign currency, how often they default, how much more they default in bad times, and what they pay for domestic bank credit. Moments that are not targeted serve as a check. The baseline capital requirement is $\theta = 0.09$, the RBI's minimum CRAR. The implied wedge is $\tau = 0.0634 \times 0.09 = 0.57\%$.

Table 3: Parameters set directly

Parameter	Description	Value	Source
R	Domestic real risk-free rate, annual	1.025	Real 10-year G-Sec yield, RBI
R^*	Foreign real rate, annual	1.015	India minus US real rate differential
R^e	Real return on bank equity	1.09	Median return on equity of scheduled commercial banks, 2000 to 2025, RBI
ξ^B	Bank equity inflow	0.041	Equity raised by public sector banks, FY2009 to FY2019, over bank net worth
α	Capital share	0.30	Standard value
σ_e	Exchange rate volatility	0.07	Annual changes in the INR/USD rate, RBI
θ	Capital requirement	0.09	RBI minimum capital ratio
χ	Leverage adjustment cost	2	Limits the response of total borrowing to the wedge
ξ^F	Firm entry	0	See text

Table 4: Targeted moments

Moment	Target	Source	Parameter	Value
Domestic share of debt, s	0.62	Prowess, firms firms w/ access to foreign credit	Curvature of recovery wedge, ψ	1.879
Leverage, k/n^F	2.40	Prowess, firms w/ access to foreign credit	Productivity constant, $\mathcal{A}$	0.360
Average default rate	4.25%	Slippage ratio, RBI	Idiosyncratic risk, σ_z	0.288
Default rate, bad minus good times	4.5 pp	Slippage ratio, RBI	Aggregate shock, σ_A	0.078
Domestic loan spread, $R_d - R$	1.7 pp	Prowess, large borrowers	Recovery share, κ	0.85

Matching the data. The five parameters in Table 4 are solved jointly, but each is tied mainly to one moment. The curvature ψ of the recovery wedge sets the share of debt in domestic currency, the productivity constant $\mathcal{A}$ sets leverage, idiosyncratic risk σ_z sets the average default rate, the aggregate shock σ_A sets how much default rises in bad times, and the recovery share κ sets the domestic loan spread.

Default rates. I measure default with the slippage ratio, which the RBI defines as the loans that become non-performing during a year as a share of performing loans at the start of the year. Like the default rate in the model, it is a flow. The ratio was 1.4 per cent in 2024–25, and it averaged about 6.5 per cent over 2015–16 to 2017–18, peaking at 7.6 per cent.I target an average default rate of 4.25 per cent and a gap of 4.5 percentage points between bad and good times, which correspond to about 2 per cent in normal years and 6.5 per cent at the peak.

Recovery in default. I choose κ so that the domestic loan spread is 1.7 percentage points, the spread paid by large Indian firms, which are the firms able to borrow abroad. This requires $\kappa = 0.85$, which is higher than recovery rates under India's Insolvency and Bankruptcy Code. The two measure different things. κ is the share of a defaulting firm's project value that lenders recover. Measured recovery rates compare what lenders receive with what they are owed, and a firm defaults precisely because what it owes exceeds what it is worth. A κ as low as measured recovery rates would imply higher spreads than large firms pay and I treat this parameter as one to target the spreads within the range observed in the data.

The aggregate shock. The shock A scales the realized return on capital. The model has no separate price of capital, so A captures both changes in profitability and the revaluation of installed capital, which in models with an explicit price of capital operates through that price. Its volatility is therefore set by the swing in default rates rather than by the volatility of profit rates.

Entry, exit and residuals. The banker exit rate follows from the stationarity condition, $(1 - \tau_x^B)R^e + \xi^B = 1$, which gives $\tau_x^B = 0.120$ as a residual. On the firm side, stationarity, $(1 - \tau_x^F)R^{e,F} + \xi^F = 1$, pins down only one combination of exit and entry. Firms that enter at the end of period 1 would arrive after the shock, without the currency exposures it acts on. I set $\xi^F = 0$, so that firm net worth in period 2 consists of

the balance sheets the shock actually hit, and let the exit rate clear the condition. This gives $\tau_x^F = 0.087$, an expected firm life of about twelve years. Finally, $\bar{\lambda}$ equals leverage at the baseline, 2.40, so the adjustment cost is zero there.

Untargeted moments. Table 5 compares moments that the calibration does not target with the data. At the calibrated parameters, the lending incentive also exceeds the precautionary motive, so banks lend up to the requirement.

Table 5: Untargeted moments

Moment	Model	Data	Source
Real return on capital	5.9%	5.1 to 7.8%	Return on capital employed, 11.4 to 12.6%, less inflation of 4.5 to 6%
Return on capital over the risk-free rate	3.4 pp	2.6 to 5.3 pp	Same, less the real G-Sec yield
Foreign debt spread, $R_f - R^*$	1.6 pp	About 1.7 pp	RBI, external commercial borrowing
Solvency floor, θ_{floor}	0.031	0.03	Leverage ratio: Basel III minimum 3%, RBI 3%

6 Results

This section shows how firms and banks respond to a tighter capital requirement, and how the regulator weighs these responses in choosing the requirement.

6.1 Firms' response to tightening

A higher requirement raises the wedge on domestic credit and firms respond by shifting toward foreign currency debt. Figure 9 shows the domestic share of debt at each wedge. With no wedge, firms borrow 70 per cent of their debt at home. At the baseline wedge of 0.57 per cent this falls to 62 per cent, and at a wedge of 1.5 per cent to 52 per cent.

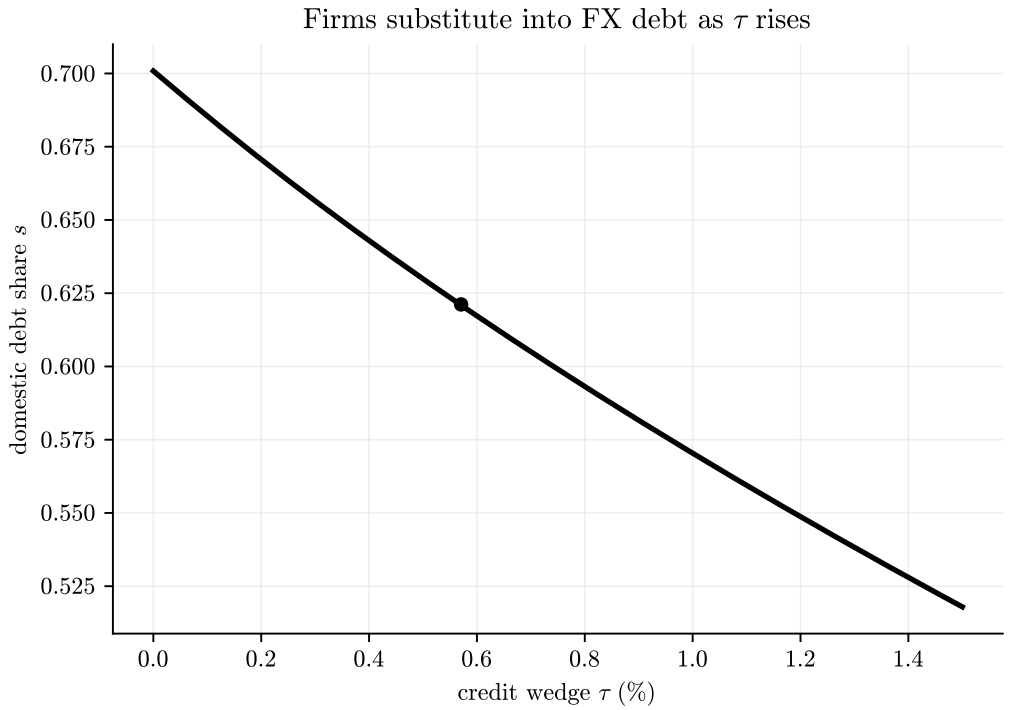


Figure 9: Domestic share of debt against the credit wedge.

Notes: This figure plots the domestic share of debt against the credit wedge in the model. The dot marks the baseline wedge corresponding to a $\theta = 0.09$ that gives $\tau = 0.57$ per cent.

