

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

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**Abstract:** We use a new dataset on macroprudential FX regulations to evaluate their effectiveness and unintended consequences. Our results support the predictions of a model in which banks and markets lend in different currencies, but only banks can screen firm productivity. Regulations significantly reduce bank FX borrowing, but firms respond by increasing FX debt issuance. Moreover, regulations reduce bank sensitivity to exchange rates, but are less effective at reducing the sensitivity of the broader economy. Therefore, FX regulations on banks mitigate bank vulnerability to currency fluctuations and the global financial cycle, but appear to partially shift the snowbanks of vulnerability elsewhere.

**Keywords:** Macroprudential policy, FX regulations, currency mismatch, capital flows, cross-border banking

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## I. Introduction

The global financial crisis has prompted renewed interest in tools to reduce macroeconomic and financial vulnerabilities, strengthen financial systems, and improve country resilience. A key component of this strategy is greater use 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.<sup>1</sup> One type of tool, macroprudential foreign exchange (FX) regulations, however, has received less attention, despite the long-standing research documenting the vulnerabilities associated with currency mismatch.

This paper seeks to fill this gap. It provides a detailed assessment of macroprudential regulations on the use of foreign currencies by banks, including a theoretical model which allows firms to choose their amount, currency and source of funding, as well as an empirical assessment of the direct and unintended consequences of FX regulations using a rich new dataset. We find that macroprudential FX policies are effective in accomplishing their primary goal of reducing bank exposure to foreign currency risk. But do they simply shift the risk elsewhere—similar to “shifting a snowbank” (a pile of snow) from one place to another? We find some evidence of a “shifting snowbank” effect, as reduced FX lending from banks causes some firms to increase FX debt issuance to investors. This shifting is fairly modest, however, so that aggregate exposure to FX debt declines meaningfully. 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 companies and the broader economy. As a result, although macroprudential FX regulations can substantially improve the resilience of the banking sector to the global financial cycle, the benefits to the broader economy may be more moderate, as some vulnerability may shift to less informed, less efficient and/or unregulated sectors.

Exposure to foreign currency borrowing and currency mismatch has been a habitual concern, especially in emerging markets. Foreign currency exposure can increase a country’s vulnerability to sudden stops, currency depreciations, and financial and banking crises, as well as limit the ability of the exchange rate and monetary policy to respond to shocks (Rey, 2013). Despite these concerns, foreign currency exposure has continued to increase—especially in the corporate and household sector.<sup>2</sup> For example, over our sample period from the mid-

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<sup>1</sup> Cerutti *et al.* (2015) and Forbes (2018) are recent surveys of this extensive literature.

<sup>2</sup> See Acharya *et al.* (2015), Bruno and Shin (2016), Chui *et al.* (2014, 2016), and Du and Schreger (2016).

1990s through end-2014, total FX borrowing in international debt securities and bank loans more than tripled to about \$12 trillion. In just the six years after the Global Financial Crisis (from 2009-2015), cross-border FX borrowing in international debt securities and loans increased by around \$2.5 trillion—a sharp contrast to almost no change in comparable cross-border borrowing in local currency. Concerns about the macroeconomic and financial risks related to FX exposure have increased interest in using macroprudential FX regulations.

Evaluating the effects of macroprudential FX measures has been challenging, however, partly due to insufficient data linked to the limited experience with these tools until recently, and partly due to identification challenges related to macroprudential regulations being introduced as a response to financial and macroeconomic developments.<sup>3</sup> An evaluation should assess not only the direct effects of these measures on the intended sector of the economy (such as banks), but also any spillovers or leakages as firms, banks, and other entities respond to the regulations. These types of unintended consequences have been highlighted in analyses of other types of macroprudential regulations and capital controls.<sup>4</sup> If these leakages and substitution effects occur, can these macroprudential policies achieve their primary goal of reducing aggregate country vulnerability to currency risk?

This paper attempts to tackle these challenges in an assessment of the direct and indirect effects of macroprudential FX regulations on banks and the broader economy. We develop a model of bank versus market lending, building on the seminal work of Holmstrom and Tirole (1997), but add the dimension that lending and borrowing are also differentiated between domestic and foreign currencies. Domestic firms choose the amount and currency of funding and the type of lender (bank versus market). Firms have private information about their productivity and whether they are hedged (e.g., exporters produce some of their output in foreign currency). Banks can screen firms at a cost and identify their productivity and export/hedging status, while market investors can only lend indiscriminately (albeit with partial information on hedging/export status). Funding in foreign currency is cheaper than in domestic currency, but subject to exchange rate risk.

In equilibrium, exporters (which are productive and hedged against FX risk) attract cheap funding in foreign currency, while productive non-exporters obtain funding from banks

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<sup>3</sup> Papers which include some discussion of macroprudential FX regulations as part of their broader analyses of macroprudential tools are: Nier *et al.* (2011), Cerutti *et al.* (2015), Vandenbussche *et al.* (2015), and Avdjiev *et al.* (2016b). Two papers which focus on FX regulations are De Crescenzo *et al.* (2017) and Aguirre and Repetto (2017), but neither considers the leakages, broader effects on the economy, or sensitivity to currency movements.

<sup>4</sup> See Agénor and da Silva (2017) for a recent survey.

in domestic and foreign currency. When the currency depreciates, a fraction of unhedged firms and their associated banks default. Adding macroprudential FX regulations increases banks' cost of funding in foreign currency, reducing their FX borrowing and lending. This reduces the expected exposure of banks to socially costly default, but depresses productive investment and causes some firms to migrate their FX borrowing from banks to debt markets. As more funding shifts to investors (who can not screen), lending efficiency declines. The result of macroprudential FX regulations is a welfare trade-off: banks are less sensitive to currency movements so that there is a lower risk of bank failure after depreciations, but this is balanced by lower aggregate investment, a lower productivity of investment, and an increased sensitivity of investors (*e.g.*, the non-bank funding source) to currency movements.

Our simple framework yields clear predictions 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. We focus on four implications that are testable with our rich cross-country dataset on macroprudential FX regulations. The model suggests that after an increase in macroprudential FX regulations: (1) banks borrow and lend less in foreign currency (with no change in their borrowing and lending in local currency); (2) some firms shift away from bank borrowing and increase their FX borrowing from market investors (with no increase in firm non-FX borrowing); (3) banks are less exposed to exchange rate movements; and (4) firms experience less reduction in their exposure to exchange rate movements than banks.

To test these four predictions, we build a rich dataset on macroprudential FX regulations, defined as policies directed at the broader banking system (compared to microprudential regulations that target individual institutions) and that are based on the currency denomination of the capital transaction. The dataset is based on four sources that each document and measure macroprudential FX regulations in different contexts or for different countries: Shim *et al.* (2013), Vandenbussche *et al.* (2015), Cerutti *et al.* (2017), and an updated version of Reinhardt and Sowerbutts (2015). Our resulting dataset includes information on macroprudential regulations in 48 countries over the period 1995-2014. It has broader country and period coverage of macroprudential FX regulations, as well as a more detailed categorization of different types of regulations, than previously available.

The empirical analysis confirms the four model predictions, as well as provides additional details on how tighter macroprudential FX regulations affect (or do not affect)

different types of cross-border capital flows, banks, and sensitivity 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. There is also some evidence that this occurs because the regulations reduce domestic lending in FX, increase the average rate at which banks lend, and reduce the share of banks' non-performing loans. The FX regulations, however, also appear to have the unintended consequence of causing companies to partially shift their FX funding toward international debt issuance. Although this shifting effect is fairly small, this partially mitigates the benefits to the broader economy from the reduced exposure to FX risk, especially if the risks shift to sectors that are more vulnerable to currency movements. These results are robust to a series of sensitivity tests, including different approaches aimed at accounting for any endogeneity in the country's decision to adjust FX measures as well as controlling for any concurrent use of capital controls.

The magnitudes of the estimates also suggest that these effects of macroprudential FX regulations are meaningful. A tightening of FX regulations causes banks to reduce their cross-border borrowing in FX by about a third over four quarters, a reduction equivalent to about 0.5%-0.7% of GDP. For major emerging markets, such as Brazil or Indonesia, this is equivalent to reducing cross-border bank FX borrowing by more than half. At the same time, corporates increase FX debt issuance by about 10% of median annual FX debt issuance for the full sample over four quarters, equivalent to a 15%-20% increase in FX corporate debt issuance for emerging markets such as Brazil and Indonesia. Combining these various estimates suggests that FX regulations 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). A series of extensions also provides evidence on the effectiveness of different types of FX measures and specific instruments (albeit with more limited sample size), as well as their dynamics over time.

Our results have several important implications. They support a growing body of research showing that macroprudential regulations can be effective at accomplishing their direct goals<sup>5</sup>—in this case significantly reducing the FX exposure of banks to currency

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<sup>5</sup> Prominent examples include: Dell'Ariccia *et al.* (2011), Ostry *et al.* (2012), Kuttner and Shim (2013), Akinci and Olmstead-Rumsey (2015), Bruno *et al.* (2015), Cerutti *et al.* (2015), Forbes *et al.* (2015), Vandebussche *et al.* (2015),

movements. This result is particularly relevant for the debate on how to address long-standing concerns about vulnerabilities related to foreign currency borrowing and currency mismatch.<sup>6</sup> These vulnerabilities have prompted some countries to consider the use of capital controls. Our results suggest that any such countries could instead consider macroprudential FX regulations—especially countries for which capital controls (but not macroprudential FX regulations) are illegal, such as in the European Economic Area and in some trade agreements.

The analysis also supports a growing literature that shows that even when macroprudential FX regulations work in terms of their direct goals, there can be leakages and unintended consequences.<sup>7</sup> Ranciere *et al.* (2010) highlight the importance of incorporating these potential leakages in any analysis of the impact of macroprudential FX regulations. In our analysis, these leakages are much smaller than the direct effects of FX regulations, but still significant and economically meaningful.

Finally, this paper moves beyond most other work on macroprudential regulations by assessing if the regulations achieve the broader goal of improving financial resilience. The results suggest that macroprudential FX regulations can improve the resilience of the banking sector to currency fluctuations, but do less to improve the resilience of the broader economy to exchange rate movements. The net benefits may still be positive, as improving the resilience of banking institutions can reduce systemic vulnerabilities, just as a snowplow moving the snow off the road makes the road system safer. Just as the snowplow inevitably pushes a portion of the snow to block your driveway, however, macroprudential FX regulations can also shift some vulnerability to other sectors outside the regulatory perimeter. These other institutions may be harder to monitor and less well informed than banks, less able to screen for the risks inherent in corporate borrowing in FX, and less able to handle any losses after a depreciation. This shifting snowbank of risks could mitigate some of the benefits of the macroprudential FX regulations.

This paper proceeds as follows. Section II presents the theoretical model of bank and market lending in domestic and foreign currency. Section III describes the data, including the

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and Beirne and Friedrich (2017).

<sup>6</sup> For discussions of “original sin” and vulnerabilities related to foreign currency exposure and mismatch, see Eichengreen and Hausmann (1999), Bordo and Meissner (2005), Desai *et al.* (2008), Zettelmeyer *et al.* (2011), Benmelech (2012), Niepmann and Schmidt-Eisenlohr (2017), and Kearns and Patel (2016).

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

compilation of the dataset on macroprudential FX regulations. Section IV presents the empirical framework and reports results on the direct and indirect effects of FX regulations on bank and firm borrowing and debt issuance, including accounting for endogeneity, for different types of FX regulations and capital controls, and additional robustness tests. Section V assesses the impact of the regulations on bank and corporate sensitivity to currency movements, including how the regulations correspond to other measures of bank performance. Section VI concludes.

## II. Model

To assess the impact of macroprudential FX regulations, we develop a simple model of bank versus market lending in domestic or foreign currency. This framework builds on Holmstrom and Tirole (1997) by incorporating asymmetric information between lenders and borrowers, with banks as special lenders because of their ability to screen for firm productivity at a cost. We diverge from Holmstrom and Tirole (1997) by also incorporating how asymmetric information affects a lender's choice of the currency of their loans, with banks also able to screen for a firm's hedge against currency risk.<sup>8</sup> While Holmstrom and Tirole (1997) consider an environment with a single good, we consider two goods in order to allow for a choice between foreign and domestic currency. While our model is not intended to explain all the factors that influence firm borrowing decisions, it provides a useful framework for the subsequent empirical analysis of the impact of macroprudential FX regulations.

There are two dates ( $t = 0, 1$ ) and a domestic ( $D$ ) and a foreign ( $F$ ) good. Let  $e_t$  be the exogenous exchange rate (the value of one  $F$  good in  $D$  goods) at date  $t$ . We normalize the exchange rate at  $t = 0$  to one,  $e_0 \equiv 1$ . To allow for the intensive margin of FX-induced default, we include a continuous exchange rate at  $t = 1$ . To ease exposition, we use a uniform distribution for  $e_1$  and drop the index:

$$e \sim U [0, b], \tag{1}$$

where  $0 < b < \infty$ , and higher values of  $e$  correspond to a depreciation of the  $D$  currency.

The economy contains four groups of risk-neutral agents: domestic firms, banks,

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<sup>8</sup> In Holmstrom and Tirole (1997), banks can also monitor firms to reduce moral hazard. This assumption is not included in our model.

investors, and savers. All agents take the observable funding rates ( $r_D, r_F$ ) and lending rates ( $R_D, R_F$ ) as given. Lenders (banks and investors) and savers make zero profits due to competition, while firms maximize expected profits (in  $D$  goods).<sup>9</sup> At  $t = 0$ , savers are endowed with large amounts of the domestic and foreign goods. Savers can lend their funds to banks and investors. Their required return is  $0 < r_F < r_D$  in foreign and domestic currency, respectively.<sup>10</sup> Hence, lenders fund themselves in domestic and foreign currency at these rates. We assume lenders are fully hedged, so their funding is in the currency of the loan to firms.<sup>11</sup>

At  $t = 0$ , a unit continuum of firms has a domestic investment opportunity. Firms are penniless and they seek to borrow from a lender. The amount of borrowing, the type of lender, and the currency of the loan are endogenous in our model. Firms are heterogeneous in the productivity of their opportunities, which is private information to the firm. A fraction  $1 - p \in (0,1)$  of firms has zero productivity, while the remainder  $p$  produces at  $t = 1$  according to a continuous, increasing and concave production function. We assume the simple form:

$$y = I^\alpha, \tag{2}$$

where total investment  $I$  at  $t = 0$  comprises domestic and foreign funding,  $I = d + f$ , and  $\alpha \in (0,1)$  shapes the concavity of the production function.<sup>12</sup>

Among the productive firms, a fraction  $q \in (0,1)$  are exporters and therefore have a natural hedge against FX risk; a fraction  $\phi$  of their output  $y$  is in the  $F$  good. For expositional simplicity, we assume a complete hedge, ( $\phi_{Exp} = 1$ ), though our qualitative results extend to partial hedges.<sup>13</sup> Non-exporters produce entirely in the  $D$  good ( $\phi_{Non-Exp} = 0$ ).

For the lenders, banks are special (relative to investors) in that they have access to a screening technology. Upon paying a fixed cost,  $c > 0$ , a bank can identify the productivity and hedge of firms. In contrast, market investors do not observe firm characteristics and may therefore be subject to adverse selection. This difference in screening technology is the only

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<sup>9</sup> The results generalize when lenders and firms share the surplus generated from lending and productive investment.

<sup>10</sup> The assumption of cheaper funding in FX is consistent with evidence in Kubo (2008) and Temesvary (2013).

<sup>11</sup> Such prudential behavior arises endogenously if banks or investors have charter value (Keeley, 1990). Evidence also suggests that banks are usually hedged against direct FX risk (e.g., Brauning and Ivashina, 2017; Borio *et al.*, 2017).

<sup>12</sup> The following results are obtained for a sufficiently concave production function (i.e.,  $\alpha$  close to  $\frac{1}{2}$ ), which ensures that firms have a positive demand for borrowing in foreign currency.

<sup>13</sup> We assume that exporters and productive non-exporters have the same productivity. All of our results qualitatively extend to the case in which exporters are more productive than non-exporters. For expositional clarity, we focus on one source of heterogeneity for exporters, namely their natural hedge.



source of heterogeneity across different types of lenders. We also assume that a fraction  $O \in (0,1)$  of exporters are publicly observed to be exporters (*i.e.*, are productive and have a hedge), which investors observe even in the absence of any screening.

There is universal protection by limited liability. If a firm fails to repay at  $t = 1$ , it defaults and receives zero. We assume zero recovery upon bankruptcy, such that lenders also receive zero upon firm bankruptcy. Our results extend qualitatively to positive recovery values.

Next, consider a regulator concerned about the stability of banks. When banks lend in foreign currency to non-exporters (who produce their output in domestic currency), a depreciation of the domestic currency can trigger firm default and, as a result, bank default.<sup>14</sup> Bank default is associated with a social cost  $\Delta$ , which is proportional to the expected exposure of banks (the probability of default times the lending volume outstanding).<sup>15</sup> To reduce this expected social cost, the regulator may impose a macroprudential tax,  $t \geq 0$ , on the foreign funding of banks.<sup>16</sup> Hence, the effective cost of foreign funding for banks is  $r_F + t$ . We proceed by deriving the results for a general value of  $t$  and obtain the unregulated economy for  $t = 0$ .

This fairly simple framework yields a unique equilibrium for lending patterns: an unregulated equilibrium (without macroprudential regulations,  $t = 0$ ) and with macroprudential FX regulations  $t > 0$ . The remainder of this section summarizes the equilibrium, focusing on the testable implications in the empirical analysis in Sections IV and V. The derivations and proofs are in Appendix A. We focus on the scenario with a low enough cost of screening,  $c < \underline{c}$ .

### Unregulated Equilibrium:

- i.* Exporters borrow in  $F$  and never default. If their export status is observed, they borrow from the market at rate  $R_O^M = r_F$ ; if unobserved, they borrow from banks at  $R_E^B = r_F + c$ .

