DISCUSSION PAPER SERIES

DP12766

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INTERNATIONAL MACROECONOMICS AND FINANCE and MONETARY ECONOMICS AND FLUCTUATIONS

ISSN 0265-8003

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Discussion Paper DP12766
Published 02 March 2018
Submitted 02 March 2018

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Abstract

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JEL Classification: F32, F34, G15, G21, G28

Keywords: macroprudential policies, FX regulations, Banking flows, International debt issuance

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Acknowledgements
The views in this paper are those of the authors and do not necessarily represent the views of any institution with which they are affiliated. We would like to thank Jason Allen, Glenn Hoggarth, Patrick Honohan, Brad Setser, Frank Smets, Livio Stracca, and participants at the AEA 2018 meetings in Philadelphia and Global Linkages Conference in Dublin for valuable comments. Further thanks to Matthew Cormier, Min Jae Kim, Duncan Whyte, and Sanjana Bhatnagar for outstanding research assistance

Macroprudential FX Regulations: Shifting the Snowbanks of FX Vulnerability?*

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February 28, 2018

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I. Introduction

The global financial crisis has prompted renewed interest in tools to reduce macroeconomic vulnerabilities, strengthen financial systems, and improve country resilience. A key component of this strategy is greater use of a range of macroprudential tools — such as countercyclical capital buffers, tighter reserve ratios, leverage ratios, and restrictions on loan-to-value and debt-to-income ratios. Several papers have analyzed the use and effectiveness of many of these tools.[1] One type of tool, macroprudential foreign exchange (FX) regulations, however, has received less attention, despite the long-standing research documenting the vulnerabilities associated with currency mismatch.

This paper seeks to fill this gap. It provides a detailed assessment of macroprudential regulations on the use of foreign currencies by banks, including theoretical predictions of how they could work and then empirical assessments of their direct and unintended consequences using a rich new dataset. We find that macroprudential FX policies are effective in accomplishing their primary goal of reducing bank exposure to foreign currency risk. But do they simply shift the risk elsewhere—similar to "shifting a snowbank" (a pile of snow) from one place to another? We find some evidence of a "shifting snowbank" effect, as reduced FX lending from banks causes some firms to increase FX debt issuance to investors. This shifting is only partial, however, so that aggregate exposure to FX debt declines. Our results also show that these FX regulations reduce the sensitivity of banks to currency movements, but are less successful at reducing the sensitivity of the corporate sector and the broader economy. As a result, although macroprudential FX regulations can substantially improve the resilience of the banking sector to the global financial cycle, the benefits to the broader economy may be more moderate, as some vulnerability shifts to other sectors that may be less informed and make less efficient lending choices.

Exposure to foreign currency borrowing and currency mismatch has been a habitual concern, especially in emerging markets. Foreign currency exposure can increase a country's vulnerability to sudden stops, currency depreciations, and financial and banking crises, as well as limit the ability of the exchange rate and monetary policy to respond to shocks (Rey, 2013). Despite these concerns, foreign currency exposure has continued to increase—especially in the corporate and household sector. For example, over our sample period from the mid-1990s through end-2014, total FX borrowing in international debt securities and bank loans more

[1] Cerutti *et al.* (2015) and Forbes (2018) are recent surveys of this extensive literature.

than tripled to about $12 trillion USD. FX borrowing has continued to grow since the 2008 crisis—with cross-border FX borrowing in international debt securities and FX loans increasing by around $2.5 trillion USD between 2009 and 2015—a sharp contrast to almost no change in comparable cross-border borrowing in local currency over the same period. Concerns about the macroeconomic and financial risks related to FX exposure have increased interest in using macroprudential FX regulations to mitigate these risks.

Evaluating the effects of macroprudential FX measures has been challenging, however, partly due to limited data availability and partly due to the limited experience with these tools until recently.[2] An evaluation should also assess not only the direct effects of these measures on the intended sector of the economy (such as banks), but also any spillovers or leakages as firms, banks, and other entities respond to the regulations. These types of unintended consequences have been highlighted in analyses of other types of macroprudential regulations and capital controls.[3] For example, if macroprudential FX regulations on banks reduce bank borrowing and lending in foreign currency, do banks compensate by increasing borrowing and lending in domestic currency? Do firms shift to other sources of funding—and if so—where and in what currency? If these substitution effects occur, can these macroprudential policies achieve their primary goal of reducing aggregate country vulnerability to currency risk? Is it better to reduce FX-related risks in banks, which have broader systemic implications for the financial system (whether through direct FX exposure or default exposure to unhedged borrowers), but are closely monitored? Is it optimal to shift FX-related risks to other sectors (such as non-bank financial institutions) that appear to have less systemic importance, but may be less well-informed, less closely monitored, and more vulnerable to currency movements?

This paper attempts to tackle these challenges in an assessment of the direct and indirect effects of macroprudential FX regulations on banks and the broader economy. We develop a parsimonious model of bank versus market lending, building on the seminal work of Holmstrom and Tirole (1997), but adding the dimension that lending and borrowing is also differentiated between domestic and foreign currencies. Domestic firms seek funding from lenders, but have private information about their productivity. Banks can screen firms at a

[2] Papers which include some discussion of macroprudential FX regulations as part of their broader analyses of macroprudential tools are: Nier *et al.* (2011), Cerutti *et al.* (2015), Vandenbussche *et al.* (2015), and Avdjiev *et al.* (2016b). Two papers which focus on FX regulations are De Crescenzio *et al.* (2017) and Aguirre and Repetto (2017), but neither consider the leakages, broader effects on the economy, or sensitivity to currency movements.
[3] See Agénor and da Silva (2017) for a recent survey.

cost and identify unproductive, low-productivity, and high-productivity firms, while market investors can only lend indiscriminately. Funding in foreign currency is cheaper than in domestic currency, but subject to exchange rate risk. When the domestic currency depreciates, low-productivity firms and their associated banks default. Macroprudential FX regulation increases banks' cost of funding in foreign currency (if the regulation is a liability-side measure) or the equilibrium lending rate to firms (if an asset-side measure). Banks continue to lend in domestic currency to high-productivity firms (who endogenously prefer stable funding costs over the lower costs associated with FX funding), but stop lending to low-productivity firms. Low-productivity firms, however, shift some of their foreign currency borrowing from banks to investors, and some unproductive firms also receive FX borrowing from investors. Total factor productivity declines, as FX lending shifts from banks to investors (who cannot screen) and, therefore, a share of FX lending shifts to less productive firms. The overall impact on welfare is ambiguous and reflects a tradeoff between two forces: FX regulation provides the benefit of reducing the social cost of bank failure after depreciations, but has the cost of a reducing output due to the less efficient allocation of FX lending.

Our simple framework yields four testable implications for how macroprudential FX regulations affect bank and corporate borrowing, cross-border capital flows, FX exposure in different sectors of the economy, and macroeconomic vulnerability to exchange rate movements. After an increase in macroprudential FX regulations: (1) banks borrow and lend less in foreign currency (with no change in their borrowing in local currency); (2) firms shift away from bank borrowing and increase their FX borrowing from market investors (with no increase in firm and bank non-FX borrowing from investors); (3) banks are less exposed to exchange rate movements; and (4) firms experience some reduction in their exposure to exchange rate movements, but less than for banks.

To test these four predictions, we build a rich data set on macroprudential FX regulations and use panel-data methods to better understand how macroprudential FX regulations affect banks, firms, international capital flows, and sensitivities to currency movements. Macroprudential FX regulations are defined as policies directed at the broader financial system (compared to prudential regulations that target individual institutions) and that are based on the currency denomination of the capital transaction. We build our dataset based on four sources that each document and measure macroprudential FX regulations in different contexts or for different countries: Shim *et al.* (2013), Vandenbussche *et al.* (2015),

Cerutti *et al.* (2015) and Reinhardt and Sowerbutts (2018). Our resulting data set includes information on macroprudential regulations in 48 countries over the period 1995-2014 and has not only broader country and period coverage of macroprudential FX regulations, but a more detailed categorization of different types of regulations than previously available. This allows us to test if there are different effects on banks and/or different spillovers on the broader economy based on the type of regulation, such as if they are 'asset based' (*i.e.*, aimed at shifting the currency composition of lending away from FX to local currencies) or 'liability based' (*i.e.,* aimed at reducing the share of FX in the funding of domestic banks).

The empirical analysis focuses on the four testable implications from the model and shows that tighter macroprudential FX regulations: (1) reduce the volume of FX borrowing and share of FX borrowing by banks (with no significant effect on banks' non-FX borrowing); (2) increase the volume of FX debt issuance and the share of FX issuance by firms (with no significant impact on firms' and banks' non-FX debt issuance); (3) reduce the sensitivity of banks' stock returns to currency movements; and (4) have less impact on the sensitivity of firms' stock returns to currency movements. These results suggest that macroprudential FX regulations on banks are successful in accomplishing their direct goals — of reducing the FX exposure of banks and sensitivity of banks to currency movements — but also have the unintended consequence of causing companies to partially shift their FX funding toward international debt issuance. In sum, these findings provide evidence supporting the testable implications of our theoretical model.

The magnitudes of the estimates also suggest that these direct and indirect effects of macroprudential FX regulations are meaningful. A tightening of FX regulations causes banks to reduce their cross-border borrowing in FX by about a third, a reduction equivalent to about 0.5%-0.7% of GDP. For major emerging markets, such as Brazil or Indonesia, this is equivalent to reducing cross-border bank FX borrowing by more than half. At the same time, corporates increase FX debt issuance by about 10% of median annual FX debt issuance for the full sample, equivalent to a 15%-20% increase in FX corporate debt issuance for emerging markets such as Brazil and Indonesia. Combining these various estimates suggests that FX regulations still cause a meaningful reduction in the aggregate FX borrowing of the country—as the reduction in cross-border FX bank borrowing is substantially greater than the increase in FX corporate debt issuance—but that 10%-16% of the aggregate FX exposure shifts from banks to other sectors (such as investors and non-bank financial institutions). The effects are larger if the FX measures focus on bank liabilities instead of bank assets.

If the primary goal of the regulations is to reduce FX lending by banks, and the corresponding exposure of banks to currency movements (even if just through the vulnerability of the companies to which they lend and not necessarily through direct currency risk), then macroprudential FX regulations appear to be effective. This goal is important if banks generate systemic risks to the financial system, and regulators seek to insulate them from sharp currency movements. On the other hand, the macroprudential FX regulations also appear to shift a portion of this risk and currency exposure to other sectors of the economy, particularly investors and other financial institutions outside the regulatory perimeter. These investors and other financial institutions may be more diversified, located abroad, and not be viewed as systemically-important financial institutions, even if they did suffer losses after currency movements and enter bankruptcy. Any of these scenarios suggests that shifting some currency risk to this non-bank sector could reduce systemic financial risk. On the other hand, these investors and non-bank financial institutions may be less well informed than banks, less able to screen for the risks inherent in corporate borrowing in FX, and less able to handle subsequent losses after a depreciation. In this case, shifting currency risk to this non-bank sector could increase systemic financial risk in ways that could be harder to monitor and assess if these institutions are outside the regulatory perimeter.

Our results have several important implications. They support a growing body of research showing that macroprudential regulations can be effective at accomplishing their direct goals[4]—in this case significantly reducing the FX exposure of banks to currency movements. This result is particularly relevant for the debate on how to address long-standing concerns about vulnerabilities related to foreign currency borrowing and currency mismatch[5]. These concerns have continued since the crisis, as FX exposure in the bank and corporate sector has increased in many emerging markets.[6] These vulnerabilities related to FX exposure prompted some countries to consider the use of capital controls. Our results suggest that any such countries should also consider macroprudential FX regulations—especially countries for which capital controls (but not macroprudential FX regulations) are illegal, such as in the European Economic Area and in some trade agreements.

[4] Prominent examples include: Dell'Ariccia *et al.* (2011), Ostry *et al.* (2012), Kuttner and Shim (2013), Akinci and Olmstead-Rumsey (2015), Bruno *et al.* (2015), Cerutti *et al.* (2015), Forbes *et al.* (2015),Vandenbussche *et al.* (2015), and Beirne and Friedrich (2017).

[5] For a discussion of "original sin", the role of foreign currency exposure in emerging market crises, and vulnerabilities related to currency mismatch, see Corsetti *et al.* (1999), Eichengreen and Hausmann (1999), Galindo *et al.* (2003), Bordo and Meissner (2005), Desai *et al.* (2008), Zettelmeyer *et al.* (2011), and Kearns and Patel (2016). Benmelech (2012) discusses the role of foreign currency exposure in developed countries in the 2008 crisis.

[6] See Acharya *et al.* (2015), Bruno and Shin (2016), Chui *et al.* (2014, 2016), and Du and Schreger (2016).

The analysis also supports a rapidly growing literature that shows that even when macroprudential FX regulations work in terms of their direct goals, there can be leakages and unintended consequences[7]—in this case of increasing FX debt issuance by corporates that is held by investors and institutions outside the regulatory perimeter. Ranciere *et al.* (2010) highlight the importance of incorporating these potential leakages in any analysis of the impact of macroprudential FX regulations. In our analysis, these leakages are smaller than the direct effects of FX regulations, but still significant and economically meaningful.

Finally, this paper moves beyond most other work assessing the effects of macroprudential regulations to test not only their direct and leakage effects on variables such as borrowing, lending, and capital flows—but also takes the next step to test if the regulations achieve the broader goal of improving financial resilience. More specifically, this paper tests whether the macroprudential FX regulations reduce vulnerability to exchange rate movements, and therefore to the broader global financial cycle. The results suggest that macroprudential FX regulations can achieve this goal of improving the resilience of the banking sector to currency fluctuations, but does less to improve the resilience of the broader economy and equity markets to currency fluctuations, partly due to this "shifting snowbank" of vulnerability to other sectors of the economy. This may still provide net benefits by improving the resilience of financial institutions that can create broader systemic vulnerabilities, just as when the snowplow moves the snow off the road, it makes the road system safer for most cars. Yet, just as the snow plow inevitably pushes a portion of the snow from the road into a pile in front of your driveway—blocking the area you carefully shoveled in the morning to get out your car—macroprudential FX regulations on banks can also shift some vulnerability to currency movements to other sectors, mitigating some of the benefits.

This paper proceeds as follows. Section II presents the theoretical model of bank and market lending in domestic and foreign currency. Section III describes the data, including the compilation of the dataset on macroprudential FX regulations. Section IV presents the empirical framework and reports results on the direct and indirect effects of FX regulations on bank and firm borrowing and debt issuance. Section V assesses the impact of the regulations on bank and corporate vulnerability to currency movements. Section VI concludes.

[7] Several papers documenting these leakages of regulations to other sectors are: Aiyar *et al.* (2014), Reinhardt and Sowerbutts (2015), Cerutti *et al.* (2015) and Agénor and da Silva (2017). Papers documenting the international spillovers when regulations or capital controls in one country deflect capital flows to others are: Ghosh *et al.* (2014), Giordani *et al.* (2014), Pasricha *et al.* (2015), Forbes *et al.* (2016), Beirne and Friedrich (2017), and Kang *et al.* (2017).

II. Theoretical Model

Before assessing the impact of macroprudential FX regulations, we develop a simple framework of bank versus market lending in domestic or foreign currency. This framework shares with the seminal work of Holmstrom and Tirole (1997) the emphasis on asymmetric information between lenders and borrowers, with banks as special lenders because of their ability to reduce the consequences of asymmetric information at a cost. In Holmstrom and Tirole (1997), banks can monitor firms to reduce their moral hazard problem—a channel that is absent in our model. Instead, we focus on how asymmetric information affects banks' (and other lenders') choice of the currency of their loans. Screening allows banks to identify more productive firms that are more likely to remain solvent after currency depreciations.[8] Moreover, Holmstrom and Tirole (1997) consider an environment with a single good, while we consider two goods in order to allow for a choice between foreign and domestic currency.

To begin, assume that there are two dates, $t = 0, 1,$ and a domestic D and a foreign F good. Let e_t be the exogenous exchange rate (the value of D goods in terms of F goods) at date t. We focus on FX risk (that is, the volatility of the exchange rate), with no changes to its expected level, which we normalize to one, $E_0\,[e_1] = e_0 \equiv 1$. Specifically, the exchange rate process is bivariate and can involve either depreciation or appreciation:

$$e_1 \in \{e_L, e_H\}, \qquad (1)$$

where $e_L < 1 < e_H$ and the probability of an appreciation is $\Pr\{e_1 = e_H\} \equiv q \in (0, 1)$.

The economy is populated by four groups of risk-neutral agents: domestic firms, banks, investors, and savers. There are many banks, investors, and savers, each of whom take the observable funding and lending rates as given and make zero profits due to competition.[9] A unit continuum of savers is each endowed with K_D units of the domestic good and K_F units of the foreign good, respectively. The outside option of savers is given by constant-returns-to-scale technologies that yield r_D and $r_F < r_D$ at $t = 1$, respectively. Thus, banks and investors can fund themselves in domestic and foreign currency at these rates. Banks and investors are hedged, so they obtain funding in the currency of the loan to firms.[10]

[8] Stiglitz and Weiss (1981) is a seminal paper modelling bank screening in a one-good economy.
[9] Our results can be generalized to a setting in which lenders and firms share the surplus from lending.
[10] Such prudential behavior would arise endogenously if banks or investors had charter value (Keeley, 1990). Evidence also suggests that banks are hedged against direct FX risk (e.g., Brauning and Ivashina, 2017; Borio *et al*., 2017).

At $t = 0$, a unit continuum of firms $j \in [0,1]$ has a domestic investment opportunity normalized to unit size. Since firms do not have own funds, they may seek to borrow from either banks or investors in either domestic or foreign currency. Firms are heterogeneous in the quality of their opportunities, which yield a safe return A_j at $t = 1$. Firm productivity is private information, but the distribution is publicly known and can take three values:

$$A_j \in \{0, A_L, A_H\}, \tag{2}$$

where $0 < A_L < A_H$. A firm has low productivity with probability $\Pr\{A_j = A_L\} \equiv p_L \in (0,1)$, and high productivity with probability $\Pr\{A_j = A_H\} \equiv p_H \in (0, 1 - p_L)$. There is universal protection by limited liability. If a firm cannot repay a loan at $t = 1$, the bank or investor seizes its assets. A bankrupt firm receives zero and, for simplicity, the bank or investor recoups its asset value fully. Our results hold for partial recovery upon firm default.