Figure 10 shows default probabilities in a state of currency depreciation as well as appreciation. As the wedge rises from zero to 1.5 per cent. The default probability after a depreciation rises by about 10 per cent, from 4.82 to 5.32 per cent, while the default probability after an appreciation falls by about 8 per cent, from 3.57 to 3.29 per cent. The average rises by about 2.5 per cent, from 4.19 to 4.30 per cent. Tightening therefore moves default risk into the states where the currency depreciates.

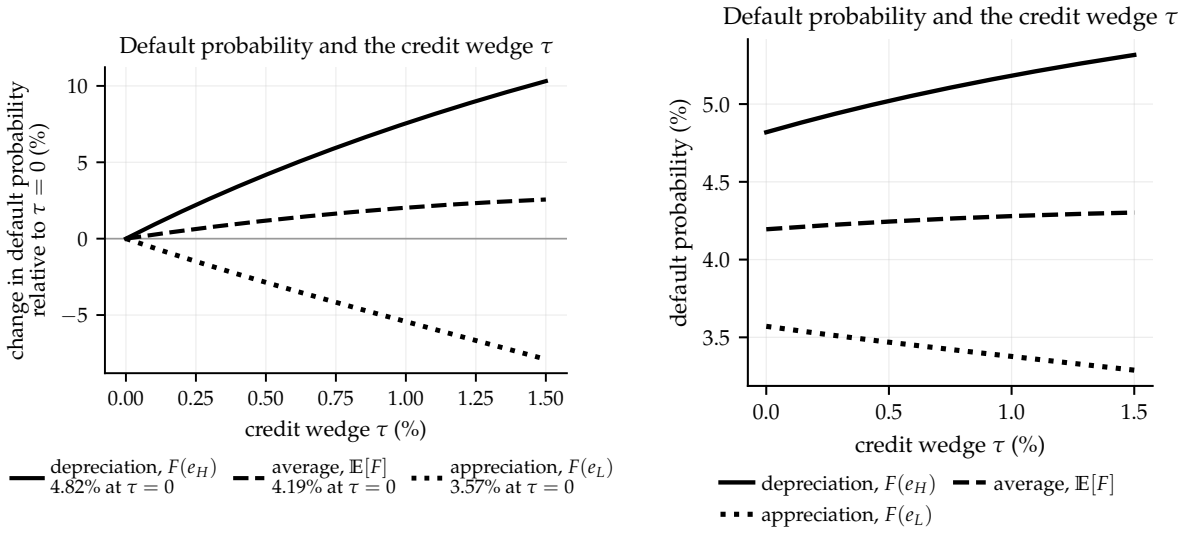


Figure 10: Default probability against the credit wedge.

Notes: This figure plots the default probability of firms against the credit wedge in percent change from $\tau = 0$ (left) and in levels (right).

6.2 Banks and lending after a crisis

The benefit of a higher requirement appears after an adverse shock. Figure 11 shows the credit wedge τ in the state when the currency depreciates and productivity is low (henceforth, referred to as the crisis state). Better capitalized banks ration less after an adverse shock: the crisis wedge falls from 2.8 per cent at $\theta = 0.056$ to 1.4 per cent at the baseline and 0.9 per cent at $\theta = 0.15$. It never reaches zero. A higher requirement gives banks more capital going into the crisis but it also requires more capital behind every loan afterwards.

How much banks lend also depends on the requirement. The requirement caps lending at N^B/θ, but a bank can lend less and hold a voluntary buffer as explained in equation 32. A bank chooses to lend up to the limit when the lending incentive outweighs the precautionary motive. Below a requirement of 5.6 per cent, the precautionary motive wins. Banks hold more capital than what the regulation mandates, and the requirement has no bite. To avoid results driven by the finite horizon of the model, I focus on requirements of 5.6 per cent and above, where banks lend up to the limit.

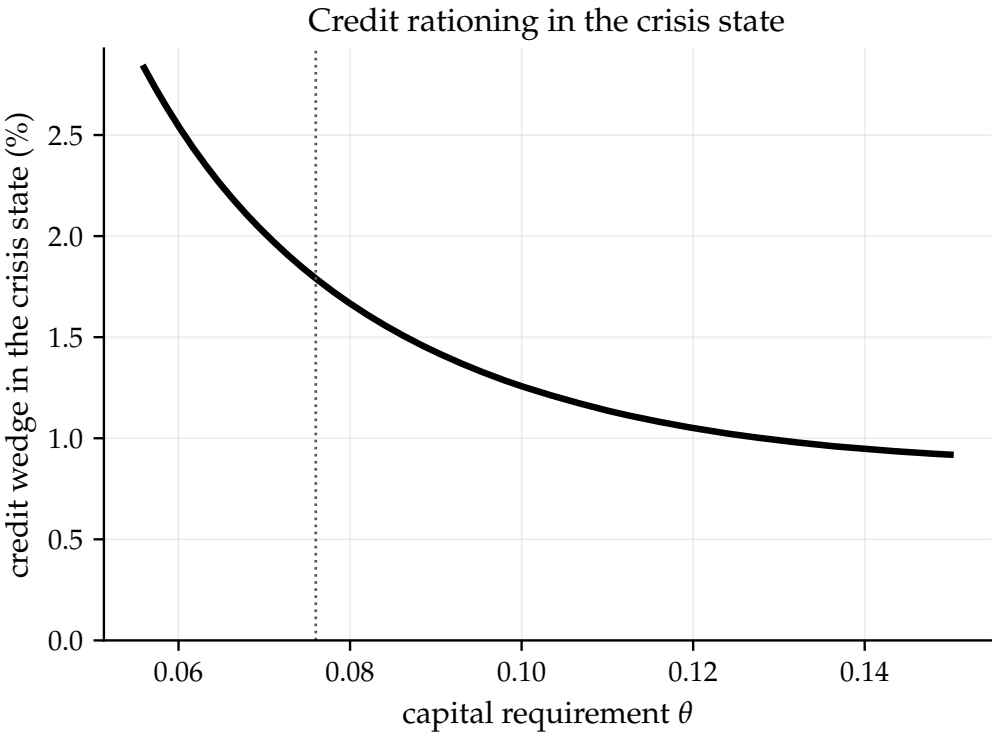


Figure 11: Credit wedge in the crisis state against the capital requirement.

Notes: This figure plots the credit wedge τ against the capital requirement in a crisis state

6.3 Optimal policy

Welfare adds up the value of firms, the rents earned by banks, households' wages and the cost of deposit insurance. Since every requirement I consider is above the solvency floor of banks at 3.1 per cent, they stay solvent after every shock and the deposit insurance never pays out. Welfare is then the sum of firm value, bank rents and wages.

6.3.1 Bank Rents and Market Failure

Total bank value or the total value of bank rents come from three places. Bank rents in normal times before any shocks hit, and bank rents after good or bad shocks are realized. Figure 12 plots each of them and Figure 13 plots the total bank value.

Normal Times: Before any shock, the wedge is simply the cost of the capital requirement. Banks must fund a share θ of each loan with expensive equity instead of cheap

deposits. Each unit of equity earns the same return at every requirement. higher requirement means more equity behind every loan, and firms pay the return on all of it. Rents in normal times therefore rise steadily with θ.

After Bad Shocks: When aggregate productivity is low, more firms default and banks lose part of their capital. Capital is now scarcer and the wedge becomes the price of that scarcity. It rises until firms borrow only what bank capital can support. If a bank enters the crisis state with more capital, they can ration less and so the wedge is smaller. Therefore, when capital requirements are higher, the wedge and subsequently the rents fall.

After good shocks: When productivity is high, firms repay and banks come out with plenty of capital. Up to a requirement of about 6.5 per cent, banks have more than enough to fund every loan firms want, so there is no wedge and no rent. Above it, the requirement binds even after a boom. Firms with high net worth want to borrow more than banks are allowed to lend, and a wedge appears.

Total: Between 5.6 and 6.5 per cent, the rents banks lose after bad shocks roughly offset the rents they gain in normal times, and total rents are flat. Above 6.5 per cent, rents after good shocks switch on and total rents climb with the requirement. From about 10 per cent on, banks earn more after good shocks than after bad ones.