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<sup>14</sup> A depreciation of the domestic currency generally has two effects on firms: it raises the cost of repaying debt denominated in foreign currency (a financial effect) and reduces output prices relative to comparable foreign goods (a competitiveness effect). This model assumes that the financial effect dominates such that a depreciation increases the probability of firm bankruptcy. For evidence that this financial effect often dominates the competitiveness effect, especially in emerging markets (which are more likely to use FX macroprudential regulations), see Kalemli-Özcan *et al.* (2016) and Kearns and Patel (2016).

<sup>15</sup> For estimates of the cost of bank defaults, see Laeven and Valencia (2013).

<sup>16</sup> Another approach could be to impose the macroprudential tax on the FX lending of banks. The results in this case are qualitatively similar, but the exposition is easier if the tax is on bank liabilities. In practice, macroprudential FX regulations target bank assets and liabilities, and the differences are discussed in more detail in Sections III and IV.

- ii. Productive non-exporters borrow in both currencies from banks at rates  $R_D^B = \frac{b(r_F+c)}{2}$  and  $R_F^B = \frac{b(r_F+c)^2}{2(r_D+c)}$ . Firms default – and banks therefore fail – whenever the domestic currency depreciates,  $e > e^* = 2 \frac{r_D+c}{r_F+c}$ .
- iii. Unproductive firms receive no funding.

The lending pattern of the unregulated equilibrium shows that banks are exposed to default after a depreciation of the local currency D. The resulting expected social cost of bank default due to FX exposure could provide the incentive to adopt macroprudential FX regulations. Implementing macroprudential FX regulations, however, changes the equilibrium in a number of ways.

Equilibrium with Macroprudential FX Regulation:

- i. **A marginal increase in the macroprudential tax rate reduces banks' FX funding with no significant effect on banks' non-FX funding. This corresponds to a reduction in firms' FX borrowing from banks, with no effect on firms' non-FX borrowing.**

*Details:* For  $t < t^* \equiv \underline{c} - c$ , a marginal increase in the tax rate  $t$  raises the cost of bank borrowing in FX by all firms, which reduces bank borrowing in  $F$  by productive exporters (despite their perfect hedge from  $F$  income),  $\frac{df_E^*}{dt} < 0$ , as well as bank borrowing in  $F$  by productive non-exporters,  $\frac{df^*}{dt} < 0$ . Productive non-exporters continue to borrow in  $D$  from banks, and unproductive firms continue not to receive any bank or market funding. Since banks fund themselves in the currency requested by firms, banks reduce their FX funding, with no change in their non-FX funding.

- ii. **If the tax increase is substantial, a *partial shifting* effect also occurs, in which firms replace FX borrowing from banks with FX borrowing from markets, with no significant effect on firms' non-FX borrowing.**

*Details:* For  $t \geq t^*$ , a marginal increase in the tax rate  $t$  further reduces borrowing in  $F$  by productive exporters from banks. At the same time, the tax increase induces productive non-exporters to switch their  $F$  borrowing from banks to the market (while still keeping their  $D$  borrowing from banks). Moreover, since market investors cannot

screen lenders' productivity, they start lending to unproductive firms in  $F$ .<sup>17</sup>

**iii. Macroprudential FX regulation reduces the expected exposure of banks to currency movements.**

*Details:* Because  $\frac{df^*}{dt} < 0$  in (i), banks' exposure to currency movements falls, i.e.,

$\frac{dEE}{dt} < 0$ , as long as firms' default risk upon depreciation is sufficiently frequent, i.e.,

$$\frac{e^*}{b} < \frac{1}{2-\alpha}.$$

**iv. Macroprudential FX regulation will not reduce the exposure of firms to currency movements by as much as for banks.**

*Details:* When the tax  $t$  is increased from 0 to  $t^*$ , the exposure of productive non-exporters to currency movements falls, because the higher funding costs reduce their borrowing in  $F$ . When  $t \geq t^*$ , however, these firms shift their  $F$  borrowing from banks to the market, and unproductive firms begin to receive market funding in  $F$ . As a result, the reduced exposure to  $F$  by banks does not correspond to a commensurate reduction in exposure to  $F$  by firms.<sup>18</sup> Therefore, the effect of the regulations on the aggregate exposure of firms to currency movements is ambiguous, but there is less reduction in exchange rate sensitivity for firms than for banks.<sup>19</sup>

These four key predictions of the effects of macroprudential FX regulations are evaluated in the remainder of the paper using our rich data on macroprudential FX regulations, cross-border capital flows and international bond issuance. The model also yields additional predictions on the equilibrium with FX regulations. Two of these merit discussion in order to understand the tradeoffs involved with these regulations, although we will leave testing of these implications for other research with better-suited datasets.

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<sup>17</sup> Note that the model can allow for some substitution towards domestic funding after macroprudential FX regulation. Given our assumption of alpha close to  $\frac{1}{2}$ , however, this channel is muted. This approach is consistent with the empirical evidence in Section IV.

<sup>18</sup> The exposure of exporters stays constant (as they are fully hedged).

<sup>19</sup> Note that the exposure of firms to FX risk could increase or decrease after macroprudential FX regulation in our model, but in all scenarios will not fall by as much as that of banks. The indeterminate direction of the impact on firm FX exposure results from different effects of the regulations on the three types of firms: (1) Productive exporters who borrow from banks reduce their FX borrowing and overall FX exposure after macroprudential FX regulation; (2) Productive non-exporters switch to market funding in FX and their total FX borrowing will not increase (as the cost of FX borrowing from banks increases, and since the cost of FX borrowing will not decrease, it can not be optimal to increase FX borrowing); and (3) Non-productive firms begin to borrow in FX from markets, counteracting the reduction in exposure to FX risk that occurs in the other two types of firms.

First, our model suggests that macroprudential FX regulations can reduce allocational efficiency and investment in the economy. As a portion of FX funding shifts from banks (who can screen) to uninformed investors, there is an increase in lending to unproductive firms due to adverse selection. As a result, the average productivity of funded firms in the economy falls. Also important, the reduction in FX funding to productive firms (exporters and non-exporters) lowers investment in these firms, likely reducing output and labor productivity in the future. Granted, lower investment by the unhedged, non-exporters yields a benefit, *ceteris paribus*, of reduced FX exposure in this subset of firms, but there is no associated benefit from reducing investment in the productive (and hedged) exporters. Two recent and noteworthy papers, provide supportive evidence for these model predictions. Salomao and Varela (2018) uses Hungarian firm-level data to show that banks are better able to screen for more productive investment opportunities, and that when a larger share of cheaper FX borrowing is allocated through banks, the productivity of investment increases. Ayyagari et al. (2018) uses a large cross-country, firm-level dataset to show that macroprudential regulations reduce credit growth and firm-level investment.

Second, our model provides guidance on the optimal level of macroprudential FX regulations ( $t$ ). More specifically, predictions (i) and (ii) suggest that the expected effects are different for small and large increases in the macroprudential tax. Only large increases in the tax cause productive non-exporters to switch to market funding in FX and allow unproductive firms to receive FX funding. Moreover, our model suggests that there is no benefit for a regulating authority with a utilitarian welfare objective to increase the macroprudential tax beyond the value of  $t^*$ , because the expected social cost of bank failure cannot be reduced further. More specifically, at  $t = t^*$  productive non-exporters switch their FX borrowing from banks to the market, thereby leaving the regulatory perimeter so that they cannot be further affected by additional banking regulation. The remaining bank exposures to productive non-exporters in domestic currency and to productive exporters in foreign currency do not generate currency-related risks, since the former receive their income in domestic currency and the latter in foreign currency. Although assessing the optimal level of regulation would be difficult and require detailed firm-level data on currency exposures, these model implications provide a framework that could help structure additional research with the appropriate data.

### III. Data

This section discusses the data used for the empirical analysis (which is also available online) and is divided into two parts. The first provides details on the newly compiled dataset on macroprudential FX regulations that is central to this paper. The second discusses the additional control variables used in the analysis. Summary statistics for all of the key data are in Table 1, and additional details on definitions and sources are in Appendix B.

#### A. Data on Macroprudential FX Regulations

We define macroprudential FX regulations as regulations that discriminate based on the currency denomination of a capital transaction.<sup>20</sup> Macroprudential FX regulations usually focus on the domestic banking system and can be implemented by the government, the central bank, or the national prudential regulator. Our measures of macroprudential FX regulations do not include capital controls—which discriminate by the residency of the parties involved in the transaction.<sup>21</sup> Also, while our measures are macroprudential, as they are directed at systemic risks to the entire financial system stemming from FX flows and exposures, some measures (such as sectoral FX capital risk weights) can also be classified as microprudential regulations (which generally target the resilience of individual financial institutions).

To construct our database, we draw on four sources of macroprudential regulations: Shim *et al.* (2013), Vandebussche *et al.* (2015), Cerutti *et al.* (2017), and an updated version of Reinhardt and Sowerbutts (2015). Each of these datasets uses different sources and has a different focus—but includes information on macroprudential FX regulations. Shim *et al.* (2013) provides verbal descriptions of policy events broadly related to the housing sector for 60 countries at a monthly frequency from 1990-2012. Vandebussche *et al.* (2015) has detailed data on a range of macroprudential policy actions for 16 countries from Emerging Europe from 1997-2010. Cerutti *et al.* (2017) uses IMF country survey data to measure 12 macroprudential policies, including on FX- and local-currency reserve requirements, in 64 countries over 2000-14. Finally, the updated Reinhardt and Sowerbutts (2015) database on macroprudential policy actions contains data for 60 countries starting in 1995.

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<sup>20</sup> Throughout the paper, we use the terms “macroprudential FX regulations” and “FX regulations” synonymously.

<sup>21</sup> In some applications (including in many theoretical models), capital controls and FX regulations could be used to accomplish similar goals as transactions between residents and non-residents are often more likely to involve FX. The sensitivity analysis below, however, finds that there is limited overlap in the use of capital controls and the macroprudential FX regulations on banks that are the focus of this paper.

After combining these sources, we make several additional adjustments. We exclude the countries that issue safe-haven currencies (*i.e.*, the US, Japan, Switzerland, and long-standing members of the Euro Area), in order to focus on countries more vulnerable to currency mismatches and the global financial cycle and thereby likely to consider FX regulations.<sup>22</sup> We also exclude offshore centers, as defined by the BIS in *International Banking Statistics*, with the exception of Singapore and Hong Kong.<sup>23</sup> This leaves us with a sample of 48 countries for our main empirical analysis, with information on 132 changes in macroprudential FX regulations from 1995 through 2014 (on a quarterly basis) that represent either a tightening or loosening in regulation.<sup>24</sup> Some countries have made no changes to macroprudential FX policy, while others have made more than ten. There is good coverage of countries in Asia, Europe, and South America, but coverage is more limited for the Middle East and Africa.<sup>25</sup>

Figure 1 shows the cumulated changes in all macroprudential FX regulations from 1995 through 2015. 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 on the given date. The figure shows a general trend of tightening FX regulations since the mid-2000s, interrupted by a brief period of loosening during the Global Financial Crisis. In our dataset, these macroprudential FX regulations can be further disaggregated into those focusing on banks' FX assets and those focusing on banks' FX liabilities.<sup>26</sup> More specifically:

- **FX Asset-side Measures (in blue)** include all policies aimed at the FX assets of domestic banks. These generally focus on restricting FX lending to corporates and households in the domestic economy. These measures include FX capital regulations for banks (such as provisioning rules or risk weights associated with FX-lending). These also include lending standards for FX loans, incorporating both quantitative lending standards (such as loan-to-value or debt-to-income ratios for FX loans), and qualitative lending standards for FX loans (such as amortization requirements for FX loans).

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<sup>22</sup> None of these safe-haven countries have any changes in macroprudential FX regulation in our dataset, except for Austria, which has four changes in FX regulations over our sample period. Therefore, we include Austria for the main analysis. Excluding Austria has no meaningful impact on the key results.

<sup>23</sup> A sensitivity test below shows that excluding Singapore and Hong Kong has no impact on the key results.

<sup>24</sup> See Appendix B for a list of countries and more information on the sample.

<sup>25</sup> Our sample includes 17 advanced economies and 31 emerging markets (as classified by the BIS in their *International Banking Statistics*). Advanced economies increased their use of FX regulations towards the end of the sample, but emerging markets account for the vast majority of FX regulatory actions.

<sup>26</sup> These two categories can be further disaggregated into various subcategories. We do not focus on the more detailed disaggregation in this paper, however, as the sample size becomes too small to yield meaningful results.

- **FX Liability-side Measures (in red)** include all policies aimed at the FX liabilities of domestic banks. These measures generally focus on the funding decisions of banks and include FX reserve requirements and FX liquidity requirements (such as liquidity coverage ratios or taxes on non-core FX liabilities). These measures tend to specifically target FX flows with a short maturity.

The shaded areas in Figure 1 show the cumulated actions for these two types of FX measures, 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, and then experienced another surge around 2010-11, but have since been adopted at a more moderate pace. Liability-side FX regulations were adopted more gradually from 2002-2006, after which use fell by about half, until after 2010 they regained attention and their use roughly doubled during 2010-13. These different types of macroprudential FX regulations could 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).

For a final cut of the data, Figure 2 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 Figure 1, 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. Figure 2 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.

## **B. Data on International Capital Flows and other Variables**

This section discusses the international capital flow variables on bank and corporate borrowing that will be the focus of the empirical tests, and then the various control variables. To begin, in order to test the model predictions on the impact of FX regulations on cross-border loans to banks, we use quarterly data from the BIS International Banking Statistics (IBS), which reports both FX and non-FX gross capital inflows to banks, using the “locational” statistics which are based on the residency of the banking entity (and not necessarily the

location of the bank's headquarters).<sup>27</sup> These data are expressed as a percent of annual GDP (calculated as 4-quarter moving averages).<sup>28</sup> In order to test the model predictions on the "shifting" effects of the regulations to debt issuance, we use data from the BIS International Debt Statistics (IDS), which includes debt securities issued by domestic headquartered companies on international markets in FX and non-FX.

Figure 3 graphs several of these measures which are a focus of the empirical analysis. Figure 3a shows the evolution of cross-border loans to banks as a percent of GDP, broken into loans in FX (red) and non-FX (blue). Cross-border lending declines since around the crisis, with basically all of the decline occurring in FX lending. Figure 3b shows international debt issuance over the same period, also broken into FX (solid lines) and non-FX borrowing (dashed lines), and further distinguished by banks (green) and corporates (orange). International debt issuance in FX has increased fairly steadily since the crisis for corporates, but fallen for banks. Non-FX borrowing by corporates has been fairly flat, and for banks has decreased. These graphs are only suggestive, but the trends agree with the model's prediction; after a tightening in macroprudential FX regulations (such as after the 2008 crisis), cross-border FX lending by banks declines (with no change in banks' non-FX lending), while corporate FX debt issuance increases (with no increase in corporate non-FX debt issuance).

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

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<sup>27</sup> "Domestic banks" therefore include both domestically owned as well as foreign-affiliate subsidiaries and branches in that country; any intergroup transactions that involve cross-border loans or debt issuance (even if with the headquarters located in a different country) should be captured as a cross-border transaction in our dataset. See [https://www.bis.org/statistics/about\\_banking\\_stats.htm?m=6%7C31%7C637](https://www.bis.org/statistics/about_banking_stats.htm?m=6%7C31%7C637) for more information.

<sup>28</sup> 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.



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

- *Changes in non-FX macroprudential regulation*: measured by calculating any change in macroprudential regulations in the four datasets discussed above (from Shim *et al.*, 2013; Vandebussche *et al.*, 2015; Cerutti *et al.*, 2017; and Reinhardt and Sowerbutts, 2015) for country  $i$ . Then any changes in FX regulations are removed. The resulting measure is reported as +1 for any new use/tightening of any non-FX macroprudential regulation, and as -1 for any reduction/removal. The variable is the sum of its contemporaneous effect as well as three lags. Appendix A in Ahnert *et al.* (2018) discusses the compilation 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  $std_t(\cdot)$  is the standard deviation at quarterly frequency and  $\Delta e_{n,t}^F$  is the weekly change in the bilateral exchange rate between the domestic economy and foreign country  $n$ . This controls for the relative riskiness of FX- versus non-FX loans (see Rosenberg and Tirpak, 2009 and Brown and De Haas, 2012).

- *Interest rate differential, weighted based on country financial exposure*: calculated as  $= i_t^D - \sum w_{n,t}^F \cdot i_{n,t}^F$ , 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.<sup>29</sup> The weightings place more weight on the relative funding differentials for the most relevant countries/regions.

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

- *Financial openness*: measured using the Chinn-Ito (2006) index of financial openness. This is a standard control to capture any capital controls or other factors affecting

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<sup>29</sup> For evidence, see Rosenberg and Tirpak (2009), Brown and De Haas (2012), and Brown *et al.* (2014).

the ease by which banks or firms can borrow internationally.

Summary statistics for all of the variables are reported in Table 1, and additional details on variable definitions and sources is provided in Appendix B.

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

This section formally tests how macroprudential FX regulations affect different components of capital inflows, building on the theoretical framework developed in Section II. It begins by developing the specification that will be used for the remainder of the section. Then it reports the central results on how macroprudential FX regulations affect various types of capital flows in domestic and foreign currency for banks and corporates. It is worth noting that a key aspect of this series of tests is not just the effects of FX regulations on certain types of capital flows (such as bank borrowing in FX), but also whether there are no effects on other types of capital flows (such as bank borrowing in non-FX). These “non-effects” suggested in the empirical model are an important part of the hypothesis testing and provide a useful check that any results are not driven by omitted variables or endogeneity that would affect all types of capital flows. The remainder of the section includes a series of extensions: an alternative identification strategy that takes the endogenous policy response to FX borrowing into account, results for different types of FX regulations, and additional sensitivity tests.

