

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

Toni Ahnert, Bank of Canada

Kristin Forbes, MIT-Sloan School, NBER and CEPR

Christian Friedrich, Bank of Canada

Dennis Reinhardt, Bank of England

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Can macroprudential foreign exchange (FX) regulations on banks reduce the financial and macroeconomic vulnerabilities created by borrowing in foreign currency? To evaluate the effectiveness and unintended consequences of macroprudential FX regulation, we develop a parsimonious model of bank and market lending in domestic and foreign currency and derive four predictions. We confirm these predictions using a rich dataset of macroprudential FX regulations. These empirical tests show that FX regulations: (1) are effective in terms of reducing borrowing in foreign currency by banks; (2) have the unintended consequence of simultaneously causing firms to increase FX debt issuance; (3) reduce the sensitivity of banks to exchange rate movements, but (4) may not significantly reduce the sensitivity of corporates or the broader financial market to exchange rate movements. As a result, FX regulations on banks appear to be successful in mitigating the vulnerability of banks to exchange rates movements and the global financial cycle, but may have the side effect of “shifting the snowbanks” of a portion of this vulnerability to other sectors.

Key words: Macroprudential policies, FX regulations, Banking flows, International debt issuance.

JEL classification: F32, F34, G15, G21, G28.

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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.²

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 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 some corporates respond to reduced FX lending from banks by increasing FX debt issuance to investors. This shifting is only partial, however, so that aggregate exposure to FX risk for the country 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 broader economy. As a result, macroprudential FX regulations can substantially improve the resilience of the banking sector to the global financial cycle, but may provide more moderate benefits to the macroeconomy as other sectors that may be less closely monitored and regulated, such as investors, become more exposed to currency movements.

Concerns about exposure to foreign currency borrowing and currency mismatch are not new. Many emerging markets have had the longstanding challenge of “original sin” (a

¹ Prominent examples include: Dell’Ariccia *et al.* (2011), Lim *et al.* (2011), Ostry *et al.* (2012), Kuttner and Shim (2013), Zhang and Zoli (2014), 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).

² Ostry *et al.* (2012) refer to these measures as FX-related prudential measures. Throughout the paper, we use the terms “macroprudential FX regulations” and “FX regulations” synonymously. We define the term broadly so that it also includes some microprudential measures related to FX risk (including regulatory policies addressing sectoral FX capital risk weights).

large share of liabilities denominated in foreign currency) and foreign currency exposure was a key vulnerability behind the series of emerging market crisis in 1997-98.³ The global financial crisis also showed that currency mismatches are not just a concern for emerging markets.⁴ Greater foreign currency exposure increases country vulnerability to sudden stops and currency depreciations, limiting the ability of the exchange rate to act as a shock absorber as well as the ability of monetary policy to support the economy (as interest rates may need to be adjusted to support the currency rather than boost domestic demand).⁵ Over the last few years, concerns about foreign-currency exposure have shifted — with less focus on the direct exposure of sovereigns, but increased concern about FX exposure in the banking and corporate sector, including in major emerging markets such as China.⁶ Figure 1 shows the increase in foreign currency debt and bank borrowing (in solid lines), an increase which is even more striking relative to the fairly constant levels of local currency debt and bank borrowing (in dashes). Over our sample period from the mid-1990s through to end-2014, total FX borrowing in international debt securities and bank loans more than tripled to about \$12 trillion USD.

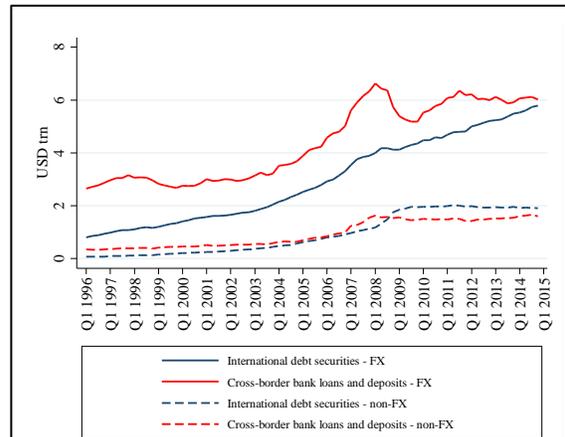


Figure 1: External debt liabilities: cumulative changes in cross border loans from international banks and international debt securities, 1996-2014. Cross-border loans and deposits from all BIS-reporting banking systems to domestic residents in a sample of advanced and emerging economies, excluding those issuing reserve currencies (see description of sample in Section III). International debt securities refer to amounts outstanding of international debt securities. To account for exchange rate valuation effects, the chart shows cumulated exchange rate adjusted changes in bank loans and deposits or net issuance of debt securities added (or subtracted) to (from) their respective 2014 Q4 stocks.
Source: IMF World Economic Outlook database, BIS International Banking and Debt Securities and authors' calculations.

These multifaceted concerns about the macroeconomic and financial risks related to FX exposure have increased interest in using macroprudential FX regulations to attempt to mitigate these risks. This attention has occurred as part of a general surge of interest in using macroprudential tools to increase overall financial resilience and reduce country vulnerabilities. There has been less attention, however, to how macroprudential FX

³ See Corsetti *et al.* (1999), Eichengreen and Hausmann (1999), Dornbusch (2002), Eichengreen *et al.* (2003), and Bordo and Meissner (2005).

⁴ For example, Benmelech (2012) discusses how 60% of the financing provided under the US Term Auction Facility went to foreign banks, largely in Europe, primarily due to concerns about currency mismatch on bank balance sheets.

⁵ For evidence on these effects, see Galindo *et al.* (2003), Forbes (2002), Desai *et al.* (2008), Kearns and Patel (2016), Zettelmeyer *et al.* (2011) and Rey (2013).

⁶ These concerns are highlighted in: Acharya *et al.* (2015), Bruno and Shin (2016), Chui *et al.* (2014, 2016), and Du and Schreger (2016).

regulations work, especially when compared to the research on other macroprudential regulations (such as housing-related measures, capital requirements, or broad macroprudential indices).⁷ One recent exception is De Crescenzo *et al.* (2017), which shows that macroprudential FX measures on banks reduce short-term international bank flows, but unlike our analysis, this paper does not consider broader effects on the economy or sensitivity to currency movements. This limited research and evidence on the impact of macroprudential FX measures may reflect challenges related to the various forms that macroprudential FX regulations can take, or the lack of a coherent dataset on the various measures and changes over time.

Perhaps most challenging in an evaluation of the effects of macroprudential FX measures is the need to assess not only their direct effects on the intended sector of the economy (such as banks), but also any spillovers or leakages as firms, banks, investors, and individuals respond to the regulations. These types of unintended consequences have been highlighted in analyses of other types of macroprudential regulations and capital controls. 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 macroprudential policies achieve their primary goal of reducing aggregate country vulnerability to currency risk? Is it better to have FX-related risks in financial institutions which may have broader systemic risks to financial systems (whether through direct FX exposure or default exposure to unhedged borrowers)? Or optimal to have FX-related risks in other sectors (such as non-bank financial institutions) that appear to have less systemic importance but may be less well-informed, less able to hedge, 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 propose a parsimonious model of bank versus market lending in domestic and foreign currency. Domestic firms seek funding from lenders, but have private information about their productivity. Banks can screen firms at a 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

⁷ Papers which have included some analysis and discussion of macroprudential FX regulations as part of their broader analyses of macroprudential tools are: Nier *et al.* (2011), Cerutti *et al.* (2015), Vandebussche *et al.* (2015), Avdjiev *et al.* (2016b), and Aguirre and Repetto (2017).

subject to exchange rate risk. When the domestic currency depreciates, low-productivity firms and their associated banks default. Macroprudential FX regulation of banks 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-quality firms (who endogenously prefer stable funding costs over the savings associated with FX funding). Low-quality firms, however, shift their borrowing in foreign currency from banks to investors, and some unproductive firms also receive FX borrowing from investors.

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. More specifically, 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 (so that their stock returns are less sensitive to exchange rate movements); and (4) firm exposure to exchange rate movements (and their sensitivity to the exchange rate) does not change significantly.

To test these four predictions, we build a rich data set on macroprudential FX regulations. Macroprudential FX regulations are defined as policies directed at the broader financial system (compared to prudential regulations that target individual institutions) and that discriminate based on the currency denomination of the capital transaction (as also defined in Ostry *et al.*, 2012). We build our dataset based on four sources that each document and measure macroprudential FX regulations in different ways or for different countries and focus on different aspects of these regulations: Shim *et al.* (2013), Vandebussche *et al.* (2015), Cerutti *et al.* (2015) and Reinhardt and Sowerbutts (2017). Our resulting data set includes information on macroprudential regulations in 48 countries over the period 1995-2014.

What makes this dataset particularly useful is not just the broader country and period coverage of macroprudential FX regulations than in other data sources, but the detailed categorization of different types of regulations. This allows us to gain a deeper understanding of the different ways in which the use of various macroprudential FX regulations have evolved over time. It also allows us to test if different types of

macroprudential FX regulations have different effects on banks and/or different spillovers on the broader economy. More specifically, our dataset allows us to differentiate between regulations that are ‘asset based’ (*i.e.*, aimed at shifting the currency composition of lending to households and corporates away from FX to local currencies) and those which are ‘liability based’ (*i.e.*, aimed at reducing the share of FX in the funding of domestic banks). The data also allows us to distinguish between different types of regulations within each of these two categories.

The paper uses this rich dataset to better understand how macroprudential FX regulations affect banks, firms, international capital flows and sensitivities to currency movements, focusing on the four testable implications from the theoretical framework. We use a panel, fixed-effects specification, which controls for a number of other variables (including changes in other macroprudential regulations) that could affect capital flows to banks and firms. The empirical results show 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 no significant 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 corporations to partially shift their source of funding and obtain more FX funding through international debt issuance (providing evidence to support the risks highlighted in Shin, 2013).

The magnitudes of the estimates also suggest that these direct and indirect effects of macroprudential FX regulations are meaningful. More specifically, a tightening of these FX regulations causes banks to reduce their cross-border borrowing in FX by about a third of median annual cross-border bank borrowing across quarters when inflows were positive (equivalent to about 0.5% to 0.7% of GDP). For several major emerging markets (such as Brazil and Poland), this is equivalent to reducing cross-border bank FX borrowing by about half. At the same time, however, corporates increase FX debt issuance by about 10% (of median annual FX debt issuance for the full sample), equivalent to a 20%-30% increase in FX corporate debt issuance for major emerging markets such as Brazil and Poland.