Relative to investors, banks are special in that they have access to a screening technology. Upon paying a fixed cost, $c > 0$, a banker can identify the productivity of firms; that is, a banker who screens observes A_j. In contrast, the investors do not observe firm productivity and, therefore, may be subject to adverse selection. This difference in screening technology is the only source of heterogeneity across different types of lenders.

A. Lending in Domestic Currency

To start, suppose that funding in foreign currency is unavailable ($K_F = 0$). Let R_D denote the competitive lending rate in domestic currency offered by screening banks. In equilibrium, this rate covers the costs of funding in domestic currency and screening:

$$R_D^* = r_D + c\,. \tag{3}$$

Unproductive firms, $A_j < R_D^*$, do not receive funding in domestic currency from banks, while productive firms do. Funding in domestic currency is relatively expensive, so only high-productivity firms may attract funding in domestic currency from screening banks:

$$A_L < r_D + c < A_H\,. \tag{4}$$

As shown in Illustration 1, firms with $A_j \in \{0, A_L\}$ receive no funding and do not invest, while high-productivity firms with $A_j = A_H$ receive funds, invest, and make a safe profit, $\pi_D =$

$A_H - R_D^* > 0$, which is the entire surplus from lending and investment. We assume that demand for domestic funding can be met, $K_D \geq p_H$. When lending is only in domestic currency, little credit and investment occurs, but both firms and banks never default.

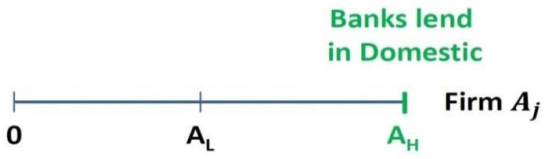

Illustration 1: Banks lend in domestic currency to high-productivity firms.

To complete the analysis, we study when banks choose to screen. The resulting conditions also ensure that investors choose not to lend to firms in domestic currency (because investors and non-screening banks are identical). Intuitively, the screening cost must be low relative to the consequences of adverse selection faced by investors.[11]

B. Lending in Domestic and Foreign Currency

We consider $p_L < K_F < 1 - p_H$, so foreign capital can cover the financing needs of all low-productivity firms, but not that of all zero- and low-productivity firms together. We construct an equilibrium in which banks choose to screen and lend to low-productivity firms in *F* and to high-productivity firms in *D*. This equilibrium requires (i) low-productivity firms to default after depreciation and (ii) high-productivity firms to prefer stable funding in *D* over cheaper funding in *F*.

Let R_F be the competitive lending rate in foreign currency. A bank that screens has opportunity costs $r_F + c$; it receives R_F after an appreciation and the liquidation value $A_L e_L$ after a depreciation (since the domestic firm produces in *D* goods). Thus:

[11] There are two conditions. First, if $\rho_D > r_D + c = R_D^*$, where ρ_D is the lending rate of investors, then only firms $A_j \in \{0, A_L\}$ may borrow. The investor receives zero from the proportion $\frac{1-p_L-p_H}{1-p_H}$ of unproductive firms and A_L from the residual proportion of low-productivity firms (due to partial default, $A_L < \rho_D$). For investors not to choose to lend at this rate, the funding cost in domestic currency must exceed the expected revenue from lending, $r_D > \frac{p_L}{1-p_H} A_L$. Second, if $\rho_D \leq r_D + c$, then high-productivity firms A_H may also seek funding from investors. The best possible rate investors can receive is $\rho_D = r_D + c$. Then, investors do not lend in domestic currency when the funding cost in domestic currency exceeds the expected revenue from lending, $(1 - p_L - p_H) * 0 + p_L A_L + p_H \rho_D < r_D$, which results in an upper bound on the screening cost, $c < \tilde{c} \equiv \frac{(1-p_H) r_D - p_L A_L}{p_H} > 0$.

$$R_F^* = \frac{r_F + c - (1-q)A_L e_L}{q}. \quad (5)$$

To verify that firms with productivity A_L default after a depreciation, $A_L e_L < R_F^*$, we require an upper bound on the exchange rate after depreciation, $e_L < \bar{e}_L \equiv \frac{r_F + c}{A_L}$. Conversely, repayment after an appreciation requires $A_L e_H \leq R_F^*$. Using $q e_H + (1-q)e_L = 1$, we obtain $A_L \geq r_F + c$, which results in the intuitive ordering of firm productivity and funding costs:

$$0 < r_F + c \leq A_L < r_D + c < A_H. \quad (6)$$

When do high-productivity firms prefer borrowing in domestic over foreign currency? Borrowing in *D* yields a low but stable profit $\pi_D > 0$. In contrast, borrowing in *F* is cheaper. If the tighter upper bound on the exchange rate after depreciation $e_L < \widehat{e_L} \equiv \frac{r_F + c}{A_H}$ holds, high-productivity firms default after depreciation, with expected firm profits $\pi_F = q\left(A_H - \frac{R_F}{e_H}\right)$. Hence, $\pi_D > \pi_F$ whenever the benefit of stable funding exceeds the cost differential, $(1-q)\left(A_H - A_L \frac{e_L}{e_H}\right) \geq r_D + c - \frac{r_F + c}{e_H}$. Using $E[e_1] = 1$, this condition is $A_H \geq \underline{A_H} \equiv A_L \frac{e_L}{e_H} + \frac{e_H - e_L}{e_H} \frac{e_H(r_D + c) - (r_F + c)}{e_H - 1}$. Intuitively, high-quality firms prefer stable funding in domestic currency over a high loss after a depreciation (associated with foreign currency funding).

Given the competitive lending rate by screening banks, when is it optimal for investors to lend in foreign currency? Let investors offer a rate ρ_F. If $\rho_F > R_F^*$, only unproductive firms can be attracted, which cannot be optimal. Thus, $\rho_F \leq R_F^*$. Suppose only firms with low productivity are attracted, while high-productivity firms continue to borrow in domestic currency.[12] The highest possible benefit for investors arises for $\rho_F = R_F^*$, receiving $\frac{p_L}{1-p_H}(qR_F^* + (1-q)A_L e_L)$. Thus, lending from investors in foreign currency is profitable if the screening cost saving is higher than the cost of adverse selection:

$$c > \overline{c} \equiv \frac{1 - p_L - p_H}{p_L} r_F. \quad (7)$$

In sum, the availability of cheap funding in foreign currency increases firm investment as low-productivity firms also receive funds and invest. The downside of this FX-lending

[12] When investors also attract high-productivity firms, one can show that lending from investors is profitable in this case whenever the screening cost is sufficiently high, $c > \hat{c} \equiv \frac{r_F}{e_H(p_L + p_H)} - r_D + (1-q)\left[A_H - \frac{e_L}{e_H}\frac{p_L A_L + p_H A_H}{p_L + p_H}\right]$.

induced credit boom is greater exposure to FX risk. After the domestic currency depreciates, low-productivity firms default and banks suffer losses. Illustration 2 shows this equilibrium with both domestic and foreign currency lending (but without macroprudential regulation).

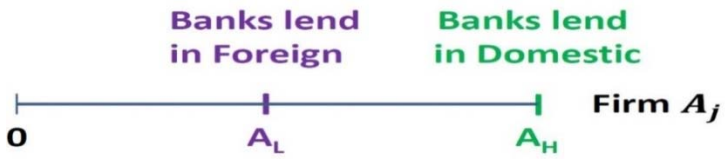

Illustration 2: Equilibrium for $c < \bar{c}$. Banks lend in domestic currency to high-productivity firms and in foreign currency to all low-productivity firms.

This equilibrium highlights how the inclusion of the currency dimension in borrowing changes the ranking of firm funding choices from that resulting from the single currency framework in Holmstrom and Tirole (1997). More specifically, in Holmstrom and Tirole (1997), undercapitalized firms receive no funding, medium-capitalized firms receive bank funding, and high-capitalized firms receive market funding. In our model, in contrast, high-quality firms receive domestic funding from banks, and lower-quality firms receive foreign funding (from either banks or investors, depending on the state of FX regulation).

C. Macroprudential FX Regulation of Banks

Consider a regulator concerned about the financial stability of banks due to a social cost of bank failure $\Delta > 0$. When the regulator imposes a macroprudential tax $\tau > 0$ on banks, what is the impact on funding and lending, the sensitivity to FX risk, and welfare?

i. Liability-side measures

With a macroprudential tax on funding for banks in foreign currency (a liability-side measure), the effective cost of borrowing for banks after the tax is $r_F + \tau$. If screening banks were to lend in F to low-productivity firms, the competitive lending rate would be:[13]

$$R_F^{**} = R_F^* + \frac{\tau}{q} > R_F^*. \qquad (8)$$

[13] The conditions for default after depreciation and high-productivity firms preferring borrowing in domestic currency are relaxed. Low-productivity firms are assumed to continue to repay fully after appreciation, $A_L \geq r_F + c + \tau$.

For intermediate screening costs, banks lend in F without a tax, but stop doing so after the tax, where banks still lend to high-productivity firms in domestic currency:

$$\frac{1-p_L-p_H}{p_L} r_F - \tau \equiv \overline{c_L} \leq c < \overline{c}. \qquad (9)$$

The benefit of taxing FX borrowing by banks is to reduce FX lending by banks (to zero in our stylized model) and, therefore, reduce the probability of a (socially costly) default of banks after depreciation. This benefit amounts to $(1-q)\,\Delta$. There is a partial substitution from bank lending in F to investor lending in F, as low-quality firms now obtain some funding through FX bond issuance. Since investors are not subject to FX regulation, they can still obtain funding in F at the rate r_F and lend to firms of productivity $A_j \in \{0, A_L\}$.

There is also a cost, however, associated with the tax on FX borrowing by banks. Not all low-productivity firms receive FX funding because of the capacity constraint, $K_F < 1-p_H$, so only a fraction $\frac{K_F}{1-p_H} \in (0,1)$ of these firms continue to be funded. Also, a fraction $\frac{1-p_H-K_F}{1-p_H}$ of unproductive firms are funded in F, so domestic output decreases after macroprudential FX regulation by an amount $p_L A_L \frac{1-p_H-K_F}{1-p_H}$. Illustration 3 shows the equilibrium.

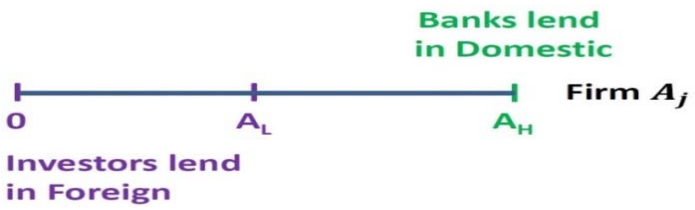

Illustration 3: Equilibrium after macroprudential FX regulation of banks. Banks lend in domestic currency to high-productivity firms and investors lend in foreign currency to a fraction of zero- and low-productivity firms.

Foreign currency borrowing from investors is feasible as long as adverse selection is not too severe (Akerlof, 1970). Competitive investors are repaid from the fraction $\frac{p_L}{1-p_H}$ of low-quality firms, receiving $e_L A_L$ after depreciation, with full repayment ρ_F^* after appreciation. Thus, the competitive lending rate of investors is:

$$\rho_F^* = \frac{\frac{1-p_H}{p_L} r_F - (1-q) e_L A_L}{q}. \qquad (10)$$

To ensure that investors can still attract low-quality firms, $e_H A_L \geq \rho_F^*$, the share of low-productivity firms must be high enough (in order to limit the extent of adverse selection):

$$p_L A_L \geq (1 - p_H)\, r_F. \qquad (11)$$

ii. Asset-side measures

Next, we show that if a macroprudential tax is applied to bank lending in foreign currency (an asset-side measure) instead of to bank funding in foreign currency, the result is qualitatively identical. If screening banks were to lend in F to low-productivity firms, the competitive lending rate would be $R_F^{***} = R_F^* + \tau > R_F^*$. Paralleling the previous analysis, we derive an intermediate range of screening costs such that banks lend in F only without a tax:

$$\frac{1-p_L-p_H}{p_L} r_F - q\,\tau \equiv \overline{c_A} \leq c < \overline{c}, \qquad (12)$$

where $\overline{c_L} < \overline{c_A}$. Thus, the range of screening costs for which a given tax reduces bank FX lending and shifts to funding in foreign currency by investors (through debt issuance) is larger for liability- than for asset-side measures. Intuitively, a higher funding cost in foreign currency (from liability-side measures) affects the bank in all states, while a higher lending rate in foreign currency (from asset-side measures) only matters when the firm survives.

iii. Evaluating the impact of macroprudential FX regulation

Our model shows that macroprudential FX regulations generate both benefits and costs to the broader economy. The primary benefit is avoiding bank failure after depreciations (caused by a default of firms borrowing in FX)—with the attendant social and economic costs documented elsewhere.[14] The primary cost of FX regulations is a reduction in domestic output due to the resulting credit rationing in foreign funding for low-productivity firms, since investors who cannot screen (mis-)allocate some FX lending to unproductive firms. Taken together, macroprudential FX regulation enhances welfare if and only if:

$$\Delta \geq \frac{p_L A_L \left(\frac{1-p_H-K_F}{1-p_H}\right)}{1-q} \qquad (13)$$

[14] For estimates of the cost of bank defaults, see Laeven and Valencia (2013).

FX regulation is more likely to be welfare enhancing if the social cost of bank default is higher, or if the output loss from reduced FX lending to low productivity firms is smaller.

iv. Sensitivity to FX risk

Consider the sensitivity of banks and firms to FX risk before and after macroprudential regulation. We consider the interim range of information costs derived in the previous two subsections, $\overline{c_A} < c < \overline{c}$, such that banks lend to low-productivity firms in F without regulation and investors lend after FX regulation on banks is introduced. This shows that after FX regulation, the exposure of banks to FX risk is reduced, while the exposure of investors increases. The exposure of firms that still receive FX funding is unchanged, but some firms no longer receive FX funding, yielding a net effect of only a small reduction in firm sensitivity to currency movements (and less of a reduction than occurs for banks). The "snowbank" of exposure to currency risk has shifted away from banks and moved to create challenges for investors, though some of the snow 'melted' as some firms are credit rationed.

D. Testable implications of the model

This section has developed a simple and stylized model of informed bank and uninformed market lending in domestic and foreign currency. This model yields four testable implications about the effects of FX macroprudential regulation of banks:

(1) Banks borrow and lend less in foreign currency (but do not change their borrowing in local currency).

(2) Some firms shift away from banks to increase their FX borrowing from market investors (with no increase in non-FX borrowing by firms and banks).

(3) Banks' exposure to exchange rate movements declines significantly.

(4) Firms' exposure to exchange rate movements declines moderately, and by less than that for banks.

III. The Data

This section discusses the data used for the empirical analysis. It is divided into two parts. The first provides details on the newly compiled dataset on macroprudential FX

regulations that is central to this paper. The second discusses the additional explanatory and control variables used in the analysis.

A. Data on Macroprudential FX Regulations

We define macroprudential FX regulations as regulations that discriminate based on the currency denomination of a capital transaction.[15] Macroprudential FX regulations usually focus on the domestic banking system and can be implemented by the government, the central bank, or the national prudential regulator. Our measures of macroprudential FX regulations do not include capital controls—which discriminate by the residency of the parties involved in the transaction—although there is substantial overlap in these two types of measures given that transactions between residents and non-residents are more likely to involve FX. Also, while our measures are macroprudential, as they are directed at systemic risks to the entire financial system stemming from FX flows and exposures, some measures (such as sectoral FX capital risk weights) can also be classified as microprudential regulations (which generally target individual financial institutions).

To construct our database, we draw on four leading sources of information on macroprudential regulations: Shim *et al.* (2013), Vandenbussche *et al.* (2015), Cerutti *et al.* (2015), and Reinhardt and Sowerbutts (2018). Each of these four datasets uses different data sources and has a different focus—but includes some information on macroprudential FX regulations. More specifically, Shim *et al.* (2013) provides verbal descriptions of policy events broadly related to the housing sector for 60 countries at a monthly frequency over the period 1990-2012. Vandenbussche *et al.* (2015) provides a detailed database of a broad range of macroprudential policy actions for 16 countries from Emerging Europe over the period 1997-2010. Cerutti *et al.* (2015) uses an IMF database on country surveys to provide intensity measures for 12 macroprudential policies, including measures of FX- and local-currency reserve requirements, in a set of 64 countries over the period 2000-14. Finally, Reinhardt and Sowerbutts (2018) build a database on macroprudential policy actions for 60 countries starting in 1995. Appendix A explains in more detail how we use the information contained in these sources to construct our dataset on macroprudential FX regulations.

After combining these sources, our dataset includes information on 132 changes in macroprudential FX regulations from 1995 through 2014 (on a quarterly basis) that represent

[15] This follows Ostry *et al.* (2012), who refer to these measures as FX-related prudential measures. Throughout the paper, we use the terms "macroprudential FX regulations" and "FX regulations" synonymously.

either a tightening or loosening in regulation. This full sample includes both advanced and emerging economies, but we exclude reserve-issuing countries (*i.e.,* long-standing members of the Euro Area, the US, Switzerland and Japan) to focus on countries more vulnerable to currency mismatches and the global financial cycle. We also exclude offshore centers, as defined by the BIS in *International Banking Statistics*, with the exception of Singapore and Hong Kong. This leaves us with a sample of 48 countries for our main empirical analysis, with 17 advanced economies and 31 emerging markets.[16] The full list of countries is reported at the end of Appendix A in Table A1 (with the cumulated number of changes in each type of macroprudential regulation by country). Some countries have made no changes to macroprudential FX policy, while others have made more than ten. The list shows that there is good coverage of countries that meet our criteria in Asia, Europe, and South America. Coverage is more limited for the Middle East and Africa.

Figure 1 shows the cumulated changes in all macroprudential FX regulations from 1995 through 2015, broken into those in advanced and emerging economies. Any adoption or tightening of each regulation in the dataset is counted as a +1, and any reduction or removal is a -1, with the graph showing the cumulated total at the given date. The figure shows that about 90% of accumulated changes in macroprudential FX regulations have occurred in emerging market economies—with very few changes in these policies in advanced economies over the sample period. This is not surprising as emerging economies tend to have the greatest exposure to foreign currency and currency mismatch, and therefore the greatest related vulnerabilities that the measures are aimed to mitigate.