##### **A. Estimation Framework**

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

$$F_{i,t} = \alpha + \sum_{k=0}^3 \beta_k fxm_{i,t-k} + \gamma' X_{i,t-1} + \delta_i + \delta_t + \varepsilon_{i,t}, \quad (15)$$

where  $F_{i,t}$  is the measure of quarterly gross cross-border capital inflows for the respective

sector of country  $i$  (discussed in Section III.B).<sup>30</sup> The variable  $fxm_{i,t-k}$  captures changes in macroprudential FX measures (discussed in Section III.A), expressed as a dummy variable that takes the value of +1 if restrictions on FX lending or borrowing are tightened (and -1 if loosened). To account for potential time lags in the impact of these policies, we include the contemporaneous value of  $fxm_{i,t}$  as well as its three lags, and evaluate their joint effect by testing if the sum of all four coefficients is significantly different than zero. Sensitivity tests in Section C examine the dynamics of the effects and show that some effects grow, and others fade, for different windows.  $X_{i,t-l}$  is a set of control variables (discussed in Section III.B);  $\delta_i$  are country-fixed effects and  $\delta_t$  are global time effects. The sample period is 1996 Q1– 2014 Q4.

Several details of this specification and variables merit further discussion.<sup>31</sup> 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. For example, in order to test the central model predictions 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 a percent of GDP, as well as the FX share of total capital inflows to banks. In order to test the model predictions on the “shifting” effects of the regulations,  $F_{i,t}$  is measured as FX and non-FX net international debt issuance by corporates and banks as a percent of GDP, as well as the change in the FX share of total net debt issuance by each group.

A second noteworthy feature of equation (15) is the measure of macroprudential FX regulation,  $fxm_{i,t-k}$ . This is measured as a dummy variable capturing the changes in macroprudential FX regulations and discussed in more detail in Appendix A of Ahnert *et al.* (2018). In our main analysis, this aggregates all of the different types of macroprudential FX regulations, but in some extensions, it only includes specific types of these regulations (such as whether they target bank assets or liabilities).

A final important point in equation (15) is the time fixed effects ( $\delta_t$ ), which are included

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<sup>30</sup> Quarterly capital inflows are scaled by annual GDP, which is calculated as a 4-quarter moving average of annual data to avoid breaks due to annual GDP rising or falling from Q4 to Q1. We scale by annual GDP rather than quarterly GDP because the sum of the contemporaneous coefficient and three lags on  $fxm_{i,t}$  reported in the regression tables can then be read as the effect on capital flows to annual GDP over a one-year period.

<sup>31</sup> To ensure that large observations are not driving the results, all dependent and independent variables are winsorised at the 2.5% level (except for variables based on bounded indices). In order to account for exchange rate valuation effects, changes in shares are calculated based on a series of stocks calculated by adding cumulated exchange rate adjusted changes in bank loans and deposits or net issuance of debt securities to initial stocks. Before winsorising the resulting shares, we exclude changes in the share of bank loans or corporate debt issuance in FX that are above +100% or below -100%. (Including these large changes in shares has no meaningful impact on the key results.)

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

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

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

To test the predictions of our model, Table 2 begins by testing for the effects of FX regulations on gross cross-border loans from international banks to domestic banks over four quarters—using the specification in equation (15) and the data discussed in Section III. According to implication (*i*) of the model in Section II, increased macroprudential FX regulations should reduce the volume of banks' FX funding and share of FX funding, with no significant effect on banks' non-FX funding.<sup>32</sup> The first three columns report reduced-form results with no control variables, columns (4) through (6) report results with the full set of controls discussed in Section III (plus the global-time dummies), and columns (7) through (9) report results with explicit controls for global factors (global volatility, global growth, and changes in US interest rates), instead of the global-time fixed effects.<sup>33</sup> Each set of three columns relies on the same variants of the dependent variables for each specification (FX capital inflows, the share of FX inflows in total inflows, and non-FX inflows), a pattern repeated below. 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

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<sup>32</sup> For this set of tests, we focus on bank funding through cross-border bank borrowing, which is banks' primary form of cross-border funding. In the next part of the analysis, we also evaluate effects on funding through debt issuance.

<sup>33</sup> The global variables follow the capital flow literature, such as Forbes and Warnock (2012) and Avdjiev *et al.* (2016a).

quarterly coefficient estimates ( $\sum_{k=0}^3 \beta_k$ ), 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 differentiate these from the other coefficient estimates reported with standard errors (in parentheses).

The results in Table 2 support the predictions on how FX regulations affect international borrowing by domestic banks over four quarters (starting with the quarter in which the policy change is implemented). Tighter regulations are correlated with a significant decrease in foreign currency borrowing by banks and in the FX share of total international borrowing by banks, over the subsequent year. To put the magnitude of these estimates in context, tighter FX regulations correspond to a decline in cross-border FX loans to banks by 0.50% – 0.66% of GDP over the next year. 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 tighter FX regulations correspond to a decline in FX cross-border loans by banks of about one-third. Or, to put this in the context of individual countries, consider Brazil and Indonesia—two countries which have been concerned about FX exposure. In both countries, FX loans to banks are a little less than 1% of GDP, suggesting that an increase in macroprudential FX regulations corresponds to a reduction in FX loans to banks by over half.

In contrast, and as also expected, the increase in macroprudential FX regulations does not have a significant effect on non-FX borrowing by banks (columns 3, 6, and 9). Banks do not significantly increase their borrowing in local currency to compensate for their reduced borrowing in FX. Corresponding estimates for the impact of macroprudential FX regulations on total international borrowing by banks (not reported) show that the aggregate effect is weakly negative—as expected—but only significant at the 10% level. This suggests that the reduction in international FX borrowing by banks after tighter regulations is not fully compensated for by increased non-FX borrowing. This supports the findings in Drechsler *et al.* (2018) that banks tend to hedge different risk exposures (for FX risk in our analysis, and interest rate risk in Drechsler *et al.*, 2018).

The other coefficient estimates in Table 2 generally have the expected sign, albeit with mixed significance.<sup>34</sup> The coefficients that are most often significant are those on GDP growth

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<sup>34</sup> An increase in non-FX macroprudential regulations is usually positively associated with cross-border inflows, albeit generally insignificant. This could indicate that increased regulation increases confidence in the financial system and thereby supports greater inflows, as tentatively found in Reinhardt and Sowerbutts (2015) and Forbes *et al.* (2015).

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 lower 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).

The results in Table 2 support the model’s key prediction (i.e., testable implication *i*) that tighter macroprudential FX regulations reduce bank’s cross-border borrowing in FX, with no significant reduction in their non-FX cross-border borrowing. A corresponding part of this prediction, however, is that firm’s will reduce their FX borrowing from banks, with no significant reduction in their non-FX borrowing from banks. Unfortunately, our lending dataset only includes cross-border capital flows and does not have information on domestic lending. Therefore, to test this channel, we use enhanced BIS data that provides information on domestic lending in both local and foreign currencies. This data, however, has several limitations: it only begins in 2012Q3 (thereby truncating our sample in roughly half); it only covers 30% of the countries in our sample; and it is only available for lending to non-banks (which includes non-bank financials) and not just corporates (as in the model). With these important caveats, the results in columns (10) and (11) of Table 2 support the main predictions of the model.<sup>35</sup> An increase in FX regulations corresponds to a significant reduction in FX domestic lending by banks to non-banks (largely corporates) over the next year, with no significant effect on non-FX lending by banks to non-banks.<sup>36</sup>

Next, in addition to FX regulations generating these direct effects on bank borrowing and lending, the model predicts the regulations could have a “shifting” effect. More specifically, some domestic firms would increase their FX debt issuance (model prediction *ii*). A test of this implication is reported in Table 3, following the same format as Table 2, except the dependent variable is now the debt issuance of domestic corporations. The coefficient estimates on macroprudential FX regulations again support the model predictions. Tighter macroprudential regulations are correlated with a significant increase in FX debt issuance by corporates, and a significant increase in the share of corporate FX debt issuance. The

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<sup>35</sup> To conserve space, for these and many subsequent tests, we focus on the central specifications with the full set of control variables and global-time effects. The only change in this set of tests is the use of robust standard errors (instead of clustering by country) due to the much more limited sample.

<sup>36</sup> The coefficient on the share of FX lending is negative (as expected), but insignificant. This reflects the small decline in non-FX domestic lending, mitigating the impact on the ratio of FX lending.

magnitude of this effect continues to be economically meaningful, albeit substantially smaller than that of the regulations on international bank flows. More specifically, international debt issuance by corporates increases by 0.05% to 0.06% of GDP following a tightening in FX regulations. This suggests the effect of macroprudential regulations on cross-border FX corporate debt issuance is moderate, given that net FX debt issuance is around 0.6% of GDP (at the sample median when net FX debt issuance was positive). For some countries, however, the impact is substantially larger. For example, in Brazil and Indonesia, FX debt issuance is 0.26% and 0.36% of GDP, respectively, suggesting that tighter FX regulations correspond to roughly a 15% to 20% increase in this issuance.

In contrast to this significant and meaningful “shifting” effect of corporates increasing FX debt issuance, the model predicts that there would be no corresponding increase in corporate non-FX debt issuance. Columns 3, 6, and 9 of Table 3 show that companies do not respond to reduced FX lending by banks by increasing their non-FX debt issuance—only their FX debt issuance. Moreover, columns (10) and (11) show there is also no significant increase in international debt issuance by banks, in FX or non-FX. Instead, debt issuance is negative for banks, albeit only marginally significant (at the 10% level) for FX issuance. This also agrees with model prediction *i*, that banks would reduce their FX funding from all sources (i.e. from savers independent of the specific instrument or the way savings are intermediated, thus not just cross-border loans as in our baseline results).<sup>37</sup> This series of results—that tighter FX regulations correspond to a significant increase in corporate FX debt issuance, but no increase in corporate non-FX debt issuance, and no increase in debt issuance in FX or non-FX by banks, not only supports the model’s key predictions, but also suggests that any changes in corporate FX debt issuance do not reflect omitted variables or endogeneity that would be expected to affect debt issuance generally.

Combining the results of Tables 2 and 3 allows us to assess the aggregate effects of an increase in macroprudential FX measures on country exposure to FX risk through banks, as well as the degree of “shifting snowbanks” (i.e., the substitution of FX exposure from banks to investors who hold the new FX corporate debt issuance). This shifting of FX risk can be calculated as the ratio of net FX debt issuance by corporates to international FX loans to banks. This ratio indicates that after an increase in FX regulations, about 10% of the decline in FX exposure in banks shifts to corporate debt issuance (and thereby to investors and other

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<sup>37</sup> In practice, interbank loans may be more affected than banks’ debt issuance, given bank loans tend to be shorter-term in maturity than debt securities, and FX regulations primarily target debt/loans at shorter maturities.

non-bank financial institutions).<sup>38</sup> This suggests that even though increased macroprudential FX regulations on banks lead 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 country.

Finally, although not modelled in Section II, in order to fully understand the impact of the FX regulations on cross-border capital flows, it is also worth assessing the effects of FX regulations on cross-border bank loans to non-banks. To the extent that international banks providing these cross-border loans are not subject to the FX regulations (and therefore similar to market investors), tighter FX regulations would not be expected to impact their direct cross-border FX lending to firms in the same way they affect domestic banks.<sup>39</sup> This is supported by empirical tests, which use the same framework as Tables 2 and 3 and find no significant effect of FX regulations on FX cross-border loans to non-banks. These results are only suggestive, however, as the data on cross-border loans to *non-banks* also includes loans to non-bank financial institutions and households (as well as corporates), and is therefore a less precise test for the channels in the model (which focuses on corporates).<sup>40</sup>

This combination of results provides evidence that macroprudential FX regulations have the intended direct effect of decreasing bank borrowing and lending in FX, but also have the unintended consequence of causing corporates to shift a portion of their FX borrowing to international FX debt issuance. The fact that bank borrowing and lending in domestic currency does not simultaneously fall, and that corporate (and bank) international debt issuance in domestic currency does not simultaneously increase, is also informative. It suggests that these results are not capturing some types of omitted variable or endogeneity that would lead to a general decline in bank borrowing and lending, or a general increase in international debt issuance. Nonetheless, these key results merit sensitivity testing to assess their robustness.

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<sup>38</sup> Another way to calculate this ratio would be to adjust for the fact that not all FX lending by banks goes to corporates—with recently enhanced BIS data showing that on, average, 62% of FX loans from banks to non-banks are lent to the corporate sector (with the remainder lent to households, government and non-bank financials). Taking this into account, the “shifting” effect of FX exposure would be about 13% (instead of 10%). This new BIS data, however, is only available for limited countries (Canada, Cyprus, Denmark, United Kingdom, Korea, Sweden and South Africa).

<sup>39</sup> Effects are observationally equivalent if the international banks making cross-border loans cannot screen firms’ quality (as for market investors).

<sup>40</sup> For example, household may have more restricted access to international funding and/or market issuance than the firms which are the focus of the model.



### **C. Sensitivity Tests: Endogeneity, Type of Regulation, and Other Extensions**

This section performs a series of robustness checks on the key results, including specifications that should better identify the exogenous component of macroprudential regulations, that test for any differential effects (including magnitudes) from different types of FX regulations, that control for any overlap between capital controls and FX regulations, and that explore the timing of the effects of FX regulations and several additional sensitivity 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 (Tables 2 and 3, respectively). 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 the tests discussed below.

#### *1. Endogeneity*

Two potential endogeneity concerns with these tests of the impact of FX regulations on capital flows in this cross-country setting are omitted variable bias and reverse causality. Omitted variable bias could occur if factors correlated with FX regulations, but not explicitly included in our empirical specification, affect cross-border capital flows. One example of this type of hard-to-measure variable is the implementation of economic or financial reforms that change a country’s risk-return profile and affect capital inflows. If these types of reforms are adopted around the time that FX regulations are adjusted, but not included in the specification, estimates of the effects of changes in FX regulations could be biased. Our empirical specification, however, compares each set of results for FX relative to non-FX flows, and for bank borrowing relative to corporate debt issuance, thereby implicitly providing a set of control tests for any omitted variables that would affect all types of flows. More specifically, any such omitted variables that affect all flows would not explain the consistently different coefficient estimates on the different types of flows. This identification strategy provides a much stronger test of the effects of FX regulations by implicitly controlling for omitted variables that could bias estimates of FX regulations on capital flows relative to approaches that only consider the effect of FX regulations on one specific type of capital flow.

Another potential concern is that changes in our dependent variables could lead to the implementation of macroprudential policy instead of vice-versa (*i.e.*, reverse causality). For example, the increased use of FX in the economy and the associated increase in the aggregate FX exposure could heighten concerns about risks to domestic financial stability, causing policymakers to tighten regulations on banks' exposure to FX. To address this possibility, we adopt an alternative identification approach that relies on an "exogenous" macroprudential policy shock. This approach builds on previous work in the macroeconomics literature assessing the impact of policy shocks, such as Auerbach and Gorodnichenko (2013), who construct exogenous fiscal policy shocks, and Furceri *et al.* (2016), who compute exogenous monetary policy shocks. In particular, we estimate a first-stage regression of FX regulations on a range of variables that could affect the implementation of FX regulations. Then we use the residuals from this regression, which should be a more exogenous measure of changes in FX regulations, as the explanatory variable in our baseline fixed-effects regressions (instead of using our -1/0/1 measure of changes in macroprudential FX regulations).<sup>41</sup>

To select the set of variables that could cause policymakers to adjust FX regulations, we include variables capturing the risks and vulnerabilities for financial stability in emerging markets, as discussed in the IMF's recent Global Financial Stability Report (Figure 1.1.4 in GFSR, 2018). The IMF highlights five (related) vulnerabilities: (i) high leverage; (ii) flighty investors; (iii) trade exposures; (iv) large external financing needs; and (v) short-term foreign currency debt. We proxy for these vulnerabilities with the following variables: domestic credit growth, real house price growth, non-FX regulation, financial openness, exchange rate appreciation, real GDP growth, GDP growth forecasts, international debt issuance by corporates, and cross-border FX loans to banks. This selection of variables is also consistent with the limited literature on what determines the use of macroprudential and prudential regulations more broadly, including Cerutti *et al.* (2015) and Cerutti *et al.* (2017).

Table 4a presents results from these first-stage regressions estimating a more exogenous measure of changes in macroprudential FX regulations based on a range of models. The results in columns (1) through (4) suggest that stronger GDP growth, domestic credit growth,

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<sup>41</sup> We continue to use fixed effects, as in our baseline regressions, following the suggestion of Gormley and Matsa (2014) to control for unobserved heterogeneity.

house price growth, increased financial openness, greater use of non-FX regulations, and faster expected GDP growth over the next year are all positively associated with increases in FX regulations. Each of these variables usually has the expected sign, but most are not individually significant. This captures the well-known challenge of predicting exactly when macroprudential regulations are adjusted. The one exception is the coefficient on exchange rate appreciation, which suggests that larger appreciations consistently correspond to increases in macroprudential FX regulations. Columns (5) and (6) also add lagged values of the dependent variables from our baseline analysis in order to remove any impact of any trends in these variables that could be driving the variation in FX regulation.

Next, we use the residuals from the six different specifications in Table 4a as more exogenous measures of changes in FX regulations in our baseline model in equation (15). For each specification, we focus on whether macroprudential FX regulations decrease international bank borrowing (or share of borrowing) in FX, and whether they increase corporate debt issuance (or share of debt issuance) in FX (from Tables 2 and 3, respectively). Table 4b reports the subsequent results (with each column of Table 4a corresponding to a row in Table 4b) for the key coefficients on FX regulations as in columns 4 and 5 of Tables 2 and 3. The results support the key conclusions from the main analysis; tighter FX regulations correspond to a significant increase in the level and share of cross-border FX loans to banks and a significant decrease in the level and share of cross-border FX debt issuance by corporates. The results are also usually robust across the six different specifications using different variables to predict changes in FX regulations.<sup>42</sup>

## *2. Different Types and Magnitudes of Macroprudential FX Regulations*

Do different types of macroprudential FX regulations have different effects? This is challenging to answer because more disaggregated measures of FX regulations severely limit the degrees of freedom for analysis. Nonetheless, this section uses several different approaches to better understand differential effects across different types of FX regulations.