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), with the larger effects 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 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—all of which suggest 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 potentially less able to handle any 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. An assessment of macroprudential regulations therefore needs to consider not only the direct effects on banks, but these types of implications for the vulnerability of the broader economy.

The insights of this paper build on the recent body of literature improving our understanding of the direct and spillover effects of macroprudential regulations. It supports the growing evidence showing that macroprudential FX regulations on banks can be effective at accomplishing their direct goals—in this case on reducing the FX exposure of banks to currency movements. The analysis also supports a rapidly growing literature that shows that even when macroprudential FX regulations work in terms of affecting their

direct goals, there can be leakages and they can have unintended consequences⁸—in this case of increasing FX debt issuance by corporates 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.

Finally, this paper moves beyond most other work assessing the effect 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 important goal of improving the resilience of the banking sector to currency fluctuations, but does less to improve the resilience of the broader economy and market index 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 it safer for most cars. Yet, just as the snow plow inevitably pushes some 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 to the aggregate economy.

This paper proceeds as follows. Section II presents the theoretical model showing the direct and spillover effects of macroprudential FX regulations, and the impact on bank and corporate sensitivity to currency movements. Section III describes the compilation of the dataset on macroprudential FX regulations at the core of the paper. Section IV describes the empirical framework and other variables used for the analysis. Section V reports the central empirical results on the direct and indirect effects of macroprudential FX regulations on bank and firm borrowing and debt issuance, as well as the results for different types of regulations. Section VI assesses the impact of macroprudential FX regulations on bank and corporate vulnerability to currency movements. Section VII concludes.

⁸ Several papers documenting these leakages of regulations to other, unregulated sectors are: Aiyar *et al.* (2014), Bengui and Bianchi (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

There are two dates, $t = 0, 1$, and a domestic and a foreign good, D and F . Let e_t be the exchange rate (the value of D goods in terms of F goods) at date t . We focus on FX risk without changes in the expected level normalized to one, $E_0 [e_1] = e_0 \equiv 1$. Specifically, the exchange rate process is bivariate and can involve either depreciation or appreciation:

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

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 three groups of risk-neutral agents: banks, domestic firms, and investors. The currency of funding and lending is observable. There are many banks and investors, each of whom takes the funding and lending rates as given and makes zero profits due to competition.⁹ Let r_D and r_F denote the exogenous costs of funding in domestic and foreign currency, respectively. Banks and investors are hedged, that is they obtain funding in the currency of the loan to firms.¹⁰

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 their 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. In particular, we suppose that firm productivity can take three values:

$$A_j \in \{0, A_L, A_H\}, \quad (2)$$

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.

⁹ Our results can be generalized to a setting in which banks/investors and firms share the surplus from lending.

¹⁰ We make this assumption for two reasons. First, empirical evidence suggests that banks are hedged against direct FX risk (e.g., Brauning and Ivashina, 2017; Borio *et al.*, 2017). Second, such prudential behavior would arise endogenously if banks had charter value; see also Keeley (1990).

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.

A. Lending in Domestic Currency

We start our analysis by supposing that funding in foreign currency is unavailable ($r_F = \infty$). Let R_D denote the competitive lending rate in domestic currency offered by screening banks, which covers the costs of funding in domestic currency and screening:

$$R_D^* = r_D + c. \quad (3)$$

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, such that only high-productivity firms may attract funding in domestic currency from screening banks:

$$A_L < r_D + c < A_H. \quad (4)$$

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 funding, invest, and make positive profits, $\pi_D = A_H - R_D^* > 0$ (Figure 2). Since competitive banks break even in expectation, firms receive the entire surplus from lending and investment. When lending is only in domestic currency, little credit and investment occurs, but both firms and banks never default.

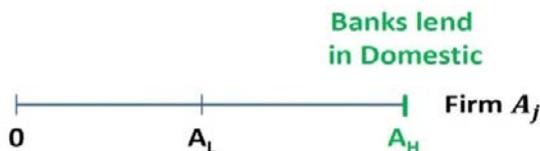


Figure 2: Banks lend in domestic currency to high-productivity firms only.

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. There are two conditions. First, if $\rho_D > r_D + c$, 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 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 yields an upper bound on the screening cost:

$$c < \tilde{c} \equiv \frac{(1-p_H) r_D - p_L A_L}{p_H} > 0. \quad (5)$$

B. Lending in Domestic and Foreign Currency

Consider funding in foreign currency that is cheaper than funding in domestic currency, $r_D > r_F > 0$. We construct an equilibrium in which banks choose to screen and lend to low-productivity firms A_L in F and to high-productivity firms A_H in D . This equilibrium requires (i) default by low-productivity firms after depreciation and (ii) high-productivity firms to prefer stable funding in domestic currency over cheaper funding in foreign currency.

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:

$$R_F^* = \frac{r_F + c - (1-q)A_L e_L}{q}. \quad (6)$$

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:

$$0 < r_F + c \leq A_L < r_D + c < A_H. \quad (7)$$

Under what condition does a high-productivity firm 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 $e_L < \hat{e}_L \equiv \frac{r_F+c}{A_H}$ holds, high-productivity firms default after depreciation. Therefore, expected firm profits are $\pi_F = q \left(A_H - \frac{R_F}{e_H} \right)$. Hence, $\pi_D > \pi_F$ whenever the benefit of stable funding exceeds the cost differential, $(1-q) \left(A_H - A_L \frac{e_L}{e_H} \right) \geq r_D + c - \frac{r_F+c}{e_H}$.¹¹

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 cost of adverse selection:

$$c > \bar{c} \equiv \frac{1-p_L-p_H}{p_L} r_F. \quad (8)$$

In sum, the availability of cheap funding in foreign currency increases firm investment as low-productivity firms also invest. The downside of this FX-lending induced credit boom is greater exposure to FX risk. After the domestic currency depreciates, low-productivity firms default and banks suffer losses. Figure 3 shows this equilibrium with both domestic and foreign currency lending (but without macroprudential regulation).



Figure 3: Equilibrium allocation for $c < \bar{c}$. Banks lend in domestic currency to high-productivity firms and in foreign currency to low-productivity firms. Investors do not lend.

¹¹ Using $E[e_1] = 1$, this condition can be stated as $A_H \geq \underline{A}_H \equiv A_L \frac{e_L}{e_H} + \frac{e_H - e_L}{e_H} \frac{e_H(r_D+c) - (r_F+c)}{e_H - 1}$. Another reason for domestic currency is an outright preference for stable funding, for example for mean-variance preferences.

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, $c > \hat{c} \equiv \frac{r_F}{e_H(p_L+p_H)} - r_D + (1-q) \left[A_H - \frac{e_L}{e_H} \frac{p_L A_L + p_H A_H}{p_L + p_H} \right]$.

C. Macroprudential FX Regulation of Banks

Suppose there is a regulator concerned about the financial stability of banks, perhaps due to some (unmodelled) social cost of bank failure. The regulator imposes a macroprudential tax $\tau > 0$ on banks. We study the impact on the funding and lending of banks, respectively.

i. Liability-side measures

Beginning 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

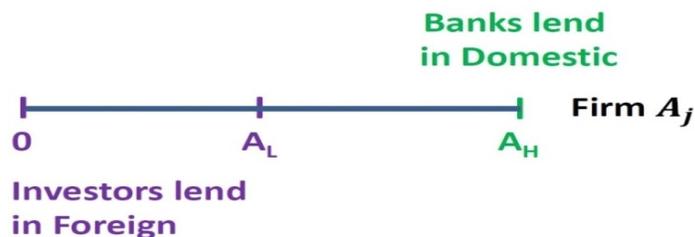
$$R_F^{**} = R_F^* + \frac{\tau}{q} > R_F^*. \quad (9)$$

For an intermediate screening cost, banks lend in F without a tax, but stop lending in F after the tax:

$$\frac{1-p_L-p_H}{p_L} r_F - \tau \equiv \bar{c}_L \leq c < \bar{c}. \quad (10)$$

Observe that banks still lend to high-productivity firms in domestic currency. The benefit of taxing FX borrowing by banks is to avoid FX lending by banks and, therefore, no (socially costly) default of banks after a depreciation.

There is a substitution from bank lending in F to investor lending in F , as firms now obtain 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 $A_j \in \{0, A_L\}$. Figure 4 shows the equilibrium.



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

Figure 4: Equilibrium after macroprudential FX regulation of banks. Banks lend in domestic currency to high-productivity firms and investors lend in foreign currency to all other firms.

ii. Asset-side measures

Next, we show that if a macroprudential tax is applied on bank lending in foreign currency (an asset-side measure), instead of on 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, the intermediate range of screening costs for which banks lend in F only without a tax is:

$$\frac{1-p_L-p_H}{p_L} r_F - q \tau \equiv \bar{c}_A \leq c < \bar{c}, \quad (11)$$

where $\bar{c}_L < \bar{c}_A$. 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. The intuition for this result is that 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 does not default. This framework also suggests that macroprudential FX bank regulation (through either asset- or liability-side based measures) will cause a reduction in average domestic productivity, since unproductive firms receive funding.

iii. Sensitivity to FX risk

Finally, we examine 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, $\bar{c}_A < c < \bar{c}$, such that banks lend to low-productivity firms in F without regulation and investors lend after such regulation is introduced. This shows that after FX regulation, the exposure of banks to FX risk is reduced, while the exposure of firms is basically unchanged and that of investors increases.

More specifically, before the FX regulations are introduced, a bank that lends to low-productivity firms in F makes a positive profit after an appreciation and defaults after a

depreciation of the domestic currency.¹⁴ Firms are directly exposed to currency risk. The banks are exposed to movements in the currency through the impact of the currency on the firms to which they lend (but not through their own direct exposure to currency risk).