The dashed line highlights a market failure. A bank keeps capital for a crisis because in this state, capital is worth a lot. It allows the bank to lend at a high crisis wedge but when a bank decides how much capital to keep, it only thinks about its own profit. If all banks kept more capital, the crisis wedge would fall and every firm could borrow more cheaply after a crisis. That gain goes to firms and not to the bank that keeps the capital, so no bank keeps capital for it. Banks as a group don't mind this either, because a shortage of capital after a crisis is what lets them charge a high wedge. On their own, banks never keep more than about 5.6 per cent. The requirement fixes this by making every bank keep more capital, so the crisis wedge falls. The falling dashed line shows this fix at work.

Since banks are competitive, total bank rents rise with the requirement even though no bank wants to keep more on its own. A bank that keeps extra capital by itself cannot charge more for it since firms would borrow from other banks. So extra capital only costs the bank money. When the requirement makes every bank keep more, firms have

no cheaper bank to go to, and all banks charge more at once.

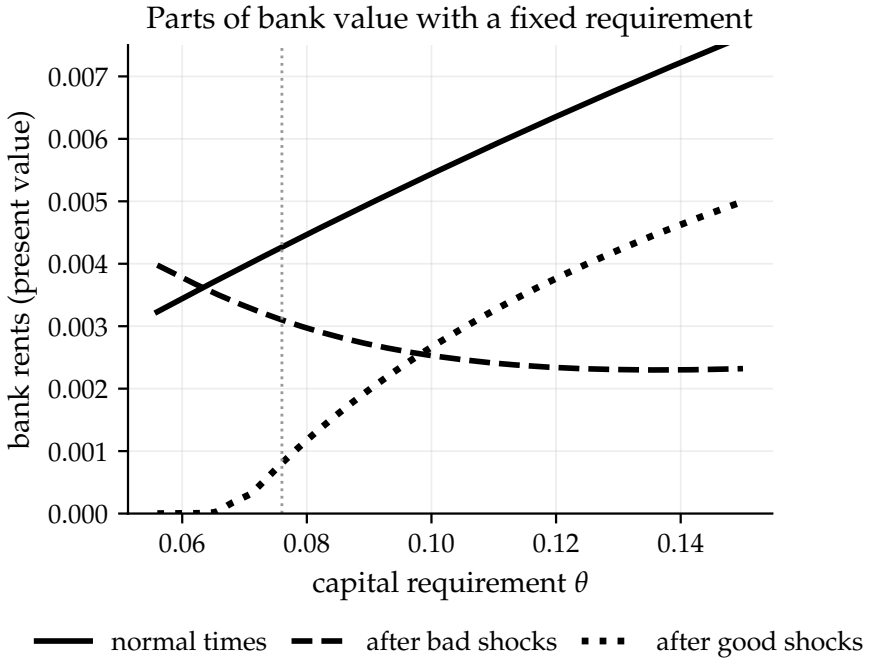


Figure 12: Components of Bank Value

Notes: This figure plots the bank rents earned by the bank for any capital requirement θ in normal times (solid line), after a bad shock (dashed line) and after a good shock (dotted line). Bad shocks are the two states with low productivity, and good shocks the two states with high productivity. The two period-2 lines show the expected present value of rents earned in those states, so the three lines add up to total bank rents.

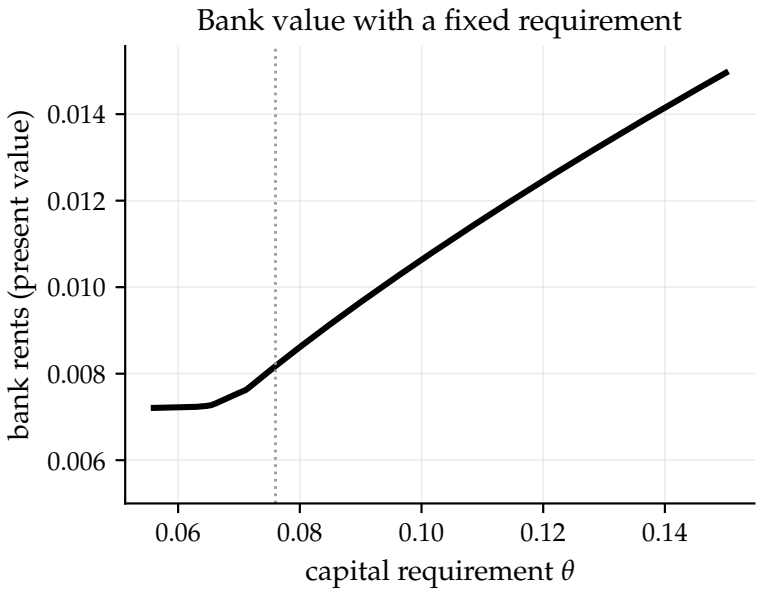


Figure 13: Total Bank Value

Notes: This figure plots the total bank rent earned by the bank for any capital requirement θ.

6.3.2 Firm Value

Figure 14 shows how firm value changes with the requirement θ. Firms are forward looking and gain from a lower crisis wedge. They pay for it in two ways. A higher wedge in normal times pushes them towards foreign currency debt leaving them more exposed to depreciation. And above a requirement of 6.5 per cent, firms also pay a wedge after good shocks. Firm value rises up to 6.5 per cent after which it falls monotonically.

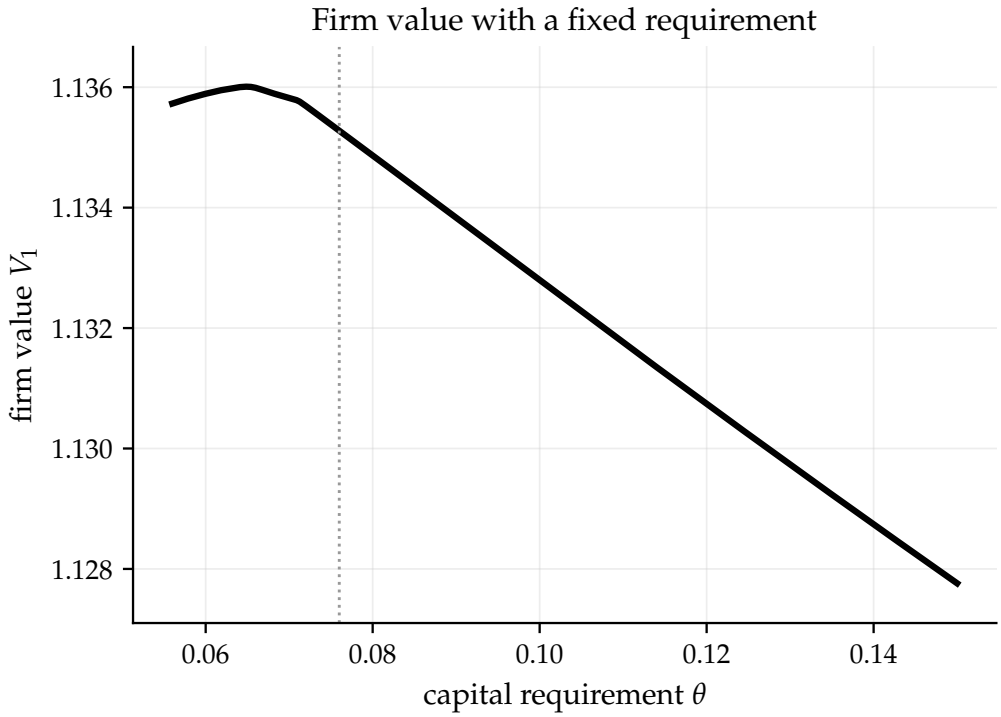


Figure 14: Firm Value

Notes: This figure plots the firm value for any capital requirement θ.

6.3.3 Optimal Requirement

Figure 15 adds the three. Welfare peaks at $\theta = 0.076$. Between 6.5 per cent and the optimum at 7.6 per cent, firm value falls less than what bank rents rise by, while wages barely change. This difference is a real gain. With better capitalized banks, firms keep investing after a crisis. Above the optimum, this gain levels off while the cost of the wedge in normal times and after good shocks keeps rising. The wedge also makes firms install less capital, which lowers wages. The optimum requirement is somewhat below RBI's long run regulatory minimum at 9 per cent and closer to the Basel III recommended 8 per cent.