To begin, we focus on any differential effects if the FX macroprudential regulations target banks' assets or liabilities, using the definitions in Section III.A.<sup>43</sup> Results are shown in

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<sup>42</sup> The only results which are not significant at the 5% level across all specifications are when house price growth is included in the first stage regressions. The data on house price growth is more limited and restricts the sample size, excluding a number of countries which have changed FX regulations.

<sup>43</sup> We have also examined effects using narrower definitions of FX regulations, but the number of regulatory actions quickly becomes so limited that results become sensitive to minor changes in specification and country inclusion.

Table 5, which repeats the baseline from Tables 2 and 3, with the full set of controls and global-period dummy variables. The results are similar for asset- and liability-based measures when assessing the effect on cross-border loans to banks, but differ when assessing the impact on FX debt issuance 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. For both measures, FX regulations continue to have a positive effect on FX debt issuance by corporates—but this effect is only significant for liability-side regulations, for which the magnitude is estimated to be about three times larger than for 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 FX loans to banks in FX, but only the liability-side measures, may have the unintended side-effect of increasing FX corporate debt issuance. Repeating the calculations to gauge the degree of “shifting,” an increase in liability-side FX measures causes FX debt issuance by corporates to increase by 16% of the reduction in FX loans by banks (instead of 10% when all FX regulations are aggregated).<sup>44</sup> In other words, liability-side regulations appear to cause more “shifting snowbanks” of currency vulnerability from banks to other sectors.

One possible reason for these differential effects 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, and often only certain segments of bank lending (such as through mortgages) — thus affecting a smaller share of bank balance sheets and thus a smaller aggregate effect. Closely related, if asset-side regulations primarily affect bank lending to households, while liability-side regulations affect lending to both corporates and households, it is natural that tighter liability-side FX regulations correspond to a greater response in the corporate sector. Supporting this hypothesis, in some countries most FX regulations target the asset-side, a large share of which are regulations on LTV ratios, DTI ratios, and other aspects of FX lending for mortgages (such as in Hungary and Poland). A final possible explanation is the maturity of the capital flows targeted by these different measures. FX liability-based measures tend to focus on shorter-term inflows, while FX asset-based

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<sup>44</sup> This is calculated as 0.0788 (Table 5, column 4) divided by 0.487 (Table 5, column 1). If one also incorporates that only about 62% of FX loans from banks to non-banks are likely lent to the corporate sector, the degree of shifting increases to 26%.

measures tend to focus on longer-term maturities. As macroprudential measures often involve a greater relative cost for short-term than longer-term capital flows, these shorter-term flows are the ones most affected.

Macroprudential FX regulations could have different effects based not only on whether they target assets or liabilities, but also based on how large the change in the regulation is. Assessing the intensity of changes in macroprudential regulation is even more difficult, however, because most data on macroprudential regulations only records whether the regulation is tightened or loosened using dummy variables (as in our dataset). This is the standard treatment in the literature, because it is impossible to compare discrete changes in different types of regulations (*i.e.*, a 10% increase in FX reserve requirements is unlikely to correspond to a 10% increase in the FX liquidity coverage ratio). It is even difficult to compare changes of the same magnitude in a specific FX regulation across countries, given different definitions and coverage (*i.e.*, a 10% increase in the liquidity coverage ratio can mean very different things based on the country's definition of what qualifies as a liquid asset). A few papers have shown that having more macroprudential measures in place or "major" changes in regulations generate larger effects, results that are intuitive but do not provide concrete information on how a given change would be expected to affect a key outcome variable.<sup>45</sup>

In an effort to move beyond this standard treatment of macroprudential regulations, we extend our analysis to estimate the impact of concrete changes in specific regulatory instruments. More specifically, we focus on two databases which provide information on the intensity of macroprudential FX policies, albeit in a limited sample or for a limited set of measures. First, Cerutti *et al.* (2017) includes data with information on the intensity of FX reserve requirement changes for a sample similar to ours.<sup>46</sup> Second, Vandebussche *et al.* (2015) includes information on the intensity of other types of regulations: foreign currency liquidity requirements, the maximum ratio of foreign currency loans to own funds, risk weights on foreign currency mortgage loans, consumer loans and corporate loans. These more detailed data, however, have two important disadvantages: the data ends in 2010 (thereby missing a period of active use of macroprudential FX regulations) and the data is only

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<sup>45</sup> More specifically, Cerutti *et al.* (2017) create a measure which is the sum of the number of different types of macroprudential measures in use. Forbes *et al.* (2015) classify a subset of their measures of capital controls and macroprudential measures as those which were "major", based on the attention by investors, financial analysts, or international financial institutions (as assessed by coverage in analyst reports, IMF papers, and surveys).

<sup>46</sup> Specifically, the authors state that given the mostly quantitative nature of reserve requirements, values above or below 1 and -1 for their index can capture the intensity in the changes (with the index ranging from -3 to +5).

available for Eastern Europe (thereby severely limiting country coverage).

Keeping these caveats in mind, the resulting estimates give some idea of the magnitude of the effects from these specific FX regulations. First, a large increase in reserve requirements on foreign currency borrowing (proxied by the quantitative index taking a value of 5) leads to a decline in FX loans to banks by 0.46% of GDP and an increase in FX international debt issuance by 0.15% of GDP. Second, an increase in the foreign currency liquidity requirement by 10pp reduces FX loans to banks by 2.9% of GDP and increases international FX debt issuance by corporates by 0.36% of GDP. Third, a tightening in the maximum ratio of FX loans to own funds from 400% to 200% reduces FX loans to banks by around 1% of GDP and increases FX debt issuance by corporates by 0.05% of GDP. Finally, an increase in the risk weight on foreign currency mortgage loans, consumer loans or corporate loans by 50pp above the local currency risk weights reduces FX inflows to banks by 0.26%, 0.46% or 1.83% of GDP, respectively, and corresponds to an increase in FX international debt issuance by corporates by about 0.07% of GDP in each case. All of these estimated effects of specific changes in FX regulations have the expected sign, and several of the estimates (such as for foreign currency liquidity requirements) are consistently significant, despite the limited sample size.<sup>47</sup>

### 3. Capital Controls and FX Regulations

As an additional series of robustness checks, we test how the use of capital controls could interact with the use of FX regulations (as highlighted in Bacchetta *et al.*, 2019), and if different approaches to controlling for capital controls could affect the main results. An insufficient treatment of capital controls could bias our key results in either direction. For example, capital controls which tax or limit bank borrowing from abroad could have a similar effect as FX regulations (reducing cross-border FX bank borrowing), so that omitting to control for any concurrent changes in capital controls could bias our estimates of FX regulations on cross-border FX bank borrowing toward finding a larger effect. In contrast, other types of capital controls, such as taxing or limiting corporate debt sold to foreigners, could have the opposite effect as FX regulations (reducing cross-border debt issuance), so that omitting to control for these concurrent changes could bias our estimates toward finding no effect of FX regulations. Bacchetta *et al.* (2019) also highlight that capital controls on bond inflows significantly decrease the likelihood of companies issuing debt in foreign currency and

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<sup>47</sup> Detailed results are available on request. Each of these estimates are based on regressions using the same format as the baseline regressions in Tables 2 and 3, including all of the control variables and global-time effects.

can reduce the magnitude of the “shifting effect” to corporate FX bond issuance from tighter FX regulations on banks.

To assess if capital controls could be affecting our key results, we begin by examining if capital controls tend to be used concurrently with FX regulations. To measure capital controls, we focus on two data sources which have the broadest country and period coverage: Chinn-Ito (2006)<sup>48</sup> and Fernandez, Klein, Rebucci, Schindler and Uribe (2016)<sup>49</sup>—called FKRSU below.<sup>50</sup> The Chinn-Ito dataset (last updated Sept 2019) measures “Financial Openness”—the inverse of capital account restrictions—so we multiply the measures by -1 to be consistent with our other measures of controls. This measure is constructed based on IMF data on restrictions on cross-border financial flows (i.e., capital controls), which are used to create a principal component that forms their index measure. The FKRSU data (last updated June 2019) uses similar underlying IMF data but uses a different approach for aggregating any changes in capital controls into an index, and then disaggregates capital controls into those on inflows and outflows, as well as those targeting different types of financial flows. The main advantage of the Chinn-Ito data is its broader sample coverage (over 180 countries), as compared to the FKRSU data which only includes about 100 countries and is missing some key countries in our dataset which have actively used FX regulations. The main advantage of the FKRSU data, however, is that it is possible to focus on more disaggregated types of controls that may have more overlap with the FX regulations that are the focus of our paper.

Then, to assess the extent of any overlap between the use of FX regulations and capital controls, we estimate the correlation between changes in FX regulations and four different measures of capital controls that would be most likely to overlap with the focus of our paper: the opposite of the Chinn-Ito measure of financial openness, the FKRSU measure of controls on inflows, the FKRSU measure of controls on inflows for money markets, and the FKRSU measure of controls on inflows for bond sales and financial credits. The correlation between changes in each of these measures of capital controls and changes in FX regulations in our dataset is extremely low—usually close to zero, and never more than 0.04. As another approach, we also examine if capital controls seem to be used as a complement or substitute to FX regulations. To do this, we estimate how many incidents of a tightening of FX regulations in our dataset overlap with either a tightening of capital controls by any of these

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<sup>48</sup> For more information, see [http://web.pdx.edu/~ito/Chinn-Ito\\_website.htm](http://web.pdx.edu/~ito/Chinn-Ito_website.htm).

<sup>49</sup> For more information, see <http://www.columbia.edu/~mu2166/fkrsu/>

<sup>50</sup> Both of these datasets (as with almost all data on capital controls) is annual, so we convert our data on FX regulations from quarterly to annual basis for some of the comparisons below as needed.

measures or a loosening of controls. Once again, the overlap is extremely low. While there are 47-61 country-years which record a tightening of FX regulations (and where data on capital controls are available), the largest overlap with a tightening of capital controls is 8 (for the FKRSU measure of controls on capital inflows) and with a loosening is 10 (for the Chinn-Ito measure of controls). For other measures of capital controls, there is generally much less overlap. Both of these pieces of evidence suggest that FX regulations are generally not used as a complement to capital controls.

Even if capital controls and FX regulations are not often implemented simultaneously, it is still worth more formally testing if our estimated effects of FX regulations could be capturing an omitted variable from changes in capital controls—or if the results change in any way with different measures of capital controls. Our baseline analysis already included changes in capital controls over the last year as measured by the Chinn-Ito index, but it is still useful to explore if other measures can affect the results. To explore this, we repeat our baseline analysis assessing the impact on cross-border bank loans and debt issuance (from Tables 2 and 3), with several variants: (1) add a control for changes in capital controls in the current year (as well as past year) using the Chinn-Ito index measure and report a test of the joint significance of the current and lagged effects (as done for the FX regulation measures);<sup>51</sup> (2) convert the Chinn-Ito index to a -1/0/+1 dummy variable so that it more closely corresponds to changes in our measure of FX regulations; (3) instead use the FKRSU indicator of changes in controls on capital inflows (continuing to use a -1/0/+1 dummy to capture changes);<sup>52</sup> (4) fill in missing observations for the FKRSU dummy indicator using the Chinn-Ito dummy indicator; (5) use the FKRSU measure of money market inflow restrictions (continuing to fill in missing values with the Chinn-Ito data); (6) use the FKRSU measure financial credit inflow restrictions (for bank loans) and bond inflow restrictions (for bond issuance) (continuing to fill in missing values with the Chinn-Ito data); (7) drop controls for changes in FX regulations and control for changes in capital controls based on the Chinn-Ito dummy measure; (8) drop controls for changes in FX regulations and control for changes in capital controls based on the FKRSU measure of controls on inflows (continuing to fill in missing values with the Chinn-Ito data).

Table 6 reports the key results, of the joint tests for the significance of the coefficients on FX regulations and/or capital controls. More specifically, in almost all of the specifications,

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<sup>51</sup> The remaining variants all include both the current and lagged effects to match the specification of the FX regulation measure, but the results are qualitatively similar when only including lagged effects.

<sup>52</sup> Results when the FKRSU index is used instead of the dummy measures are basically unchanged.



tighter FX regulations continue to correspond to: a significant reduction in cross-border bank loans in FX (and the share in FX), a significant increase in cross-border corporate debt issuance in FX (and the share in FX), with no significant effect on non-FX bank loans or non-FX corporate debt issuance. The only exception is when the more limited FKRSU data is used to measure capital controls, which leads to a reduction in the sample size (and several countries which have actively used FX measures are dropped from the sample), causing the coefficient on cross-border FX debt issuance to just become insignificant (now only at the 12% level). This would support the results in Bacchetta *et al.* (2019), which finds that capital controls can reduce the “shifting” effect from FX bank regulations increasing corporate debt issuance. When changes in capital controls based on the Chinn-Ito dummy measure are used to fill in for missing observations with the FKRSU dummy measure so that the sample size remains unchanged, however, this one exception becomes significant again.

Finally, it is worth highlighting the different results throughout this series of sensitivity tests for the effects of capital controls and those for the effects of macroprudential FX regulations on banks. An increase in capital controls often corresponds to a reduction in cross-border bank loans and corporate debt issuance in FX, as well as the share of bank loans and debt issuance in FX, but the coefficients are often insignificant and can switch signs. When the more detailed measures of capital controls from the FKRSU dataset are used, the coefficient on capital controls is negative and significant at the 10% level for the share of bank debt in FX—but not the other measures. Moreover, as shown in the bottom rows, when controls for capital controls are included but not FX regulations, the coefficients on capital controls continue to be generally insignificant. In contrast, the negative effect of FX regulations on cross-border FX bank borrowing, and positive effect on corporate FX debt issuance, are fairly robust. This set of results supports the earlier results that countries do not appear to use these two types of policies as substitutes or complements in a way that could bias the estimated effects of macroprudential FX regulations on banks in our sample.

#### *4. Timing and Additional Sensitivity Tests*

As a final series of robustness checks, we test for how the effects of FX regulations evolve over time, as well as of any impact of sample composition, variable definitions, and including additional explanatory variables. A sample of these results is reported in Appendix Table C1.

To begin, we explore if different timing conventions for the impact of FX regulations can affect the main results. In the base case, we assess if changes in FX regulations affect each variable after four quarters (starting with the quarter when the regulation is changed). We

focus on this four-quarter window in order to be consistent with other work assessing the impact of macroprudential regulations (such as Aiyar *et al.*, 2014 and Forbes *et al.*, 2017), but the effect of the regulations could grow or fade over different windows.<sup>53</sup> To better understand these effects, we allow for the FX regulations to affect each of the dependent variables for an additional year and then test for the joint significance of the FX regulations over the corresponding eight quarters.<sup>54</sup> Tighter FX regulations continue to correspond to a significant reduction in cross-border FX loans, in the FX share of cross-border bank loans, and in the FX share of corporate debt issuance. The “non-results” are also robust—with no significant effect of the FX regulations on non-FX bank loans or non-FX corporate debt issuance over the full 8 quarters. The one change in the key results is the volume of FX corporate debt issuance, which remains positive, but is no longer significant over the longer time period.

To better understand how these timing effects evolve, and not just the aggregate effect over the four- or eight quarters, Figure 4 uses the estimated coefficients from this model allowing for FX regulations to affect each variable over the longer window and graphs the cumulated effect of the regulations by quarter. Each graph also includes the 90% and 95% confidence intervals in different shades of grey. The results confirm the meaningful negative effect of FX regulations on cross-border FX bank flows, and meaningful positive effect on the FX share of corporate debt issuance, with both of these effects gradually building over almost two years. The results also show that the impact of the regulations on the FX share of bank flows and on cross-border FX corporate debt issuance may peak around a year after the change in regulations, with some evidence the effects then fade over time. (Graphs of the “non-effects” show no meaningful impact of the regulations over the full window—as would be expected.) The different patterns in these graphs suggest that it is difficult to make strong claims about the precise timing by which macroprudential FX regulations affect cross-border capital flows, with some evidence that the effects peak after about a year, but other evidence that the effects could continue to cumulate over two years.

Next, we repeat the main analysis allowing for changes in FX regulations to effect each variable over four quarters, but exclude offshore centers (Hong Kong and Singapore), or

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<sup>53</sup> It is also possible that FX regulations have some impact before the enactment date—either because the changes were announced earlier, or because news of the change “leaked” in advance. Our data set does not include announcement dates (and in many cases the announcement date is the same as the enactment date). Evidence in Forbes *et al.* (2016) also finds no significant effect of changes in capital controls in the month before or month of a change in capital controls—a policy change similar to the changes in FX regulations studied in this paper.

<sup>54</sup> To be consistent, we also allow for any changes in non-FX regulations to occur over the same extended period of 8 quarters. Tests of the individual coefficients for any given quarter (for the FX regulations or non-FX regulations) are often insignificant, even if they are jointly significant over the full period.

exclude the quarters around the global financial crisis (from 2008Q3 through 2009Q2). Then, we repeat the analysis when only tightenings or introductions in macroprudential FX measures are included (not loosening or removals), when the variables are not financially weighted (as discussed in Section III), or when five episodes where an FX regulation appears to have been reversed or meaningfully reduced within four quarters are excluded.<sup>55</sup> Next, we drop one country at a time (to exclude any impact from a country with frequent adjustments in regulations). We have also added controls for: the current account balance as a share of GDP (to proxy for net capital inflows), institutional quality, and aggregate financial exposure.<sup>56</sup> 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 is also correlated with firms increasing their FX debt issuance, with no significant effect on firms' and banks' non-FX debt issuance.

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

If the primary motivation for macroprudential FX regulations is to reduce the vulnerability of the economy to currency movements, do the regulations achieve this goal? Does the reduction in FX borrowing by banks significantly reduce bank exposure to currency movements? And if so, through what channels? If bank exposure to currency risk declines, does the portion of this exposure that shifts to other sectors of the economy imply that the aggregate vulnerability of the economy does not meaningfully improve—especially if the sectors where the risk shifts are more sensitive to currency movements?