After FX regulations are introduced, banks no longer lend to firms in F . As a result, banks are not exposed to any FX risk after macroprudential regulation—including not having exposure through the risk of default by the firms to which they have lent (and continuing to have no exposure through unhedged currency positions). In contrast, the exposure of low-productivity firms to FX risk is unchanged after FX regulations. The low-productivity firms continue to borrow in FX and have exposure to currency movements. The identity of the lender has changed, however, with banks replaced by investors. Irrespective of the regulation, these low-productivity firms default after a depreciation of the domestic currency. Investors, however, now have increased exposure to currency risk, due to their exposure to the default risk of these low-productivity firms. In short, the “snowbank” of exposure to currency risk has shifted away from banks, but part of the “snowbank” has moved to create challenges for investors.

D. Testable implications of the model

This section has developed a simple and stylized model of informed bank and uninformed market lending with FX risk and FX regulation of banks. This model yields four testable implications about the effects of FX regulation of banks:

- (1) Banks borrow and lend less in foreign currency (but do not change their borrowing in local currency).
- (2) Firms increase their FX borrowing from market investors, shifting away from banks (with no increase in non-FX borrowing by firms and banks).
- (3) Banks are less exposed to exchange rate movements (and their stock returns are less sensitive to exchange rate movements).
- (4) Firms' exposure to exchange rate movements (and the corresponding sensitivity of firm stock returns) do not change significantly.

¹⁴ The present model implies zero expected profits because of competition, which is the same after macroprudential regulation. Once banks keep some of the surplus from the lending relationship, however, the pre-regulation profit of banks' lending in F is higher, and more volatile, than the post-regulation profits.

III. The Data on Macroprudential FX Regulations

We follow Ostry *et al.* (2012) and 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, by the central bank, or by 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. Our measures also are predominantly macroprudential, as they are directed at systemic risks to the entire financial system stemming from FX flows and exposures (as compared to microprudential regulations that generally target individual financial institutions). Some of our policies contain elements of microprudential regulation, however, such as sectoral FX capital risk weights.

In order to construct our database, we draw on four leading databases of macroprudential regulations: Shim *et al.* (2013), Vandebussche *et al.* (2015), Cerutti *et al.* (2015), and Reinhardt and Sowerbutts (2017). 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 to 2012. Vandebussche *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 to 2010. Cerutti *et al.* (2015) uses an IMF database on country surveys to provide intensity measures for 12 macroprudential policies, among them measures of FX- and local-currency reserve requirements, in a set of 64 countries over the period 2000 to 2014. Finally, Reinhardt and Sowerbutts (2017) builds 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.

¹⁵ Although Ostry *et al.* (2012) use the term “FX-related prudential measures” instead of macroprudential FX regulations.

After combining these various sources, our dataset includes information on 132 changes in macroprudential FX regulations from 1995 through 2014 (assessed on a quarterly basis) that represent 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) in order 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 the *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). Some countries have made no changes to macroprudential FX policy, while others have made more than 10. The list shows that there is good coverage of countries that meet our criteria in Asia (including Australia and New Zealand), Europe, and South America. Coverage is more limited for the Middle East and Africa.¹⁷

Figure 5 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 financial vulnerabilities that the measures are aimed to mitigate.¹⁸

In our dataset, these macroprudential FX regulations can be disaggregated into those focusing on banks' FX assets and those on banks' FX liabilities. Moreover, these two categories can be further disaggregated into different subcategories. Figure 6 shows the

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 split 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, however, Hong Kong and Singapore (classified by the BIS as offshore centres) in our AE group.

¹⁷ The only countries in our sample from the Middle East and Africa are: Kuwait, Saudi Arabia and South Africa.

¹⁸ This also reflects that fact that a number of the major advanced economies are reserve issuing countries and therefore not included in the sample.

cumulated actions for each of these different types of macroprudential FX regulations—using the same procedure as in Figure 5—except now macroprudential FX regulations are arranged by action type rather than by country group. These distinctions between the different types of FX regulations 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 restrict FX lending to specific borrowers (for example those lacking a natural hedge). More specifically, these different levels of disaggregation in the macroprudential 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 asset-side 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 hard-to-quantify restrictions for FX loans (e.g., 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. These 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.

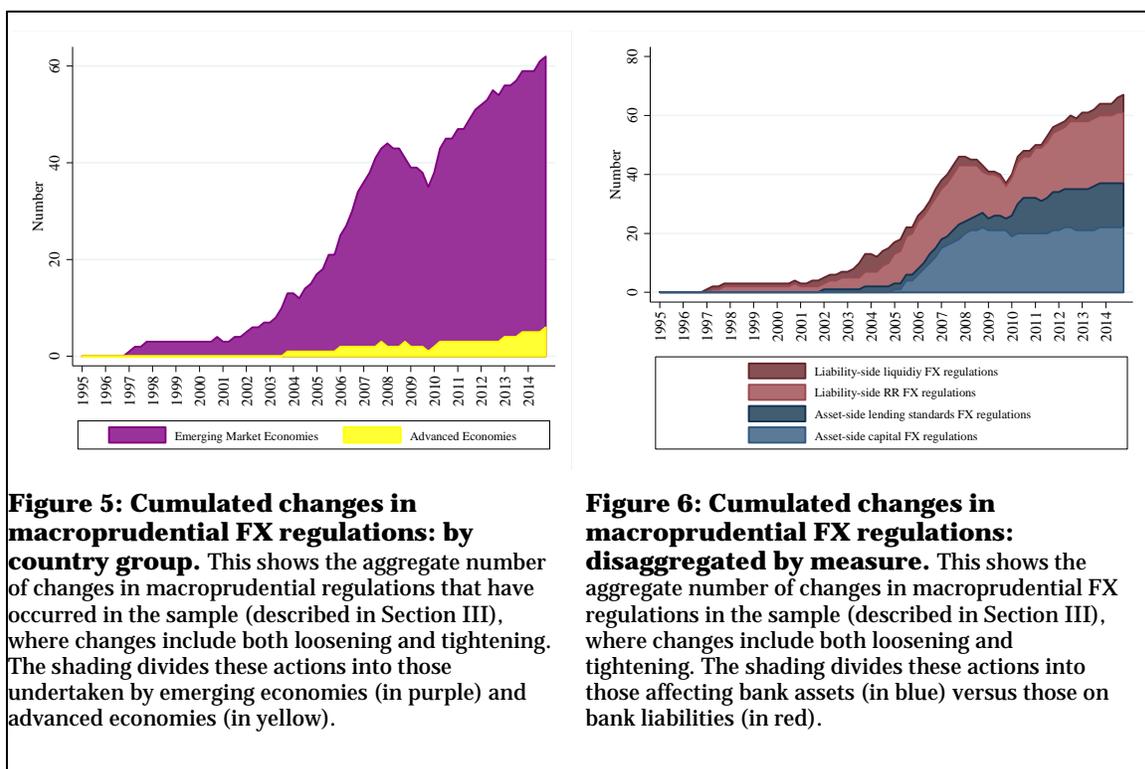


Figure 6 shows that both asset- and liability-side FX measures have been widely used, with 30 cumulated liability-side regulations and 37 cumulated asset-side measures at the end of the sample period. Asset-side FX regulations started to be adopted more rapidly just before the global financial crisis—from 2006-2008—and then experienced another surge of interest around 2010-2011, but have since been adopted at a more moderate pace. Liability-side FX regulations were adopted more gradually from 2002 to 2006, after which use fell by about half, until after 2010 they garnered more attention such that their use roughly doubled in the three years from 2010-2013. The more disaggregated breakdown (in the shading) is also noteworthy, with most liability-side measures focusing on reserve requirements instead of liquidity. On the other hand, the asset-side measures are split more evenly between the two subgroups of capital regulations (which were most widely adopted just before the crisis) and lending standards (which were adopted more quickly after the crisis).

For a final cut of the data, Figure 7 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 5 and 6, 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. For example, in 2008, there were about 8 episodes of tightening of macroprudential FX regulations, while there were about 11 episodes of loosening.

Figure 7 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 banks’ balance sheets, and then later dominated by regulations on the asset side from 2006 onwards. During the 2008-2009 crisis, there was a general loosening of all four types of regulations. Then another tightening cycle began after the peak of the crisis from 2010-2011, followed by a slower but continued general trend of tightening from 2012-2014. In contrast to the earlier pre-crisis tightening cycle, however, this more recent tightening has included more liability-side regulations, although also continuing to see a number of asset-side FX regulations in most years.

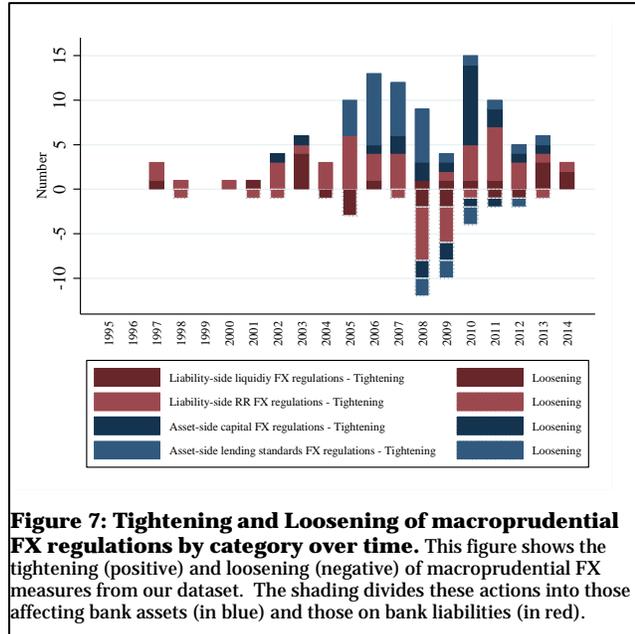


Figure 7: Tightening and Loosening of macroprudential FX regulations by category over time. This figure shows the tightening (positive) and loosening (negative) of macroprudential FX measures from our dataset. The shading divides these actions into those affecting bank assets (in blue) and those on bank liabilities (in red).

IV. Estimation Framework and Data

In order to test the four key predictions of the model 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. This allows us to control for domestic and global factors over time and is similar to the specifications used to predict international capital flows (or just international banking flows) in Forbes and Warnock (2012), Bruno and Shin (2015a), and Avdjiev *et al.* (2016a).