In our dataset, these macroprudential FX regulations can be disaggregated into those focusing on banks' FX assets and those on banks' FX liabilities. These two categories can be further disaggregated into subcategories. Figure 2 shows the cumulated actions for each of these different types of regulations—using the same procedure as in Figure 1—except now FX regulations are arranged by action type rather than by country group. These distinctions could be important and allow us to assess whether different types of macroprudential FX regulations have different effects on the economy. For example, measures targeting banks' FX liabilities might affect their FX lending to all their borrowers, while asset-side measures might only

[16] Throughout this paper we classify Advanced Economies (AEs) and Emerging Market Economies (EMEs) along similar lines to the BIS in their *International Banking Statistics*, which splits countries/entities into developed, developing and offshore centres. This implies that most Central and Eastern European, as well as most Asian countries (except Japan), are classified as EMEs. We include Hong Kong and Singapore, which are classified by the BIS as offshore centres, in our AE group.

restrict FX lending to specific borrowers (for example those lacking a natural hedge). More specifically, the levels of disaggregation in the FX measures available in our data are:

- **FX Asset-side Measures (blue):** Asset-side measures include all policies aimed at the FX assets of domestic banks. These generally focus on restricting FX lending to corporates and households in the domestic economy. These measures can be further broken into two subcategories: (i) FX capital regulations for banks (in light blue), such as provisioning rules or risk weights associated with FX-lending; and (ii) Lending standards for FX loans (in dark blue), which contain quantitative lending standards, such as loan-to-value (LTV) ratios or debt-to-income (DTI) ratios for FX loans, and qualitative lending standards for FX loans, such as amortization requirements for FX loans. Lending standards for FX loans often apply to all borrowers in the domestic economy and are therefore harder to evade than FX capital regulations (which primarily apply to domestic banks and thus could be circumvented by borrowing either from foreign banks in the domestic economy or directly from abroad).

- **FX Liability-side Measures (red):** Liability-side measures include all policies aimed at the FX liabilities of domestic banks. These measures generally focus on the funding decisions of banks. Liability-side measures can be further broken into two subcategories: (i) FX reserve requirements (in light red) and (ii) FX liquidity requirements (in dark red), such as liquidity coverage ratios or taxes on non-core FX liabilities, which tend to specifically target FX flows with a short maturity.

Figure 2 shows that asset- and liability-side FX measures have been widely used, with 30 cumulated liability-side regulations and 37 cumulated asset-side measures at the end of the sample period. Asset-side FX regulations started to be adopted more rapidly just before the global financial crisis—from 2006-08, and then experienced another surge around 2010-11, but have since been adopted at a more moderate pace. Liability-side FX regulations were adopted more gradually from 2002-2006, after which use fell by about half, until after 2010 they garnered more attention, with their use roughly doubled during 2010-13.

For a final cut of the data, Figure 3 uses the same categories to break out the number of times each macroprudential FX measure was either tightened or loosened. This is useful to better understand what is driving the cumulated statistics in Figures 1 and 2, as "no change" in the cumulated graphs could mask no change in the given regulation by any country, or a number of countries which tightened the measure while an equal number simultaneously

loosened. The figure shows that, in many periods, the latter is the case—with some years when a large number of countries simultaneously tightened and loosened different policies.

Figure 3 also shows several distinct phases in macroprudential FX regulations. There was a gradual tightening cycle from about 2002 to 2008 (during which few measures were loosened). This tightening cycle was initially dominated by macroprudential FX regulations on the liability side of bank balance sheets, and later dominated by regulations on the asset side from 2006 onwards. During the 2008-09 crisis, there was a general loosening of all four types of regulations. Another tightening cycle began after the peak of the crisis from 2010-11, followed by a slower but continued general trend of tightening from 2012-14. In contrast to the earlier pre-crisis tightening cycle, this more recent tightening has included more liability-side regulations, although also a number of asset-side FX regulations in most years.

B. Data on International Capital Flows and other Variables

This section begins by discussing the international capital flow variables on bank and corporate borrowing that will be the focus of the empirical tests, and then closes with a discussion of the various control variables.

To begin, in order to test model prediction #1 on the impact of FX regulations on cross-border loans to banks, we use data from the BIS International Banking Statistics (IBS), which reports both FX and non-FX gross capital inflows to banks. These data are expressed as a percent of annual GDP and calculated as 4-quarter moving averages.[17] In order to test model prediction #2 on the spillover effects of the regulations, we use data from the BIS International Debt Statistics (IDS), which includes debt securities issued by domestic headquartered companies on international markets in FX and non-FX.

Figure 4 graphs several of these measures which will be a focus of the empirical analysis. Figure 4a shows the evolution of cross-border loans to banks as a percent of GDP, broken into loans in FX (red) and non-FX (blue). This shows the decline in cross-border lending since around the crisis, with basically all of the decline occurring in FX lending. Figure 4b shows international debt issuance over the same period, also broken down into FX (solid lines) and non-FX borrowing (dashed lines), and further distinguished into borrowing by banks (green)

[17] In the BIS banking statistics, capital 'flows' are calculated as estimated exchange rate-adjusted changes in stocks; therefore they should not be affected by exchange-rate valuation effects. See Appendix B for how we estimate the FX and non-FX components of cross-border bank loans.

and corporates (orange). This shows that international debt issuance in FX has increased fairly steadily since the crisis for corporates, but fallen for banks. Non-FX borrowing by corporates has been fairly flat, and for banks has decreased. These graphs are only suggestive, but the trends agree with the model's prediction; after a tightening in macroprudential FX regulations (such as after the 2008 crisis), cross-border FX lending by banks declines (with no change in non-FX lending by banks), while corporate debt issuance in FX increases (with no increase in corporate non-FX debt issuance or bank debt issuance in FX or non-FX).

The empirical analysis also includes a number of control variables that merit discussion. These variables were chosen to be consistent with existing literature, most closely following recent work on the determinants of cross-border bank flows in Avdjiev *et al. (*2016a) and Bruno and Shin (2016). The main innovation in our control variables is that when we calculate the exposure of country *i* to certain variables in other countries, we weight the respective variable by country *i*'s "financial exposure" instead of its trade exposure. As explained in Lane and Shambaugh (2010) and Bénétrix *et al.* (2015), this can be important when countries have different currency exposures than trade exposures (such as many emerging markets which are more exposed to US dollar movements than predicted based purely on trade patterns). A sensitivity test shows that this weighting does not impact the key results.

We include five variables in our baseline specification, focusing on variables with some variation over time so that they are not absorbed in country fixed effects. These controls are:

- *Changes in non-FX macroprudential regulation*: measured by calculating any change in macroprudential regulations in the four datasets discussed above (from Shim *et al.*, 2013; Vandenbussche *et al.,* 2015; Cerutti *et al.,* 2015; and Reinhardt and Sowerbutts, 2017) for country *i.* Then any changes in FX regulations are removed. The resulting measure is reported as +1 for any new use/tightening of any non-FX macroprudential regulation, and a -1 for any reduction/ removal. The variable is evaluated by summing up its contemporaneous effect as well as its three lags. Appendix A discusses the compilation of this data in more detail.

- *Real GDP growth:* measured as quarterly real GDP (yoy) growth based on IMF statistics. This is a standard control to capture changes in country-specific returns.

- *Exchange rate volatility, weighted based on country financial exposure*: calculated as: $= std_t(\sum w_{n,t}^F \cdot \Delta e_{n,t}^F)$, where $std_t()$ is the standard deviation at quarterly frequency and

$\Delta e^{F}_{n,t}$ is the weekly change in the bilateral exchange rate between the domestic economy and foreign country *n*. This controls for the relative riskiness of FX- versus non-FX loans (see Rosenberg and Tirpak, 2009 and Brown and De Haas, 2012).

- *Interest rate differential, weighted based on country financial exposure*: calculated as $= i^{D}_{t} - \sum w^{F}_{n,t} \cdot i^{F}_{n,t}$, where i^{D}_{t} is the domestic (*D*) nominal interest rate in quarter *t*; $w^{F}_{n,t}$ is the (annual) financial weight of foreign (*F*) country *n* in quarter *t*; $i^{F}_{n,t}$ is the foreign interest rate of country *n* in quarter *t,* and *n* captures the major currencies/currency areas (USD, GBP, EUR, YEN, CHF). This controls for the return/funding costs of FX loans relative to the return/funding costs of non-FX loans.[18] The weightings place more weight on the relative funding differentials for the most relevant countries/regions.

- *Sovereign rating*: measured as the change in sovereign rating, based on data from Trading Economics in order to capture any changes in country-specific risk.

- *Financial openness*: measured using the Chinn-Ito (2008) index of financial openness. This is a standard control to capture any capital controls or other factors affecting the ease by which banks or firms can borrow internationally.

Additional details on each of these independent variables are provided in Appendix B, including data sources and definitions (in Appendix Table B1) and summary statistics (in Appendix Table B2).

IV. Empirical Results: Direct Effects and Leakages of Macroprudential FX Regulations

This section formally tests how macroprudential FX regulations affect different components of capital inflows, building on the theoretical framework developed in Section II. It begins by summarizing the key predictions in a diagram, and then develops the specification that will be used for the remainder of the section. Next it reports the central results on how macroprudential FX regulations affect various types of capital flows in domestic and foreign currency for banks and corporates. For this baseline analysis, we aggregate the different types

[18] For evidence, see Rosenberg and Tirpak (2009), Brown and De Haas (2012), and Brown *et al.* (2014).

of macroprudential FX regulations. Finally, this section ends with tests for different effects of the disaggregated measures of macroprudential regulations.

Our theoretical model provides guidance on the various interactions between banks, corporations, and international investors that determine lending and borrowing in international and foreign currency. Figure 5 provides an overview over the channels and effects of macroprudential FX regulations tested in this analysis, and the signs of the expected effects of these channels. The figure shows the two domestic entities of primary interest in the analysis in light blue (domestic banks and domestic corporations)—and their primary sources of international funding in light green (international banks and debt markets). Each form of borrowing is shown by arrows, with each flow also broken into that in domestic currency (outlined in black) and foreign currency (outlined in purple). The channels that are not a focus of the analysis due to data limitations are dotted and less distinct.[19] Each of these borrowing channels (represented by the arrows) in Figure 5 is then colored to indicate how the model predicts it will be affected by tighter macroprudential FX regulations. Red indicates a predicted decrease in cross-border borrowing (a negative coefficient for β_1), green indicates a predicted increase (a positive coefficient), and grey indicates no significant change in borrowing/lending (an insignificant coefficient).

The diagram succinctly summarizes the model's main predictions; an increase in macroprudential FX regulations would be expected to: (1) decrease domestic bank borrowing (and lending) in foreign currency (in red) with no effect on bank borrowing in non-FX; (2) increase corporate borrowing in FX from market investors (in green), with no impact on corporate borrowing in non-FX or bank borrowing in non-FX from international investors. Testing for these "non-effects" is just as important a part of the hypothesis testing as the negative effect of FX regulation on FX loans to banks, and positive effect on corporate FX debt issuance. The channels for which the model does not have a clear prediction are left white (such as on FX debt issuance by banks). Also, Figure 5 shows the relevant table in the paper that reports the corresponding results for the estimates of each channel.

[19] We do not focus on lending by international banks directly to domestic corporations because the only cross-border data on bank lending to non-banks available for a sufficient time series includes non-bank financials as well as corporations. This share is also smaller than the other flows that are the focus of the paper, with recently enhanced BIS data suggesting that at the end of 2014, the share of cross-border lending to corporates in lending to all non-banks was only around 20%. Nonetheless, in the next section we include a sensitivity tests using this data, which supports the other conclusions. Also, since the paper focuses on cross-border borrowing, we do not focus on changes in lending by domestic banks to domestic corporates; enhanced data from the BIS on the local balance sheet of international banks is too short for a meaningful analysis of local lending in FX to the corporate sector.

A. Estimation Framework

To test the first two predictions on how macroprudential FX regulations affect bank and corporate borrowing in domestic and foreign currency, we use a cross-country panel regression framework with country- and time-fixed effects. We control for domestic and global factors over time, similar to the in the specifications used to predict international capital flows (or just international banking flows) in Forbes and Warnock (2012), Bruno and Shin (2016), and Avdjiev *et al. (*2016a). More specifically, our baseline equation is:

$$F_{i,t} = \alpha + \sum_{k=0}^{3} \beta_1 \quad fxm_{i,t-k} + \delta_t + \gamma' X_{i,t-1} + \delta_i + \varepsilon_{i,t}, \qquad (14)$$

where $F_{i,t}$ is the measure of quarterly gross cross-border capital inflows for the respective sector of country i (discussed in Section III.B).[20] The variable $fxm_{i,t-k}$ captures changes in macroprudential FX measures (discussed in Section III.A), expressed as a dummy variable that takes the value of +1 if restrictions on FX lending or borrowing are tightened (and –1 if they are loosened). To account for potential time lags in the impact of these policies, we include the contemporaneous value of $fxm_{i,t}$ as well as its three lags, and evaluate their joint effect by testing if the sum of all four coefficients is significantly different than zero. $X_{i,t-1}$ is a set of control variables (discussed in Section III.B); δ_i are country-fixed effects and δ_t are global time effects. The sample period is 1996 Q1– 2014 Q4.

Several details of this specification and variables merit further discussion.[21] First, the left-hand side variable, $F_{i,t}$, is measured in several different ways in order to test the different predictions of the model and better understand the direct and indirect effects of the macroprudential FX regulations. More specifically, in order to test model prediction #1 on the impact of the regulations on cross-border loans to banks, $F_{i,t}$ is measured as FX or non-FX gross capital inflows to banks, as well as the FX share of total capital inflows to banks. In order to test model prediction #2 on the spillover effects of the regulations, $F_{i,t}$, is measured as FX and non-FX net international debt issuance by corporates and banks, as well as the change in

[20] Quarterly capital inflows are scaled by annual GDP, which is calculated as a 4-quarter moving average of annual data to avoid breaks due to annual GDP rising or falling from Q4 to Q1. We scale by annual GDP rather than quarterly GDP because the sum of the contemporaneous coefficient and three lags on $fxm_{i,t}$ reported in the regression tables can then be read as the effect on capital flows to annual GDP over a one year period.

[21] To ensure that large observations are not driving the results, all dependent and independent variables are winsorised at the 2.5% level (except for variables based on bounded indices). In order to account for exchange rate valuation effects, changes in shares are calculated based on a series of stocks calculated by adding cumulated exchange rate adjusted changes in bank loans and deposits or net issuance of debt securities to initial stocks. Before winsorising the resulting shares, we exclude changes in shares above +100% or below -100%.

the FX share of total net debt issuance by each group. (Extensions also consider the impact of regulations on total loans to banks and total debt issuance by corporates.)

A second noteworthy feature of equation (14) is the measure of macroprudential FX regulation, $fxm_{i,t-k}$. This is measured as a dummy variable capturing the changes in macroprudential FX regulations and discussed in more detail in Appendix A. In our main analysis, this aggregates all of the different types of macroprudential FX regulations, but in some extensions it only includes changes in FX regulations targeting bank assets or those targeting bank liabilities, disaggregated as discussed in Section III.A.

A final important point in equation (14) is the time fixed effects (δ_t), which are included to control for all global factors common across countries in each period. These global factors have been shown to be an important driver of global capital flows, such as in Forbes and Warnock (2012), Rey (2013), and Avdjiev *et al.* (2016a), but there are different views on which factors are most important (such as the role of global risk or monetary policy in advanced economies). By controlling for a global-time fixed effect, we do not need to take a stance on exactly which global factors are important, or worry about time effects shared by all countries that are difficult to measure. To show that this assumption does not affect our main results, however, we also report tests where we include standard global variables that have been shown to be associated with global capital flows (such as global volatility, global growth, and changes in US monetary policy) instead of this common global-time fixed effect. These different specifications of global factors have no meaningful impact on the key results.

All the independent variables are lagged by one quarter (or by one year in the case of GDP growth) to reduce endogeneity concerns. Additional details on each of these independent variables are provided in Appendix B.

B. Baseline Results: Direct and Spillover Effects of Macroprudential FX Regulations

To test these predictions, Table 1 begins with the channels shown to the left of Figure 5—on gross cross-border loans from international banks to domestic banks—using the specification in equation (14) and the data discussed in Section III. According to Hypothesis #1 from the model, increased macroprudential FX regulations should reduce the volume of FX borrowing and share of FX borrowing by banks, with no significant effect on banks' non-FX borrowing. The first three columns report reduced-form results with no control variables,

columns (4) through (6) report results with the full set of controls discussed in Section III (plus the global-time dummies), and columns (7) through (9) report results with explicit controls for global factors (global volatility, global growth, and changes in US interest rates), instead of the global-time fixed effects.[22] Each set of three columns repeats the analysis for the same three variants of the dependent variables for each specification (FX capital inflows, the share of FX inflows in total inflows, and non-FX inflows), a pattern repeated in each set of our tests for the respective variables (*i.e.,* international bank loans or corporate debt issuance). Each column captures a different aspect of the impact of macroprudential FX regulations. Also, to simplify an interpretation of the results, the coefficients on macroprudential FX regulations and non-FX regulations are reported as the sum of the quarterly coefficient estimates ($\sum_{k=0}^{3} \beta_1$), with a reported *p*-value to indicate if the sum is jointly significant. These are written in italics, with no parentheses around the *p*-values, to clarify that this is distinct from the other coefficient estimates reported with standard errors (in parentheses).

The coefficient estimates in Table 1 support the predictions on how macroprudential FX regulations affect international borrowing by domestic banks. The estimates show that tighter macroprudential FX regulations are correlated with a significant decrease in foreign currency borrowing by banks and a significant decrease in the FX share of total international borrowing by banks, over the subsequent year. To put the magnitude of these estimates into context, cross-border FX loans to banks fall over a one-year period by 0.50% - 0.66% of GDP following a tightening in FX regulations. This suggests the effect of macroprudential regulations on cross-border FX loans to banks is large and meaningful. FX loans are around 1.9% of GDP at the median of our sample (across quarters when inflows were positive), suggesting that implementing FX regulations corresponds to a decline in FX cross-border loans by banks by about one-third. Or, to put this in the context of individual countries, consider Brazil and Indonesia—two countries which have been concerned about FX exposure. In both of these countries, FX loans to banks are a little less than 1% of GDP, suggesting that an increase in macroprudential FX regulations corresponds to a reduction in FX loans to banks by over half.