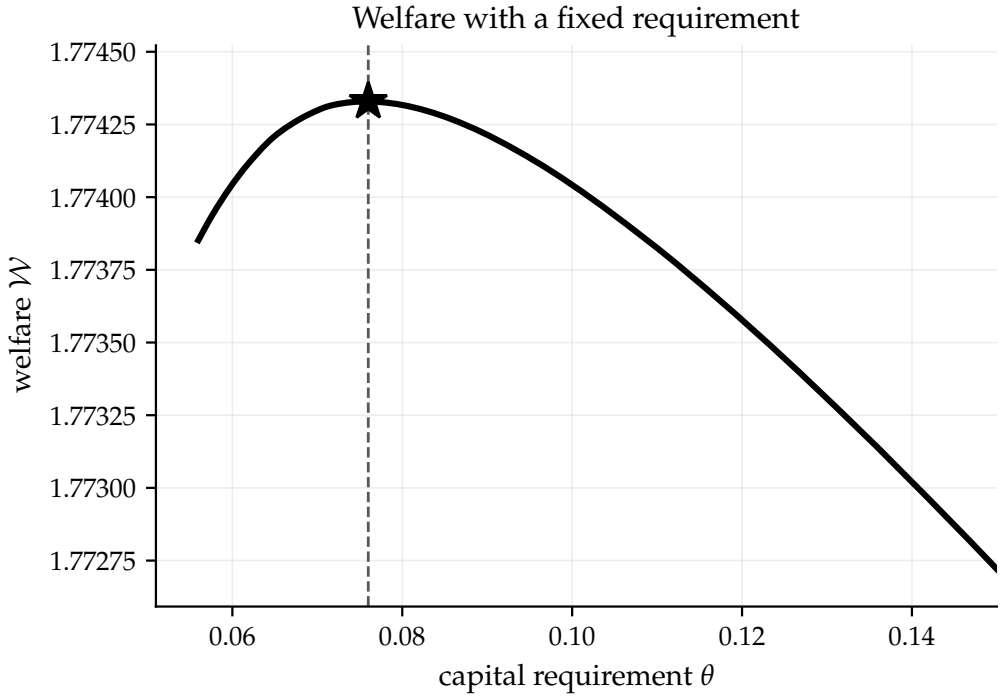


Figure 15: Welfare

Notes: This figure plots the Welfare against the capital requirement, θ. The star and dashed vertical line marks the optimum level at 0.084

Taken together, the results describe a trade-off with an intuitive resolution. A tighter capital requirement raises the cost of domestic credit, pushes firms toward foreign currency debt, and concentrates their default risk in the states where the currency depreciates. It also leaves banks better capitalized going into a crisis, so they keep lending when firms need it most. Banks do not hold this capital on their own, because no single bank gains from the lower borrowing costs its capital brings to every firm. The requirement corrects this market failure. Holding the requirement fixed across good times and bad, the regulator balances these forces at 7.6 per cent, below the RBI's minimum capital ratio of 9 per cent, which is also fixed.

6.4 Ignoring the leak

How much does the leak matter for policy? To answer this, I consider a regulator who uses the same model but believes that firms do not turn to foreign lenders when domestic credit gets more expensive. The regulator holds firms' foreign debt per unit of net worth fixed at its level under the RBI's existing 9 per cent long run requirement.

Everything else in its model is the same as in the true economy. The regulator picks the requirement that maximizes welfare in its own model, and I then ask what that requirement does in the true economy.

The regulator sets the requirement at 12.5 per cent, 5 percentage points above the optimum of 7.6 per cent (Figure 16). The regulator tightens too much because in its model, firms cannot borrow more abroad after a crisis, so the capital they can install is their own net worth, the fixed foreign debt and whatever banks can lend:

$$K_2(\omega) = \left(1 + \bar{b}_f\right) N^{F\prime}(\omega) + \frac{N^{B\prime}(\omega)}{\theta}.$$

Every unit of bank capital that a higher requirement preserves turns into more investment after a crisis, so tightening looks very valuable. In the true economy, firms that cannot get enough credit from banks after a crisis borrow abroad instead.[26] Extra bank lending then mostly replaces foreign borrowing. Investment after a crisis falls by less than the regulator expects, and a higher requirement does little to raise it. The regulator also misses the cost of the leak before a crisis. In the true economy, a higher requirement pushes firms into foreign debt, so more of them default when the currency depreciates.

[26] Foreign credit becomes more expensive as firms borrow more of it, but it is still cheaper than relying on banks alone after a crisis.

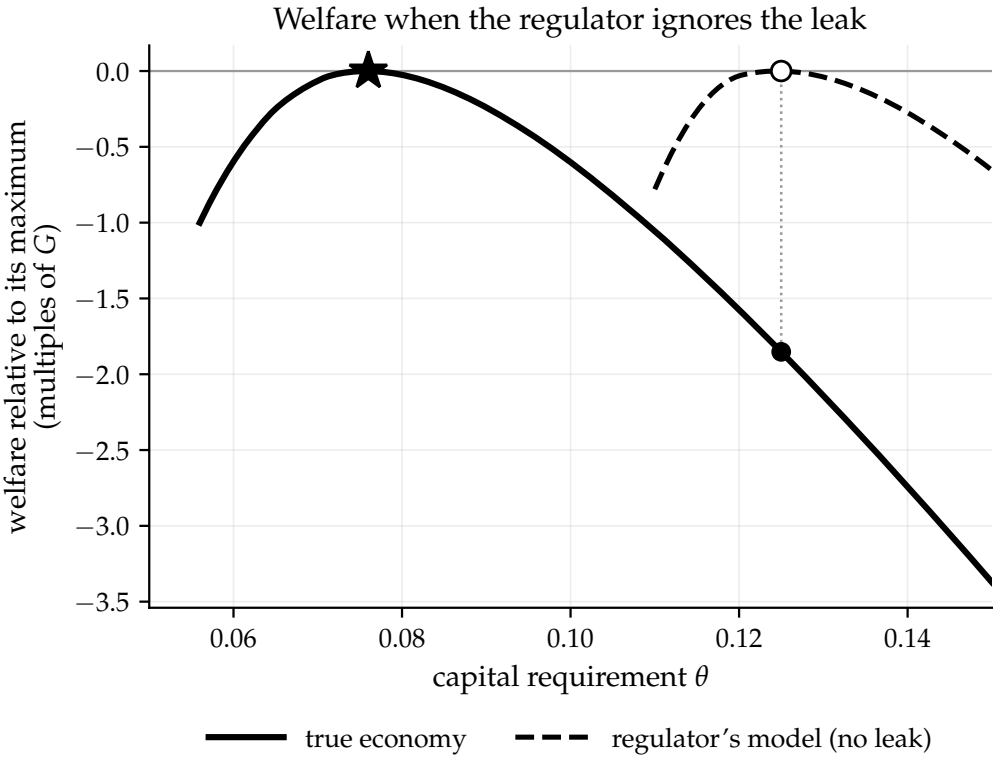


Figure 16: Welfare when the regulator ignores the leak

Notes: Welfare in the true economy (solid line) and in the regulator's model (dashed line), each measured from its own peak. G is the welfare gain from the optimal requirement over the 5.6 per cent banks hold on their own. The star marks the optimum, the open circle the regulator's choice, and the filled circle what that choice delivers in the true economy.

7 Conclusion

This paper highlights a tension inherent to macroprudential policy: it acts on banks, but its effects do not stop with banks. Measures that strengthen and stabilize the financial system also restrain the credit to firms. Part of the credit they restrain reappears as foreign currency debt on firm balance sheets, and this debt is costly when the currency depreciates. The leakage matters for policy because banks remain exposed to these firms through their balance sheets. By making firms riskier and more prone to default, the policy feeds back onto the banks themselves. Optimal policy therefore requires a careful evaluation of both the firm side and the bank side.