More specifically, our baseline equation is:

$$F_{i,t} = \alpha + \sum_{k=0}^3 \beta_1 FXMP_{t-k} + \delta_t + \gamma' X_{i,t-1} + \delta_i + \varepsilon_{i,t}, \quad (12)$$

where $F_{i,t}$ is the measure of quarterly gross cross-border capital inflows from the respective sector of country i (discussed in more detail below).¹⁹ $FXMP_{t-k}$ is the measure of macroprudential FX regulations (discussed in Section III), expressed as a dummy variable that takes the value of 1 if domestic policy makers tighten restrictions on FX lending or borrowing (and -1 if they loosen these) over the last year. $X_{i,t-1}$ is a set of control variables (discussed in more detail below); δ_i are country fixed effects and δ_t are global time effects. The sample period is 1996 Q1– 2014 Q4.

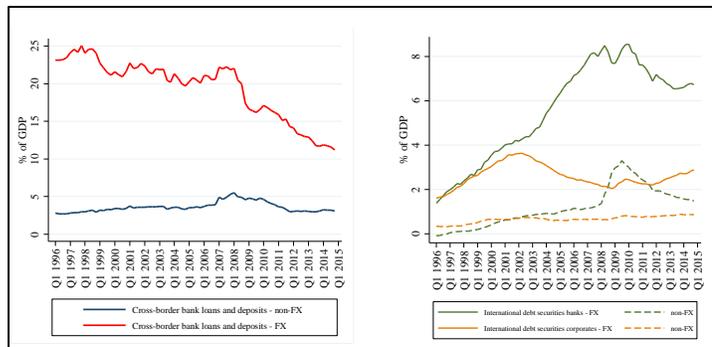
Several details of this specification and variables merit further discussion.²⁰ First, the left-hand side variable, $F_{i,t}$, is measured in several different ways in order to test the different predictions of the model and better understand the direct and indirect effects of the macroprudential FX 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. These data are from the BIS International Banking Statistics (IBS) and the data on capital inflows are expressed as a % of annual GDP, calculated as 4-quarter moving averages.²¹ Also, 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 the FX share of total net debt issuance by each group. These data are from the BIS International Debt Statistics (IDS) and include debt securities issued by domestic headquartered companies on international markets. (Extensions also consider the impact of regulations on total loans to banks and total debt issuance by corporates.)

¹⁹ 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 FXMP reported in the regression tables can then be read as the effect on capital flows to annual GDP over a one year period.

²⁰ To ensure that large observations are not driving the results, all dependent and independent variables are winsorised at the 2.5% level. 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%.

²¹ 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.

Figures 8a and 8b graph several of these measures which will be a focus of the empirical analysis. Figure 8a shows the evolution of cross-border loans to banks as a percent of GDP, broken into loans in FX (in red) and non-FX (in blue). This shows the decline in cross-border lending since around the time of the crisis, with basically all of the decline occurring in FX lending.²² Figure 8b shows



Figures 8a and 8b: Cross-border bank borrowing and international debt issuance over time. Figure 8a shows the evolution of cross-border loans to banks, broken into loans in FX and non-FX. Figure 8b 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.

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 (in green) and corporates (in 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 general 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 change in corporate non-FX debt issuance or bank debt issuance in FX or non-FX).

A second noteworthy feature of equation (12) is the measure of macroprudential FX regulation, $FXMP_{t-k}$. 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 third important point in equation (12) 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

²² Hoggarth *et al.* (2016) highlight that debt inflows from banks in foreign currency are especially prone to booms and busts and most sensitive to external factors (especially changes in global risk).

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. We also can capture common global factors and time effects 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.

Finally, the control variables in the vector $X_{i,t-1}$ are 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 (2015a). The main innovation in our control variables is that when we calculate the exposure of country i to a specific variable 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), Bénétrix *et al.*, (2015) and Forbes *et al.* (2017), 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 calculation does not impact the key results.

We include five variables in our baseline specification, focusing on variables that have some variation across time so that they are not already absorbed in the country fixed effects (δ_i). These controls are:

- *Changes in non-FX macroprudential regulation*: measured by calculating any change in macroprudential regulations in the four datasets discussed in Section III (from Shim *et al.*, 2013; Vandebussche *et al.*, 2015; Cerutti *et al.*, 2015; and Reinhardt and Sowerbutts, 2017). Then any changes in macroprudential FX regulation are removed. The resulting measure is then reported as +1 for any new use or tightening of any non-FX macroprudential regulation, and a -1 for any reduction or removal. To be consistent with our main RHS variable measuring changes in FX regulation ($FXMP_{t-k}$), the variable measuring changes in non-FX regulation incorporates any changes over the last year. 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 $\Delta e_{n,t}^F$ is the weekly change of the bilateral exchange rate between the domestic economy and foreign country n . This controls for the relative riskiness of FX-loans versus that of non FX-loans.²³ The weightings place more weight on the relative differentials for the most relevant countries/regions.
- *Interest rate differential, weighted based on country financial exposure*: calculated as $= i_t^D - \sum w_{n,t}^F \cdot i_{n,t}^F$, where i_t^D is the domestic (D) nominal interest 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 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.²⁴ The weightings place more weight on the relative funding differentials for the most relevant counties/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.

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. This includes details on data sources and definitions (in Appendix Table B1) and summary statistics (in Appendix Table B2).

²³ For evidence, see Rosenberg and Tirpak (2009) and Brown and De Haas (2012).

²⁴ For evidence, see Rosenberg and Tirpak (2009), Brown and De Haas (2012), and Brown *et al.* (2014).

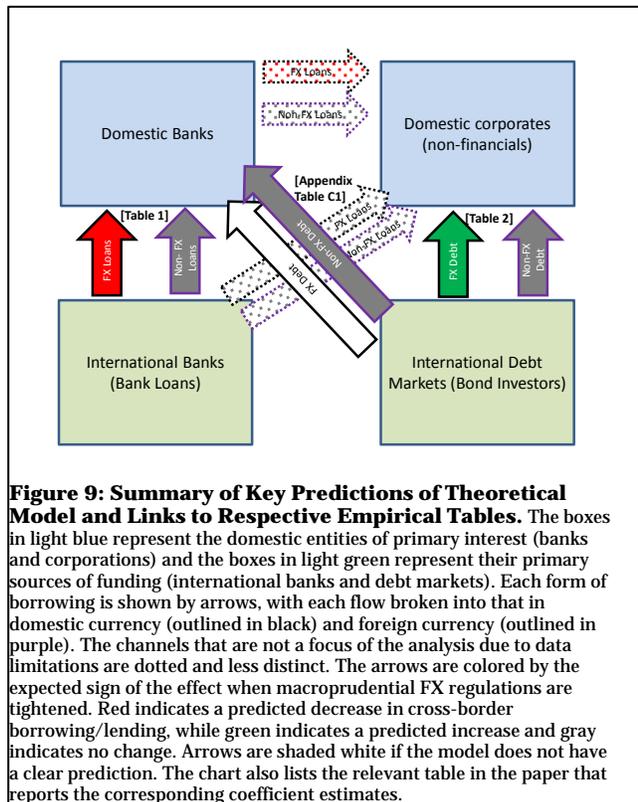
V. Empirical Results: Direct Effects and Leakages of Macroprudential FX Regulations

This section formally tests how macroprudential FX regulations affect different components of capital inflows, building on the framework developed in the theoretical model in Section II. The section begins by summarizing the key predictions in a diagram, and then presents the baseline 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 of macroprudential FX regulations. Then, in the last part of the section, we test for different effects of the disaggregated measures of macroprudential regulations.

The theoretical model developed in Section II provides guidance on the various interactions between banks, corporations, and international investors that determine lending and borrowing in international and foreign currency. To solidify exactly which channels and effects of macroprudential FX regulations are tested in this analysis, and the signs of the expected effects on these different channels, Figure 9 provides an overview. 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.²⁵ Each of these borrowing channels (represented by the arrows) in Figure 9 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 for β_1), and grey indicates no significant change in borrowing/lending (an insignificant coefficient for β_1).

²⁵ 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 data by the BIS starting in 2013 Q4 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% (ranging from 16% for lending to developing Asia and the Pacific to 33% in developing Europe. 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.

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 9 shows the relevant table in the paper that reports the corresponding results for the estimates for each channel.

A. 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 9—on gross cross-border loans from international banks to domestic banks—using the specification in equation (12) and the data discussed in Sections III and IV. 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 IV (including 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.²⁶ Each set of three

²⁶ These global variables follow papers in the literature predicting capital flows, such as Forbes and Warnock (2012) and Avdjiev *et al.* (2016a).

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 which will be 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 with standard errors.

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 Poland—two countries which have been concerned about FX exposure. In both of these countries, FX loans to banks are about 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 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 impact of the 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.²⁷ 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 set of channels to the right of Figure 9 — on how tighter macroprudential FX regulations affect international debt issuance by domestic corporations. Hypothesis #2 predicts that increased macroprudential 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 increased by 0.05% - 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 Poland FX debt issuance is 0.26% and 0.15% of GDP, respectively, suggesting that tighter FX regulations correspond to roughly 20% to 30% increase in this issuance (relative to the sample median).

Combining the results of Table 1 and Table 2 allows us to assess the aggregate

²⁷ An increase in non-FX macroprudential regulations is usually positively associated with cross-border inflows. Although the coefficients are generally not significant, 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).

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).²⁸ 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 effects of FX regulations on cross-border loans to non-banks. This would agree with the model’s predictions of no significant effect on cross-border loans to corporates (as shown in Figure 9). 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

²⁸ 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 a limited set of countries (Canada, Cyprus, Denmark, United Kingdom, Korea, Sweden and South Africa).

of increased FX 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 not surprising 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. Appendix Tables C2 and C3 report a selection of these tests. 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, the tables report four sensitivity tests. In Appendix Table C2, Columns (1) through (6) show the results when offshore centres (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. In Appendix Table C3, Columns (1) through (6) show the results when only tightening in macroprudential measures are include (not loosening or removals), and columns (7) through (12) shows results when the variables are not financially weighted (as discussed in Section III). We have also performed a series of sensitivity tests using other control variables, and dropping one country at a time (to exclude any impact from one country which has frequently adjusted macroprudential FX regulations). In this 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 9, 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.