In contrast, and as also expected, the increase in macroprudential FX regulations does not have a significant effect on non-FX borrowing by banks (columns 3, 6, and 9). Banks do not significantly increase their borrowing in local currency to compensate for their reduced borrowing in FX. This is confirmed in column 1 of Appendix Table C1, which reports the

[22] These global variables follow papers in the literature predicting capital flows, such as Forbes and Warnock (2012) and Avdjiev *et al. (*2016a).

impact of macroprudential FX regulations on total international borrowing by banks. The aggregate effect is weakly negative—as expected—but only significant at the 10% level, suggesting that the reduction in international FX borrowing by banks after tighter regulations is not fully compensated for by increased non-FX borrowing.

The other coefficient estimates in Table 1 generally have the expected sign, albeit with mixed significance.[23] The coefficients that are most often significant are those on GDP growth and sovereign ratings—which suggest that faster growth and higher ratings are significantly correlated with increased capital inflows, especially in foreign currency. The global variables also have the expected signs in columns (7) through (9), with lower volatility, higher global growth, and reduction in US interest rates correlated with stronger FX borrowing by banks. The other results are basically unchanged when these global control variables are included, suggesting that their effects are largely captured in the global-time effects (in columns 1-6).

Next, Table 2 follows the same format as Table 1, except now tests the channels to the right of Figure 5 — on how macroprudential FX regulations affect international debt issuance by domestic corporations. Hypothesis #2 predicts that increased regulations cause firms to increase the total volume of FX debt issuance and the share of their total issuance in FX, with no significant impact on firms' and banks' non-FX debt issuance. The coefficient estimates on macroprudential FX regulations in Table 2 again have the predicted effects. Tighter macroprudential regulations are correlated with a significant increase in foreign currency debt issuance by corporates, and a significant increase in the share of corporate debt issued in FX by corporates, with no significant effect on non-FX debt issuance. The magnitude of these effects continues to be economically meaningful, albeit substantially smaller than that of increased macroprudential FX regulations on international bank flows. More specifically, international debt issuance by corporates increases by 0.05% to 0.06% of GDP following a tightening in FX regulations. This suggests the effect of macroprudential regulations on cross-border FX corporate debt issuance is moderate, given that net FX debt issuance is around 0.6% of GDP (at the sample median when net FX debt issuance was positive). For some countries, however, the impact is substantially larger. For example, in Brazil and Indonesia FX debt issuance is 0.26% and 0.36% of GDP, respectively, suggesting that tighter FX regulations correspond to roughly a 15% to 20% increase in this issuance.

[23] An increase in non-FX macroprudential regulations is usually positively associated with cross-border inflows, albeit generally insignificant. This could indicate that increased regulation increases confidence in the financial system and thereby supports greater inflows, as tentatively found in Reinhardt and Sowerbutts (2015) and Forbes *et al.* (2015).

Combining the results of Table 1 and Table 2 allows us to assess the aggregate effects of an increase in macroprudential FX measures on country exposure to FX risk through banks, as well as the degree of "shifting snowbanks" (*i.e.*, the substitution of FX exposure from banks to investors who hold the new FX corporate debt issuance). This "shifting" of FX risk can be calculated as the ratio of net FX debt issuance by corporates to international FX loans to banks. This ratio indicates that after an increase in FX regulations, about 10% of the decline in FX exposure in banks shifts to corporate debt issuance (and thereby to investors and other non-bank financial institutions).[24] This suggests that even though increased macroprudential FX regulations on banks leads to some "shifting snowbanks" of currency risk to other sectors of the economy, namely investors in our framework, there is still a meaningful net reduction in aggregate FX borrowing in the economy.

To complete the hypothesis testing and better understand the full set of relationships for which data is available (including those not formally included in the model), Appendix Table C1 reports several additional results. Columns (2) through (5) test for any impact of FX regulations on cross-border loans to non-banks. Although this data includes loans to non-bank financial institutions as well as corporates, and therefore does not exactly test the channels in the model (which only focuses on corporates), it finds no significant effect of FX regulations on cross-border loans to non-banks. This would agree with the model's prediction of no significant effect on cross-border loans to corporates (as shown in Figure 5). The table also reports the impact of FX regulations on total international debt issuance by corporates (combining FX and non-FX)—for which there is no model prediction—in column (10). The results show no significant effect at the 5% level, but a weakly significant positive relationship (when assessed at the 10% level). This weak positive effect of FX regulations on total corporate debt issuance is not surprising given that the regulations correspond to an increase in FX issuance and no significant change in non-FX issuance—in both the theoretical model and empirical results in Table 2.

Finally, as an additional set of tests to "complete the story", columns (6) through (9) of Appendix Table C1 report estimates of the effect of increased FX regulations on international debt issuance by banks. The estimates find no significant effect at the 5% level of increased FX

[24] Another way to calculate this ratio would be to adjust for the fact that not all FX lending by banks goes to corporates—with recently enhanced BIS data showing that on, average, 62% of FX loans from banks to non-banks are lent to the corporate sector (with the remainder lent to households, government and non-bank financials). Taking this into account, the "shifting" effect of FX exposure would be about 13% (instead of 10%). This new BIS data, however, is only available for limited countries (Canada, Cyprus, Denmark, United Kingdom, Korea, Sweden and South Africa).

regulation on international debt issuance by banks—whether measured as foreign currency issuance, the FX share of issuance, domestic currency issuance, or total issuance. This supports the predictions of the theoretical model, and is in sharp contrast to the results for corporate debt issuance (which found a significant positive effect of macroprudential FX regulations on FX issuance and the share of FX issuance). Table C1, however, suggests that there may be a weakly negative effect for bank debt issuance—albeit only significant at the 10% level for FX inflows and total inflows. This weakly negative impact on bank FX debt issuance may reflect the overall reduction in bank exposure to FX risk after increased macroprudential FX regulations. It is unsurprising that banks reduce this risk more through loans than net debt issuance, however, as bank loans tend to be shorter-term in maturity than debt securities, and FX regulations primarily target debt/loans at shorter maturities.

This combination of results provides evidence that macroprudential FX regulations have the intended direct effect of decreasing bank borrowing in FX, but also have the unintended consequence of causing corporations to take on more international debt in foreign currency. The fact that corporations do not simultaneously increase international debt issuance in domestic currency, and that banks do not significantly increase debt issuance in any currency, also suggests that these results are not capturing some type of omitted variable that would lead to a general increase in international borrowing or debt issuance in foreign currency. Macroprudential FX regulations only correspond to an increase in corporate FX debt issuance—but not an increase in other forms of international corporate borrowing (through debt or bank loans), nor bank corporate debt issuance.

Since these results reported in Tables 1 and 2 are central to understanding the impact of macroprudential FX regulations, we also perform several sensitivity tests, a selection of which are reported in Appendix Table C2. For each test, we focus on whether macroprudential FX regulations decrease international bank borrowing (or share of borrowing) in FX and non-FX, and whether they increase corporate debt issuance (or share of debt issuance) in FX and non-FX. These are the results that are significant in Tables 1 and 2. We do not report all of the "non-results" that are not significant (nor expected to be significant), as they continue to be insignificant in all of these tests.

More specifically, Appendix Table C2, Columns (1) through (6), show the results when offshore centers (Hong Kong and Singapore) are excluded, and columns (7) through (12) show results when the quarters around the global financial crisis (from 2008Q3 through 2009Q2)

are excluded. We have also repeated the analysis when only tightening in macroprudential measures are included (not loosening or removals), and when the variables are not financially weighted (as discussed in Section III). In additional sensitivity tests, we have dropped one country at a time (to exclude any impact from one country which has frequently adjusted macroprudential FX regulations). We have also added controls for: the current account balance as a share of GDP (to proxy for net capital inflows), institutional quality, and aggregate financial exposure.[25] In this entire series of tests, the main results discussed above are unchanged and continue to support our main hypotheses. Tighter FX regulation of banks is correlated with banks borrowing less in foreign currency, with no significant effect on their non-FX borrowing. Tighter FX regulation of banks is correlated with firms increasing their FX debt issuance, substituting away from banks, with no significant effect on firms' and banks' non-FX debt issuance.

Taken as a whole, these results suggest that FX regulations are successful in accomplishing their direct goal — of reducing the FX exposure of banks — but also have the unintended consequence of corporations shifting away from banks and obtaining some FX funding through other sources—primarily through debt issuance in foreign currency to investors. This "shifting of the snowbank" is only partial, as the reduction in international FX borrowing by banks is larger as a percent of GDP than the estimated increase in FX debt issuance by corporates. Both effects, however, are not only significant, but economically meaningful. The estimates also confirm the various other predictions of the theoretical model and Figure 5, including the variables for which there is not expected to be a significant impact of macroprudential FX regulations, such as on bank cross-border borrowing in domestic currency, and corporate and bank issuance of non-FX debt.

C. Effects of Different Forms of Macroprudential FX Regulations

Macroprudential FX regulations appear to effect international borrowing and debt issuance. But do different types of macroprudential FX regulations have different effects on banks and corporates? The theoretical model shows that regulations targeting the liability-side of bank balance sheets (*i.e.,* aimed at raising the cost of FX funding of domestic banks) work through somewhat different channels than those targeting the asset-side (*i.e.,* aimed at raising the cost of bank FX lending to households and corporates in the domestic economy). This

[25] Institutional quality is measured by the rule of law and aggregate financial exposure is measured relative to GDP by the Bénetrix *et al.* (2015) data. Both are described in more detail in Appendix B.

section tests for any differential effects of the various forms of macroprudential FX regulations. These results should be interpreted cautiously, however as the more limited observations for these finer gradations of macroprudential FX regulations imply that there are more limited degrees of freedom.

Table 3 reports the baseline estimates from Tables 1 and 2, except now focusing on results for liability-based FX measures on the left and asset-based measures on the right (as defined in Section III.A).[26] We continue to focus on the baseline specification with the full set of control variables and global-period dummy variables.[27] Each side of the table reports results of the impact on cross-border loans to banks in three columns and international debt issuance by corporates in the next three columns, with each set starting with the impact on FX inflows, then the share of FX flows in total inflows, and then non-FX inflows.

The results for asset- and liability-based FX macroprudential measures are similar when assessing the effect on cross-border loans to banks, but different when assessing the impact on debt issuance in FX by corporates. More specifically, both asset- and liability-side FX measures are correlated with a significant decrease in FX borrowing by banks—with the magnitude of the coefficient estimated to be larger for asset-side regulations, but only significant at the 10% level in column (8). For both measures, FX regulations continue to have a positive effect on FX debt issuance by corporates—but this effect is only estimated to be significant (at either the 5% or 10% level) for liability-side regulations. The magnitude of the coefficient on FX debt issuance is also estimated to be about three times larger for liability-side than asset-side regulations. (In both cases, there continues to be no significant effect on non-FX debt issuance by corporates and banks.)

These results suggest that both asset- and liability-side FX measures are effective in their direct goal of reducing cross-border loans to banks in FX. Only the liability-side measures, however, may also have the unintended side-effect of increasing FX debt issuance by corporates. Performing similar calculations as above to gauge the degree of "shifting", an increase in liability-side FX measures causes FX debt issuance by corporates to increase by 16% of the reduction in FX loans by banks (instead of 10% when all FX regulations are aggregated).[28] In other words, liability-side regulations appear to cause more "shifting of the

[26] We also repeat these tests with the more disaggregated categories of macroprudential FX regulations discussed in Section III. This additional disaggregation, however, yields results that are not robust across different specifications, undoubtedly due to the limited degrees of freedom for such specific type of action.
[27] Results are basically identical when the individual global variables are included instead of the global-time dummy.
[28] This is calculated as 0.0788 (Table 3, column 4) divided by 0.487 (Table 3, column 1). If one also takes into account

snowbanks", *i.e.*, more shifting of vulnerability to currency movements from banks to other sectors. As a result, asset-side regulations may provide a greater improvement in a country's resilience to currency movements, as they decrease bank exposure to currency risk but simultaneously generate less shifting of this risk to other sectors (such as investors).

One possible reason for these differential effects, as suggested in the theoretical model, is that liability-based measures affect all forms of bank funding in all states of the world. In contrast, asset-based measures only affect bank lending upon repayment—thus affecting a smaller share of bank balance sheets and having a smaller aggregate effect. Closely related, if asset-side regulations primarily affect bank lending to households, while liability-side regulations affect lending to both corporates and households, it is natural that tighter liability-side FX regulations correspond to a greater response in the corporate sector. Supporting this hypothesis, in some countries most FX regulations target the asset-side, a large share of which are regulations on LTV ratios, DTI ratios, and other aspects of FX lending for mortgages (such as in Hungary and Poland, see Table A1). A final possible explanation for the different effects of the asset- and liability-based measures is the maturity of the capital flows targeted by these measures. FX liability-based measures tend to focus on shorter-term inflows, while FX asset-based measures tend to focus on longer-term maturities. As the macroprudential measures often involve a greater relative cost for short-term than longer-term capital flows, these shorter-term flows are the ones most affected.

V. Empirical Results: Macroprudential FX Regulations and Resilience to Currency Movements

This section assesses how macroprudential FX regulations on banks affect the exposure of banks and the broader economy to exchange rate movements. If the primary motivation of macroprudential FX regulations is to reduce the vulnerability of the economy to sharp currency movements, do the regulations achieve this goal? Does the reduction in FX borrowing by banks significantly reduce bank exposure to currency movements? And if so, does the exposure largely shift to other sectors of the economy, so that the aggregate vulnerability of the economy is improved by less than policy makers might have intended? Or, if the vulnerability shifts to sectors that are less able to handle this risk (such as uniformed investors in the model), could this even increase the economy-wide FX risks?

that only about 62% of FX loans from banks to non-banks are likely lent to the corporate sector, the degree of shifting could increase to 26%.

This section attempts to go one step beyond most other work assessing the direct and spillover effects of macroprudential FX regulations by also testing if the regulations attain one of their ultimate goals: reducing the vulnerability of the economy to exchange rate movements. As discussed in the introduction, there is longstanding evidence of the multifaceted risks and challenges created by exposure to currency movements. If macroprudential FX regulations can mitigate these challenges and risks, they could provide substantive benefits to the broader economy. This approach of testing for the potential effects on country resilience builds on the academic literature identifying ways to increase the effectiveness of regulation in order to strengthen its welfare impact (e.g., Nier *et al.*, 2011, Mendicino *et al.*, 2015, Agénor 2016, and IMF-FSB-BIS, 2016).

A. Empirical Framework and Data

The theoretical model developed in Section II provides guidance on how macroprudential FX regulations affect the relationship between exchange rate movements and banks' and corporates' stock returns. More specifically, the model yields two hypotheses on the impact of an increase in macroprudential FX regulations: banks' exposure to exchange rate movements declines (so that their stock returns are less sensitive to exchange rate movements) and firms' exposure to exchange rate movements will also decline, but not by as much as for banks. These are testable implications #3 and #4 from the model.

Complicating an analysis of these sensitivities, we do not have a clear measure of returns for each of the sectors of the economy of interest (*i.e.,* just banks or just corporates). On a positive note, we do have fairly extensive information on financial stock returns, which is largely banks, thereby allowing us to assess the sensitivity of banks to currency movements both before and after the implementation of FX regulations. We also have information on broad stock returns for a large sample of countries—returns which capture the sensitivity of corporates, banks, and non-bank financial institutions (including some investors). We will proxy corporate returns using these broad market indices.[29]

Next, in order to test if macroprudential FX regulations on banks affect bank and corporate sensitivity to currency movements, we estimate the following equation:[30]

[29] To better isolate corporate returns from this broad market index, an extension uses a constructed series of corporate stock returns (discussed below). The key results are unchanged.
[30] In related work, Bruno and Shin (2016) examine how depreciations affect equity prices and Bekaert and Mehl (2017) assess the sensitivity of equity markets to global and regional equity returns.

$$\Delta eprice_{i,t} = \alpha + \alpha_i + \beta\, \Delta exrate_{i,t} + \delta\, fxm_{i,t}$$

$$+\mu\, \Delta exrate_{i,t} \times fxm_{i,t} + controls_{i,t} + \varepsilon_{i,t}, \qquad (15)$$

where $\Delta eprice_{i,t}$ is, in country i and quarter t, the return of a stock market index covering financial sector firms or the broad market, respectively (depending on the hypothesis tested). Next, $\Delta exrate_{i,t}$ is the growth rate of a financially-weighted exchange rate (where an increase is defined as an appreciation of the domestic currency) and $fxm_{i,t}$ is a measure of FX regulation that captures the cumulated policy stance over the current and the last three quarters.[31] Further, following Baele *et al.* (2010), $controls_{i,t}$ contains a set of variables that affect stock returns through channels other than the exchange rate, such as standard macro factors, liquidity factors and risk premium factors, as well as a global volatility index as a proxy for global influences. Finally, α_i are country-fixed effects that capture time-invariant differences between countries (e.g., differences in the level of economic or financial development). Details on the sources and the construction of the variables are in Appendix B.[32]

The focus of the analysis is the response of stock returns to a change in the financially-weighted exchange rate. This is represented by the marginal effect of the exchange rate movement on stock returns, which is a function of the policy stance of the FX regulations:

$$\frac{\Delta eprice_{i,t}}{\Delta exrate_{i,t}} = \beta + \mu\, fxm_{i,t} \ . \qquad (16)$$

Our theoretical model shows that an appreciation of the domestic currency leads to an increase in the ex-post profits of banks and corporates, so that β is expected to be positive. Furthermore, if FX regulation is effective in reducing the exposure of banks and corporates to exchange rate movements, the coefficient μ should be negative, so that a tightening of FX regulations (i.e., an increase in $fxm_{i,t}$) would reduce exchange rate sensitivity. Since banks are directly affected by FX regulation, however, and corporates can switch to market-based FX borrowing and therefore not reduce their foreign currency borrowing by as much as banks, we would expect the coefficient μ to be more negative for banks than for corporates.