The evidence comes in two steps. Firms that depend more on bank credit respond to a tightening by moving out of bank loans and into foreign currency debt, while their

total borrowing stays roughly unchanged. Firms that carry more foreign currency debt then report larger foreign exchange losses, lower profits and a higher chance of distress in years when the rupee falls. Taken together, the two steps show that a tightening leaves firms more exposed to a depreciation. Earlier work has traced macroprudential leakage mostly through lenders. These results add a margin on the borrower side, where the leakage takes the form of currency exposure.

I then develop a two-period small open economy model that brings firms and banks together in one framework. The model makes the channels of the trade-off explicit. A higher capital requirement makes banks safer. It also raises the cost of domestic credit, moving firms toward foreign currency debt and increasing their likelihood of default in states where the currency depreciates. Since banks hold the domestic debt of these same firms, the defaults that follow a depreciation impose losses on banks. The requirement still has value because it shifts lending capacity across states. Banks hold more capital and firms pay more for credit in normal times. In return, the wedge on domestic credit is smaller after a crisis, when firms need credit most. Each bank takes the price of credit as given, so it does not count that its capital lowers borrowing costs for every firm after a crisis. Left alone, banks hold too little capital, and the requirement corrects this market failure. Setting the optimal stance of policy therefore requires balancing these two forces. The model calibrated to India puts the optimal requirement is somewhat below the central bank's minimum of 9 per cent. A regulator who ignores the leak would set the requirement almost 5 percentage points higher.

The broader lesson is that macroprudential policy cannot be judged by the balance sheets of the regulated banks alone. When firms can borrow elsewhere, tightening domestic credit can move risk rather than remove it. In an open economy, the risk it moves can take the form of currency exposure that can come back to the banking system in a depreciation episode. Hence, for emerging markets where firms have access to foreign currency debt, macroprudential policy needs to account for both the resilience of banks and the currency composition of corporate balance sheets.

The results also point to the importance of accessible and liquid currency hedging markets. The RBI's concern for the stability of the domestic banking system will remain, and so will its use of macroprudential tools. Restricting foreign borrowing through tighter capital controls does not solve the problem either since firms that lose bank credit need to still invest in productive opportunities. Non-bank lenders can only serve part of the firms' demand for credit and India's corporate bond market is open mainly to highly rated firms. Foreign borrowing is therefore a useful source of fund-

ing for firms. The risk lies in leaving it unhedged. Deeper and more liquid hedging markets would let firms that turn abroad protect themselves against a depreciation at a market price, choosing how much to hedge based on their own costs and revenues, so that a tighter capital requirement makes banks safer without leaving the firms they lend to more fragile.

The findings suggest several directions for further work, starting with an endogenous exchange rate. If firm defaults and consequent capital outflows feed back into the exchange rate, the fragility channel would be stronger and more closely tied to the external conditions under which emerging markets borrow. Another extension would be to study seniority between lenders. Domestic and foreign lenders may differ in their seniority over firm assets, which could lead to richer default and restructuring outcomes.

References

Viral V Acharya and Siddharth Vij. Foreign currency borrowing of corporations as carry trades: Evidence from india. Technical report, National Bureau of Economic Research, 2020.

Tobias Adrian, Paolo Colla, and Hyun Song Shin. Which financial frictions? parsing the evidence from the financial crisis of 2007 to 2009. *NBER macroeconomics annual*, 27(1):159–214, 2013.

Toni Ahnert, Kristin Forbes, Christian Friedrich, and Dennis Reinhardt. Macroprudential fx regulations: shifting the snowbanks of fx vulnerability? *Journal of Financial Economics*, 140(1):145–174, 2021.

Shekhar Aiyar, Charles W Calomiris, and Tomasz Wieladek. Does macro-prudential regulation leak? evidence from a uk policy experiment. *Journal of Money, Credit and Banking*, 46(s1):181–214, 2014.

Zohair Alam, Adrian Alter, Jesse Eiseman, Gaston Gelos, Heedon Kang, Machiko Narita, Erlend Nier, and Naixi Wang. Digging deeper—evidence on the effects of macroprudential policies from a new database. *Journal of Money, Credit and Banking*, 2019.

Laura Alfaro, Gonzalo Asis, Anusha Chari, and Ugo Panizza. Corporate debt, firm

size and financial fragility in emerging markets. *Journal of International Economics*, 118:1–19, 2019.

Stefan Avdjiev, Catherine Casanova, Patrick McGuire, and Goetz Von Peter. International prudential policy spillovers: a global perspective. 2016.

Bo Becker and Victoria Ivashina. Cyclicality of credit supply: Firm level evidence. *Journal of Monetary Economics*, 62:76–93, 2014.

Ben S Bernanke, Mark Gertler, and Simon Gilchrist. The financial accelerator in a quantitative business cycle framework. *Handbook of macroeconomics*, 1:1341–1393, 1999.

Markus Brunnermeier, Andrew Crockett, Charles AE Goodhart, Avinash Persaud, Hyun Song Shin, et al. *The fundamental principles of financial regulation*, volume 11. ICMB, Internat. Center for Monetary and Banking Studies Geneva, 2009.

Valentina Bruno and Hyun Song Shin. Capital flows and the risk-taking channel of monetary policy. *Journal of monetary economics*, 71:119–132, 2015.

Valentina Bruno and Hyun Song Shin. Global dollar credit and carry trades: a firm-level analysis. *The Review of Financial Studies*, 30(3):703–749, 2017.

Valentina Bruno and Hyun Song Shin. Currency depreciation and emerging market corporate distress. *Management Science*, 66(5):1935–1961, 2020.

Eugenio Cerutti, Stijn Claessens, and Luc Laeven. The use and effectiveness of macroprudential policies: New evidence. *Journal of financial stability*, 28:203–224, 2017.

Michael KF Chui, Ingo Fender, and Vladyslav Sushko. Risks related to eme corporate balance sheets: the role of leverage and currency mismatch. *BIS Quarterly Review September*, 2014.

Janko Cizel, Jon Frost, Aerdt Houben, and Peter Wierts. Effective macroprudential policy: cross-sector substitution from price and quantity measures. *Journal of Money, Credit and Banking*, 51(5):1209–1235, 2019.

Nicolas Crouzet. Aggregate implications of corporate debt choices. *The Review of Economic Studies*, 85(3):1635–1682, 2018.

Wenxin Du and Jesse Schreger. Sovereign risk, currency risk, and corporate balance sheets. *The Review of Financial Studies*, 35(10):4587–4629, 2022.

Barry Eichengreen, Ricardo Hausmann, and Ugo Panizza. The pain of original sin. *Other People's Money: Debt Denomination and Financial Instability in Emerging Market Economies, University of Chicago Press, Chicago*, 2003.

Barry Eichengreen, Ricardo Hausmann, and Ugo Panizza. Currency mismatches, debt intolerance, and the original sin: Why they are not the same and why it matters. In *Capital controls and capital flows in emerging economies: Policies, practices, and consequences*, pages 121–170. University of Chicago Press, 2007.

Barry Eichengreen, Ricardo Hausmann, and Ugo Panizza. Yet it endures: The persistence of original sin. *Open Economies Review*, 34(1):1–42, 2023.

Vadim Elenev, Tim Landvoigt, and Stijn Van Nieuwerburgh. A macroeconomic model with financially constrained producers and intermediaries. *Econometrica*, 89(3):1361–1418, 2021.

Luigi Falasconi, Pablo Herrero, Caterina Mendicino, and Dominik Supera. The foreign liability channel of bank capital requirements. *Available at SSRN 4999829*, 2024.

Gabriele Galati and Richhild Moessner. Macroprudential policy, a literature review. *Journal of Economic Surveys*, 27(5):846–878, 2013. doi: https://doi.org/10.1111/j.1467-6419.2012.00729.x. URL https://onlinelibrary.wiley.com/doi/abs/10.1111/j.1467-6419.2012.00729.x.

Rohit Goel, Swapnanil SenGupta, and Udaibir Saran Das. Corporate foreign exchange risk in india: firm-level evidence and some policy implications. *Margin: the journal of applied economic research*, 19(2):131–186, 2025.