B. 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 (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 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, focusing on results for liability-based FX measures on the left and asset-based measures on the right (as defined in Section III).²⁹ The table continues to focus on the baseline specification with the full set of control variables and global-period dummy variables.³⁰ 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 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 closer to 16% of the reduction in FX loans by banks (instead of 10% when all FX regulations are aggregated).³¹ In other words, liability-side regulations may cause more

²⁹ 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 actions.

³⁰ Results are basically identical when the individual global variables are included instead of the global-time dummy.

³¹ This is calculated as 0.0788 (Table 3, column 4) divided by 0.487 (Table 3, column 1). If one also takes into

“shifting of the snowbanks”, *i.e.*, more shifting of vulnerability to currency movements from banks to other sectors than occurs with liability-side regulations. 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 through certain channels—therefore affecting a smaller share of bank balance sheets and having a smaller aggregate effect. Another possible explanation for the different effects of the asset- and liability-based measures is related to the maturity of the capital flows which the different measures target. FX liability-based measures tend to focus on shorter term inflows, while FX asset-based measures tend to focus on longer-term maturities. Since the macroprudential measures often involve a greater relative cost for short-term than longer term capital flows, it is not surprising these shorter-term flows are the ones most affected.

VI. Empirical Results: Macroprudential 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. The previous section documented that FX regulations appear to achieve their direct goal of reducing FX borrowing by banks, albeit with the unintended consequence of simultaneously increasing FX debt issuance by corporates. 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 successfully 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 the uniformed investors in the model in Section II), could this even lead to an increase in economy-wide FX risks?

account 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 for the broader economy. This approach of testing for the potential effects on country welfare builds on academic literature assessing the welfare impact of macroprudential regulation (e.g., Nier *et al.* 2011, Cerutti *et al.* 2015, and IMF-FSB-BIS 2016) and identifying ways to increase the effectiveness of regulation in order to strengthen its welfare impact (e.g., Kashyap *et al.*, 2014, Mendicino *et al.*, 2015, and Agénor 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 are less exposed to exchange rate movements (so that their stock returns are less sensitive to exchange rate movements); and firms' exposure to exchange rate movements (and their sensitivity to the exchange rate) does not change significantly. These are testable implications #3 and #4 from the model.

It should be noted that hypothesis #4 assumes a full substitution from bank-based funding in FX to market-based funding in FX for corporates. If true, this would imply that corporate exposure to currency movements would not decrease significantly after a tightening of macroprudential FX regulations; many corporations would simply shift from borrowing in FX from banks to borrowing in FX from international investors (with a small increase in aggregate FX borrowing as some low productivity firms can also access FX borrowing). As shown in Section V, however, this shifting from borrowing in FX from banks to issuing debt in FX to investors is only partial—with the increase in FX debt issuance by corporates around 10% to 16% of the reduction in FX loans by banks. As a result, it is unlikely that any reduction in bank exposure to currency movements would correspond to an equivalent increase in exposure to currency movements in other sectors of the economy (such as investors).

Further 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. 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). Given this broad grouping, and the fact that the substitution from bank FX borrowing to corporate FX debt issuance is only partial, we expect a “weaker” version of the model’s prediction to hold in the data for the broad returns. More specifically, we expect that an increase in macroprudential FX regulations will correspond to a significant reduction in the sensitivity of banks’ stock returns to exchange rate movements (as in hypothesis #3) and that this reduction will be *larger* than any reduction in the sensitivity of corporates’ stock returns (a “weaker” version of hypothesis #4). We will proxy corporate returns using the broad market index.³²

Next, in order to test if macroprudential FX regulations on banks affect bank and corporate sensitivity to currency movements, we estimate the following equation:³³

$$\Delta price_{i,t} = \alpha + \alpha_i + \beta \Delta exrate_{i,t} + \delta cfxm_{i,t} + \mu \Delta exrate_{i,t} \times cfxm_{i,t} + controls_{i,t} + \varepsilon_{i,t}, \quad (13)$$

where $\Delta price_{i,t}$ is, in country i and quarter t , the return of a stock market index comprising financial sector firms or a stock market index covering 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 $cfxm_{i,t}$ is a measure of FX regulation that captures the cumulated policy stance over the current and the last three quarters. 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

³² In order to better isolate corporate returns from this broad market index, a sensitivity test uses a constructed series of corporate stock returns based on the residuals of a regression from broad market stock returns on financial stock returns. The key results are unchanged.

³³ 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.

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 all variables are in Appendix D.

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

$$\frac{\Delta eprice_{i,t}}{\Delta exrate_{i,t}} = \beta + \mu cfxm_{i,t} . \quad (14)$$

The theoretical model in Section II 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 and a tightening of FX regulations (i.e., an increase in $cfxm_{i,t}$) 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.

B. Results

Tables 4 and 5 present the results of estimating Equation (13) on a sample of up to 24 countries over the period 2000Q1 to 2014Q4.³⁴ 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).

Starting with Table 4, columns (1) and (2) only include the three variables central to our exchange rate sensitivity tests, while columns (3) and (4) add the standard controls for

³⁴ The number of countries in the sample is limited by the availability of the financial stock returns variable. For the list of countries included in this analysis, see Appendix D. Standard errors are clustered by country.

equity return regressions that is our baseline regression. 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).³⁵

In each of the specifications in columns (1) - (4), the coefficients on the FX regulation 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 equation (13) 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)), however, and the estimated magnitude of the coefficient is about 60% 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 estimated size of these effects. Focusing on the columns with the full set of controls in columns (3) and (4), when the cumulated policy stance for the 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. Therefore, tighter macroprudential FX regulations reduced the sensitivity of stock returns to exchange rate shocks by almost twice as much for

³⁵ 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.

banks than for the broader market (a similar magnitude results from the estimates in columns (1) and (2), with no controls).

Next, given that the broad market index is only a rough proxy for corporate stock returns (as the broad index 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 for corporate stock returns 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 do not significantly affect corporate sensitivity to exchange rate movements. 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. This supports hypothesis #4 in the model that macroprudential regulations do not significantly reduce the sensitivity of corporates to exchange rate movements.

The final 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 emerging markets to exchange rate movements (e.g., Eichengreen and Hausmann, 1999; Dornbusch, 2002; Acharya *et al.*, 2015; Chui *et al.*, 2014, 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., Forbes, 2002; Kappler *et al.* 2013)—so columns (8) and (9) reports 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 (in columns (3) and (4)) 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 C4 reports a final set of robustness checks—all of which confirm 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 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).

In each of these sensitivity tests, the key results are unchanged and agree with the predictions of the theoretical model. 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 the reduction in sensitivity for banks. A rough measure of corporate stock returns (that excludes financials), also finds no evidence that increased macroprudential regulations reduce the sensitivity of corporate stock returns to exchange rate movements.

VII. Conclusions

The 2008 global financial crisis increased awareness of the importance for countries to develop a comprehensive macroprudential framework that supports the financial stability of the entire economy (not just individual institutions) and reduces the amplification mechanisms of systemic risk. A rapidly 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 (such as reducing credit growth in banks). This literature, however, is also beginning to document how these tools often have unintended consequences (such as leakages to non-regulated institutions and spillovers to other countries). One of these macroprudential tools which is being more widely utilized, but received relatively less attention in academic research, is regulations on FX exposure. This is despite the longstanding evidence that exposure to currency movements can present an important vulnerability for many economies. The limited research on these tools at least partially reflects the limited data

available until recently.

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 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 (so that their stock returns are less sensitive to exchange rate movements); and (4) firm exposure to exchange rate movements (and their sensitivity to the exchange rate) does not change significantly. Each of these results agrees with the main predictions of the model.

These results have a number of important implications for the research on and application of macroprudential regulations—on foreign currency exposure as well as more broadly. First, these results build on existing evidence that macroprudential regulations can significantly affect the institutions and variables which they are designed to impact—in our case, causing a large and meaningful reduction in bank borrowing in FX. Second, the results build on an even newer set of papers showing that macroprudential regulations can generate unexpected consequences—in our case causing firms to increase debt issuance in FX by a meaningful amount, albeit smaller than the reduction in FX bank borrowing. Third, the results go a step further than most research by assessing not only the immediate and leakage/spillover effects of the macroprudential regulations—but also assessing if they achieve their overriding 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—thereby reducing this important amplification mechanism. But this increased resilience of banks partly occurs by “shifting the snowbanks” of vulnerability to currency movements to other sectors of the economy (namely investors in our framework), thereby partially mitigating the benefits of reduced currency exposure to the aggregate economy.

These results 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 occurs with banks)? Are risks in these other sectors potentially an even greater concern as they are in the “shadow” and even less well understood than those in the regulated sector? These types of factors should be carefully considered when setting a regulatory perimeter for macroprudential policy.

Another key implication of this paper is for the debate on capital controls versus macroprudential policy. Capital controls are considered by some countries concerned about excessive borrowing in foreign currency (especially for bank borrowing in FX, which Hoggarth *et al.* (2016) shows is particularly volatile and linked to booms and busts). 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 can generate a number of costs and distortions.³⁶ Macroprudential regulations on banks, however can also correspond to an increase in FX debt issuance by corporates. Whether capital controls would generate the same leakage and shifting of currency exposures would depend on how the controls were structured and enforced, and whether the investors that assumed any additional FX risk through corporate debt issuance were primarily foreign or domestic.

A final key 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. The regulations also generate other costs, however, such as by increasing the exposure of other sectors (*i.e.*, investors) to FX risks. 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 any costs related to the corresponding reduction in corporate lending, lower level

³⁶ For evidence on the costs and distortions created by capital controls, see Forbes (2007, 2007b).

of investment, and any 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 (*i.e.*, receive the snowbank) are less informed, less hedged, and less able to manage exchange rate movements than banks, or present unexpected systemic risks (perhaps because they are not regulated), could there even be a scenario 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.