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

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<sup>55</sup> For this test, we code the initial change in the FX regulation and subsequent reversal (including any meaningful change that reduces the impact of the initial regulation even if it is not completely reversed) as “no change”. These five “reversal” episodes are for the FX regulations for: Serbia in 2004q2, Thailand in 2006q4, Serbia in 2008q2, Romania in 2008q3, and Hungary in 2010q3.

<sup>56</sup> Institutional quality is measured by the rule of law and aggregate financial exposure is measured relative to GDP using the Bénétrix *et al.* (2015) data. Both are described in more detail in Appendix B.

multifaceted risks and challenges created by exposure to currency movements. If macroprudential FX regulations can mitigate these challenges and risks, they could provide substantive benefits to the broader economy. This approach of testing for the potential effects on country resilience builds on the academic literature identifying ways to increase the effectiveness of regulation in order to strengthen its welfare impact (e.g., Nier *et al.*, 2011, Mendicino *et al.*, 2015, Agénor 2016, and IMF-FSB-BIS, 2016).

### A. Empirical Framework and Data

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

In order to test if macroprudential FX regulations on banks have these effects on sensitivity to currency movements, we estimate the following equation:<sup>57</sup>

$$\Delta price_{i,t} = \alpha + \alpha_i + \beta \Delta exrate_{i,t} + \delta fxm_{i,t} + \mu \Delta exrate_{i,t} \times fxm_{i,t} + controls_{i,t} + \varepsilon_{i,t}, \quad (16)$$

where  $\Delta price_{i,t}$  is, in country  $i$  and quarter  $t$ , the return of a stock market index covering financial sector firms or the corporate sector, respectively (depending on the prediction tested).<sup>58</sup> Next,  $\Delta exrate_{i,t}$  is the growth rate of a financially-weighted exchange rate (where an increase is defined as a depreciation of the domestic currency) and  $fxm_{i,t}$  is a measure of FX regulation that captures the cumulated policy stance over the current and the last three quarters.<sup>59</sup> Following Baele *et al.* (2010),  $controls_{i,t}$  contains a set of variables that affect stock

<sup>57</sup> In related work, Bruno and Shin (2016) examine how depreciations affect equity prices.

<sup>58</sup> We do not have precise measures of returns for just banks or just corporates. Therefore, we use financial stock returns (which is largely banks) to proxy for bank returns, and we use the overall stock return index (which includes corporates, banks, and non-bank financial institutions) to proxy for corporate returns. To better isolate corporate returns from this broad index, we also construct a series of corporate stock returns. The key results are unchanged.

<sup>59</sup> In equation (16),  $fxm_{i,t}$  is measured as the sum of the contemporaneous value of the FX measure plus its three lags. We do not include the contemporaneous value and its three lags separately (as in the analysis in Section IV, equation (1)) to make the calculation of the interaction term in equation (16) straightforward. The smaller country sample in equation (16) also limits the number of lagged and interaction terms that can be included relative to in Section IV.

returns through channels other than the exchange rate, such as standard macro factors, liquidity factors and risk premium factors, as well as a global volatility index as a proxy for global influences. Finally,  $\alpha_i$  are country-fixed effects that capture time-invariant differences across countries (e.g., differences in the level of economic or financial development). Details on the sources and construction of the variables are in Appendix B.<sup>60</sup>

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

$$\frac{\Delta price_{i,t}}{\Delta exrate_{i,t}} = \beta + \mu fxm_{i,t}. \quad (17)$$

Our theoretical model shows that a depreciation of the domestic currency (an increase in  $e$ ) leads to a decrease in the ex-post profits of banks and corporates, so that  $\beta$  is expected to be negative. Furthermore, if tighter FX regulations are effective in reducing sensitivity to exchange rate movements, the coefficient  $\mu$  should be positive. Banks respond to FX regulations by reducing their borrowing and lending in FX, which should reduce their sensitivity to currency movements. Some companies will simultaneously reduce their FX borrowing from banks, but a portion could switch from FX borrowing from banks to the markets, while other firms would start issuing FX debt (as more funding is provided by uniformed investors that lack banks' ability to screen). For each of these channels explained in more detail in the model's prediction (*iv*), corporates would not be expected to reduce their FX borrowing and exposure by as much as banks, such that the coefficient  $\mu$  would be larger (more positive) for banks than for corporates.

## B. Main Results

Table 7 presents the results for a sample of up to 24 countries over the period 2000Q1 to 2014Q4.<sup>61</sup> For most results, we report one set of specifications for financial stock returns (representing banks' stock returns) as the dependent variable and another set for broad market stock returns (representing corporates' stock returns). Columns (1) and (2) only

<sup>60</sup> All variables (except global volatility) have been winsorized at the 2.5% level to reduce the impact of outliers.

<sup>61</sup> Standard errors are clustered by country. The country sample is limited by the availability of the financial stock returns variable. The countries for which data is available for this analysis are: Australia, Austria, Brazil, Canada, Czech Republic, Denmark, Hong Kong SAR, Hungary, Indonesia, Korea, Malaysia, Mexico, New Zealand, Norway, Philippines, Poland, Saudi Arabia, Singapore, South Africa, Sweden, Thailand, Turkey, United Kingdom, and Vietnam.

include the three variables central to our exchange rate sensitivity tests, while columns (3) and (4) add standard controls for equity return regressions (the baseline). We will focus on the first three variables in each column: the cumulated FX regulation measure; the financially-weighted exchange rate; 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.<sup>62</sup>

In each of the specifications in columns (1) - (4), the coefficients on FX regulations are insignificant—albeit usually negative and larger for financials—possibly indicating that increased macroprudential FX regulations on banks could reduce bank stock returns. The coefficient on the exchange rate is negative and significant in each case, suggesting that currency depreciations correspond to lower stock returns (as predicted in the model).<sup>63</sup>

Most important for our analysis, the coefficient on the interaction term (the coefficient  $\mu$  in equations (16) and (17)) is positive 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 positive and significant at the 5% level for bank returns (columns (1) and (3)), and the estimated magnitude of the coefficient is over 50% larger for banks than corporates in each case. This suggests that macroprudential FX regulations reduce banks' sensitivity to exchange rate movements more than that for the broader economy—as predicted.

The magnitudes of the coefficients in Table 7 also provide more information on the size of these effects. Focusing on the columns with the full set of controls in columns (3) and (4), when the macroprudential FX regulation is neutral, a 1 percentage point depreciation in the financially-weighted exchange rate leads to a decrease in stock market returns for financials by 1.46 percentage points, and for the broad market by 1.18 percentage points. When FX regulations are tightened, the same depreciation corresponds to a 0.67 percentage point decline in returns for financials and 0.75 percentage point decline for the broader market. Hence, tighter macroprudential FX regulations reduce the sensitivity of stock returns to

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<sup>62</sup> 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.

<sup>63</sup> This is consistent with evidence from Kalemli-Özcan *et al.* (2016), which suggests that in response to a depreciation in crisis times, financial channels dominate real channels.

exchange rate shocks for both banks and the broader economy, but the effect is almost twice as large for banks (and insignificant for corporates).

Next, since the broad market index is only a rough proxy for corporate stock returns (as this includes banks as well as non-bank financial institutions), column (5) shows results when an artificially-constructed measure of corporate stock returns is used instead of the broad market index. This proxy is calculated by regressing the broad market return index on the financial return index and taking the residual. This should better isolate the impact on corporate returns—but should be interpreted cautiously as this regression could also remove the effects of any omitted variables that affect both corporate and financial stock returns. With this caveat, the estimates support the model's predictions that FX macroprudential regulations reduce corporate sensitivity to exchange rate movements by less than that for banks. More specifically, the coefficient on the interaction term between FX regulation and the exchange rate is insignificant and negative—a sharp contrast to the positive and significant coefficient for the financial index, as well as to the positive and sometimes weakly significant coefficient for the broad index. Since the coefficient estimate is insignificant, we are cautious about interpreting the sign of the effect on corporates—but can conclude that this suggests any effect of macroprudential regulations on the sensitivity of corporates to exchange rate movements is small and insignificant.<sup>64</sup>

The final four columns of Table 7 further explore this relationship between macroprudential FX 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 FX exposure) 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; Acharya *et al.*, 2015; Chui *et al.*, 2014 and 2016), so columns (6) and (7) repeat the main results (with the full set of controls) for only the emerging markets in our sample. Other work has suggested that the impact of exchange rate movements on the economy may be non-linear and greater after large movements (e.g., Kappler *et al.* 2013)—so columns (8) and (9) report results only for large exchange rate movements, defined as movements in the exchange rate

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<sup>64</sup> It is also possible, however, that these estimates understate the reduction in FX exposure due to the differential impact on small firms. More specifically, smaller firms are more likely to rely on banks for funding, and if FX regulations cause banks to reduce their FX lending to these smaller firms, these firms may be unable to issue debt on international markets. These smaller firms would therefore be forced to reduce their FX borrowing and exposure—whether by shifting to local currency borrowing or not borrowing at all. These effects would not be captured in the empirical analysis as these smaller firms are also less likely to be included as part as the main equity index.

below the 10th percentile and above the 90th percentile. In both of these scenarios, the key signs and significance from the base case remain unchanged—but the estimated magnitudes of the coefficients are all larger. For example, and most relevant to this paper’s analysis, tighter macroprudential FX 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 C2 reports a final set of robustness checks—all of which agree with the main results in Table 7. Columns (1) and (2) use the first lags of all control variables to mitigate endogeneity concerns. Columns (3) and (4) exclude the variables for the stock market turnover ratio and the rule of law, as both were interpolated from annual to quarterly frequency. Next, columns (5) and (6) exclude 2008Q4, which was a period of very sharp exchange rate movements (corresponding to the collapse of Lehman Brothers). We have also repeated the analysis using dollar exchange rates (instead of financial-exposure weighted exchange rates) to calculate exchange rate movements for each country ( $\Delta exrate_{i,t}$ ).

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

### **C. The Channels Through Which FX Regulations Affect Banks**

The last section has shown that macroprudential FX regulations correspond to a significant reduction in the sensitivity of bank stock returns to exchange rate movements; but how does this occur? This section provides some initial evidence, focusing on the key mechanisms suggested in the theoretical model and for which data for our cross-section of countries (particularly emerging markets) is available. Specifically, Section II.C. highlights three channels through which tighter FX regulations could affect banks’ lending outcomes:

- *The lending rate that banks charge to their customers for FX loans increases, such that borrowing costs increase.*
- *The number of firms that borrow from banks may not change significantly, because the increase in borrowing costs causes productive, non-exporting firms to shift their FX funding from banks to investors, but maintain the same amount of non-FX funding from*



banks, while exporters do not change their source of funding (although they borrow less) and other companies that increase borrowing do so through market issuance.

- *The share of non-performing bank loans falls*, because banks are less exposed to firm bankruptcies following currency depreciations.

Table 8 reports empirical evidence on these three effects using annual data.<sup>65</sup> For each test, we report two results: the coefficient from a regression of the variable of interest on changes in FX regulations (as defined above) with country and time fixed effects, and then the same specification with additional time-varying controls for each country's business and financial cycle (captured by real GDP growth and credit growth, respectively).

Columns (1) and (2) report results for the relationship between FX regulations and net borrowing costs. Both coefficients on the FX measures are positive and significant (at least at the 10% level), as expected; a tightening of FX regulations makes lending more expensive and increases the lending rate that banks charge to their customers. Next, Columns (3) and (4) report results for the relationship between FX regulations and the number of borrowers from banks. Both coefficients are negative, but insignificant, agreeing with the model prediction of no significant change in the number of borrowers.<sup>66</sup> Columns (5) and (6) assess the relationship with the share of banks' non-performing loans. Both coefficients on FX regulations are again negative, as expected, and significant (at least at the 10% level). This supports the prediction that tighter FX regulations reduce the share of non-performing loans.

All in all, these results provide additional support for the key mechanisms highlighted in the theoretical model on how tighter macroprudential FX regulations affect banks. These also provide additional support for how these regulations could reduce bank sensitivity to currency movements—by reducing the share of loans made to firms that are more sensitive to currency movements, and therefore reducing banks' share of non-performing loans. These results are not definitive empirical tests, however, and should be interpreted as conditional correlations which provide support for the key channels highlighted throughout this paper.

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<sup>65</sup> See Appendix B for more information on data definitions and sources.

<sup>66</sup> When the analysis is repeated with only FX measures targeting bank assets, both coefficients remain negative and become significant (at the 5% level).

## **VI. Conclusions**

A growing literature is beginning to document how macroprudential tools can improve financial stability and reduce the amplification of systemic risk. This literature, however, is also beginning to document how these tools often have unintended consequences. One macroprudential tool which is becoming more widely utilized, but has received relatively less attention in academic research, is regulations on FX exposure. This is despite longstanding evidence that foreign currency exposure can generate important economic vulnerabilities.

This paper attempts to address this gap by analyzing the direct and indirect effects of macroprudential FX regulations. 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 model predictions. 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 and lending in local currency); (2) firms shift away from bank FX borrowing and increase their FX borrowing from market investors (with no increase in firm non-FX borrowing from investors); (3) banks are less exposed to exchange rate movements; and (4) firms experience less reduction in their exposure to exchange rate movements than banks. Each of these results supports the main predictions of the model. This combination of results suggests that macroprudential FX regulations on banks accomplish their direct goals and significantly reduce bank vulnerability to currency movements, but can also generate leakages and generate a partial “shifting snowbanks” of FX vulnerability to other sectors of the economy.

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

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

Another important caveat is that the analysis in this paper does not provide a full cost-benefit calculation of the impact of macroprudential regulations—either in the theoretical model or the empirical analysis. For example, the model suggests that macroprudential regulations may reduce investment and the average productivity of investment (as more lending is done by less-informed investors), a pattern documented in Salomao and Varela (2018) and which could have long-term implications for productivity and growth. Similarly, macroprudential regulations can generate additional costs and benefits than those explored in this paper—such as the distortions as firms, banks and individuals find ways to reduce the impact of the regulations (perhaps by shifting business to other countries with a different regulatory framework). A full test of these various effects is beyond the scope of this paper—but would be a promising avenue for future work.

With these caveats, the results in this paper have important implications for the application of macroprudential policy. One key implication is for the debate on capital controls versus macroprudential policy. Countries concerned about excessive borrowing in foreign currency may consider capital controls (especially for bank borrowing in FX, which is particularly volatile and linked to booms and busts<sup>67</sup>). The analysis in this paper suggests that capital controls are generally not used concurrently with FX regulations. Macroprudential regulations on banks appear to be effective in reducing this vulnerability in the financial system without resorting to capital controls—controls which are illegal in some contexts (such as for EU members and in some trade agreements). Although macroprudential bank regulations can also generate unintended consequences, capital controls can do so also.<sup>68</sup>

A final implication for the application of macroprudential policies is the importance of the regulatory perimeter when evaluating the impact on aggregate welfare. Our results suggest that macroprudential FX regulations can reduce risks in a systemically-important sector of the economy (banks). This needs to be balanced, however, against any increase in risks in

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<sup>67</sup> See Hoggarth *et al.* (2016).

<sup>68</sup> For example, Keller (2018) shows that capital controls can cause banks to increase FX lending to domestic firms (in order to better hedge their foreign currency deposits when international hedging becomes more expensive), thereby causing an increase in the foreign currency exposure of domestic companies. For other evidence on the costs and distortions created by capital controls, see Forbes (2007).

other sectors which are in the “shadow” and potentially less well understood than those in the regulated sector.<sup>69</sup> Are these shadow investors less informed and/or less able to manage exchange rate movements than banks? Do the regulations generate other costs, such as shifting more lending to entities that are less able to screen, leading to a reduction in output and less efficient allocation of capital? Even if the overall FX exposure of the economy falls, does this benefit outweigh other costs of the regulation? Just as a fresh snowbank rarely stays white for long, the impact of macroprudential regulation on country resilience can quickly get muddy.

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<sup>69</sup> Bengui and Bianchi (2014) explore this question in a model of the impact of capital controls, a model which finds that the controls reduce risk on regulated agents but increase risk taking in the “shadow” economy.

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Variable	Mean	Median	Std. Dev.	Min	Max	Obs.
<b><u>Dependent variables</u></b>						
Cross-border 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
<b><u>FX regulations</u></b>						
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
<b><u>Control variables</u></b>						
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

**Table 1: Summary Statistics for Baseline Regressions**

Definitions and sources for the data summarized above are in Appendix B. Quarterly capital inflows are scaled by annual GDP, which is calculated as a 4-quarter moving average of annual data to avoid breaks due to annual GDP rising or falling from Q4 to Q1. We scale by annual GDP rather than quarterly GDP because the sum of the contemporaneous coefficient and three lags on  $fxm_{i,t}$  in equation (15) can then be read as the effect on capital flows to annual GDP over one year. FW indicates “financially weighted”.