Samuel G Hanson, Anil K Kashyap, and Jeremy C Stein. A macroprudential approach to financial regulation. *Journal of economic Perspectives*, 25(1):3–28, 2011.

Ricardo Hausmann and Ugo Panizza. On the determinants of original sin: an empirical investigation. *Journal of international Money and Finance*, 22(7):957–990, 2003.

Òscar Jordà. Local projections for applied economics. *Annual Review of Economics*, 15 (1):607–631, 2023.

Yun Jung Kim, Linda L Tesar, and Jing Zhang. The impact of foreign liabilities on small firms: Firm-level evidence from the korean crisis. *Journal of International Economics*, 97(2):209–230, 2015.

Enrique G Mendoza. Macroprudential policy: Promise and challenges. Technical report, National Bureau of Economic Research, 2016.

Friederike Niepmann and Tim Schmidt-Eisenlohr. Foreign currency loans and credit risk: Evidence from u.s. banks. *Journal of International Economics*, 135:103558, 2022. ISSN 0022-1996. doi: https://doi.org/10.1016/j.jinteco.2021.103558. URL https://www.sciencedirect.com/science/article/pii/S0022199621001380.

Ila Patnaik, Ajay Shah, and Nirvikar Singh. Foreign currency borrowing by indian firms: Towards a new policy framework, 2015.

Dennis Reinhardt and Rhiannon Sowerbutts. Regulatory arbitrage in action: evidence from banking flows and macroprudential policy. 2015.

Alonso Villacorta. Business cycles and the balance sheets of the financial and non-financial sectors. 2018.

Jin Young Yang and Hyunduk Suh. Heterogeneous effects of macroprudential policies on firm leverage and value. *International Review of Financial Analysis*, 86:102554, 2023. ISSN 1057-5219. doi: https://doi.org/10.1016/j.irfa.2023.102554. URL https://www.sciencedirect.com/science/article/pii/S1057521923000704.

Appendix A

Table A. 1: Macroprudential actions in India, 2004 to 2012

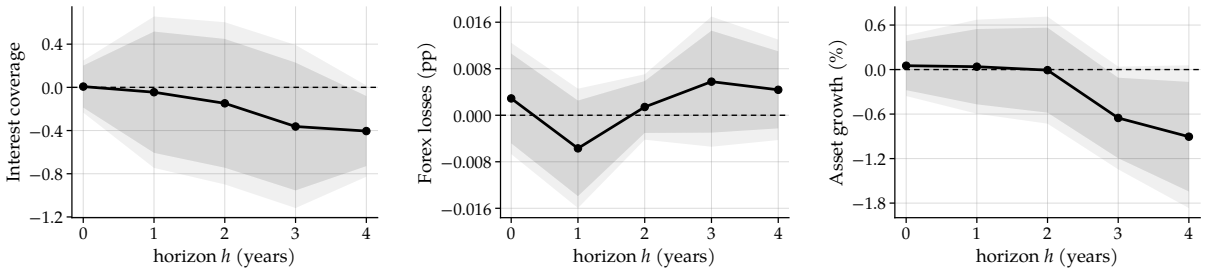
Instrument	Dates	Actions	What the actions did	Why they are left out
Cash reserve ratio	Sep 2004 to Nov 2012	23	13 increases from 4.5% to 9% (Sep 2004 to Aug 2008); 3 cuts to 5% (Oct 2008 to Jan 2009); 3 increases to 6% and a wider reserve base (Nov 2009 to Apr 2010); 4 cuts to 4.25% (2012)	Used with the policy rate to manage liquidity through the capital-inflow boom and the 2008 crisis, so it moves with the monetary cycle. It acts on bank funding, not on the capital charge on loans.
Statutory liquidity ratio	Sep 2008, Nov 2009, Dec 2010	3	Temporary cut from 25% to 24% in the crisis, restored in 2009, cut again in 2010	Crisis liquidity management. A requirement on government bond holdings, not a charge on lending.
Household and housing credit	Dec 2004 to Dec 2010	6	Risk weights on housing and consumer loans (Dec 2004, May 2007, May 2008, Dec 2010); LTV caps on housing loans (Dec 2010); 2% provisions on housing teaser loans (Dec 2010)	Aimed at household credit.
Urban cooperative bank lending limit	Nov 2010	2	Cap on housing, real estate and commercial real estate lending by urban cooperative banks (one measure, coded twice)	Binds only urban cooperative banks, small lenders that rarely lend to the firms in the sample, and is aimed at real estate.
Sector-specific risk weights and provisions	Jul 2005 to Nov 2008	8	Commercial real estate risk weight raised to 125% (Jul 2005) and 150% (Apr 2006); general provisions on standard advances raised from 0.25% to 0.4% (Nov 2005); higher provisions on personal loans, capital market exposures, commercial real estate and large housing loans (Jun 2006, Sep 2006, Jan 2007); both reversed in Nov 2008 (2 actions)	Targeted the sectors of the 2005 to 2007 boom rather than corporate lending as a whole. The one broad step (Nov 2005) was 0.15 percentage points, and all were unwound in the 2008 crisis. They enter the full-period robustness check.
Total		42	None of the 42 actions changes the minimum capital ratio (9% throughout), a capital buffer, a systemic surcharge or the leverage ratio.	

Table A. 2: Lender-based macroprudential actions in India, April 2013 to March 2022, by group

Group	Instruments	Tightenings	Easings	Total
Capital and provisioning charges	Minimum capital requirements, conservation buffer, countercyclical provisions, surcharges on systemically important banks, leverage ratio, loan loss provisioning, large-borrower and large exposure rules	18	6	24
Reserve and liquidity requirements	Cash reserve ratio, liquidity coverage ratio, net stable funding ratio, statutory liquidity ratio	8	7	15
Household credit and non-bank lenders	Risk weights on housing loans, housing finance company exposure limits	1	3	4
Foreign exchange rules	Limits on foreign currency positions and hedging requirements	2	1	3
Total		29	17	46

Notes: Lender-based actions recorded in the iMaPP database (Alam et al. 2019) between April 2013 and March 2022.