References

- Acharya, V., S. Cecchetti, J. D. Gregorio, S. Kalemli-Ozcan, P. Lane, and U. Panizza (2015). Corporate Debt in Emerging Economies: A Threat to Financial Stability? *Report for Committee on International Economics Policy and Reform (CIEPR) and Brookings Institute*.
- Agénor, P.-R. (2016). Growth and Welfare Effects of Macroprudential Regulation, *Centre for Growth and Business Cycle Research Discussion Paper Series 218*, Economics, The University of Manchester.
- Agénor, P.-R. and L. Pereira da Silva (2017). Financial Spillovers, Spillbacks, and the Scope for International Macroprudential Policy Coordination. *Unpublished mimeo*.
- Aguirre, H., and G. Repetto (2017). Capital and Currency-Based Macroprudential Policies: An Evaluation Using Credit Registry Data. *BIS Working Papers* No. 672.
- Aiyar, S., C. W. Calomiris, and T. Wieladek. (2014). Does Macro-Prudential Regulation Leak? Evidence from a UK Policy Experiment. *Journal of Money, Credit and Banking*, 46(s1), 181–214.
- Akinci, O. and J. Olmstead-Rumsey (2015). How Effective are Macroprudential Policies? An Empirical Investigation. *International Finance Discussion Paper 1136*, Board of Governors of the Federal Reserve System (U.S.).
- Avdjiev, S., L. Gambacorta, L. Goldberg, and S. Schiaffi (2016a). The Shifting Drivers of International Capital Flows. *Unpublished mimeo*.
- Avdjiev, S., C. Koch, P. McGuire, and G. von Peter (2016b). International Prudential Policy Spillovers: A Global Perspective. *BIS working papers* no. 589 (October).
- Baele, L. G. Bekaert and K. Inghelbrecht (2010). The Determinants of Stock and Bond Return Comovements. *Review of Financial Studies*, 23(6), 2374–2428.
- Bairne, J. and C. Friedrich (2017). Macroprudential Policies, Capital Flows, and the Structure of the Banking Sector. *Journal of International Money and Finance* 75, 47–68.
- Bekaert, G. and A. Mehli (2017). On the Global Financial Market Integration “Swoosh” and the Trilemma. *NBER Working Papers* 23124.
- Bénétrix, A., L. Philip, and J. Shambaugh (2015). International Currency Exposures, Valuation Effects and the Global Financial Crisis. *Journal of International Economics*, 96(1), 98–109.
- Bengui, J. and J. Bianchi (2014). Capital Flow Management when Capital Controls Leak. Paper presented at the 15th Jacques Polak Annual Research Conference, Nov. 13-14.
- Benmelech, E. (2012). An Empirical Analysis of the Fed’s Term Auction Facility. *NBER Working Papers* 18304.
- Bordo, M. and C. Meissner (2005). The Role of Foreign Currency Debt in Financial Crises: 1880-1913 vs. 1972-1997. *NBER Working Papers* 11897.
- Borio, C., R. McCauley, and P. McGuire (2017). FX Swaps and Forwards: Missing Global Debt? *BIS Quarterly Review* September 2017.
- Brauning, F. and V. Ivashina (2017). Monetary Policy and Global Banking. *NBER Working Paper* 23316.

- Brown, M. and R. De Haas (2012). Foreign Currency Lending in Emerging Europe: Bank-level Evidence, *Economic Policy*, 27(69), 59-98.
- Brown, M., K. Kirschenmann, and S. Ongena (2014). Foreign Currency Loans-Demand or Supply Driven? *Journal of Money, Credit and Banking* 46(7), 1313–554.
- Bruno, V. and H. Shin (2015a). Cross-Border Banking and Global Liquidity. *Review of Economic Studies* 82 (2).
- Bruno, V., I. Shim, and H. Shin (2015b). Comparative Assessment of Macroprudential Policies. *BIS Working Papers* 502.
- Cerutti, E., S. Claessens, and L. Laeven (2015). The Use and Effectiveness of Macroprudential Policies: New Evidence. *IMF Working Papers* 15/61.
- Chinn, M. D. and H. Ito (2008). A New Measure of Financial Openness. *Journal of Comparative Policy Analysis*, Volume 10, Issue 3, 309–322. Note that this paper uses the most recent version of the dataset.
- Chui, M., I. Fender, and V. Sushko (2014). Risks Related to EME Corporate Balance Sheets: the Role of Leverage and Currency Mismatch. *BIS Quarterly Review*, 35–47.
- Chui, M., E. Kuruc, and P. Turner (2016). A New Dimension to Currency Mismatches in the Emerging Markets: Non-Financial Companies. *BIS Working Papers* 550.
- Corsetti, G., P. Pesenti, and N. Roubini (1999). What Caused the Asian Currency and Financial Crisis? *Japan and the World Economy* 11 (3), 305–373.
- De Crescenzo, A., M. Golin, and F. Molteni (2017). Have Currency-Based Capital Flow Management Measures Curbed International Banking Flows? *OECD Working Papers on International Investment* 2017/04.
- Dell’Ariccia, G., P. Rabanal, C. Crowe, and D. Igan (2011). Policies for Macrofinancial Stability: Options to Deal with Real Estate Booms. *IMF Staff Discussion Notes* 11/02.
- Desai, M., C. Foley, and K. Forbes (2008). Financial Constraints and Growth: Multinational and Local Firm Responses to Currency Crises. *Review of Financial Studies* 21 (6), 2857–2888.
- Dornbusch, R. (2002). A Primer on Emerging-Market Crises. In S. Edwards and J. Frankel (Eds.), *Preventing Currency Crises in Emerging Markets*, 743–754. Chicago: University of Chicago Press.
- Du, W. and J. Schreger (2016). Sovereign Risk, Currency Risk, and Corporate Balance Sheets. *Unpublished Working Paper*.
- Eichengreen, B. and R. Hausmann (1999). Exchange Rates and Financial Fragility. *Proceedings - Economic Policy Symposium - Jackson Hole, Federal Reserve Bank of Kansas City*, 329–368.
- Eichengreen, B., R. Hausmann, and U. Panizza (2003). Currency Mismatches, Debt Intolerance and Original Sin: Why They are Not the Same and Why it Matters. *NBER Working Papers* 10036.
- Forbes, K. (2002). How Do Large Depreciations Affect Firm Performance? *IMF Staff Papers* 49, 214–238.
- Forbes, K., I. Hjortsoe, and T. Nenova (2017). Current Account Deficits During Heightened Risk: Menacing or Mitigating? *Economic Journal* 127(May), 571–623.

- Forbes, K., M. Fratzscher, T. Kostka, and R. Straub (2016). Bubble Thy Neighbour: Portfolio Effects and Externalities from Capital Controls. *Journal of International Economics*, 99 (C), 85–104.
- Forbes, K., M. Fratzscher, and R. Straub (2015). Capital Flow Management Measures: What are They Good For? *Journal of International Economics* 96 (1, July), S76–S97.
- Forbes, K. and F. Warnock (2012). Capital Flow Waves: Surges, Stops, Flight and Retrenchment. *Journal of International Economics* 88(2, Nov), 235–251.
- Galindo, A., U. Panizza, and F. Schiantarelli (2003). Debt Composition and Balance Sheet Effects of Currency Depreciation: A Summary of the Micro Evidence. *Emerging Markets Review* 4, 330–339.
- Ghosh, A., M. Qureshi, and N. Sugawara (2014). Regulating Capital Flows at Both Ends: Does it Work? *IMF Working Papers* 14/188.
- Giordani, P., M. Ruta, H. Weisfeld, and L. Zhu (2014). Capital Flow Deflection. *IMF Working Papers* 14/145.
- Hoggarth, G., C. Jung, and D. Reinhardt (2016). Capital Inflows: the Good, the Bad and the Bubbly. *Bank of England Financial Stability Papers* 40.
- IMF-FSB-BIS (2016). Elements of Effective Macroprudential Policies - Lessons from International Experience. Available at: <https://www.imf.org/external/np/g20/pdf/2016/083116.pdf>.
- Kang, H., F. Vitek, R. Bhattacharya, P. Jeasakul, S. Munoz, N. Wang, and R. Zandvakil (2017). Macroprudential Policy Spillovers: A Quantitative Analysis. *IMF Working Paper* WP/17/170.
- Kashyap, A.K., D.P. Tsomocos, and A. P. Vardoulakis (2014). How does Macroprudential Regulation Change Bank Credit Supply?, *NBER Working Papers* 20165.
- Kappler, M., H. Reisen, M. Schularick, and E. Turkisch (2013). The Macroeconomic Effects of Large Exchange Rate Appreciations. *Open Economies Review*, 24(3), 471-494.
- Kearns, J. and N. Patel (2016). Does the Financial Channel of Exchange Rates Offset the Trade Channel? *BIS Quarterly Review*, 95–113.
- Keeley, M.C. (1990). Deposit Insurance, Risk, and Market Power in Banking, *American Economic Review* 80(5), 1183–1200.
- Kuttner, K. and I. Shim (2013). Can Non-Interest Rate Policies Stabilize Housing Markets? Evidence From a Panel of 57 Economies. *BIS Working Papers* 433.
- Lane, P. and J. Shambaugh (2010). Financial Exchange Rates and International Currency Exposures. *American Economic Review*, 100(1), 518–540.
- Lim, C., F. Columba, A. Costa, P. Kongsamut, A. Otani, M. Saiyid, T. Wezel, and X. Wu (2011). Macroprudential Policy: What Instruments and How to Use Them? Lessons from Country Experiences. *IMF Working Papers* 11/238.
- McCauley, R.N., Bénétrix, A.S., P.M. McGuire, and G. von Peter (2017). Financial Deglobalisation in Banking? *Trinity Economics Papers* 1717, Trinity College Dublin, Department of Economics.
- Mendicino, C., K. Nikolov, J. Suarez, and D. Supera (2015). Welfare Analysis of Implementable Macroprudential Policy Rules: Heterogeneity and Trade-offs. Download: http://www.cemfi.es/~suarez/MNSS_2015.pdf