[31] In equation (15), $fxm_{i,t}$ is measured as the sum of the contemporaneous value of the FX measure plus its three lags. We do not include the contemporaneous value and its three lags separately (as in the analysis in Section IV, equation (14)) to make the calculation of the interaction term in equation (15) straightforward. The smaller country sample in equation (15) also limits the number of lagged and interaction terms that can be included relative to in Section IV.

[32] All variables (except the global volatility index) have been winsorized at the 2.5% level on each side of the distribution to reduce the impact of outliers.

B. Results

Table 4 presents the results of estimating equation (15) on a sample of up to 24 countries over the period 2000Q1 to 2014Q4.[33] For most results, we report one set of specifications for financial stock returns (representing banks' stock returns) as the dependent variable and another set for broad market stock returns (representing corporates' stock returns). Columns (1) and (2) only include the three variables central to our exchange rate sensitivity tests, while columns (3) and (4) add standard controls for equity return regressions and are our baseline regressions. We will focus on the first three variables in each column: the cumulated FX regulation measure (henceforth simply referred to as "FX regulation"); the financially-weighted exchange rate (defined as an appreciation of the domestic currency), and their interaction. The signs of the other control variables are generally similar for financials and the broad market indices and have the expected signs, albeit some have fluctuating significance.[34]

In each of the specifications in columns (1) - (4), the coefficients on FX regulations are insignificant—albeit usually negative and larger for financials—possibly indicating that increased macroprudential FX regulations on banks could reduce bank stock returns. The coefficient on the exchange rate is positive and significant in each case, suggesting that currency appreciation corresponds to higher stock returns (as predicted in the model).

Most important for our analysis, the coefficient on the interaction term (the coefficient μ in equations (15) and (16)) is negative in each of the four columns. This suggests that increased macroprudential FX regulations reduce the sensitivity of banks and corporates to exchange rate movements. This coefficient, however, is only negative and significant at the 5% level for bank returns (columns (1) and (3)), and the estimated magnitude of the coefficient is over 50% larger for banks than corporates in each case. This suggests that macroprudential FX regulations reduce bank sensitivity to exchange rate movements more than that for the broader economy—as predicted.

The magnitudes of the coefficients in Table 4 also provide more information on the size of these effects. Focusing on the columns with the full set of controls in columns (3) and (4),

[33] Standard errors are clustered by country. The country sample is limited by the availability of the financial stock returns variable. The countries for which data is available for this analysis are: Australia, Austria, Brazil, Canada, Czech Republic, Denmark, Hong Kong SAR, Hungary, India, Indonesia, Korea, Malaysia, Mexico, New Zealand, Norway, Philippines, Poland, Singapore, South Africa, Sweden, Thailand, Turkey, United Kingdom, and Vietnam.

[34] For example, higher stock returns are correlated with higher industry production growth, lower inflation, a reduction in interest rates, higher stock market turnover, and a lower level of global volatility.

when the cumulated policy stance for macroprudential FX regulation is neutral, a 1 percentage point depreciation in the financially-weighted exchange rate leads to a decrease in stock market returns for financials by 1.46 percentage points and for the broad market by 1.18 percentage points. When FX regulations are tightened, the same depreciation corresponds to a 0.67 percentage point decline in returns for financials and 0.75 percentage point decline for the broader market. Hence, tighter macroprudential FX regulations reduce the sensitivity of stock returns to exchange rate shocks for both banks and the broader economy, but the effect is almost twice as large for banks (and insignificant for corporates).

Next, since the broad market index is only a rough proxy for corporate stock returns (as this includes banks as well as non-bank financial institutions), column (5) shows results when an artificially-constructed measure of corporate stock returns is used instead of the broad market index. This proxy is calculated by regressing the broad market return index on the financial return index and taking the residual. This should better isolate the impact on corporate returns—but should be interpreted cautiously as this regression could also remove the effects of any omitted variables that affect both corporate and financial stock returns. With this caveat, the estimates support the model's predictions that FX macroprudential regulations reduce corporate sensitivity to exchange rate movements by less than that for banks. More specifically, the coefficient on the interaction term between FX regulation and the exchange rate is insignificant and positive—a sharp contrast to the negative and significant coefficient for the financial index, as well as to the negative and sometimes weakly significant coefficient for the broad index. Since the coefficient estimate is insignificant, we are cautious about interpreting the sign of the effect on corporates—but instead can conclude that this result suggests any effect of macroprudential regulations on the sensitivity of corporates to exchange rate movements is small and insignificant.[35]

The final four columns of Table 4 further explore this relationship between macroprudential regulations and sensitivity to exchange rate movements under two scenarios when the impact of exchange rate movements on stock returns is expected to be larger than average: for emerging markets (which tend to have greater exposure to FX) and for larger exchange rate movements. An extensive literature focuses on the greater sensitivity of

[35] It is also possible, however, that these estimates understate the reduction in FX exposure due to the differential impact on small firms. More specifically, smaller firms are more likely to rely on banks for funding, and if FX regulations cause banks to reduce their lending to these smaller firms in FX, these firms may be too small to issue debt on international markets. These smaller firms would therefore be forced to reduce their FX borrowing and exposure—whether by shifting to local currency borrowing or not borrowing at all. These effects would not be captured in the empirical analysis as these smaller firms are also less likely to issue publically-listed equity and/or be included as part as the main equity index.

emerging markets to exchange rate movements (e.g., Eichengreen and Hausmann, 1999; Acharya *et al.*, 2015; Chui *et al.*, 2014 and 2016), so columns (6) and (7) repeat the main results (with the full set of controls) for only the emerging markets in our sample. Other work has suggested that the impact of exchange rate movements on the economy may be non-linear and greater after large movements, especially depreciations (e.g., Kappler *et al.* 2013)—so columns (8) and (9) report results only for large exchange rate movements, defined as movements in the exchange rate below the 10th percentile and above the 90th percentile. In both of these scenarios, the key signs and significance from the base case remain unchanged—but the estimated magnitudes of the coefficients are all larger. For example, and most relevant to this paper's analysis, tighter macroprudential regulations correspond to a greater reduction in the exchange rate sensitivity of emerging markets, and to all countries after large exchange rate movements, than occurs for the full sample.

Finally, Appendix Table C3 reports a final set of robustness checks—all of which agree with the main results in Table 4. Columns (1) and (2) use the first lags of all control variables to mitigate endogeneity concerns. Columns (3) and (4) exclude the variables for the stock market turnover ratio and the rule of law, as both were interpolated from annual to quarterly frequency. Next, columns (5) and (6) exclude 2008Q4, which was a period of very sharp exchange rate movements (corresponding to the collapse of Lehman Brothers). We have also repeated the analysis using dollar exchange rates (instead of financial-exposure weighted exchange rates) to calculate exchange rate movements for each country ($\Delta exrate_{i,t}$).

In each of these sensitivity tests, the key results are unchanged. Macroprudential FX regulation significantly reduces the sensitivity of bank stock returns to exchange rate movements. The sensitivity of stock returns for the broader economy may also be reduced, but this effect is often insignificant and smaller than that for banks.

VI. Conclusions

The 2008 global financial crisis increased awareness of the importance for countries to develop comprehensive macroprudential frameworks that support the financial stability of the entire economy (not just individual institutions) and reduce the amplification mechanisms of systemic risk. A growing literature is beginning to document how many of the tools that are being used more widely as part of these macroprudential frameworks can affect the specific

variables or institutions that they target. This literature, however, is also beginning to document how these tools often have unintended consequences (such as leakages to unregulated institutions and spillovers to other countries). One of these macroprudential tools which is being more widely utilized, but has received relatively less attention in academic research, is regulations on FX exposure. This is despite longstanding evidence that exposure to currency movements can present an important vulnerability for many economies.

This paper attempts to address this gap by analyzing the incidence and impact of macroprudential FX regulations on banks. It develops the key concepts in a theoretical model, compiles a dataset with detailed information on these regulations over time, and then uses it to test the predictions of the model. The results show that after an increase in macroprudential FX regulations: (1) banks borrow and lend less in foreign currency (with no change in their borrowing in local currency); (2) firms shift away from bank FX borrowing and increase their FX borrowing from market investors (with no increase in firm and bank non-FX borrowing from investors); (3) banks are less exposed to exchange rate movements; and (4) firms experience some reduction in their exposure to exchange rate movements, but less than for banks. Each of these results agrees with the main predictions of the model. These results go a step further than most research on macroprudential regulations by assessing not only their immediate and leakage/spillover effects, but also if they achieve their main goal of supporting the stability of the broader financial system and reducing the amplification mechanisms of systemic risk. Our results suggest that macroprudential FX regulations on banks do significantly reduce bank vulnerability to currency movements, but this partly occurs by "shifting the snowbanks" of vulnerability to other sectors of the economy.

Although these empirical results are robust to a number of extensions and sensitivity tests, several caveats are important. The underlying data on foreign currency borrowing is far from ideal and may miss important aspects of bank and firm FX exposures. For example, the data does not include information on firm or bank exposure to foreign currency that occurs without crossing borders (such as if a local household makes a bank deposit in foreign currency). The data also does not incorporate any transactions or changes in exposure that occur entirely through trading or lending in a third country (such as often occurs in financial centers). Moreover, the analysis does not include information on hedging—whether natural or in financial markets—which could reduce an entity's vulnerability to currency movements even if it has large gross FX positions. Many of these data challenges, however, might be expected to bias estimates toward zero, thereby suggesting some of the effects estimated in

the paper could actually be larger if better data existed. For example, if firms respond to tighter FX regulations at home by issuing FX debt abroad and selling it to foreigner (with the entire transaction in London), this leakage would not be captured in our analysis.

Another important caveat is that the analysis in this paper does not provide a full cost-benefit calculation of the impact of macroprudential regulations—either in the theoretical model or the empirical analysis. Macroprudential regulations can have much broader costs and benefits than those explored in this paper—such as on the distortions created as firms, banks and individuals find other ways to reduce the impact of the regulations (such as shifting business to other countries with a different regulatory framework). A full test of these various effects is beyond the scope of this paper—but would be a promising avenue for future work (with datasets better targeted to address these questions).

With these caveats, the results in this paper have a number of important implications for the application of macroprudential policy. They suggest that a key factor when constructing macroprudential policy should be the regulatory perimeter. If macroprudential policies partially shift risks from the regulated sector to unregulated sectors (such as market investors or the shadow financial system)—should these unregulated sectors also be included in the regulatory perimeter? Do these other sectors present systemic risks—such as by amplifying negative shocks (as can occur with banks)? Are risks in these other sectors potentially an even greater concern as they are in the "shadow" and potentially less well understood than those in the regulated sector?

Another key implication of this paper is for the debate on capital controls versus macroprudential policy. Countries concerned about excessive borrowing in foreign currency may consider capital controls (especially for bank borrowing in FX, which is particularly volatile and linked to booms and busts[36]). Macroprudential regulations on banks, however, appear to be effective in reducing this vulnerability in the financial system without resorting to capital controls—controls which are illegal in some contexts (such as for EU members and in some trade agreements). Although macroprudential bank regulations can also generate leakages (such as an increase in FX debt issuance by corporates), capital controls can also generate leakages and costs—including other ways of "shifting the snowbank" of FX risks to different sectors of the economy.[37]

[36] See Hoggarth *et al.* (2016).

[37] For example, Keller (2018) shows that capital controls can cause banks to increase FX lending to domestic firms (in

A final implication for the application of macroprudential policies, and one which draws from all of the above results, is that any such policies should be considered in the context of the aggregate welfare impact of the regulation. Macroprudential FX regulations on banks appear to yield benefits for some sectors of the economy—such as by reducing the exposure of the banking sector to FX risks and thereby reducing the social cost of bank failure. The regulations also generate other costs, however, such as by increasing the exposure of other sectors (*i.e.,* investors) to FX risks and reducing output due to the less efficient allocation of FX lending. Our estimates suggest that this "shifting of the snowbanks" of risks from one sector to the other is only partial (maybe some of the snow melts while you are shoveling)—so that the aggregate currency exposure of a country falls considerably after tighter macroprudential FX regulations in banks. But does this necessarily improve the welfare of the country as a whole? Even if overall FX exposure of the economy falls, does this benefit outweigh other costs of the regulation? The theoretical model in this paper suggests that tighter macroprudential FX regulations on banks could reduce total factor productivity, as investors lend more indiscriminately and without the knowledge from banks' screening activities. If the sectors that experience an increase in FX exposure are less productive, less informed, less able to manage exchange rate movements than banks, or present unexpected systemic risks (perhaps because they are not regulated), could there even be scenarios where systemic risk increases? Just as a fresh snowbank rarely stays white for long, the impact of macroprudential regulation on country resilience can quickly get muddy.

order to better hedge their foreign currency deposits when international hedging becomes more expensive), thereby causing an increase in foreign currency exposure of domestic companies. For other evidence on the costs and distortions created by capital controls, see Forbes (2007).

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	IBS: Cross-border loans to banks								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	FX Inflows	FX Share	Non-FX Inflows	FX Inflows	FX Share	Non-FX Inflows	FX Inflows	FX Share	Non-FX Inflows
FX regulation (t to t-3)	**-0.496***	**-0.926****	**0.106**	**-0.662****	**-0.997****	**0.0540**	**-0.628****	**-0.963****	**0.0450**
p-value	***0.0592***	***0.0200***	***0.371***	***0.0123***	***0.0104***	***0.637***	***0.0151***	***0.0110***	***0.647***
Global Factors									
Global Volatility (t-1)							-0.2466***	0.3069*	-0.1592***
							(0.0796)	(0.1554)	(0.0429)
Global Growth (t-1)							0.0691***	-0.0201	0.0113
							(0.0223)	(0.0392)	(0.0182)
Fed funds rate (Changes, t-1)							-0.1446**	0.1399	-0.0647**
							(0.0560)	(0.1242)	(0.0252)
Domestic variables									
Non-FX regulation (t to t-3)				0.222	-0.152	0.150	0.121	0.0288	0.0588
p-value				*0.186*	*0.450*	*0.135*	*0.452*	*0.870*	*0.423*
Real GDP Growth (t-1)				0.0624***	0.0181	0.0196**	0.0708***	-0.0056	0.0290***
				(0.0165)	(0.0145)	(0.0079)	(0.0145)	(0.0169)	(0.0104)
Volatility of exchange rate (FW, t-1)				-0.1925	0.0778	0.0837**	-0.1910	-0.0900	0.1046***
				(0.1168)	(0.1664)	(0.0329)	(0.1145)	(0.1575)	(0.0340)
IR differential (Changes, FW, t-1)				0.0043	0.0109	-0.0104	0.0064	0.0154	-0.0146**
				(0.0164)	(0.0612)	(0.0072)	(0.0138)	(0.0607)	(0.0071)
Sovereign Ratings (t-1)				0.0741***	-0.0629*	0.0494***	0.0721***	-0.0515	0.0359**
				(0.0261)	(0.0357)	(0.0173)	(0.0247)	(0.0339)	(0.0160)
Financial Openness (Changes, t-4)				0.4452	0.4567	0.0406	0.6345**	0.3088	0.2109
				(0.2910)	(0.7909)	(0.1643)	(0.3036)	(0.7551)	(0.1650)
Constant				-1.1112***	1.0489	-0.6812**	-0.5386	-0.0101	-0.2423
				(0.4062)	(0.7779)	(0.2630)	(0.3683)	(0.5968)	(0.2261)
Time Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	No	No	No
Observations	3,589	3,531	3,535	3,381	3,348	3,368	3,381	3,348	3,368
Adj. R-squared	0.069	0.01	0.034	0.09	0.011	0.051	0.065	0.002	0.028
Countries	48	48	48	48	47	48	48	47	48

Table 1: Hypothesis #1 - FX regulations and cross-border debt flows to banks

The table shows the estimated parameter values from a panel regression of equation (14). All columns include country and time (quarter) fixed effects. The dependent variables are estimated exchange rate-adjusted changes in the stock of cross-border loans from international banks to domestic-resident banks, for loans denominated in foreign or domestic currencies, each expressed as a % of annual GDP. The columns labelled FX Share use the same data, but express the dependent variable as the change in the share of FX-denominated loans divided by total loans. In columns 7-9, the estimates control for key global factors individually, instead of including a global-time dummy (δ_t) in equation (14).

Data are from the BIS International Banking Statistics and the split between FX and non-FX components of loans is based on authors' estimates. All data is discussed in Section III, with additional information in Appendices A and B. FW indicates "financially weighted". The sample period is 1996 Q1 – 2014 Q4. Robust standard errors are clustered at the country level and reported in brackets. ***/**/* is significant at the 1%, 5%, and 10% levels, respectively.

	IDS: International debt issuance by corporates								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	FX Inflows	FX Share	Non-FX Inflows	FX Inflows	FX Share	Non-FX Inflows	FX Inflows	FX Share	Non-FX Inflows
FX regulation (t to t-3)	**0.0588****	**0.516****	**0.00848**	**0.0549****	**0.513****	**0.00941**	**0.0530****	**0.464****	**0.0166**
p-value	***0.0167***	***0.0280***	***0.796***	***0.0370***	***0.0269***	***0.779***	***0.0336***	***0.0232***	***0.634***
Global Factors									
Global Volatility (t-1)							-0.0033	-0.0079	0.0059
							(0.0118)	(0.0879)	(0.0042)
Global Growth (t-1)							-0.0063*	-0.0131	-0.0004
							(0.0032)	(0.0183)	(0.0011)
Fed funds rate (Changes, t-1)							0.0213**	0.0892	0.0018
							(0.0081)	(0.0748)	(0.0031)
Domestic variables									
Non-FX regulation (t to t-3)				0.000220	0.0707	-0.00265	0.0123	0.0687	0.00503
p-value				*0.991*	*0.448*	*0.584*	*0.538*	*0.405*	*0.211*
Real GDP Growth (t-1)				0.0020	-0.0004	-0.0004	0.0001	-0.0061	-0.0007
				(0.0013)	(0.0085)	(0.0005)	(0.0012)	(0.0089)	(0.0005)
Volatility of exchange rate (FW, t-1)				0.0134	0.0521	-0.0082**	0.0026	0.0524	-0.0060*
				(0.0107)	(0.0463)	(0.0039)	(0.0102)	(0.0415)	(0.0031)
IR differential (Changes, FW, t-1)				-0.0031*	-0.0171	0.0005	-0.0036*	-0.0178	0.0001
				(0.0016)	(0.0170)	(0.0006)	(0.0018)	(0.0211)	(0.0006)
Sovereign Ratings (t-1)				0.0107	0.0058	-0.0012	0.0110**	0.0086	0.0012
				(0.0066)	(0.0148)	(0.0015)	(0.0051)	(0.0191)	(0.0007)
Financial Openness (Changes, t-4)				0.0215	0.3201	-0.0176	-0.0195	0.3150	-0.0245**
				(0.0483)	(0.2246)	(0.0112)	(0.0569)	(0.2172)	(0.0112)
Constant				-0.1288	0.0261	0.0207	-0.0595	-0.1367	-0.0100
				(0.0944)	(0.2706)	(0.0181)	(0.0786)	(0.4124)	(0.0165)
Time Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	No	No	No
Observations	3,344	2,804	2,736	3,147	2,728	2,613	3,147	2,728	2,613
Adj. R-squared	0.098	0.04	0.192	0.1	0.039	0.202	0.076	0.034	0.190
Countries	44	44	36	44	44	36	44	44	36

Table 2: Hypothesis #2: FX regulations and cross-border debt issuance by corporates

The table shows the estimated parameter values from a panel regression of equation (14). All columns include country and time (quarter) fixed effects. The dependent variables are net issuance of debt securities issued by domestic corporates for debt denominated in foreign or domestic currencies, each expressed as a % of annual GDP. The columns labelled FX Share use the same data, but express the dependent variables as the change in the share of FX-denominated debt issuance divided by total debt issuance.