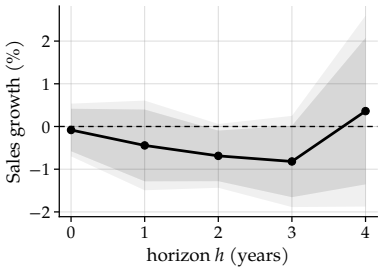
Appendix B



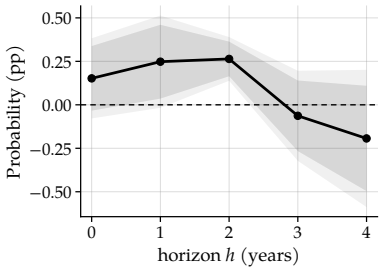
(a) Interest Coverage

(b) Forex Losses / Assets

(c) Asset Growth



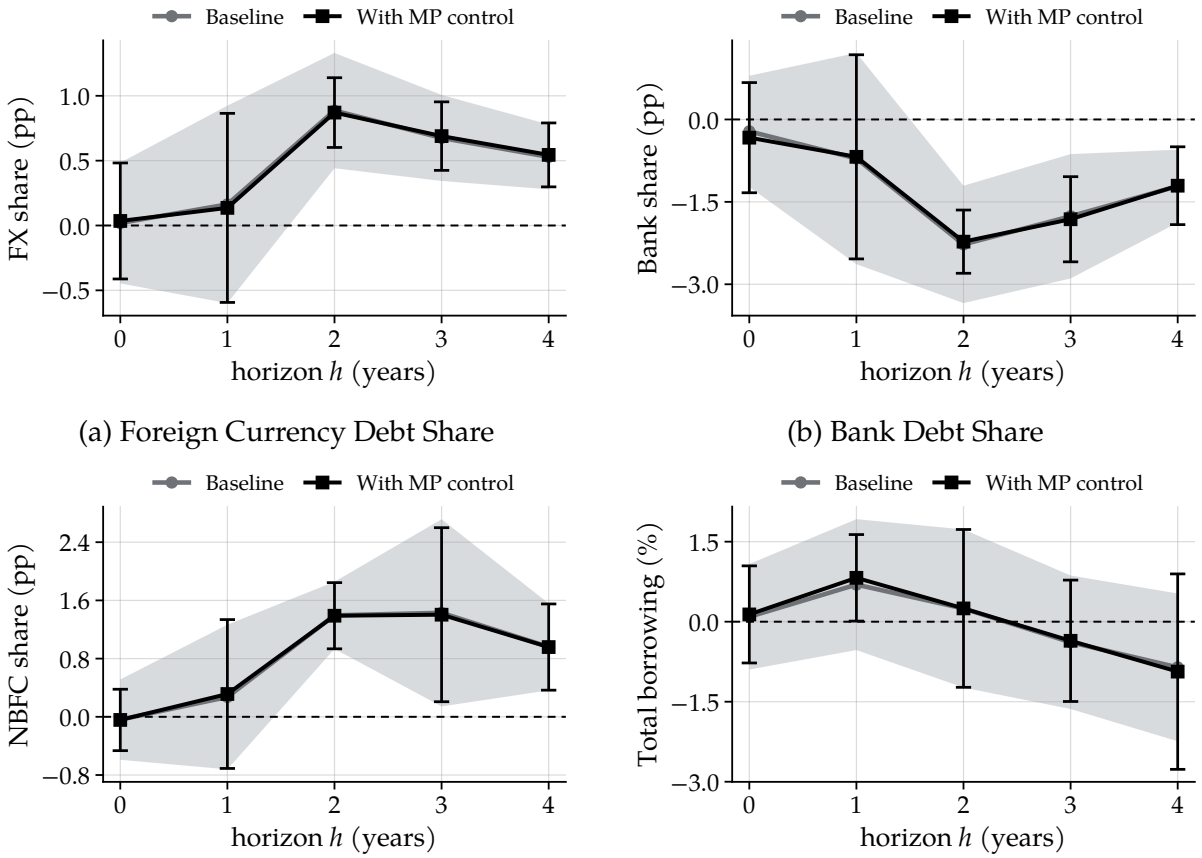
(d) Sales Growth



(e) P(Negative Net Worth)

Figure B.1: Costs of Substitution: Adding Reserve and Liquidity Requirements

Notes: Responses of the interest coverage ratio measured by PBDITA over interest (a), forex transaction losses as a ratio of firm assets (b), the cumulative growth of total assets (c), the cumulative growth of sales (d) and the probability of negative net worth in percentage points (e) of a firm following a macroprudential tightening shock that raises the capital or provisioning requirement on banks along with reserve and liquidity requirements. All regressions include firm and 3-digit industry by year fixed effects. Standard errors are two-way clustered by industry and year. Darker shaded regions denote 90% and lighter shaded regions 95% confidence intervals.



(a) Foreign Currency Debt Share

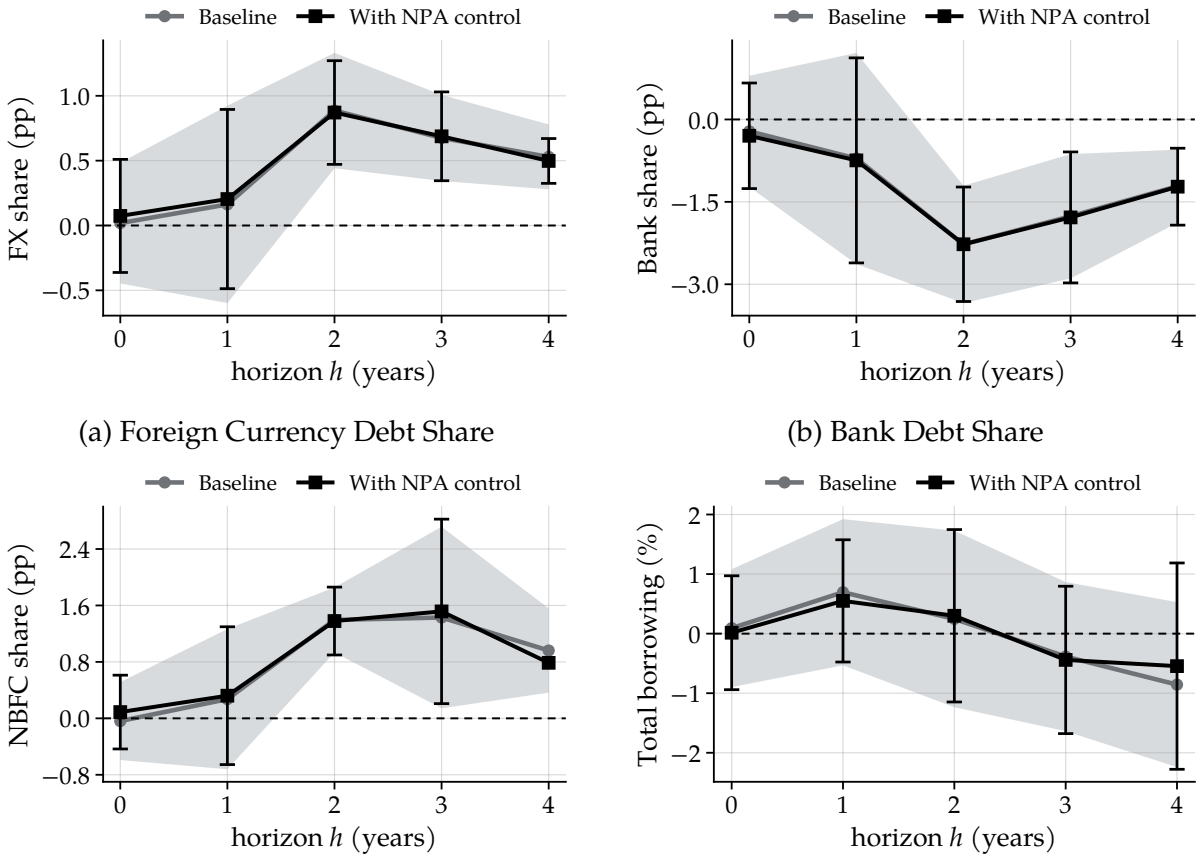
(b) Bank Debt Share

(c) NBFC Debt Share

(d) Total Borrowings (log)

Figure B.2: Controlling for Monetary Policy

Notes: This figure plots the responses of the firms share of foreign currency debt (a), bank debt (b), debt from non-bank financial corporations (c) and total borrowing (d) to macroprudential tightening action that raises the capital or provisioning requirement on banks, without (grey) and with (black) the annual change in the overnight call rate interacted with bank dependence. The band and bars are 90% confidence intervals. All regressions include firm and 3-digit industry by year fixed effects and standard errors are two-way clustered by industry and year.