- Nier, E., J. Osinski, L. Jacome, and P. Madrid (2011). Towards Effective Macroprudential Policy Frameworks: An Assessment of Stylized Institutional Models. *IMF Working Papers* 11/250.
- Ostry, J., A. Ghosh, M. Chamon, and M. Qureshi (2012). Tools for Managing Financial Stability Risks from Capital Inflows. *Journal of International Economics* 88 (2), 407–421.
- Pasricha, G., M. Falagiarda, M. Bijsterbosch, and J. Aizenman (2015). Domestic and Multilateral Effects of Capital Controls in Emerging Markets. *Bank of Canada Staff Working Papers* 15-37.
- Ranciere, R., A. Tornell, and A. Vamvakidis (2010). A New Index of Currency Mismatch and Systemic Risk. *IMF Working Papers* 10/263.
- Reinhardt, D. and R. Sowerbutts (2017). Macroprudential Policies: a Granular Database. *Mimeo*.
- Reinhardt, D. and R. Sowerbutts (2015). Regulatory Arbitrage in Action: Evidence from Banking Flows and Macroprudential Policy. *Bank of England Working Papers* 546.
- Rey, H. (2013). Dilemma not Trilemma: The Global Financial Cycle and Monetary Policy Independence. Proceedings from Jackson Hole Symposium.
- Rosenberg C., and M. Tirpák (2009). Determinants of Foreign Currency Borrowing in the New Member States of the EU. *Czech Journal of Economics and Finance*, 59(3), 216-228.
- Shim, I., B. Bogdanova, J. Shek, and A. Subeltye (2013). Database for Policy Actions on Housing Markets. *BIS Quarterly Review*.
- Shin, H. (2013). The Second Phase of Global Liquidity and Its Impact on Emerging Economics. *Keynote Address at the Federal Reserve Bank of San Francisco Asia Economic Policy Conference*.
- Vandenbussche, J., U. Vogel, and E. Detragiache (2015). Macroprudential Policies and Housing Prices: a New Database and Empirical Evidence for Central, Eastern, and Southeastern Europe. *Journal of Money, Credit and Banking* 47 (S1), 343–377.
- Wu, J. C. and F. D. Xia (2016). Measuring the Macroeconomic Impact of Monetary Policy at the Zero Lower Bound. *Journal of Money, Credit and Banking*, 48(3), 253–291.
- Zettelmeyer, J., P. Nagy, and S. Jeffrey (2011). Addressing Private Sector Currency Mismatches in Emerging Europe. In M. Kawai and E. Prasad (Eds.), *Financial Market Regulation and Reforms in Emerging Markets*, 365–406. Washington D.C.: Brookings Institution Press.
- Zhang, L. and E. Zoli (2014). Leaning Against the Wind: Macroprudential Policy in Asia. *IMF Working Papers* 14/22.

| 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 |
| <i>p-value</i> | 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 |
| <i>p-value</i> | | | | 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 (12). 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 (12).

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 Sections III and IV, with additional information in Appendixes 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 |
| <i>p-value</i> | 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 (0.0118) | -0.0079 (0.0879) | 0.0059 (0.0042) |
| Global Growth (t-1) | | | | | | | -0.0063* (0.0032) | -0.0131 (0.0183) | -0.0004 (0.0011) |
| Fed funds rate (Changes, t-1) | | | | | | | 0.0213** (0.0081) | 0.0892 (0.0748) | 0.0018 (0.0031) |
| Domestic variables | | | | | | | | | |
| Non-FX regulation (t to t-3) | | | | 0.000220 0.991 | 0.0707 0.448 | -0.00265 0.584 | 0.0123 0.538 | 0.0687 0.405 | 0.00503 0.211 |
| <i>p-value</i> | | | | | | | | | |
| Real GDP Growth (t-1) | | | | 0.0020 (0.0013) | -0.0004 (0.0085) | -0.0004 (0.0005) | 0.0001 (0.0012) | -0.0061 (0.0089) | -0.0007 (0.0005) |
| Volatility of exchange rate (FW, t-1) | | | | 0.0134 (0.0107) | 0.0521 (0.0463) | -0.0082** (0.0039) | 0.0026 (0.0102) | 0.0524 (0.0415) | -0.0060* (0.0031) |
| IR differential (Changes, FW, t-1) | | | | -0.0031* (0.0016) | -0.0171 (0.0170) | 0.0005 (0.0006) | -0.0036* (0.0018) | -0.0178 (0.0211) | 0.0001 (0.0006) |
| Sovereign Ratings (t-1) | | | | 0.0107 (0.0066) | 0.0058 (0.0148) | -0.0012 (0.0015) | 0.0110** (0.0051) | 0.0086 (0.0191) | 0.0012 (0.0007) |
| Financial Openness (Changes, t-4) | | | | 0.0215 (0.0483) | 0.3201 (0.2246) | -0.0176 (0.0112) | -0.0195 (0.0569) | 0.3150 (0.2172) | -0.0245** (0.0112) |
| Constant | | | | -0.1288 (0.0944) | 0.0261 (0.2706) | 0.0207 (0.0181) | -0.0595 (0.0786) | -0.1367 (0.4124) | -0.0100 (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 (12). 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 Sections III and IV, with additional information in Appendixes 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 |
| <i>p-value</i> | 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 |
| <i>p-value</i> | 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 | |
|--------------------------------------|----------------------------|---------------------|-----------------------------|----------------------|----------------------|-----------------------------|----------------------|----------------------------|----------------------|
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) |
| By | <i>Fin.</i> | <i>Broad</i> | <i>Fin.</i> | <i>Broad</i> | <i>Corp.</i> | <i>Fin.</i> | <i>Broad</i> | <i>Fin.</i> | <i>Broad</i> |
| Cum. FX Regulation (t to t-3) | -0.555 (1.538) | 0.470 (1.230) | -1.504 (1.298) | -0.629 (1.467) | 0.205 (0.981) | -2.437* (1.190) | -1.116 (1.482) | -5.335** (2.275) | -3.310 (2.583) |
| Ex. Rate Appreciation (t) | 1.956*** (0.214) | 1.648*** (0.154) | 1.459*** (0.224) | 1.184*** (0.162) | 0.179* (0.101) | 1.810*** (0.238) | 1.436*** (0.165) | 1.635*** (0.229) | 1.315*** (0.196) |
| FX Regulation X Ex. Rate Apprec. (t) | -0.689** (0.310) | -0.379 (0.265) | -0.781*** (0.276) | -0.432* (0.240) | 0.023 (0.171) | -0.939*** (0.275) | -0.568** (0.225) | -1.093** (0.415) | -0.705 (0.439) |
| Industry Production Growth (t) | | | 0.086* (0.045) | 0.058 (0.044) | 0.006 (0.028) | 0.107 (0.075) | 0.152** (0.059) | 0.047 (0.073) | 0.067 (0.091) |
| Inflation (t) | | | -0.144 (0.420) | -0.311 (0.308) | -0.267 (0.198) | -0.279 (0.517) | -0.379 (0.386) | 0.368 (0.780) | -0.331 (0.710) |
| Short-Term Interest Rate (t) | | | -0.278* (0.144) | -0.419** (0.187) | -0.218* (0.111) | -0.202 (0.142) | -0.305 (0.211) | -0.239 (0.285) | -0.455 (0.296) |
| Stock Market Turnover Ratio (t) | | | 0.016 (0.021) | 0.048*** (0.017) | 0.036*** (0.010) | 0.016 (0.036) | 0.030 (0.028) | 0.067* (0.034) | 0.078*** (0.025) |
| Rule of Law (t) | | | -4.225 (3.229) | -1.657 (3.375) | 1.154 (2.433) | 0.855 (3.707) | -3.267 (4.528) | 4.788 (9.649) | -5.756 (8.786) |
| Global Volatility (t) | | | -10.126*** (0.899) | -9.859*** (0.780) | -3.374*** (0.405) | -7.824*** (0.822) | -7.681*** (0.714) | -8.854*** (1.572) | -9.089*** (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. = Financial 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 (13). 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 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 Section IV. Additional information is provided in Appendix D. 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.

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 (2017)*. 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.³⁷ 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.³⁸ 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*).³⁹ 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

³⁷ 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.

³⁸ 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.

³⁹ In general, measuring intensity is inherently difficult in a cross-country setting. Following the arguments provided in *Reinhardt and Sowerbutts (2017)*, 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 “FX capital regulations for banks” and “Lending standards for FX loans,” we compare the net tightening values of these 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), Vandebussche *et al.* (2015), and Cerutti *et al.* (2015) into a common dataset and supplement it with data from Reinhardt and Sowerbutts (2017), whenever the latter provides additional information.⁴⁰

⁴⁰ This step-wise procedure is chosen because the Reinhardt and Sowerbutts (2017) database allows for a more flexible definition of policy categories

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

| Country | Asset-side FX regulations | | Liability-side FX regulations | | Total | |
|-----------------|---------------------------|-----------|-------------------------------|-----------|-------|----|
| | Tightening | Loosening | Tightening | Loosening | | |
| 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 which allow us to split information on 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 banks⁴¹ 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 key variables in the analysis is listed in Appendix Table B1.

Appendix Table B1: Data Sources for the Empirical Analysis

| Variable | Description | Source |
|--------------------------------------|--|-------------------|
| 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 |
| Global Growth | Real Quarterly GDP Growth (%) | IMF IFS |
| 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) |
| (Domestic) Real GDP Growth | 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. | IMF WEO |

⁴¹ 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).

| | | |
|----------------------------------|---|--|
| Volatility of exchange rate (FW) | $= std.dev\left(\sum w_{n,t}^F \cdot \Delta er_{n,t}\right)$ where $\Delta er_{n,t}$ is the log change in the nominal money market 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 debt liabilities, taken from Bénétrix <i>et al.</i> (2015), and are extrapolated for 2013/2014 based on 2012 values. | Data Stream; Bénétrix <i>et al.</i> (2015) |
| IR differential (Changes, FW) | $= \Delta i_t^D - \sum w_{n,t}^F \cdot \Delta i_{n,t}^F$, 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 debt liabilities, taken from Bénétrix <i>et al.</i> (2015), and are extrapolated for 2013/2014 based on 2012 values. We use discount rates or policy rates when those are available for a longer time series than money market rates. | IFS; Bénétrix <i>et al.</i> (2015) |
| 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 |
| 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) |