Data are from the BIS International Debt Statistics. All data is discussed in Section III, with additional information in Appendices A and B. FW indicates "financially weighted". The sample period is 1996 Q1 – 2014 Q4. Robust standard errors are clustered at the country level and reported in brackets. ***/**/* is significant at the 1%, 5%, and 10% levels, respectively.

	Liability-side FX regulations						Asset-side FX regulations					
	IBS: Cross-border loans to banks			IDS: Int. debt issuance by corporates			IIBS: Cross-border loans to banks			IDS: Int. debt issuance by corporates		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	FX Inflows	FX Share	Non-FX Inflows	FX Inflows	FX Share	Non-FX Inflows	FX Inflows	FX Share	Non-FX Inflows	FX Inflows	FX Share	Non-FX Inflows
FX regulation (t to t-3)	**-0.487****	**-1.037****	**0.0569**	**0.0788****	**0.688***	**-0.0228**	**-1.105****	**-1.075***	**0.0168**	**0.0247**	**0.224**	**0.0513**
p-value	***0.0242***	***0.0186***	***0.608***	***0.0265***	***0.0853***	***0.154***	***0.0300***	***0.0605***	***0.933***	***0.513***	***0.557***	***0.496***
Domestic variables												
Non-FX regulation (t to t-3)	-0.125	-0.282	0.131	0.0287	0.160**	-0.00528	0.701*	0.133	0.160	-0.0409	0.0132	-0.000347
p-value	*0.293*	*0.317*	*0.331*	*0.201*	*0.0494*	*0.311*	*0.0728*	*0.685*	*0.188*	*0.201*	*0.950*	*0.967*
Real GDP Growth (t-1)	0.0635***	0.0183	0.0201**	0.0019	-0.0008	-0.0004	0.0603***	0.0150	0.0199**	0.0023*	0.0019	-0.0005
	(0.0173)	(0.0145)	(0.0081)	(0.0013)	(0.0084)	(0.0005)	(0.0159)	(0.0142)	(0.0083)	(0.0014)	(0.0083)	(0.0005)
Volatility of exchange rate (FW, t-1)	-0.1937	0.0664	0.0848**	0.0134	0.0551	-0.0082**	-0.1838	0.0728	0.0855**	0.0131	0.0455	-0.0087**
	(0.1168)	(0.1664)	(0.0333)	(0.0105)	(0.0450)	(0.0039)	(0.1160)	(0.1656)	(0.0337)	(0.0106)	(0.0467)	(0.0041)
IR differential (Changes, FW, t-1)	0.0083	0.0159	-0.0104	-0.0033*	-0.0183	0.0006	0.0044	0.0071	-0.0090	-0.0029*	-0.0160	0.0006
	(0.0160)	(0.0618)	(0.0072)	(0.0017)	(0.0172)	(0.0006)	(0.0159)	(0.0643)	(0.0074)	(0.0017)	(0.0175)	(0.0006)
Sovereign Ratings (t-1)	0.0741***	-0.0651*	0.0498***	0.0108	0.0069	-0.0012	0.0744***	-0.0600	0.0488***	0.0108	0.0062	-0.0013
	(0.0260)	(0.0357)	(0.0176)	(0.0067)	(0.0152)	(0.0015)	(0.0272)	(0.0359)	(0.0176)	(0.0066)	(0.0156)	(0.0016)
Financial Openness (Changes, t-4)	0.4305	0.4403	0.0481	0.0212	0.3303	-0.0165	0.4173	0.4315	0.0400	0.0254	0.3432	-0.0188
	(0.2859)	(0.7895)	(0.1656)	(0.0487)	(0.2261)	(0.0115)	(0.2886)	(0.7926)	(0.1631)	(0.0485)	(0.2197)	(0.0111)
Constant	-1.1091***	1.0913	-0.6896**	-0.1292	0.0071	0.0201	-1.1182**	1.0385	-0.6761**	-0.1307	0.0245	0.0234
	(0.4071)	(0.7791)	(0.2682)	(0.0948)	(0.2731)	(0.0178)	(0.4224)	(0.7759)	(0.2689)	(0.0933)	(0.2843)	(0.0190)
Time Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	3,381	3,348	3,368	3,147	2,728	2,613	3,381	3,348	3,368	3,147	2,728	2,613
Adj. R-squared	0.089	0.011	0.049	0.101	0.039	0.202	0.092	0.01	0.049	0.1	0.039	0.203
Countries	48	47	48	44	44	36	48	47	48	44	44	36

Table 3: Liability-side vs Asset-side Macroprudential FX regulations and cross-border bank and debt flows

The table presents the estimated parameter values from panel regressions. All columns include country and quarter fixed effects. See footnote to Tables 1 and 2 for variable definitions. Data are from the BIS International Banking and Debt Statistics. The split in FX and non-FX components of loans is based on authors' estimates. The sample period is 1996 Q1 – 2014 Q4. Robust standard errors, clustered at the country level, are reported in brackets. ***/**/* is significant at the 1%, 5%, and 10% level.

	Limited Controls		Base			Emerging Markets		Large ER Moves	
Stock Returns	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
By	*Fin.*	*Broad*	*Fin.*	*Broad*	*Corp.*	*Fin.*	*Broad*	*Fin.*	*Broad*
Cum. FX Regulation (t to t-3)	-0.555	0.470	-1.504	-0.629	0.205	-2.437*	-1.116	-5.335**	-3.310
	(1.538)	(1.230)	(1.298)	(1.467)	(0.981)	(1.190)	(1.482)	(2.275)	(2.583)
Ex. Rate Appreciation (t)	1.956***	1.648***	1.459***	1.184***	0.179*	1.810***	1.436***	1.635***	1.315***
	(0.214)	(0.154)	(0.224)	(0.162)	(0.101)	(0.238)	(0.165)	(0.229)	(0.196)
FX Regulation X Ex. Rate Apprec. (t)	**-0.689****	-0.379	**-0.781*****	-0.432*	0.023	**-0.939*****	-0.568**	**-1.093****	-0.705
	(0.310)	(0.265)	(0.276)	(0.240)	(0.171)	(0.275)	(0.225)	(0.415)	(0.439)
Industry Production Growth (t)			0.086*	0.058	0.006	0.107	0.152**	0.047	0.067
			(0.045)	(0.044)	(0.028)	(0.075)	(0.059)	(0.073)	(0.091)
Inflation (t)			-0.144	-0.311	-0.267	-0.279	-0.379	0.368	-0.331
			(0.420)	(0.308)	(0.198)	(0.517)	(0.386)	(0.780)	(0.710)
Short-Term Interest Rate (t)			-0.278*	-0.419**	-0.218*	-0.202	-0.305	-0.239	-0.455
			(0.144)	(0.187)	(0.111)	(0.142)	(0.211)	(0.285)	(0.296)
Stock Market Turnover Ratio (t)			0.016	0.048***	0.036***	0.016	0.030	0.067*	0.078***
			(0.021)	(0.017)	(0.010)	(0.036)	(0.028)	(0.034)	(0.025)
Rule of Law (t)			-4.225	-1.657	1.154	0.855	-3.267	4.788	-5.756
			(3.229)	(3.375)	(2.433)	(3.707)	(4.528)	(9.649)	(8.786)
Global Volatility (t)			-10.126***	-9.859***	-3.374***	-7.824***	-7.681***	-8.854***	-9.089***
			(0.899)	(0.780)	(0.405)	(0.822)	(0.714)	(1.572)	(1.682)
Country Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1,204	1,204	1,093	1,093	1,093	594	594	252	252
R-squared	0.177	0.173	0.338	0.392	0.162	0.375	0.391	0.518	0.556
Number of Countries	24	24	23	23	23	13	13	22	22

Clustered standard errors in parentheses (*** p<0.01, ** p<0.05, * p<0.1). Constant included but not reported.

Fin. = Finanical Sector, Broad = Broad Market, Corp. = Corporates only. Larger value of each coefficient pair in absolute terms is marked in bold.

Table 4: Market Vulnerability to Currency Movements

The table shows the estimated parameter values from a panel regression of equation (15). All columns include country fixed effects. The dependent variables are stock returns of financials ("Fin."; which is primarily banks), the broad market ("Broad"; which includes banks, non-bank financials, and corporates) and corporates ("Corp"; which is an estimate of corporate returns). All columns control for the cumulated FX regulation measure (sum over the current and the last three quarters), the financially weighted exchange rate (defined as an appreciation of the domestic currency) and their interaction term. Column (5) uses a proxy for corporate stock returns, estimated as the residual of a regression of the broad return index on the financial index. Columns (6) and (7) restrict the sample to emerging markets. Columns (8) and (9) are based on the full sample, but include only large exchange rate movements (*i.e.*, values below the 10th and above the 90th percentile in the distribution of exchange rate movements). The specifications and data are discussed in Sections III and VI. Additional information is provided in Appendix B. The sample period is 2000 Q1 – 2014 Q4. Robust standard errors are clustered at the country level and reported in brackets. ***/**/* is significant at the 1%, 5%, and 10% levels, respectively.

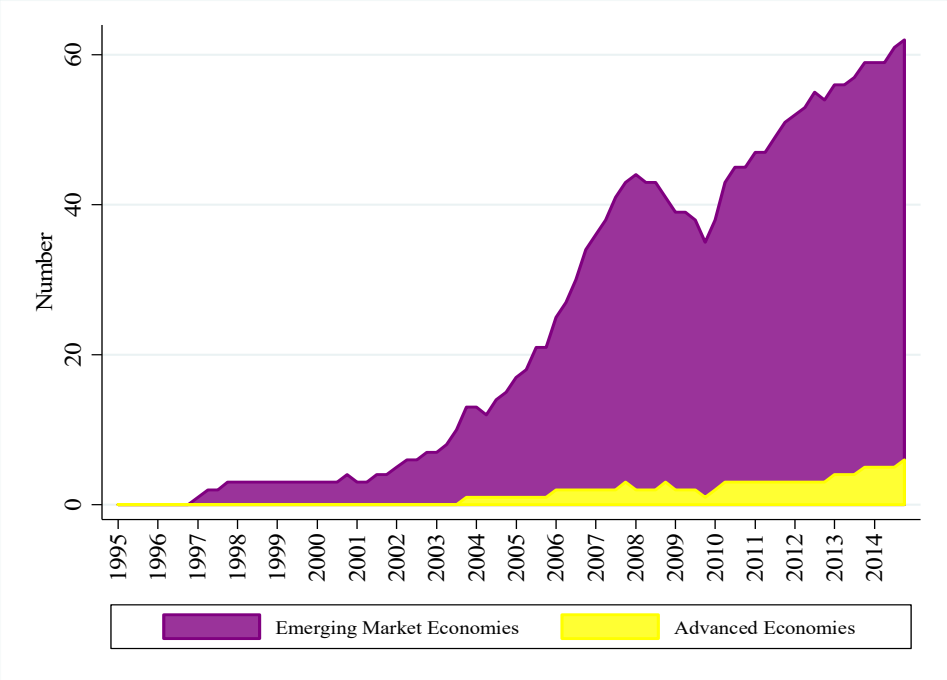


Figure 1: Cumulated changes in macroprudential FX regulations: by country group. This figure shows the aggregate number of changes in macroprudential regulations that have occurred in the sample (described in Section III), where changes include both loosening and tightening. The shading divides these actions into those undertaken by emerging economies (in purple) and advanced economies (in yellow).

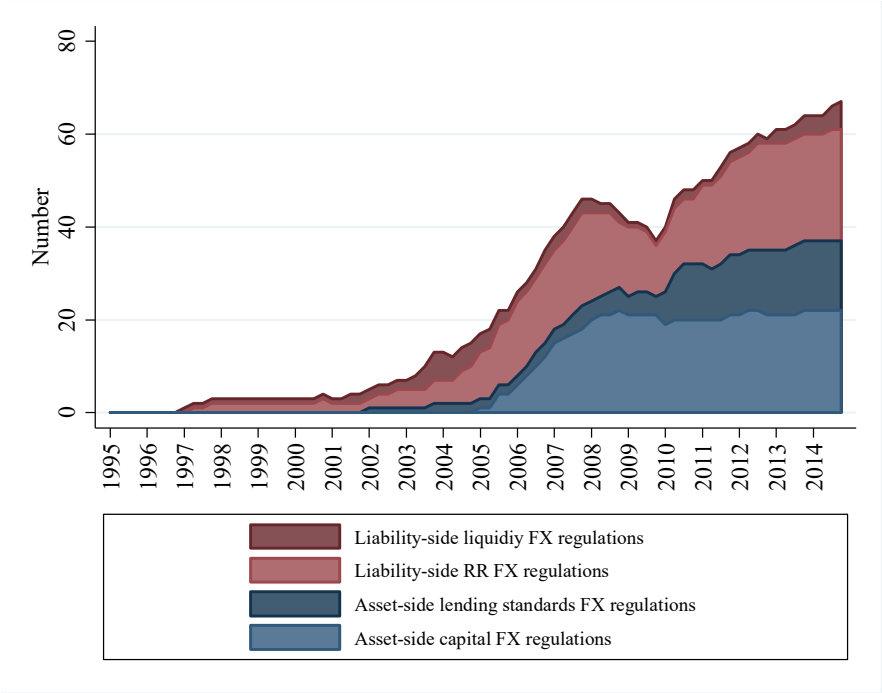


Figure 2: Cumulated changes in macroprudential FX regulations: disaggregated by measure. This figure shows the aggregate number of changes in macroprudential FX regulations in the sample (described in Section III), where changes include both loosening and tightening. The shading divides these actions into those affecting bank assets (in blue) versus those on bank liabilities (in red).

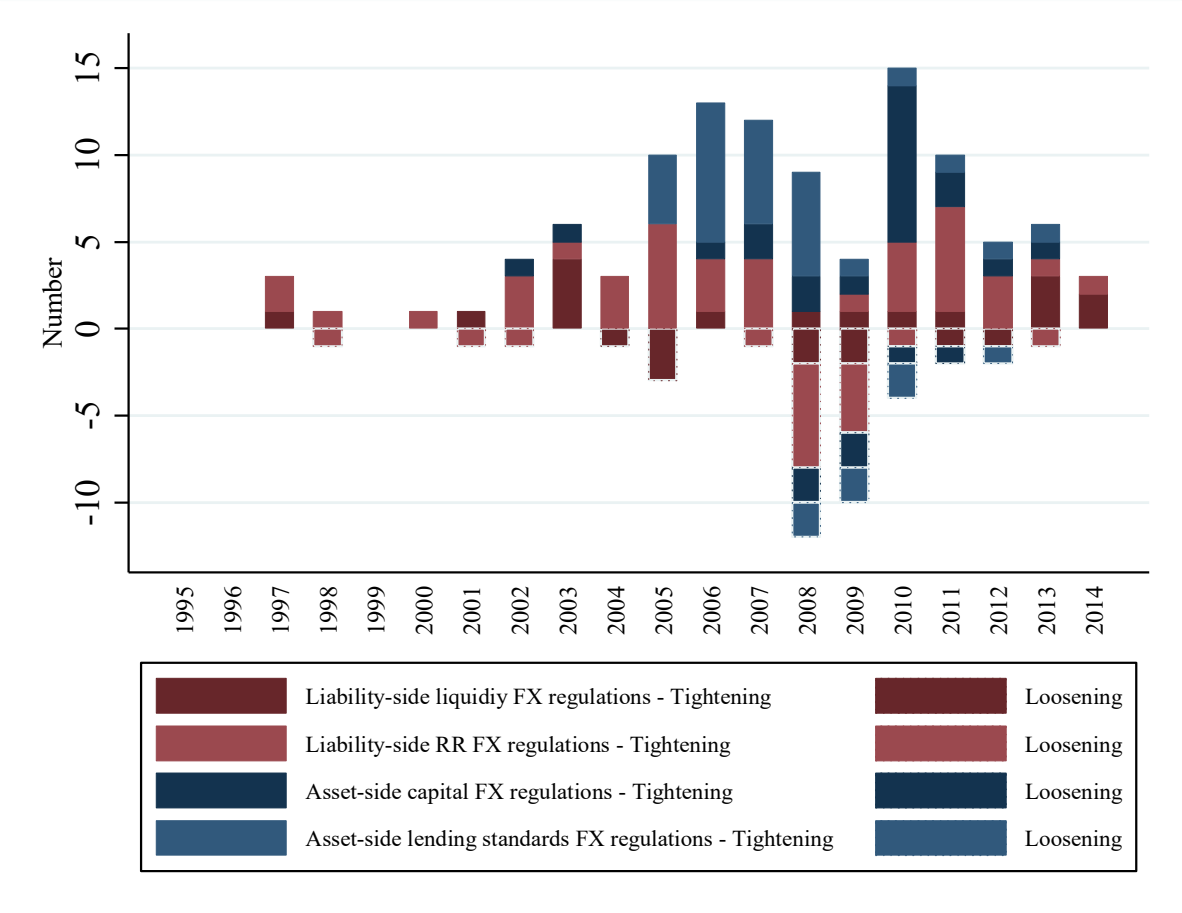


Figure 3: Tightening and Loosening of macroprudential FX regulations by category over time. This figure shows the tightening (positive) and loosening (negative) of macroprudential FX measures from our dataset. The shading divides the actions into those affecting bank assets (in blue) and those on bank liabilities (in red).