	IBS: Cross-border loans to banks									IBS: Domestic bank loans to non-banks	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
	FX Inflows	FX Share	Non-FX Inflows	FX Inflows	FX Share	Non-FX Inflows	FX Inflows	FX Share	Non-FX Inflows	FX Inflows	Non-FX Inflows
<b>FX regulation (t to t-3)</b>	<b>-0.496*</b>	<b>-0.926**</b>	<b>0.106</b>	<b>-0.662**</b>	<b>-0.997**</b>	<b>0.0540</b>	<b>-0.628**</b>	<b>-0.963**</b>	<b>0.0450</b>	<b>-0.956**</b>	<b>-0.403</b>
<i>p-value</i>	<i>0.0592</i>	<i>0.0200</i>	<i>0.371</i>	<i>0.0123</i>	<i>0.0104</i>	<i>0.637</i>	<i>0.0151</i>	<i>0.0110</i>	<i>0.647</i>	<i>0.0466</i>	<i>0.358</i>
<b>Global Factors</b>											
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)		
<b>Domestic variables</b>											
Non-FX regulation (t to t-3)				0.222	-0.152	0.150	0.121	0.0288	0.0588	0.140	0.0614
<i>p-value</i>				<i>0.186</i>	<i>0.450</i>	<i>0.135</i>	<i>0.452</i>	<i>0.870</i>	<i>0.423</i>	<i>0.459</i>	<i>0.801</i>
Real GDP Growth (t-1)				0.0624***	0.0181	0.0196**	0.0708***	-0.0056	0.0290***	-0.1758**	-0.1079*
				(0.0165)	(0.0145)	(0.0079)	(0.0145)	(0.0169)	(0.0104)	(0.0716)	(0.0646)
Volatility of exchange rate (FW, t-1)				-0.1925	0.0778	0.0837**	-0.1910	-0.0900	0.1046***	-0.2216	-0.4128
				(0.1168)	(0.1664)	(0.0329)	(0.1145)	(0.1575)	(0.0340)	(0.2082)	(0.2551)
IR differential (Changes, FW, t-1)				0.0043	0.0109	-0.0104	0.0064	0.0154	-0.0146**	0.1614	0.0478
				(0.0164)	(0.0612)	(0.0072)	(0.0138)	(0.0607)	(0.0071)	(0.1229)	(0.1238)
Sovereign Ratings (t-1)				0.0741***	-0.0629*	0.0494***	0.0721***	-0.0515	0.0359**	0.4039***	0.2842***
				(0.0261)	(0.0357)	(0.0173)	(0.0247)	(0.0339)	(0.0160)	(0.1442)	(0.1011)
Financial Openness (Changes, t-4)				0.4452	0.4567	0.0406	0.6345**	0.3088	0.2109	-0.4675	0.2044
				(0.2910)	(0.7909)	(0.1643)	(0.3036)	(0.7551)	(0.1650)	(1.5806)	(1.2114)
Constant				-1.1112***	1.0489	-0.6812**	-0.5386	-0.0101	-0.2423	-5.7676**	-4.1395***
				(0.4062)	(0.7779)	(0.2630)	(0.3683)	(0.5968)	(0.2261)	(2.3006)	(1.5600)
Time Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	No	No	No	Yes	Yes
Observations	3,589	3,531	3,535	3,381	3,348	3,368	3,381	3,348	3,368	138	138
Adj. R-squared	0.069	0.01	0.034	0.09	0.011	0.051	0.065	0.002	0.028	0.267	0.198
Countries	48	48	48	48	47	48	48	47	48	15	15

**Table 2: Hypothesis #1 - FX regulations and cross-border debt flows to banks**

The table shows the estimated parameter values from a panel regression of equation (15). 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 ( $\delta_t$ ) in equation (15). Data are from the BIS International Banking Statistics (IBS) and the split between FX and non-FX components of loans is based on authors' estimates. All data is discussed in Section III, with additional information in Appendix 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									IDS: International debt issuance by banks	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
	FX Inflows	FX Share	Non-FX Inflows	FX Inflows	FX Share	Non-FX Inflows	FX Inflows	FX Share	Non-FX Inflows	FX Inflows	Non-FX Inflows
<b>FX regulation (t to t-3)</b>	<b>0.0588**</b>	<b>0.516**</b>	<b>0.00848</b>	<b>0.0549**</b>	<b>0.513**</b>	<b>0.00941</b>	<b>0.0530**</b>	<b>0.464**</b>	<b>0.0166</b>	<b>-0.110*</b>	<b>-0.00833</b>
<i>p-value</i>	<i>0.0167</i>	<i>0.0280</i>	<i>0.796</i>	<i>0.0370</i>	<i>0.0269</i>	<i>0.779</i>	<i>0.0336</i>	<i>0.0232</i>	<i>0.634</i>	<i>0.0865</i>	<i>0.885</i>
<b>Global Factors</b>											
Global Volatility (t-1)							-0.0033	-0.0079	0.0059		
							(0.0118)	(0.0879)	(0.0042)		
Global Growth (t-1)							-0.0063*	-0.0131	-0.0004		
							(0.0032)	(0.0183)	(0.0011)		
Fed funds rate (Changes, t-1)							0.0213**	0.0892	0.0018		
							(0.0081)	(0.0748)	(0.0031)		
<b>Domestic variables</b>											
Non-FX regulation (t to t-3)				0.000220	0.0707	-0.00265	0.0123	0.0687	0.00503	0.0301	0.0327
<i>p-value</i>				<i>0.991</i>	<i>0.448</i>	<i>0.584</i>	<i>0.538</i>	<i>0.405</i>	<i>0.211</i>	<i>0.317</i>	<i>0.275</i>
Real GDP Growth (t-1)				0.0020	-0.0004	-0.0004	0.0001	-0.0061	-0.0007	0.0011	-0.0015
				(0.0013)	(0.0085)	(0.0005)	(0.0012)	(0.0089)	(0.0005)	(0.0031)	(0.0024)
Volatility of exchange rate (FW, t-1)				0.0134	0.0521	-0.0082**	0.0026	0.0524	-0.0060*	0.0092	0.0505
				(0.0107)	(0.0463)	(0.0039)	(0.0102)	(0.0415)	(0.0031)	(0.0182)	(0.0353)
IR differential (Changes, FW, t-1)				-0.0031*	-0.0171	0.0005	-0.0036*	-0.0178	0.0001	0.0089	-0.0030
				(0.0016)	(0.0170)	(0.0006)	(0.0018)	(0.0211)	(0.0006)	(0.0062)	(0.0034)
Sovereign Ratings (t-1)				0.0107	0.0058	-0.0012	0.0110**	0.0086	0.0012	0.0462*	0.0175***
				(0.0066)	(0.0148)	(0.0015)	(0.0051)	(0.0191)	(0.0007)	(0.0263)	(0.0062)
Financial Openness (Changes, t-4)				0.0215	0.3201	-0.0176	-0.0195	0.3150	-0.0245**	0.0230	0.1969
				(0.0483)	(0.2246)	(0.0112)	(0.0569)	(0.2172)	(0.0112)	(0.0685)	(0.1655)
Constant				-0.1288	0.0261	0.0207	-0.0595	-0.1367	-0.0100	-0.5540	-0.2871**
				(0.0944)	(0.2706)	(0.0181)	(0.0786)	(0.4124)	(0.0165)	(0.3457)	(0.1271)
Time Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	No	No	No	Yes	Yes
Observations	3,344	2,804	2,736	3,147	2,728	2,613	3,147	2,728	2,613	3,321	2,054
Adj. R-squared	0.098	0.04	0.192	0.1	0.039	0.202	0.076	0.034	0.190	0.210	0.109
Countries	44	44	36	44	44	36	44	44	36	47	28

**Table 3: Hypothesis #2: FX regulations and cross-border debt issuance by corporates**

The table shows the estimated parameter values from a panel regression of equation (15). 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 (IDS). All data is discussed in Section III, with additional information in Appendix 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.

**Table 4a: First-stage regressions predicting changes in FX regulations**

	FX Regulations					
	(1)	(2)	(3)	(4)	(5)	(6)
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Real GDP Growth (t-1)	0.0010 (0.0013)	-0.0018 (0.0016)	0.0005 (0.0013)	-0.0006 (0.0014)	0.0004 (0.0014)	0.0009 (0.0014)
Exchange Rate Appreciation (FW, t-1)	0.0015** (0.0006)	0.0012** (0.0006)	0.0016** (0.0006)	0.0013* (0.0007)	0.0014** (0.0006)	0.0014** (0.0006)
Financial Openness (Changes, t-4)	0.0580* (0.0309)	0.0449 (0.0292)	0.0572* (0.0310)	0.0307 (0.0346)	0.0572* (0.0307)	0.0573* (0.0320)
Non-FX regulation (t-1)	0.0068 (0.0126)	-0.0017 (0.0102)	0.0062 (0.0127)	0.0096 (0.0121)	0.0009 (0.0105)	-0.0006 (0.0112)
GDP growth forecast (one year ahead)		0.0127** (0.0062)				
Domestic Credit Growth (t-1, yoy)			0.0005 (0.0006)			
Real Houseprice Growth (t-1, yoy)				0.0008 (0.0007)		
Cross-border FX loans to banks (sum t-1 to t-2)					0.0003 (0.0007)	
International Debt Issuance by Corporates (sum t-1 to t-2)						0.0156* (0.0092)
Constant	0.0041 (0.0057)	-0.0312* (0.0186)	0.0051 (0.0061)	0.0023 (0.0081)	0.0058 (0.0062)	0.0036 (0.0061)
Country Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	3,381	3,372	3,214	2,665	3,366	3,130
R-squared	0.0323	0.0372	0.0328	0.0451	0.0324	0.0337
Adj. R-squared	0.0175	0.0221	0.0168	0.0279	0.0172	0.0186
Countries	48	48	48	43	48	44

**Table 4b: Key coefficients from 2<sup>nd</sup>-stage regressions of baseline model**

	IBS: Cross-border loans to banks		IDS: Int. debt issuance by corporates	
	(1)	(2)	(3)	(4)
	FX Inflows	FX Share	FX Inflows	FX Share
<u>FX regulation (t to t-3)</u>				
Model 1	-0.710**	-0.935**	0.0598**	0.523**
<i>p-value</i>	0.0127	0.0241	0.0295	0.0354
Model 2	-0.630**	-1.008**	0.0598**	0.524**
<i>p-value</i>	0.0161	0.0175	0.0313	0.0358
Model 3	-0.718**	-0.915**	0.0584**	0.547**
<i>p-value</i>	0.0102	0.0205	0.0481	0.0314
Model 4	-0.936***	-0.692	0.0576*	0.592**
<i>p-value</i>	0.00225	0.137	0.0774	0.0150
Model 5	-0.616**	-1.030**	0.0598**	0.523**
<i>p-value</i>	0.0187	0.0152	0.0296	0.0351
Model 6	-0.569**	-0.989**	0.0597**	0.523**
<i>p-value</i>	0.0417	0.0244	0.0296	0.0355

**Table 4: More exogenous measures of macroprudential FX regulations**

Table 4a shows results of first-stage regressions of changes in macroprudential FX regulations on a range of explanatory variables. Table 4b then uses the residuals of these six different first-stage regressions as a more exogenous measure of macroprudential FX regulations in equation (15), replicating column 4 of Tables 2 and 3. The “Model” number listed in each row in Table 4B corresponds to the same numbered column in Table 4a. See notes to Tables 2 and 3 for more details, and Appendix B for variable definitions. Robust standard errors, clustered at the country level, are reported in brackets. \*\*\*/\*\*/\* is significant at the 1%, 5%, and 10% level.

	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
<b>FX regulation (t to t-3)</b>	<b>-0.487**</b>	<b>-1.037**</b>	<b>0.0569</b>	<b>0.0788**</b>	<b>0.688*</b>	<b>-0.0228</b>	<b>-1.105**</b>	<b>-1.075*</b>	<b>0.0168</b>	<b>0.0247</b>	<b>0.224</b>	<b>0.0513</b>
<i>p-value</i>	<b>0.0242</b>	<b>0.0186</b>	<b>0.608</b>	<b>0.0265</b>	<b>0.0853</b>	<b>0.154</b>	<b>0.0300</b>	<b>0.0605</b>	<b>0.933</b>	<b>0.513</b>	<b>0.557</b>	<b>0.496</b>
<b>Domestic variables</b>												
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 5: 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 2 and 3 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.

		IBS: Cross-border loans to banks				IBS: Int. debt issuance by corporates			
Capital Control Measure		FX Inflows	FX Share	Non-FX Inflows	Obs. Countries	FX Inflows	FX Share	Non-FX Inflows	Obs. Countries
		(1)	(2)	(3)		(4)	(5)	(6)	
(1) Chinn-Ito: Capital Account Restrictions	FX Regulation (t to t-3)	-0.677**	-1.016**	0.0567	3381	0.0549**	0.518**	0.00913	3147
	p-value	0.0113	0.0104	0.631	48	0.0395	0.0250	0.786	44
	Capital Controls (Changes, t plus t-4)	0.0635	0.229	-0.145		-0.0193	-0.501	0.0271	
	p-value	0.914	0.863	0.711		0.824	0.143	0.122	
(2) Chinn-Ito: Capital Account Restrictions (dummy)	FX Regulation (t to t-3)	-0.672**	-1.006**	0.0533	3381	0.0546**	0.525**	0.00896	3147
	p-value	0.0112	0.0118	0.655	48	0.0449	0.0244	0.791	44
	Capital Controls (Changes, t plus t-4)	0.00974	0.125	-0.0676		0.0195	-0.0223	0.00570	
	p-value	0.898	0.672	0.494		0.233	0.726	0.133	
(3) FKRSU: inflow restrictions (kai, dummy)	FX Regulation (t to t-3)	-0.758***	-0.847*	0.0636	2922	0.0516	0.473*	0.0115	2684
	p-value	0.00993	0.0863	0.625	42	0.121	0.0983	0.781	38
	Capital Controls (Changes, t plus t-4)	-0.122	-0.103	0.00687		0.0104	0.0830	-0.00397	
	p-value	0.154	0.415	0.792		0.361	0.170	0.175	
(4) FKRSU: inflow restrictions (dummy) with Chinn-Ito where missing	FX Regulation (t to t-3)	-0.658**	-0.962**	0.0579	3393	0.0556**	0.539**	0.00878	3155
	p-value	0.0111	0.0136	0.607	48	0.0354	0.0213	0.789	44
	Capital Controls (Changes, t plus t-4)	-0.112	-0.141	0.0128		0.0113	0.0792	-0.00147	
	p-value	0.148	0.252	0.703		0.265	0.200	0.652	
(5) FKRSU: Money market restrictions (dummy, mm_pbln (purchases locally by non-residents) in 1-3 and mm_siar (sale and issue abroad by residents) in 4-6; Chinn-Ito where missing)	FX Regulation (t to t-3)	-0.658***	-1.096***	0.0799	3389	0.0537**	0.526**	0.00840	3151
	p-value	0.00978	0.00632	0.494	48	0.0406	0.0230	0.804	44
	Capital Controls (Changes, t plus t-4)	-0.0978	-0.560*	0.107		-0.0188	-0.0706	0.0102	
	p-value	0.417	0.0907	0.362		0.209	0.651	0.397	
(6) FKRSU: Financial credits and bond sale restrictions (dummy, fci (financial credit inflow restrictions) in 1-3 and bo_siar (sale and issue abroad by residents) in 4-6; Chinn-Ito where missing)	FX Regulation (t to t-3)	-0.636**	-1.012***	0.0639	3,393	0.0572**	0.502**	0.00993	3147
	p-value	0.0133	0.00782	0.573	48	0.0388	0.0328	0.769	44
	Capital Controls (Changes, t plus t-4)	-0.0277	-0.672*	0.0820		0.00743	-0.140	0.0123	
	p-value	0.834	0.0989	0.521		0.756	0.446	0.231	
(7) Chinn-Ito: Capital Account Restrictions (dummy)	FX Regulation (t to t-3)				3381				3147
	p-value				48				44
	Capital Controls (Changes, t plus t-4)	0.00969	0.127	-0.0684		0.0196	-0.0251	0.00572	
	p-value	0.897	0.669	0.489		0.232	0.693	0.130	
(8) FKRSU: inflow restrictions (dummy) with Chinn-Ito where missing	FX Regulation (t to t-3)				3393				3155
	p-value				48				44
	Capital Controls (Changes, t plus t-4)	-0.101	-0.126	0.0117		0.0105	0.0711	-0.00153	
	p-value	0.186	0.310	0.730		0.298	0.256	0.642	

**Table 6: Macprudential FX regulations and different measures of capital controls**

The table presents the estimated parameter values from panel regressions. See test for description of different specifications in each test. All columns include country and quarter fixed effects. See footnote to Tables 2 and 3 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.

Stock Returns By	Limited Controls		Base			Emerging Markets		Large ER Moves	
	(1) <i>Fin.</i>	(2) <i>Broad</i>	(3) <i>Fin.</i>	(4) <i>Broad</i>	(5) <i>Corp.</i>	(6) <i>Fin.</i>	(7) <i>Broad</i>	(8) <i>Fin.</i>	(9) <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 Depreciation (FW) (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 Depr. (FW) (t)	<b>0.689**</b> (0.310)	0.379 (0.265)	<b>0.781***</b> (0.276)	0.432* (0.240)	-0.023 (0.171)	<b>0.939***</b> (0.275)	0.568** (0.225)	<b>1.093**</b> (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	0.18	0.17	0.34	0.39	0.16	0.38	0.39	0.52	0.56
Number of Countries	24	24	23	23	23	13	13	22	22

**Table 7: Market vulnerability to currency movements**

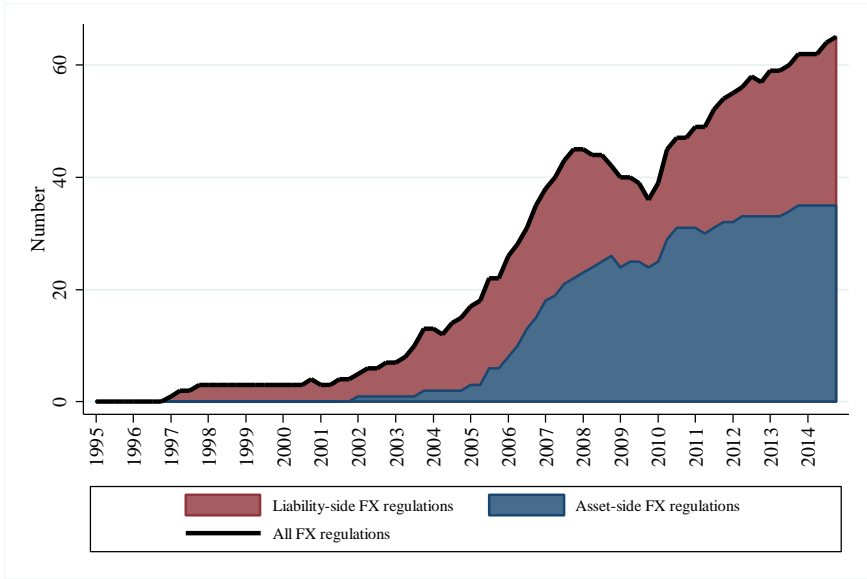
The table shows the estimated parameter values from a panel regression of equation (16). All columns include country fixed effects. The dependent variables are stock returns of financials (“Fin.”; which is primarily banks), the broad market (“Broad”; which includes banks, non-bank financials, and corporates) and corporates (“Corp.”; which is an estimate of corporate returns). All columns control for the cumulated FX regulation measure (summed over the current and the last three quarters), the financially weighted exchange rate (defined as a depreciation of the domestic currency) and their interaction term. Column (5) uses a proxy for corporate stock returns, estimated as the residual of a regression of the broad return index on the financial index. Columns (6) and (7) restrict the sample to emerging markets. Columns (8) and (9) are based on the full sample, but include only large exchange rate movements (*i.e.*, values below the 10<sup>th</sup> and above the 90<sup>th</sup> percentile in the distribution of exchange rate movements). The specifications and data are discussed in Sections III and VI. Additional information is provided in Appendix B. The sample period is 2000 Q1 – 2014 Q4. Robust standard errors are clustered at the country level and reported in brackets. \*\*\*/\*\*/\* is significant at the 1%, 5%, and 10% levels, respectively. The larger value of each coefficient pair in absolute terms is marked in bold.