Appendix Table B2: Summary Statistics

| Variable | Mean | Median | std. dev. | min | max | Obs. |
|---|--------|--------|-----------|--------|--------|-------|
| <u>Dependent variables</u> | | | | | | |
| Cross-bank loans to banks (% of GDP) | | | | | | |
| <i>All currencies</i> | 0.235 | 0.067 | 2.203 | -6.993 | 10.028 | 3,593 |
| <i>FX</i> | 0.172 | 0.042 | 1.792 | -5.617 | 7.915 | 3,589 |
| <i>Non-FX</i> | 0.055 | 0.011 | 0.765 | -3.14 | 4.053 | 3,535 |
| <i>Changes in Share</i> | -0.092 | -0.09 | 3.524 | -9.372 | 9.335 | 3,531 |
| Int. Debt Issuance by Corporates (% of GDP) | | | | | | |
| <i>All currencies</i> | 0.069 | 0 | 0.223 | -0.339 | 0.939 | 3,420 |
| <i>FX</i> | 0.056 | 0 | 0.199 | -0.283 | 0.787 | 3,344 |
| <i>Non-FX</i> | 0.014 | 0 | 0.07 | -0.163 | 0.49 | 2,736 |
| <i>Changes in Share</i> | -0.073 | 0 | 1.332 | -6.364 | 4.784 | 2,804 |
| <u>FX regulations</u> | | | | | | |
| FX regulations | | | | | | |
| <i>All</i> | 0.016 | 0 | 0.184 | -1 | 1 | 3,648 |
| <i>Asset-Side</i> | 0.008 | 0 | 0.141 | -1 | 1 | 3,648 |
| <i>Liability-side</i> | 0.009 | 0 | 0.127 | -1 | 1 | 3,648 |
| Non-FX regulations | 0.032 | 0 | 0.407 | -1 | 1 | 3,648 |
| <u>Control variables</u> | | | | | | |
| 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 FXMP in equation 12 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 V and VI.

| | 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* |
| <i>p-value</i> | 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 |
| <i>p-value</i> | 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 |
| <i>p-value</i> | 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 |
| <i>p-value</i> | 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 (see Figure 1).

| | Tightening only | | | | | | No financial weighting | | | | | |
|---------------------------------------|----------------------------------|------------------|----------------|---------------------------------------|---------------|----------------|----------------------------------|-----------------|----------------|---------------------------------------|----------------|----------------|
| | IBS: Cross-border loans to banks | | | IDS: Int. debt issuance by corporates | | | IBS: 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) | -0.615** | -1.030*** | 0.0676 | 0.0632** | 0.457* | 0.0200 | -0.656** | -1.000** | 0.0567 | 0.0547** | 0.506** | 0.00996 |
| <i>p-value</i> | <i>0.0156</i> | <i>0.00368</i> | <i>0.587</i> | <i>0.0350</i> | <i>0.0750</i> | <i>0.603</i> | <i>0.0138</i> | <i>0.0104</i> | <i>0.615</i> | <i>0.0383</i> | <i>0.0293</i> | <i>0.770</i> |
| Domestic variables | | | | | | | | | | | | |
| Non-FX regulation (t to t-3) | 0.221 | -0.156 | 0.151 | 0.000329 | 0.0723 | -0.00275 | 0.216 | -0.154 | 0.152 | 0.000839 | 0.0697 | -0.00270 |
| <i>p-value</i> | <i>0.187</i> | <i>0.442</i> | <i>0.133</i> | <i>0.986</i> | <i>0.439</i> | <i>0.561</i> | <i>0.192</i> | <i>0.447</i> | <i>0.134</i> | <i>0.965</i> | <i>0.456</i> | <i>0.579</i> |
| Real GDP Growth (t-1) | 0.0624*** | 0.0185 | 0.0195** | 0.0020 | -0.0001 | -0.0005 | 0.0609*** | 0.0192 | 0.0193** | 0.0020 | 0.0002 | -0.0005 |
| | (0.0166) | (0.0143) | (0.0079) | (0.0013) | (0.0084) | (0.0005) | (0.0167) | (0.0141) | (0.0080) | (0.0013) | (0.0084) | (0.0005) |
| Volatility of exchange rate (FW, t-1) | -0.1925 | 0.0794 | 0.0832** | 0.0133 | 0.0528 | -0.0082** | -0.1693* | 0.0800 | 0.0380 | 0.0100 | 0.0626 | -0.0071** |
| | (0.1166) | (0.1661) | (0.0328) | (0.0107) | (0.0460) | (0.0039) | (0.0977) | (0.1667) | (0.0250) | (0.0104) | (0.0413) | (0.0027) |
| IR differential (Changes, FW, t-1) | 0.0045 | 0.0112 | -0.0105 | -0.0031* | -0.0172 | 0.0005 | 0.0119 | 0.0150 | -0.0079 | -0.0036* | -0.0191 | 0.0006 |
| | (0.0164) | (0.0613) | (0.0072) | (0.0017) | (0.0171) | (0.0006) | (0.0185) | (0.0682) | (0.0084) | (0.0018) | (0.0200) | (0.0007) |
| Sovereign Ratings (t-1) | 0.0742*** | -0.0630* | 0.0494*** | 0.0108 | 0.0060 | -0.0012 | 0.0760*** | -0.0638* | 0.0478*** | 0.0105 | 0.0058 | -0.0011 |
| | (0.0262) | (0.0357) | (0.0173) | (0.0066) | (0.0149) | (0.0015) | (0.0257) | (0.0365) | (0.0174) | (0.0066) | (0.0147) | (0.0014) |
| Financial Openness (Changes, t-4) | 0.4404 | 0.4391 | 0.0455 | 0.0221 | 0.3346 | -0.0177 | 0.4263 | 0.4637 | 0.0440 | 0.0229 | 0.3289 | -0.0185 |
| | (0.2881) | (0.7898) | (0.1648) | (0.0482) | (0.2258) | (0.0114) | (0.2939) | (0.8020) | (0.1657) | (0.0485) | (0.2247) | (0.0111) |
| Constant | -1.1122*** | 1.0499 | -0.6816** | -0.1291 | 0.0210 | 0.0206 | -1.1323*** | 1.0511 | -0.6418** | -0.1251 | 0.0131 | 0.0192 |
| | (0.4066) | (0.7773) | (0.2627) | (0.0945) | (0.2709) | (0.0180) | (0.4163) | (0.7766) | (0.2627) | (0.0942) | (0.2677) | (0.0169) |
| 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 | 3,383 | 3,350 | 3,370 | 3,149 | 2,728 | 2,615 |
| Adj. R-squared | 0.09 | 0.011 | 0.051 | 0.1 | 0.038 | 0.202 | 0.09 | 0.011 | 0.05 | 0.099 | 0.039 | 0.201 |
| Countries | 48 | 47 | 48 | 44 | 44 | 36 | 48 | 47 | 48 | 44 | 44 | 36 |

Appendix Table C3: The Impact of Macroprudential FX Regulations, Sensitivity Checks II

All variable definitions and notes are the same as for Table 1. In columns (1) to (6), we only include macroprudential FX regulations that are newly adopted or tightened. In columns (7) to (12), we do not use financial weighting for key variables (as discussed in Section IV).

| Stock Returns By | Lag Key Variables | | Exclude Annual Vars | | Exclude 2008Q4 | |
|--------------------------------------|----------------------------|----------------------|----------------------------|----------------------|-----------------------------|----------------------|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| | <i>Fin.</i> | <i>Broad</i> | <i>Fin.</i> | <i>Broad</i> | <i>Fin.</i> | <i>Broad</i> |
| Cum. FX Regulation (t to t-3) | -1.707 (1.358) | -0.989 (1.273) | -1.230 (1.305) | -0.465 (1.401) | -1.404 (1.334) | -0.541 (1.478) |
| Ex. Rate Appreciation (t) | 1.880*** (0.217) | 1.605*** (0.156) | 1.472*** (0.214) | 1.221*** (0.156) | 1.415*** (0.231) | 1.117*** (0.169) |
| FX Regulation X Ex. Rate Apprec. (t) | -0.700** (0.334) | -0.402 (0.250) | -0.741** (0.269) | -0.445* (0.221) | -0.894*** (0.293) | -0.467* (0.241) |
| Industry Production Growth (t) | -0.013 (0.046) | 0.014 (0.039) | 0.087* (0.043) | 0.060 (0.044) | 0.086* (0.043) | 0.058 (0.040) |
| Inflation (t) | -1.825*** (0.342) | -2.115*** (0.292) | -0.159 (0.413) | -0.161 (0.318) | -0.249 (0.420) | -0.456 (0.308) |
| Short-Term Interest Rate (t) | -0.192 (0.184) | -0.318 (0.221) | -0.223* (0.112) | -0.388** (0.160) | -0.279* (0.149) | -0.408** (0.193) |
| Stock Market Turnover Ratio (t) | -0.037 (0.022) | -0.007 (0.020) | | | 0.018 (0.020) | 0.050*** (0.016) |
| Rule of Law (t) | 0.239 (3.296) | 3.476 (3.820) | | | -3.874 (3.161) | -1.189 (3.631) |
| Global Volatility (t) | -3.620*** (0.507) | -2.515*** (0.498) | -9.833*** (0.754) | -9.288*** (0.669) | -9.278*** (0.899) | -8.923*** (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. = Financial Sector, Board = Broad Market. Larger value of each coefficient pair in absolute terms is marked in bold.

Appendix Table C4: Market Vulnerability to Currency Movements: Robustness

The table shows the estimated parameter values from a panel regression of equation 13. 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 IV. Additional information is provided in Appendix D. 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.

Appendix D: Data for Analysis of Market Vulnerability to Currency Movements

Dependent Variables:

Broad Market Stock Returns: 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. Source: Haver Analytics.

Financial Stock Returns: 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. Source: Haver Analytics.

Key Variables:

Cumulated FX Regulation: The cumulated FX regulation measure combines the information of each country's FX regulation from Section III over one year. Based on the aggregated measure of FX regulations (that includes both FX regulations targeting assets and liabilities), we first compute the sum of the contemporaneous effect and its three quarterly lags. We then define the cumulated FX-measure as a variable that takes on the value of +1 if this sum is positive and the value of -1 if this sum is negative; if the sum is 0, the cumulated FX regulation measure takes on the value of zero as well.

Ex. Rate Appreciation: Financially-weighted exchange rate appreciation. We use the same methodology as in Section IV, but we now use as weights the average of foreign assets and foreign liabilities. This broader definition is a more appropriate choice to capture the financial links for the entire economy. An increase in this variable corresponds to an appreciation of the domestic currency.

Control Variables:

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. Source: 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. Source: Haver Analytics.

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.

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. The source is: Global Financial Development Database, The World Bank.

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. The source is: Worldwide Governance Indicators Database, The World Bank.

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.

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.

Country sample: 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, Vietnam.