Figure 4a

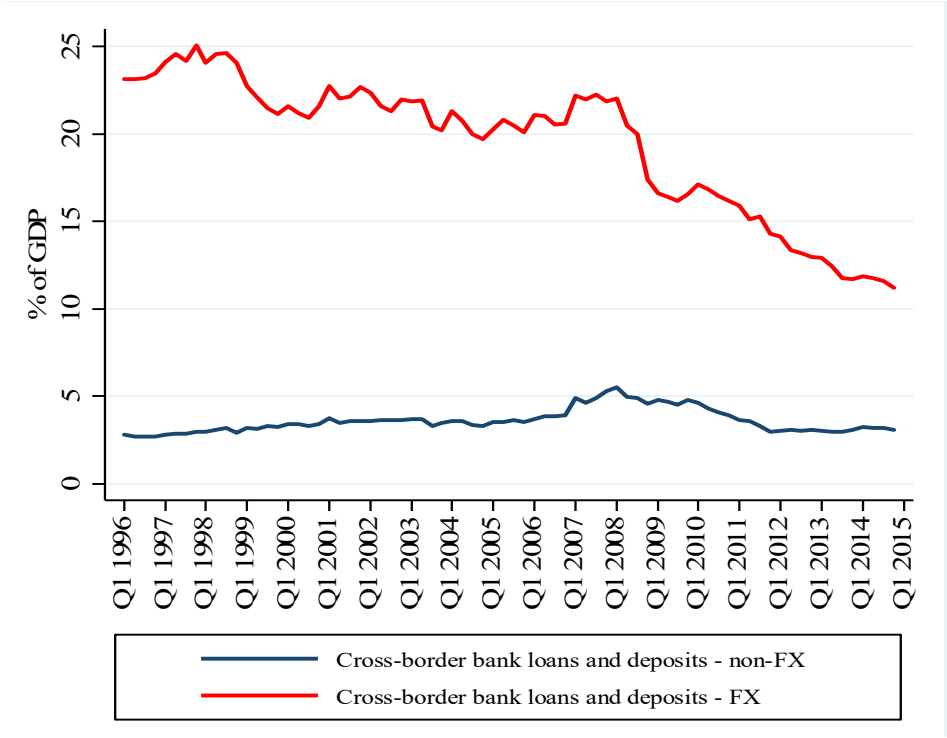
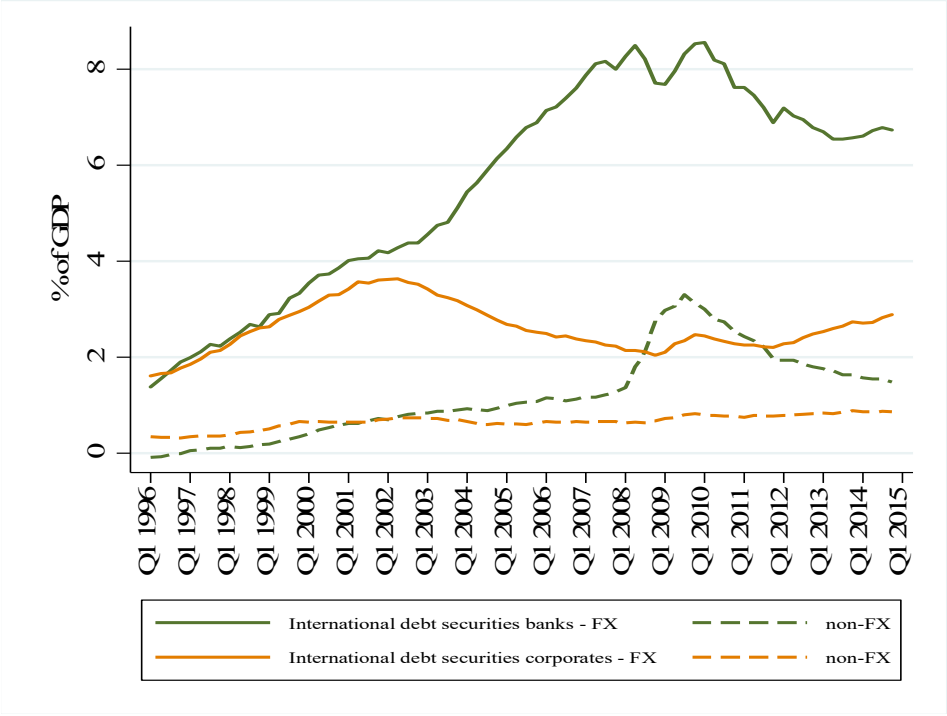


Figure 4b



Figures 4a and 4b: Cross-border bank borrowing and international debt issuance over time. Figure 4a shows the evolution of cross-border loans to banks, broken into loans in FX and non-FX. Figure 4b shows international debt issuance over the same period, also broken down into FX and non-FX borrowing, and further distinguished by borrowing by banks and corporates. All numbers are scaled by GDP.

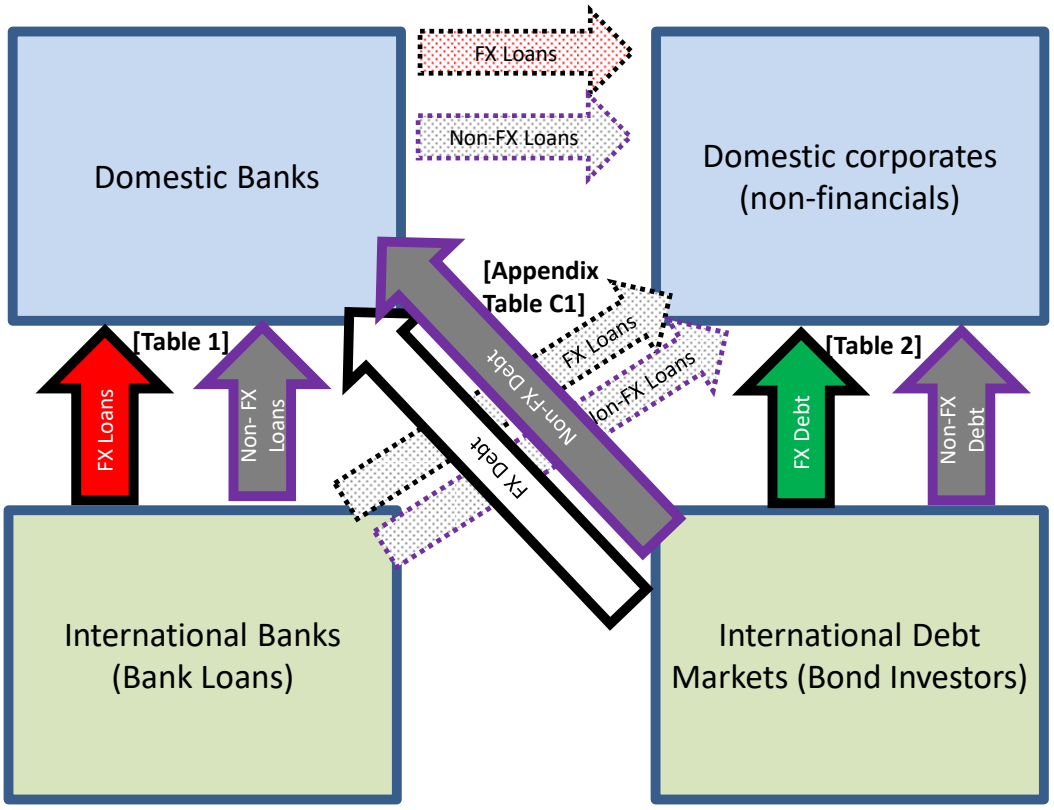


Figure 5: Summary of Key Predictions of Theoretical Model and Links to Respective Empirical Tables. The boxes in light blue represent the domestic entities of primary interest (banks and corporations) and the boxes in light green represent their primary sources of funding (international banks and debt markets). Each form of borrowing is shown by arrows, with each flow broken into that in domestic currency (outlined in black) and foreign currency (outlined in purple). The channels that are not a focus of the analysis due to data limitations are dotted and less distinct. The arrows are colored by the expected sign of the effect when macroprudential FX regulations are tightened. Red indicates a predicted decrease in cross-border borrowing/lending, while green indicates a predicted increase and gray indicates no change. Arrows are shaded white if the model does not have a clear prediction. The chart also lists the relevant table in the paper that reports the corresponding coefficient estimates.

Appendix A: Dataset on Macroprudential FX Regulations

Our dataset is constructed based on four sources of information on macroprudential regulations: Shim *et al.* (2013), Vandenbussche *et al.* (2015), Cerutti *et al.* (2015), and Reinhardt and Sowerbutts (2018). We follow Ostry *et al.* (2012) and define macroprudential FX regulations as regulations that discriminate based on the currency denomination of a capital transaction. We focus on macroprudential FX regulations that impact banks' balance sheets. In order to build this cross-section, time-series dataset, we follow the four steps outlined below. We use a quarterly frequency.

Step 1: Categorization: We extract all information on macroprudential FX regulations from each of the four datasets and sort the measures into the two categories: asset-side measures and liability-side measures. We also assign subcategories as discussed in Section III and exclude all information that does not fit in these policy categories.[38] For example, an increase in the LTV ratio for loans in FX would fall into the policy category "Asset-side measure" and into the subcategory "Lending standards for FX loans". A traditional capital control would be excluded.

Step 2: Standardization: We standardize the macroprudential FX regulations by converting them into indicator variables that capture the country-time-specific "net tightening" of a policy category. We conduct this exercise for the initial aggregation level of each dataset.[39] While mostly being equal to 0, a net tightening variable takes on the value of 1 when a macroprudential FX measure is tightened (or introduced) and the value of -1 when a macroprudential FX measure is loosened (or terminated). The reason for the conversion of all data into net tightening/loosening measures is that not all datasets provide information on the intensity, and those that provide such information are either constrained to a small set of measures (Cerutti *et al.*, 2015) or to a small set of countries (Vandenbussche *et al.*, 2015).[40] For example, a tightening in FX reserve requirement measure from Cerutti *et al.* (2015) carrying the original value of 5 (highest level of intensity) for Argentina in 2002Q1, would subsequently be converted into a net tightening measure with a value of 1 for the same country-time combination.

Step 3: Aggregation: The macroprudential FX regulations are not always defined at the same level of aggregation. Thus, before allocating these measures into categories and subcategories, we aggregate them consistently. Whenever two FX regulations are within the same policy category (or subcategory), we proceed as follows: If any two of their next-lower-level subcategories point in opposite directions, we assign the net tightening value of 0 to the top-level category. If this is not the case, we assign the direction of the net tightening value with the greatest magnitude in absolute terms to the top-level category (i.e., -1 or 1 dominate 0). For example, to construct the policy category "Asset-side measures" that comprises the subcategories "FX capital regulations for banks" and "Lending standards for FX loans," we compare the net tightening values of these

[38] We do not include regulations that discriminate on the basis of the residence principle (whether defined as a capital control or otherwise), since we focus on measures that discriminate by the currency of the transaction. We also do not consider FX-exposure limits, since we usually do not have information on the balance sheet-side to which these measures refer (e.g., they could affect the exposure of banks to FX funding but also the exposure of banks to FX lending). Finally, we do not consider macroprudential FX regulations that we cannot allocate to a specific policy category (e.g., when our original data sources list them under the label "Other FX"). The amount of information lost through these three exclusions, however, is relatively small.

[39] For example, while a first dataset could provide data on the more aggregated policy category "Lending standards for FX loans," a second dataset might provide information on the more disaggregated category "Quantitative lending standards for FX loans". These differences will be equalized in the aggregation process in Step 3.

[40] In general, measuring intensity is inherently difficult in a cross-country setting. Following the arguments provided in Reinhardt and Sowerbutts (2018), even macroprudential policies from similar policy categories can be very different in their strength. For example, an LTV limit of 80% will have a different effect and be more binding in a market where the average LTV is 90% compared to one where the average is 50%. At the same time, even the same policies might vary in their implementation; e.g., by applying LTV ratios only to second mortgages, or to all mortgages. Similarly, a change in risk weights on loans to a sector may have a very different effect depending on what share of lending is to that specific sector.

subcategories. If "FX capital regulations for banks" has a net tightening value of 1 and "Lending standards for FX loans" has a net tightening value of -1, "Asset-side measures" would take on a value of 0. If, however, "Lending standards for FX loans" would take on a value of 0 instead, "Asset-side measures" would take on a value of 1.

Step 4: Combination: Finally, after following steps 1-3 above, we merge the data on macroprudential FX regulations from Shim *et al.* (2013), Vandenbussche *et al.* (2015), and Cerutti *et al.* (2015) into a common dataset and supplement it with data from Reinhardt and Sowerbutts (2018), whenever the latter provides additional information.[41]

[41] This step-wise procedure is chosen because the Reinhardt and Sowerbutts (2018) database allows for a more flexible definition of policy categories.

Table A1: Asset-side and liability-side Macroprudential FX regulations, cumulated over the sample period

	Asset-side FX regulations		Liability-side FX regulations		
Country	Tightening	Loosening	Tightening	Loosening	Total
Argentina	0	0	1	1	2
Australia	0	0	0	0	0
Austria	4	0	0	0	4
Bulgaria	0	1	0	0	1
Bolivia	0	0	0	0	0
Brazil	1	0	2	2	5
Canada	0	0	0	0	0
Chile	0	0	1	1	2
China	0	0	1	0	1
Colombia	0	0	0	1	1
Cyprus	0	0	0	0	0
Czech Republic	0	0	0	0	0
Denmark	0	0	0	0	0
Estonia	1	2	0	0	3
United Kingdom	0	0	0	0	0
Hong Kong SAR	0	0	0	0	0
Croatia	4	1	4	6	15
Hungary	3	1	1	0	5
Indonesia	0	1	2	0	3
India	0	0	0	0	0
Iceland	0	1	2	0	3
Israel	0	0	1	0	1
Korea	4	0	3	0	7
Kuwait	0	0	0	0	0
Lithuania	0	0	0	0	0
Latvia	0	0	0	0	0
Mexico	0	0	1	0	1
Mongolia	0	0	0	0	0
Malaysia	0	0	0	0	0
Norway	0	0	0	0	0
New Zealand	0	0	0	0	0
Peru	2	0	3	0	5
Philippines	0	1	1	0	2
Poland	9	0	0	0	9
Romania	5	1	5	3	14
Russia	0	0	2	0	2
Saudi Arabia	0	0	0	0	0
Singapore	0	0	0	0	0
Serbia	5	3	7	3	18
Slovak Republic	0	0	0	0	0
Slovenia	1	0	0	0	1
Sweden	0	0	1	0	1
Thailand	0	0	1	2	3
Turkey	1	1	6	2	10
Ukraine	3	0	3	0	6
Uruguay	3	0	3	1	7
Vietnam	0	0	0	0	0
South Africa	0	0	0	0	0

Appendix B: Data Sources, Definitions, and Summary Statistics

We use two databases on international capital flows in order to measure debt and bank capital flows into FX and non-FX denominated flows: the BIS International Banking Statistics (IBS) data for cross-border bank loans provided by international banks[42] and the BIS International Debt Statistics (IDS) for the issuance of debt securities of domestic banks and corporates on international debt markets (and hence potentially bought by all types of creditors, i.e., banks and non-banks).

For the IBS (international loan) data, the currency denomination of cross-border bank loan liabilities needs to be estimated using information on cross-border bank loan assets from all BIS-reporting countries to a large set of countries. This is because only a fraction of the countries in our sample are BIS reporters and even for BIS reporters we only have information on the FX-loan liabilities of the banking system and no information on the balance sheet of non-banks. Consequently, we match information on the currency denomination of loans by international banks with the currency in use in the receiving country to determine whether a specific currency-lending pair can be classified as FX or non-FX from the perspective of the receiving country.

For the IDS (international debt) data, data on residency basis includes information on the currency denomination of debt issuance. The data refer to debt securities issued by domestic headquartered entities on international markets. This is a key component of the portfolio debt category in the balance of payments.

Additional information on control variables used in the analysis in Sections IV and V is listed in Appendix Table B1.