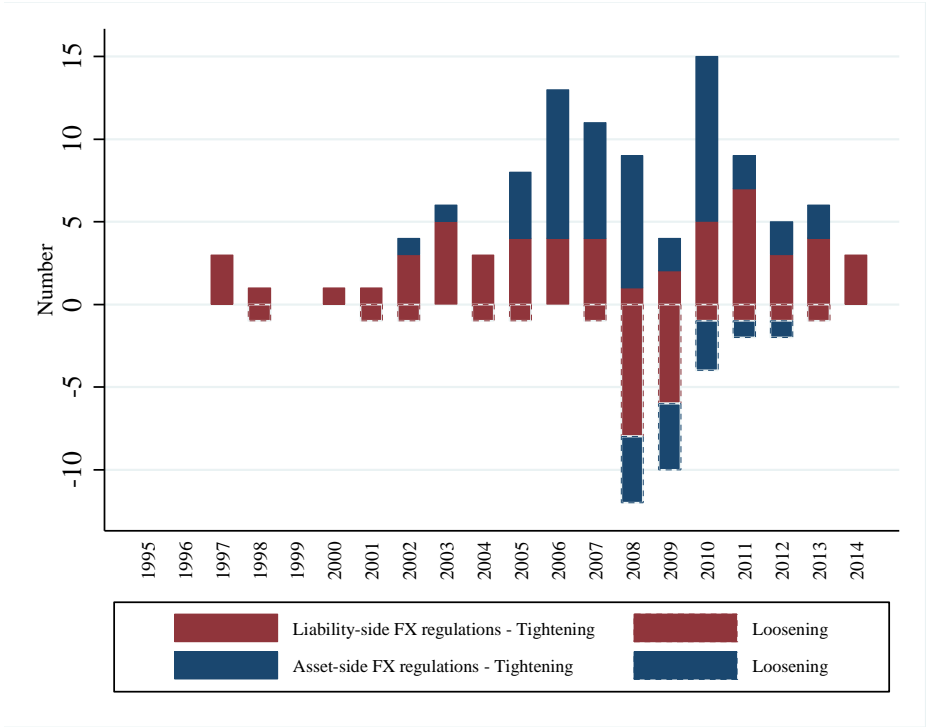
Dependent Variable	(1) Net Borrowing Costs	(2)	(3) # of Bank Borrowers	(4)	(5) Share of NP Loans	(6)
Cum. FX Regulation (t to t-3)	1.943* (1.128)	2.302** (1.095)	-23.949 (18.741)	-22.454 (18.710)	-1.078** (0.401)	-0.583* (0.339)
Real GDP Growth (t-1)		-0.118 (0.169)		-0.313 (2.321)		-0.419*** (0.120)
Credit Growth (t-1)		0.034 (0.036)		0.685 (0.948)		-0.088** (0.037)
Country Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Time Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	344	304	217	215	333	324
R-squared	0.79	0.85	0.96	0.97	0.77	0.81
Countries	26	25	25	25	43	43

**Table 8: Additional effects of FX regulations on banks**

The table shows the estimated parameter values from panel regressions of three banking sector variables on changes in FX regulations with country and time fixed effects, and then the same specification with additional time-varying controls for each country's business and financial cycle (captured by real GDP growth and credit growth, respectively). The data frequency is annual. The three banking sector variables are "Net Borrowing Costs" = Lending rate minus risk free Treasury bill rate, %; "# of Bank Borrowers" = Number of borrowers from commercial banks (per 1,000 adults); "Share of NP Loans" = Bank non-performing loans to total gross loans (%). All dependent variables are obtained from the World Bank's World Development Indicators Database and winsorized at the 2.5 percent level. Cum. FX Regulation corresponds to the cumulated FX regulation measure (summed over the current and the last three quarters) used in the previous table. Robust standard errors are clustered at the country level and reported in brackets. \*\*\*/\*\*/\* is significant at the 1%, 5%, and 10% levels, respectively.

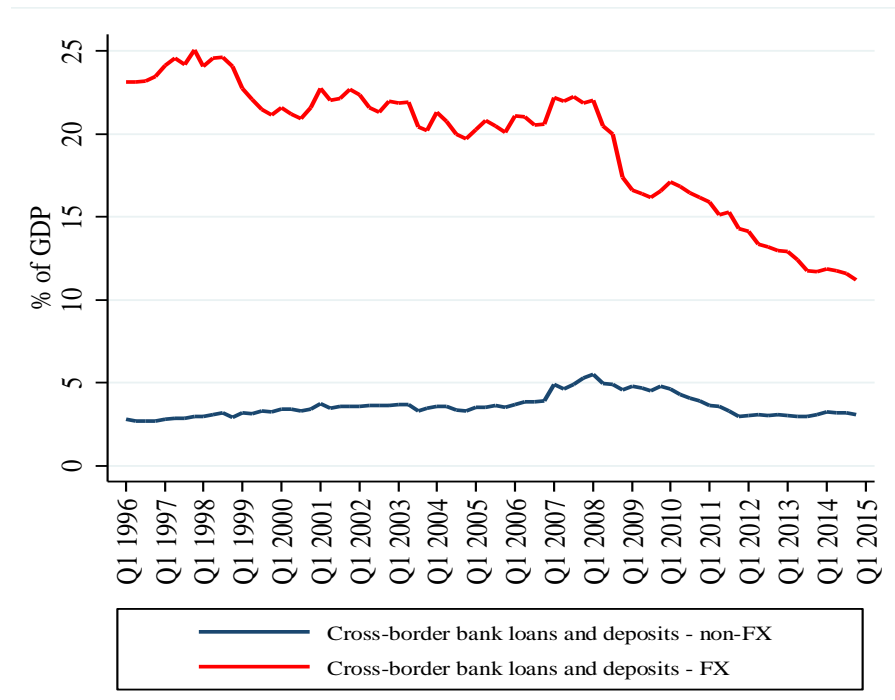


**Figure 1: Cumulated changes in macroprudential FX regulations.** This figure shows the aggregate number of changes in macroprudential FX regulations in the sample (described in Section III), where changes include both loosening and tightening. The shading divides these actions into those affecting bank assets (in blue) versus those on bank liabilities (in red).

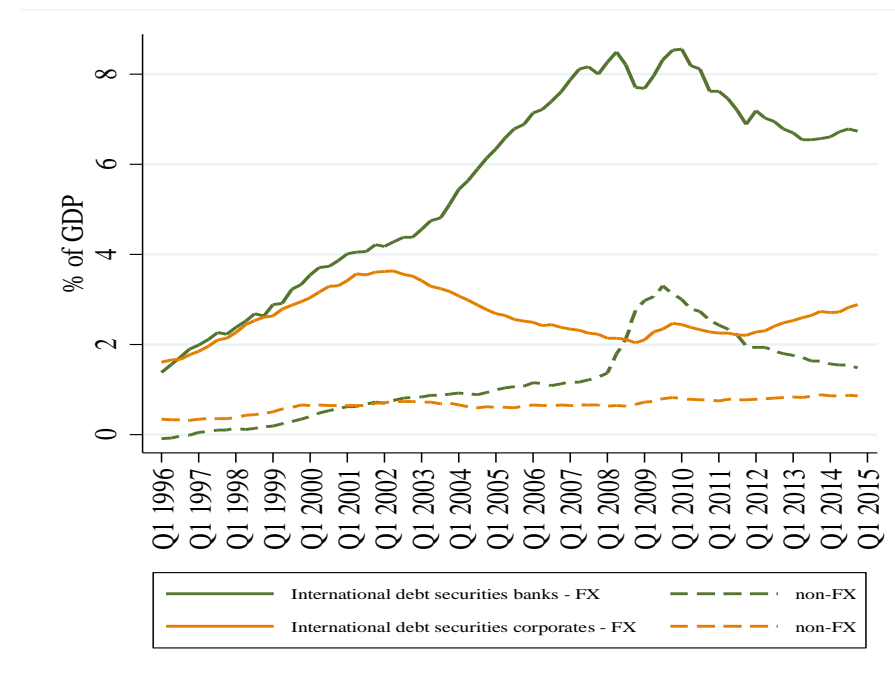


**Figure 2: Tightening and loosening of macroprudential FX regulations by category over time.** This figure shows the tightening (positive) and loosening (negative) of macroprudential FX measures from our dataset. The shading divides the actions into those affecting bank assets (in blue) and those on bank liabilities (in red).

**Figure 3a**



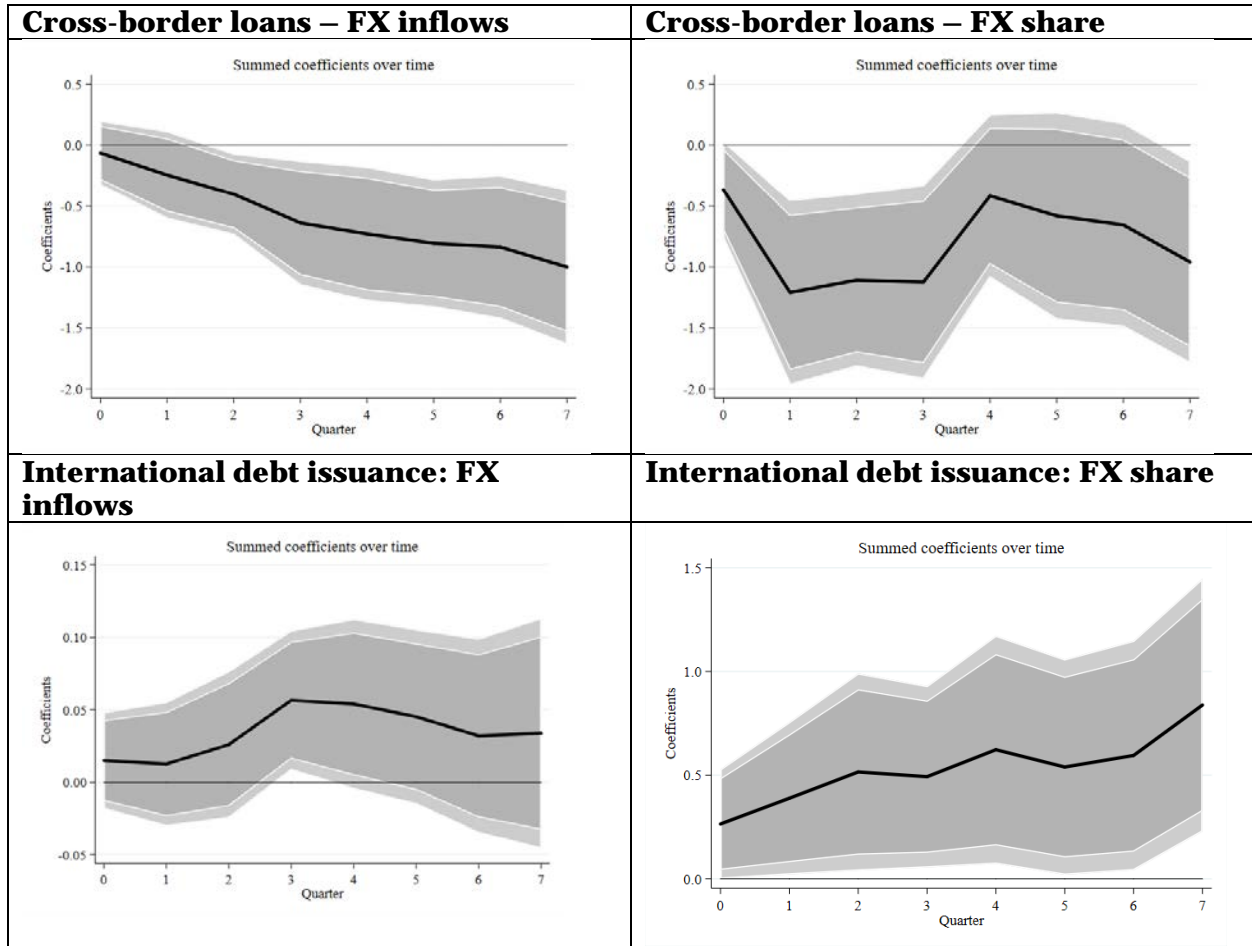
**Figure 3b**



**Figures 3a and 3b: Cross-border bank borrowing and international debt issuance over time.** Figure 3a shows the evolution of cross-border loans to banks, broken into loans in FX and non-FX. Figure 3b 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. Each series in these two figures is based on the same sample of countries, except Bolivia, Latvia, Serbia and Slovenia do not report data on cross-border corporate debt issuance (in FX or non-FX).

**Figure 4**

**Dynamic Effects of FX Regulations**



**Figure 4: Cumulated Impact of Macroprudential FX Regulations over time.** Figure 4 shows the cumulated effect of macroprudential FX regulations on cross-border FX bank flows, cross-border FX corporate debt issuance and the FX share of each type of flow by quarter, based on regressions which control for changes in FX regulations and non-FX regulations over eight quarters (starting with the quarter that the change in policy is enacted). The dark and light grey show the 90% and 95% confidence intervals, respectively.

## **Appendix A: Derivations of Equilibrium and Proofs**

This appendix characterizes the equilibrium of the model in Section II of the impact of macroprudential FX regulations on different forms of lending in domestic or foreign currency. It describes demand for funding by different types of firms, solves for the equilibrium lending rates and threshold exchange rate above which firms default, and describes the lending patterns from banks and market investors in the unregulated equilibrium and after macroprudential FX regulations.

### **A. Funding choice of productive, non-exporting firms**

Given the lending rates  $(R_D, R_F)$ , consider the funding and investment decisions for the productive, non-exporting firms. Firm profits expressed in the domestic good for a given funding profile  $(d, f)$  and realized exchange rate  $e$  at  $t = 1$  are:  $\pi(d, f; e) \equiv (d + f)^\alpha - d R_D - e f R_F$ . Thus, the firm defaults whenever the exchange rate depreciates such that it exceeds a threshold,  $e > e^*$ :

$$e^*(d, f) \equiv \frac{(d+f)^\alpha - d R_D}{f R_F}. \quad (3)$$

We use  $g(e)$  and  $G(e)$  to denote the probability density and cumulative distribution functions of the exchange rate. The firm chooses its funding mix to maximize expected profits, taking the exchange rate threshold  $e^*$  into account and lending rates as given:

$$\max_{d, f} \Pi \equiv \int_0^{e^*} \pi(d, f; e) dG(e) \quad s. t. \quad e^* = e^*(d, f). \quad (4)$$

The solution to this problem provides the amount of foreign funding, domestic funding, and investment for non-exporting firms:

$$f^* = (1 - \alpha) \left( \frac{\alpha^\alpha}{R_D} \right)^{\frac{1}{1-\alpha}}, \quad d^* = (2\alpha - 1) \left( \frac{\alpha^\alpha}{R_D} \right)^{\frac{1}{1-\alpha}}, \quad I^* = \left( \frac{\alpha}{R_D} \right)^{\frac{1}{1-\alpha}}. \quad (5)$$

The threshold exchange rate for firm default is  $e^* = 2 \frac{R_D}{R_F}$ . We henceforth impose the bound  $\alpha \geq \frac{1}{2}$  to ensure that all non-zero constraints are satisfied.

**PROOF.** The first-order conditions for this problem are  $\frac{d\Pi}{d\alpha} = G(e^*) \left( \frac{\alpha}{I^{1-\alpha}} - R_D \right) = 0$ , which yields the stated expression for  $I^*$ , and  $\frac{d\Pi}{df} = \int_0^{e^*} \left( \frac{\alpha}{I^{1-\alpha}} - e R_F \right) dG(e) = 0$ . Using the distribution,  $g(e) = \frac{1}{b}$

and  $G(e) = \frac{e}{b}$ , we obtain  $\int_0^{e^*} e dG(e) = \frac{(e^*)^2}{2b}$  and the stated default threshold of the exchange rate  $e^*$ . Using the balance-sheet identity,  $I = d + f$ , the definition of the threshold  $e^*$ , and combining it with the first-order condition yields the stated expressions for  $d^*$  and  $f^*$ . ■

## B. Funding choice of exporters

The funding and investment choice for exporters is simpler. Since funding in  $F$  is cheaper than funding in  $D$ ,  $R_D > R_F$  (as verified below). The natural hedge of exporters implies that they are not exposed to any FX risk when they fund themselves exclusively in  $F$ ,  $d_E^* = 0$ . Taking  $R_F$  as given, exporters maximize their expected profits, which simplifies to:

$$\max_{f_E} \Pi_E = \int_0^{e^*} e (f_E^\alpha - f_E R_F) dG(e). \quad (6)$$

The solution to this problem implies that exporters raise only foreign funding to invest:

$$f_E^* = \left( \frac{\alpha}{R_F} \right)^{\frac{1}{1-\alpha}} = I_E^*. \quad (7)$$

This solution agrees with the analysis in Salomao and Varela (2018), which uses Hungarian data to show that exporters are more likely to raise funding in FX because it is cheaper than local currency funding and exporters are hedged against currency risks.