(a) Foreign Currency Debt Share

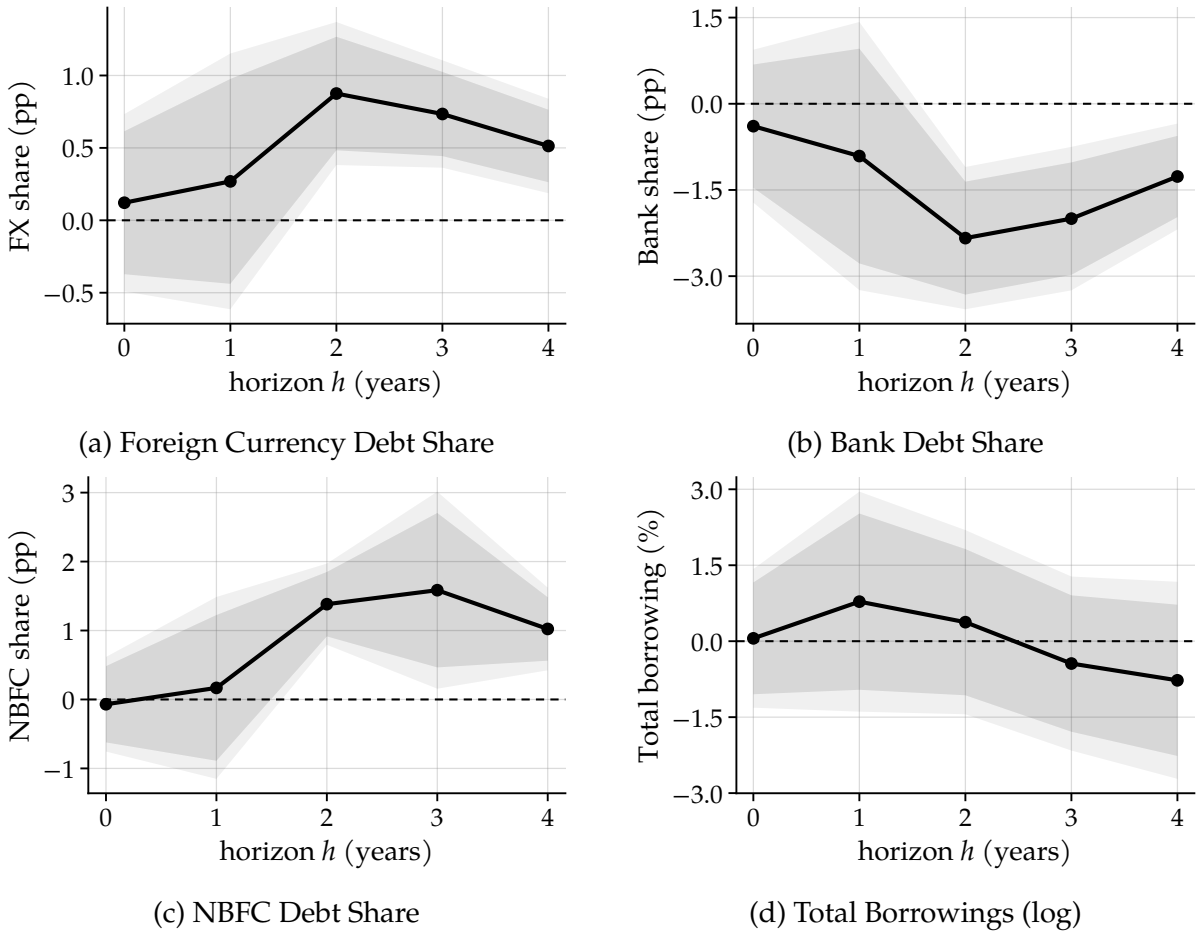
(b) Bank Debt Share

(c) NBFC Debt Share

(d) Total Borrowings (log)

Figure B.3: Controlling for Bank Bad Loans

Notes: This figure plots the responses of the firms share of foreign currency debt (a), bank debt (b), debt from non-bank financial corporations (c) and total borrowing (d) to macroprudential tightening action that raises the capital or provisioning requirement on banks, without (grey) and with (black) change in the gross non-performing asset ratio of scheduled commercial banks interacted with bank dependence. The band and bars are 90% confidence intervals. All regressions include firm and 3-digit industry by year fixed effects and standard errors are two-way clustered by industry and year.



(a) Foreign Currency Debt Share

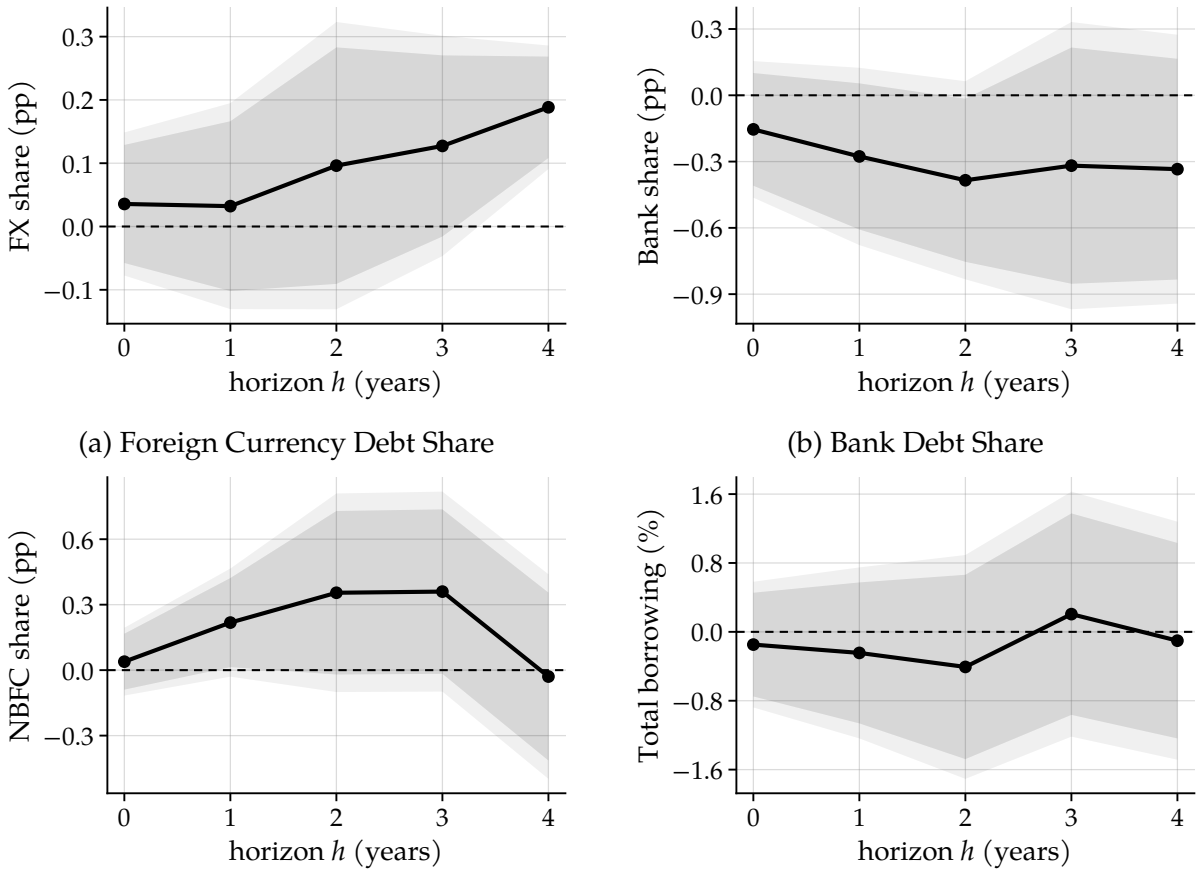
(b) Bank Debt Share

(c) NBFC Debt Share

(d) Total Borrowings (log)

Figure B.4: Fixed Cohort of Firms Present in 2013

Notes: This figure plots the responses of the firms share of foreign currency debt (a), bank debt (b) and debt from non-bank financial corporations (c) and total borrowings (d) to macroprudential tightening action that raises the capital or provisioning requirement on banks. The sample restricts firms to those present in 2013. All regressions include firm and 3-digit industry by year fixed effects and standard errors are two-way clustered by industry and year. Darker shaded regions denote 90% and lighter shaded regions 95% confidence intervals.



(a) Foreign Currency Debt Share

(b) Bank Debt Share

(c) NBFC Debt Share

(d) Total Borrowings (log)

Figure B.5: Longer Sample, 2003 to 2022

Notes: This figure plots the responses of the firms share of foreign currency debt (a), bank debt (b) and debt from non-bank financial corporations (c) and total borrowings (d) to macroprudential tightening action that raises the capital or provisioning requirement on banks. The sample extends from 2003 to 2022. All regressions include firm and 3-digit industry by year fixed effects and standard errors are two-way clustered by industry and year. Darker shaded regions denote 90% and lighter shaded regions 95% confidence intervals.

Appendix C

C.1 Firm Default Threshold Homogeneity

The threshold depends on the firm's balance sheet only through two ratios. Let $\lambda \equiv k/n^F$ denote leverage. Using the balance sheet and the definition of s (with $e = 1$), domestic debt is $b_d = s(k - n^F)$ and foreign debt is $b_f = (1 - s)(k - n^F)$. Substituting

gives

$$\bar{z}(\omega) = \frac{\lambda - 1}{\lambda} \cdot \frac{R_d\, s + R_f\, e'(1-s)}{AR^K}.$$

Net worth cancels, so the threshold depends on leverage and on the mix of debt, but not on the size of the firm.