Appendix Table B1: Data Sources for the Empirical Analysis

Variable	Description	Source
Exchange rate appreciation	Financially-weighted exchange rate appreciation, defined as $= mean\left(\sum w_{n,t}^{F} \cdot \Delta er_{n,t}\right)$, where $\Delta er_{n,t}$ is the log change in the spot exchange rate in quarter *t* vis-à-vis country *n* based on weekly data; $w_{n,t}^{F}$ is the (annual) financial weight of foreign (*F*) country *n* in quarter *t*. *n* captures the major currencies/currency areas: USD, GBP, EUR, YEN, CHF. Financial weights are based on all foreign assets and liabilities (to capture the financial links for the entire economy), taken from Bénétrix *et al.* (2015), and are extrapolated for 2013/2014 based on 2012 values. An increase in this variable corresponds to an appreciation of the domestic currency.	Data Stream; Bénétrix *et al.* (2015)
Exchange rate volatility (FW)	Financially-weighted exchange rate volatility, defined as $= std.dev\left(\sum w_{n,t}^{F} \cdot \Delta er_{n,t}\right)$, where $\Delta er_{n,t}$ is the log change in the spot exchange rate in quarter *t* vis-à-vis country *n* based on weekly data; $w_{n,t}^{F}$ is the (annual) financial weight of foreign (*F*) country *n* in quarter *t*. The standard deviation of the measure is calculated on a quarterly level. *n* captures the major currencies/currency areas: USD, GBP, EUR, YEN, CHF. Financial weights are based on foreign	Data Stream; Bénétrix *et al.* (2015)

[42] The IBS data contain only a long enough time series for loans to banks and non-banks respectively. They also include data for disaggregating loans to non-banks into loans to non-bank financials, households and corporates, but this time series is too short for our empirical analysis (starting in 2014 Q1).

	debt liabilities, taken from Bénétrix *et al.* (2015), and are extrapolated for 2013/2014 based on 2012 values.	
Fed funds rate/Shadow rate (Changes)	Quarterly change in the effective fed funds rate prior to Q4 2008 and Wu-Xia estimates of the shadow federal funds rate from Q1 2009.	Wu and Xia (2016)
Financial Openness (Changes)	The annual index of capital account openness (KAOPEN) from Chinn and Ito (2008). The index runs from 0 to 1, where higher values imply fewer restrictions on the capital account or fewer financial restrictions on the current account.	Chinn and Ito (2008, extended to 2013)
FX Regulation (*fxm*)	FX Regulation is equal to +1 for any new or tightening of macroprudential FX regulations, and -1 for any removal or reduction in these measures. See Appendix A for details on the data and calculation of this measure. For the baseline analysis in each section, we include all macroprudential FX regulations, and in extensions only include certain types of regulations—such as those targeting just bank assets or bank liabilities. The measure is calculated on a quarterly basis for the analysis in Section IV, with the contemporaneous value and three lags included separately in estimates of equation (14). In Section V, the FX measure is calculated as the cumulated value over the current and previous three quarters (and still only allowed to take on the values of -1, 0, or +1) in order to estimate the interaction term in equation (15) and given the more limited degrees of freedom resulting from the smaller sample of countries.	Calculated. See Appendix A for more information
Global Growth	Real Quarterly GDP Growth (%)	International Financial Statistics (IFS), IMF
Global Volatility	Volatility of the MSCI World Index. Realized volatility is calculated as the square root of the average of the sum of squared log daily returns. To convert to an annualized value this measure is then multiplied by the square root of 252 divided by the number of trading days in a given month.	Data Stream
Industry Production Growth	Quarter-on-quarter growth rates of an index of industry production in each country. Growth rates have been computed based on changes in the natural logarithm.	Haver Analytics
Inflation	Quarter-on-quarter growth rates of the consumer price index in each country. Growth rates computed based on changes in the natural logarithm.	Haver Analytics.
IR differential (Changes, FW)	Financially-weighted interest differential, defined as $= \Delta i_t^D - \sum w_{n,t}^F \cdot \Delta i_{n,t}^F$, where Δi_t^D is the nominal money market rate in quarter t; $w_{n,t}^F$ is the (annual) financial weight of foreign (F) country *n* in quarter *t*; $i_{n,t}^F$ is the foreign money market rate of country *n* in quarter *t*. n captures the major currencies/currency areas: USD, GBP, EUR, YEN, CHF. Financial weights are based on foreign debt liabilities, taken from Bénétrix *et al.* (2015), and are extrapolated for 2013/2014 based on 2012 values. We use discount	IFS; Bénétrix *et al.* (2015)

	rates or policy rates when those are available for a longer time series than money market rates.	
Real GDP Growth (Domestic)	Quarterly GDP growth (yoy, %). We use annual GDP growth (% and lagged by 1 year in the analysis rather than 1 quarter) where quarterly GDP growth was not available for the full time series.	World Economic Outlook (WEO), IMF
Rule of Law	This variable is a proxy for the domestic risk premium factors that affect stock market returns and is defined as: "*perceptions of the extent to which agents have confidence in and abide by the rules of society, and in particular the quality of contract enforcement, property rights, the police, and the courts, as well as the likelihood of crime and violence*." The original variable is of annual frequency and has been interpolated to quarterly frequency.	Worldwide Governance Indicators Database, The World Bank
Short-term interest rate	Quarterly change in the nominal money market rate. We use discount rates or policy rates when those are available for a longer time series than money market rates.	IFS
Sovereign Ratings	Quarterly sovereign foreign currency ratings from Fitch, S&P and Moody's are converted into a numerical scale ranging from 0 to 20 before averaging across the three ratings.	tradingeconomics.com
Stock Market Turnover Ratio (%)	This variable is a proxy for domestic liquidity factors that affect stock market returns and is defined as: "*Total value of shares traded during the period divided by the average market capitalization for the period*." The original variable is of annual frequency and has been interpolated to quarterly frequency.	Global Financial Development Database, The World Bank
Stock Returns - Broad	Broad market stock returns are the quarter-on-quarter growth rates of the most commonly used stock market index in each country. Growth rates have been computed based on changes in the natural logarithm. Index values represent quarterly averages.	Haver Analytics
Stock Returns - Financial	Financial stock returns are the quarter-on-quarter growth rates of stock market indices that comprise each country's major companies from the financial sector, in particular banks. Growth rates have been computed based on changes in the natural logarithm. Index values represent quarterly averages.	Haver Analytics

Appendix Table B2: Summary Statistics for Baseline Regressions

Variable	Mean	Median	std. dev.	min	max	Obs.
Dependent variables						
Cross-bank loans to banks (% of GDP)						
All currencies	0.235	0.067	2.203	-6.993	10.028	3,593
FX	0.172	0.042	1.792	-5.617	7.915	3,589
Non-FX	0.055	0.011	0.765	-3.14	4.053	3,535
Changes in Share	-0.092	-0.09	3.524	-9.372	9.335	3,531
Int. Debt Issuance by Corporates (% of GDP)						
All currencies	0.069	0	0.223	-0.339	0.939	3,420
FX	0.056	0	0.199	-0.283	0.787	3,344
Non-FX	0.014	0	0.07	-0.163	0.49	2,736
Changes in Share	-0.073	0	1.332	-6.364	4.784	2,804
FX regulations						
FX regulations						
All	0.016	0	0.184	-1	1	3,648
Asset-Side	0.008	0	0.141	-1	1	3,648
Liability-side	0.009	0	0.127	-1	1	3,648
Non-FX regulations	0.032	0	0.407	-1	1	3,648
Control variables						
Global Volatility	2.52	2.52	0.424	1.654	3.969	3,648
Global Growth	3.487	3.46	1.617	-1.88	7.29	3,648
Fed funds rate/Shadow rate (Changes)	-0.117	-0.07	0.485	-1.727	1	3,648
Real GDP Growth	3.732	4.039	3.636	-5.901	10.651	3,624
Volatility of exchange rate (FW)	0.668	0.529	0.522	0.042	2.402	3,489
IR differential (Changes, FW)	-0.113	-0.008	1.448	-5.291	4.171	3,501
Sovereign Ratings	13.008	13	4.578	0.333	20	3,527
Financial Openness (Changes)	0.006	0	0.089	-0.593	0.593	3,540

Note: Quarterly capital inflows are scaled by annual GDP which is calculated as a 4-quarter moving average of annual data to avoid breaks due to annual GDP rising or falling from Q4 to Q1. We scale by annual GDP rather than quarterly GDP because the sum of the contemporaneous coefficient and three lags on $fxm_{i,t}$ in equation (14) can then be read as the effect on capital flows to annual GDP over one year.

Appendix C: Sensitivity Tests and Extensions

This section includes a selection of the sensitivity tests reported and discussed in Sections IV and V.

	IBS: XB loans to banks	IBS: Cross-border (XB) loans to non-banks				IDS: International debt issuance by banks				IDS: Int. debt issuance by corporates
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	Total	FX Inflows	FX Share	Non-FX Inflows	Total	FX Inflows	FX Share	Non-FX Inflows	Total	Total
FX regulation (t to t-3)	**-0.615***	**0.0748**	**-0.209**	**0.00422**	**0.0463**	**-0.110***	**-0.255**	**-0.00833**	**-0.139***	**0.0667***
p-value	***0.0638***	***0.721***	***0.370***	***0.914***	***0.822***	***0.0865***	***0.118***	***0.885***	***0.0975***	***0.0639***
Domestic variables										
Non-FX regulation (t to t-3)	0.422*	0.0778	-0.106	0.0140	0.0917	0.0301	0.0782	0.0327	0.0285	0.00277
p-value	*0.100*	*0.105*	*0.500*	*0.567*	*0.104*	*0.317*	*0.395*	*0.275*	*0.470*	*0.890*
Real GDP Growth (t-1)	0.0854***	0.0141***	-0.0176	0.0051**	0.0211***	0.0011	0.0160**	-0.0015	-0.0003	0.0015
	(0.0221)	(0.0032)	(0.0120)	(0.0021)	(0.0039)	(0.0031)	(0.0070)	(0.0024)	(0.0042)	(0.0015)
Volatility of exchange rate (FW, t-1)	-0.1276	-0.0110	0.2827**	-0.0114	-0.0212	0.0092	0.0101	0.0505	0.0367	0.0062
	(0.1351)	(0.0305)	(0.1238)	(0.0125)	(0.0297)	(0.0182)	(0.0526)	(0.0353)	(0.0278)	(0.0123)
IR differential (Changes, FW, t-1)	-0.0048	-0.0032	0.0037	0.0010	-0.0023	0.0089	0.0144	-0.0030	0.0090	-0.0028
	(0.0188)	(0.0057)	(0.0219)	(0.0023)	(0.0059)	(0.0062)	(0.0126)	(0.0034)	(0.0078)	(0.0018)
Sovereign Ratings (t-1)	0.1498***	0.0525***	-0.0620**	0.0119***	0.0682***	0.0462*	0.0170	0.0175***	0.0674*	0.0113
	(0.0324)	(0.0126)	(0.0260)	(0.0042)	(0.0132)	(0.0263)	(0.0180)	(0.0062)	(0.0372)	(0.0072)
Financial Openness (Changes, t-4)	0.5155	0.2450	0.3266	0.0334	0.2912	0.0230	-0.2968	0.1969	0.0516	0.0033
	(0.4128)	(0.2159)	(0.3640)	(0.0593)	(0.2903)	(0.0685)	(0.2011)	(0.1655)	(0.1056)	(0.0494)
Constant	-2.2027***	-0.7301***	0.3282	-0.1514**	-0.9436***	-0.5540	-0.1252	-0.2871**	-0.8430*	-0.1337
	(0.5095)	(0.1950)	(0.5485)	(0.0716)	(0.2100)	(0.3457)	(0.3079)	(0.1271)	(0.5004)	(0.1020)
Time Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	3,382	3,381	3,345	3,360	3,381	3,321	2,619	2,054	3,389	3,215
Adj. R-squared	0.111	0.118	0.042	0.061	0.138	0.210	0.016	0.109	0.189	0.103
Countries	48	48	48	48	48	47	45	28	48	45

Appendix Table C1: Impact of FX macroprudential regulations on total flows, debt issuance by banks and cross-border loans to non-banks

Variables and definitions are the same as in Tables 1 and 2.

	Exclude offshore centres						Exclude global financial crisis					
	IBS: Cross-border loans to banks			IDS: Int. debt issuance by corporates			IIBS: Cross-border loans to banks			IDS: Int. debt issuance by corporates		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	FX Inflows	FX Share	Non-FX Inflows	FX Inflows	FX Share	Non-FX Inflows	FX Inflows	FX Share	Non-FX Inflows	FX Inflows	FX Share	Non-FX Inflows
FX regulation (t to t-3)	**-0.524****	**-0.997****	**0.0744**	**0.0531****	**0.506****	**0.00922**	**-0.548****	**-1.030*****	**0.111**	**0.0526****	**0.537****	**0.00229**
p-value	***0.0361***	***0.0114***	***0.522***	***0.0432***	***0.0271***	***0.785***	***0.0343***	***0.00656***	***0.381***	***0.0420***	***0.0315***	***0.943***
Domestic variables												
Non-FX regulation (t to t-3)	0.0830	-0.122	0.113	-0.000343	0.0750	-0.00407	0.230	-0.147	0.163	-0.00153	0.0749	-0.00285
p-value	*0.477*	*0.554*	*0.224*	*0.986*	*0.446*	*0.409*	*0.173*	*0.471*	*0.116*	*0.938*	*0.466*	*0.606*
Real GDP Growth (t-1)	0.0451***	0.0198	0.0159*	0.0026**	-0.0028	-0.0002	0.0652***	0.0274*	0.0156**	0.0020	0.0043	-0.0002
	(0.0098)	(0.0154)	(0.0080)	(0.0012)	(0.0084)	(0.0004)	(0.0171)	(0.0157)	(0.0077)	(0.0014)	(0.0078)	(0.0004)
Volatility of exchange rate (FW, t-1)	-0.1252	0.0886	0.0690**	0.0119	0.0262	-0.0069*	-0.1559	0.1774	0.0502	0.0130	0.0479	-0.0075*
	(0.1002)	(0.1705)	(0.0315)	(0.0109)	(0.0436)	(0.0040)	(0.1437)	(0.1778)	(0.0319)	(0.0115)	(0.0465)	(0.0041)
IR differential (Changes, FW, t-1)	0.0169	0.0118	-0.0104	-0.0036**	-0.0135	0.0003	0.0021	-0.0087	-0.0055	-0.0031	-0.0137	0.0004
	(0.0136)	(0.0622)	(0.0067)	(0.0016)	(0.0166)	(0.0005)	(0.0180)	(0.0631)	(0.0063)	(0.0019)	(0.0164)	(0.0004)
Sovereign Ratings (t-1)	0.0795***	-0.0628*	0.0499***	0.0095	0.0037	-0.0008	0.0728**	-0.0547	0.0456***	0.0108	0.0026	-0.0012
	(0.0226)	(0.0363)	(0.0175)	(0.0066)	(0.0147)	(0.0014)	(0.0275)	(0.0362)	(0.0157)	(0.0066)	(0.0147)	(0.0015)
Financial Openness (Changes, t-4)	0.3505	0.4595	-0.0183	0.0163	0.3368	-0.0193*	0.2548	0.4532	-0.0105	0.0126	0.3481	-0.0194
	(0.2684)	(0.8139)	(0.1610)	(0.0497)	(0.2269)	(0.0114)	(0.2290)	(0.8369)	(0.1599)	(0.0475)	(0.2427)	(0.0135)
Constant	-0.9833**	1.0596	-0.6639**	-0.1102	0.0328	0.0152	-1.1222**	0.8854	-0.6060**	-0.1294	0.0514	0.0198
	(0.3742)	(0.8187)	(0.2622)	(0.0930)	(0.2755)	(0.0168)	(0.4458)	(0.7905)	(0.2413)	(0.0938)	(0.2689)	(0.0182)
Time Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	3,229	3,196	3,216	2,995	2,576	2,461	3,189	3,161	3,176	2,971	2,568	2,469
Adj. R-squared	0.09	0.011	0.049	0.102	0.038	0.212	0.091	0.014	0.058	0.097	0.042	0.198
Countries	46	45	46	42	42	34	48	47	48	44	44	36

Appendix Table C2: The Impact of Macroprudential FX Regulations, Sensitivity Checks I

All variable definitions and notes are the same as for Table 1. In columns (1) to (6), we exclude offshore financial centers as classified by the BIS (*i.e.*, Hong Kong and Singapore). In columns (7) to (12), we exclude the quarters from 2008 Q3 to 2009 Q2, *i.e.*, the quarters from the collapse of Lehman brothers until banking flows stabilized.

	Lag Key Variables		Exclude Annual Vars		Exclude 2008Q4	
Stock Returns	(1)	(2)	(3)	(4)	(5)	(6)
By	*Fin.*	*Broad*	*Fin.*	*Broad*	*Fin.*	*Broad*
Cum. FX Regulation (t to t-3)	-1.707	-0.989	-1.230	-0.465	-1.404	-0.541
	(1.358)	(1.273)	(1.305)	(1.401)	(1.334)	(1.478)
Ex. Rate Appreciation (t)	1.880***	1.605***	1.472***	1.221***	1.415***	1.117***
	(0.217)	(0.156)	(0.214)	(0.156)	(0.231)	(0.169)
FX Regulation X Ex. Rate Apprec. (t)	**-0.700****	-0.402	**-0.741****	-0.445*	**-0.894*****	-0.467*
	(0.334)	(0.250)	(0.269)	(0.221)	(0.293)	(0.241)
Industry Production Growth (t)	-0.013	0.014	0.087*	0.060	0.086*	0.058
	(0.046)	(0.039)	(0.043)	(0.044)	(0.043)	(0.040)
Inflation (t)	-1.825***	-2.115***	-0.159	-0.161	-0.249	-0.456
	(0.342)	(0.292)	(0.413)	(0.318)	(0.420)	(0.308)
Short-Term Interest Rate (t)	-0.192	-0.318	-0.223*	-0.388**	-0.279*	-0.408**
	(0.184)	(0.221)	(0.112)	(0.160)	(0.149)	(0.193)
Stock Market Turnover Ratio (t)	-0.037	-0.007			0.018	0.050***
	(0.022)	(0.020)			(0.020)	(0.016)
Rule of Law (t)	0.239	3.476			-3.874	-1.189
	(3.296)	(3.820)			(3.161)	(3.631)
Global Volatility (t)	-3.620***	-2.515***	-9.833***	-9.288***	-9.278***	-8.923***
	(0.507)	(0.498)	(0.754)	(0.669)	(0.899)	(0.772)
Country Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1,095	1,095	1,125	1,125	1,073	1,073
R-squared	0.231	0.246	0.335	0.381	0.261	0.304
Number of Countries	23	23	23	23	23	23

Clustered standard errors in parentheses (*** p<0.01, ** p<0.05, * p<0.1). Constant included but not reported.

Fin. = Finanical Sector, Board = Broad Market. Larger value of each coefficient pair in absolute terms is marked in bold.

Appendix Table C3: Market Vulnerability to Currency Movements: Robustness

The table shows the estimated parameter values from a panel regression of equation (15). All columns include country fixed effects. The dependent variables are stock returns of financials ("Fin."; which is primarily banks), the broad market ("Broad"; which includes both banks, non-bank financial institutions, and corporates) and an artificial series of corporate stock returns ("Corp."; corresponding to the residuals of a regression of broad market stock returns on financial stock returns). Columns (1) and (2) lag all the control variables (except the first three) by one quarter. Columns (3) and (4) exclude the Stock Market Turnover Ratio and the Rule of Law variables, which are interpolated from annual to quarterly frequency. Columns (5) and (6) exclude 2008Q4, which contains the largest exchange rate movement in the sample. The specifications and data are discussed in Section III. Additional information is provided in in Appendix B. The sample period is 2000 Q1 – 2014 Q4. Robust standard errors are clustered at the country level and reported in brackets. ***/**/* is significant at the 1%, 5%, and 10% levels, respectively.