**PROOF of Exporter problem.** The first-order condition of the problem is:  $\frac{b}{2}(\alpha f^{\alpha-1} - R_F) = 0$  and yields the stated solution for  $f_E^*$ . ■

## C. General equilibrium

Next, we turn to the equilibrium lending rates and lending patterns for banks and market investors, as well as the impact of macroprudential FX regulations (set at the level  $t$ ).

Observed exporters (of fraction  $O$ ) receive cheaper funding from market investors than from banks,  $r_F \leq r_F + t$ , so they borrow from the market in  $F$ .

If banks (labelled as  $B$ ) lend in foreign currency to unobserved exporters (of fraction  $1 - O$ ), the competitive lending rate covers the costs of funding and screening and the macroprudential FX tax (with no default risk because exporters do not default):

$$R_E^B = r_F + c + t. \quad (8)$$

If banks lend to productive firms (in either currency), they require a premium for firm default that occurs for  $e > e^*$ . The competitive lending rates of banks therefore jointly solve  $R_D^B G(e^*) = r_D + c$  and  $R_F^B G(e^*) = r_F + c + t$ , which results in the following rates:

$$R_D^B = \frac{b(r_F + c + t)}{2}, \quad R_F^B = \frac{b(r_F + c + t)^2}{2(r_D + c)} > R_E^B, \quad (9)$$

which verifies the previously supposed ranking  $R_D > R_F$ .<sup>70</sup>

Next, consider the competitive lending rates offered by market investors (labelled  $M$ ). When lending in  $D$ , investors lend to unproductive firms and receive 0 with probability  $1 - p$  and to productive non-exporters and receive  $R_D^M$  with probability  $p(1 - q)G(e^*)$ , which incorporates default risk after depreciation. Thus, the lending rate is

$$R_D^M = \frac{1 - pq}{p(1 - q)G(e^*)} r_D. \quad (10)$$

The lending rate of investors is above that of banks,  $R_D^M > R_D^B$ , whenever the consequences of adverse selection are more severe than the cost of screening, which we assume henceforth:

$$c < \bar{c} \equiv \frac{1 - p}{p(1 - q)} r_D. \quad (11)$$

Turning to the competitive lending rates offered by investors in foreign currency, suppose that market investors attract non-exporters but not exporters,  $R_E^B < R_F^M \leq R_F^B$ . Our objective is to establish when this ranking holds in equilibrium. Investors lend to unproductive firms and receive 0 with probability  $1 - p$ , and to productive non-exporters and receive  $R_F^M$  with probability  $p(1 - q)G(e^*)$  because of default risk. The firm obtains funding in  $D$  from the bank,  $R_D^B G(e^*) = r_D + c$ , and funding in  $F$  from the market,  $R_F^M = \frac{1 - pq}{p(1 - q)G(e^*)} r_F$ . Solving this system of equations – where the exchange rate threshold also depends on the lending rates – yields:

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<sup>70</sup> This captures the key trade-off in Salomao and Varela (2018), that firms chose their level of foreign-currency borrowing to balance the trade-off between the lower cost of FX borrowing with higher default risk from FX exposure.

$$R_F^M = \frac{b r_F^2}{2(r_D+c)} \left( \frac{1-pq}{p(1-q)} \right)^2. \quad (12)$$

The lending rate of investors is above that of banks,  $R_F^M > R_F^B$ , whenever the consequences of adverse selection are more severe than the cost of screening and the macroprudential tax,  $c < \frac{1-p}{p(1-q)} r_F - t$ . This bound holds in the unregulated economy,  $t = 0$ , whenever

$$c < \underline{c} \equiv \frac{1-p}{p(1-q)} r_F < \bar{c}. \quad (13)$$

This series of results immediately yields the Unregulated Equilibrium stated in the main text.

The lending pattern described above, however, shows that banks are exposed to default after a depreciation of the local currency D, which is socially costly.

The expected exposure of banks can be measured as:

$$EE \equiv (1 - G(e^*))f^*. \quad (14)$$

This expected social cost of bank default due to FX exposure could provide the incentive to adopt macroprudential FX regulations. Implementing macroprudential FX regulations, however, generates a number of changes from the Unregulated Equilibrium, which are shown in the main text. Its proof is given below.

**PROOF.** First, using the equilibrium allocation, we can express the expected exposure as  $EE = (1 - \alpha) \left( \frac{2\alpha^\alpha}{b} \right)^{\frac{1}{1-\alpha}} \left( 1 - \frac{2(r_D+c)}{b(r_F+c+t)} \right) \left( \frac{1}{r_F+c+t} \right)^{\frac{1}{1-\alpha}}$ . Thus, the derivative,  $\frac{dEE}{dt}$ , is proportional to  $\frac{2}{b} (2 - \alpha) \frac{r_D+c}{r_F+c+t} - 1$ , which is negative if and only if the stated condition holds. Second, firms borrow from banks if  $t < t^*$ . Marginal increases in the tax rate affect the allocations via changes in the equilibrium interest rates,  $R_D(t)$  and  $R_F(t)$ . According, a marginally higher tax,  $dt > 0$ , depresses funding in  $F$  and total investment for both productive non-exporters and exporters. Third, higher macroprudential taxes make market funding more attractive relative to bank funding. At  $t = t^*$ , we have  $R_F^B = R_F^M$  and firms switch from banks to investors. At this point, the remaining FX lending of banks is to exporters. Since these are riskless because of their hedge, there is no point for the regulator to increase the tax above  $t^*$ . ■



## **Appendix B: Data Sources, Definitions, and Summary Statistics**

We use two databases on international capital flows in order to measure debt and bank capital flows into FX and non-FX denominated flows: the BIS International Banking Statistics (IBS) data for cross-border bank loans provided by international banks<sup>71</sup> 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 include 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.

We combine this data with our dataset on macroprudential FX regulations (discussed in Section III.A). Then we exclude the countries that issue the main safe-haven currencies (the United States, Japan, Switzerland and long-standing members of the Euro Area) and exclude small off-shore financial centers (according to BIS definitions), but include Hong Kong and Singapore.<sup>72</sup> These safe-haven issuing countries do not have any changes in macroprudential FX regulations in our underlying dataset, except for Austria, which we therefore include in our sample for the main analysis.<sup>73</sup>

Our final dataset has information on 48 countries: Argentina, Australia, Austria, Bolivia, Brazil, Bulgaria, Canada, Chile, China, Colombia, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Hong Kong, Hungary, Iceland, India, Indonesia, Israel, Korea, Kuwait, Latvia, Lithuania, Malaysia, Mexico, Mongolia, New Zealand, Norway, Peru, Philippines, Poland, Romania, Russia, Saudi Arabia, Serbia, Singapore, Slovak Republic, Slovenia, South Africa, Sweden, Thailand, Turkey, Ukraine, United Kingdom, Uruguay, and Vietnam. Detailed information on the sample and changes in FX regulation by country are available in Appendix Table A1 at: [https://papers.ssrn.com/sol3/papers.cfm?abstract\\_id=3139618##](https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3139618##)

Additional information on control variables is below in Appendix Table B1 and summary statistics are in Table 1.

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<sup>71</sup> 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). For information on the BIS adjustments to the stock data to remove exchange rate valuation effects, see: [https://www.bis.org/publ/qtrpdf/r\\_qt1509e.htm](https://www.bis.org/publ/qtrpdf/r_qt1509e.htm).

<sup>72</sup> The countries excluded as safe-haven issuing countries are: Belgium, Finland, France, Germany, Greece, Ireland, Italy, Japan, Luxembourg, Malta, Netherlands, Portugal, Spain, Switzerland, and US. The countries that are excluded as small off-shore financial centers are: Aruba, Bahamas, Bahrain, Barbados, Bermuda, Cayman Islands, Curacao, Gibraltar, Guernsey, Isle of Man, Jersey, Lebanon, Macao, Mauritius, Netherlands Antilles, Panama, Samoa, St. Maarten, Vanuatu.

<sup>73</sup> Sensitivity tests which exclude Austria, or exclude Hong Kong and Singapore, have no meaningful impact on the key results.

**Appendix Table B: Data Sources for the Empirical Analysis**

Variable	Description	Source
Domestic Credit Growth	Quarterly growth in credit by domestic banks to private non-financial sector to GDP (PBM770A, %) taken from the BIS or if not available quarterly growth in claims by other depository corporations on private sector (scaled by GDP, %) from IMF IFS.	BIS and International Financial Statistics (IFS), IMF
Exchange rate depreciation (FW)	Financially-weighted exchange rate depreciation, defined as $= \text{mean}(\sum w_{n,t}^F \cdot \Delta er_{n,t})$ , where $\Delta er_{n,t}$ is the log change in the spot exchange rate in quarter $t$ vis-à-vis country $n$ based on weekly data; $w_{n,t}^F$ is the (annual) financial weight of foreign ( $F$ ) country $n$ in quarter $t$ . $n$ captures the major currencies/currency areas: USD, GBP, EUR, YEN, CHF. Financial weights are based on all foreign assets and liabilities (to capture the financial links for the entire economy), taken from Bénétrix <i>et al.</i> (2015), and are extrapolated for 2013/2014 based on 2012 values. An increase is a depreciation.	Data Stream; Bénétrix <i>et al.</i> (2015)
Exchange rate volatility (FW)	Financially-weighted exchange rate volatility, defined as $= \text{std.dev}(\sum w_{n,t}^F \cdot \Delta er_{n,t})$ , where $\Delta er_{n,t}$ is the log change in the spot exchange rate in quarter $t$ vis-à-vis country $n$ based on weekly data; $w_{n,t}^F$ is the (annual) financial weight of foreign ( $F$ ) country $n$ in quarter $t$ . The standard deviation of the measure is calculated on a quarterly level. $n$ captures the major currencies/currency areas: USD, GBP, EUR, YEN, CHF. Financial weights are based on foreign 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)
Fed funds rate/Shadow rate (Changes)	Quarterly change in the effective federal funds rate prior to Q4 2008 and Wu-Xia estimates of the shadow rate from Q1 2009.	Wu and Xia (2016)
Financial Openness (Changes)	The annual index of capital account openness (KAOPEN) from Chinn and Ito (2008). The index runs from 0 to 1, where higher values imply fewer restrictions on the capital account or fewer financial restrictions on the current account.	Chinn and Ito (2006, extended to 2013)
FX Regulation ( $fxm$ )	Equal to +1 for any new or tightening of macroprudential FX regulations, and -1 for any removal or reduction in these measures. See the online appendix corresponding to this article or Appendix A of Ahnert <i>et al.</i> (2018) for details. Calculated on a quarterly basis for the analysis in Section IV, with the contemporaneous value and three lags included separately in estimates of equation (15). In Section V, the FX measure is calculated as the cumulated value over the current and previous three quarters (still only allowed to equal -1, 0, or +1) in order to estimate the interaction term in equation (16).	Calculated. See Appendix A of Ahnert <i>et al.</i> (2018) for more information
Global Growth	Real Quarterly GDP Growth (%)	IFS, IMF
Global Volatility	Volatility of MSCI World Index. Realized volatility calculated as square root of the average of the sum of squared log daily returns. To convert to an annualized value, this is multiplied by the square root of 252 divided by the number of trading days in a given month.	Data Stream

GDP growth forecast (one year ahead)	The one-year ahead forecast of real GDP growth.	World Economic Outlook, IMF
Industry Production Growth	Quarter-on-quarter growth rates of an index of industry production in each country. Growth rates have been computed based on changes in the natural logarithm.	Haver Analytics
Inflation	Quarter-on-quarter growth rates of the consumer price index. Growth rates computed based on changes in the natural logarithm.	Haver Analytics.
IR differential (Changes, FW)	Financially-weighted interest differential, defined as $= \Delta i_t^D - \sum w_{n,t}^F \cdot \Delta i_{n,t}^F$ , where $\Delta i_t^D$ 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 $t$ . $n$ is the major currencies/currency areas: USD, GBP, EUR, YEN, CHF. Financial weights based on foreign debt liabilities, from Bénétrix <i>et al.</i> (2015), and extrapolated for 2013/2014 based on 2012 values. We use discount rates or policy rates when available for longer than money market rates.	IFS; Bénétrix <i>et al.</i> (2015)
Number (#) of Bank Borrowers	Borrowers from commercial banks (per 1,000 adults) is the reported number of resident customers that are nonfinancial corporations (public and private) and households who obtained loans from commercial banks and other banks functioning as commercial banks. For many countries data cover the total number of loan accounts due to lack of information on loan account holders.	World Development Indicators Database, The World Bank
Real GDP Growth (Domestic)	Quarterly GDP growth (yoy, %). We use annual GDP growth (%) and lagged by 1 year in the analysis rather than 1 quarter) where quarterly GDP growth was not available for the full time series.	WEO, IMF
Real Growth in House Prices	Quarterly growth (%) in real house prices based on the selected property price series from the BIS. If these data are not available we rely on data from Cesa-Bianchi <i>et al.</i> (2015).	BIS and Cesa-Bianchi <i>et al.</i> (2015).
Net Borrowing Costs	Net borrowing costs (i.e., the risk premium on lending) are defined as the interest rate charged by banks on loans to private sector customers minus the "risk free" treasury bill interest rate at which short-term government securities are issued or traded.	World Development Indicators 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: " <i>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.</i> " The original variable is of annual frequency and has been interpolated to quarterly frequency.	Worldwide Governance Indicators Database, The World Bank
Share of NP Loans (%)	The value of nonperforming bank loans divided by the total value of the loan portfolio (including nonperforming loans before the deduction of specific loan-loss provisions). The loan amount recorded as nonperforming should be the gross value of the loan as recorded on the balance sheet, not just the amount that is overdue.	World Development Indicators Database, The World Bank

Short-term interest rate	Quarterly change in the nominal money market rate. We use discount rates or policy rates when those are available for a longer time series than money market rates.	IFS
Sovereign Ratings	Quarterly sovereign foreign currency ratings from Fitch, S&P and Moody's are converted into a numerical scale ranging from 0 to 20 before averaging across the three ratings.	tradingeconomics.com
Stock Market Turnover Ratio (%)	This variable is a proxy for domestic liquidity factors that affect stock market returns and is defined as: " <i>Total value of shares traded during the period divided by the average market capitalization for the period.</i> " The original variable is of annual frequency and has been interpolated to quarterly frequency.	Global Financial Development Database, The World Bank
Stock Returns - Broad	Quarter-on-quarter growth rates of the most commonly used stock market index in each country. Growth rates computed as changes in the natural logarithm. Index values are quarterly averages.	Haver Analytics
Stock Returns - Financial	Quarter-on-quarter growth rates of stock market indices that comprise each country's major companies in the financial sector, largely banks. Growth rates computed as changes in the natural logarithm. Index values represent quarterly averages.	Bloomberg

## Appendix C: Sensitivity Tests and Extensions

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

	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
<b>FX regulation (t to t-3)</b>	<b>-0.524**</b>	<b>-0.997**</b>	<b>0.0744</b>	<b>0.0531**</b>	<b>0.506**</b>	<b>0.00922</b>	<b>-0.548**</b>	<b>-1.030***</b>	<b>0.111</b>	<b>0.0526**</b>	<b>0.537**</b>	<b>0.00229</b>
<i>p-value</i>	<i>0.0361</i>	<i>0.0114</i>	<i>0.522</i>	<i>0.0432</i>	<i>0.0271</i>	<i>0.785</i>	<i>0.0343</i>	<i>0.00656</i>	<i>0.381</i>	<i>0.0420</i>	<i>0.0315</i>	<i>0.943</i>
<b>Domestic variables</b>												
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>	<i>0.477</i>	<i>0.554</i>	<i>0.224</i>	<i>0.986</i>	<i>0.446</i>	<i>0.409</i>	<i>0.173</i>	<i>0.471</i>	<i>0.116</i>	<i>0.938</i>	<i>0.466</i>	<i>0.606</i>
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 C1: Sensitivity analysis of the impact of macroprudential FX regulations

All variable definitions and notes are the same as for Table 2. 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.

Stock Returns By	Lagged Controls		Exclude Annual Vars		Exclude 2008Q4	
	(1) <i>Fin.</i>	(2) <i>Broad</i>	(3) <i>Fin.</i>	(4) <i>Broad</i>	(5) <i>Fin.</i>	(6) <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 Depreciation (FW) (t)	<b>-1.880***</b> (0.217)	<b>-1.605***</b> (0.156)	<b>-1.472***</b> (0.214)	<b>-1.221***</b> (0.156)	<b>-1.415***</b> (0.231)	<b>-1.117***</b> (0.169)
FX Regulation X Ex. Rate Depr. (FW) (t)	<b>0.700**</b> (0.334)	0.402 (0.250)	<b>0.741**</b> (0.269)	0.445* (0.221)	<b>0.894***</b> (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)	<b>-1.825***</b> (0.342)	<b>-2.115***</b> (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)	<b>-0.223*</b> (0.112)	<b>-0.388**</b> (0.160)	<b>-0.279*</b> (0.149)	<b>-0.408**</b> (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)	<b>-3.620***</b> (0.507)	<b>-2.515***</b> (0.498)	<b>-9.833***</b> (0.754)	<b>-9.288***</b> (0.669)	<b>-9.278***</b> (0.899)	<b>-8.923***</b> (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	0.23	0.25	0.34	0.38	0.26	0.30
Number of Countries	23	23	23	23	23	23

### Appendix Table C2: Sensitivity analysis of market vulnerability to currency movements

The table shows the estimated parameter values from a panel regression of equation (16). 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). Columns (1) and (2) lag all the control variables (except the first three) by one quarter. Columns (3) and (4) exclude the Stock Market Turnover Ratio and the Rule of Law variables, which are interpolated from annual to quarterly frequency. Columns (5) and (6) exclude 2008Q4, which contains the largest exchange rate movement in the sample. The specifications and data are discussed in Section III. Additional information is provided in Appendix B. The sample period is 2000 Q1 – 2014 Q4. Robust standard errors are clustered at the country level and reported in brackets. \*\*\*/\*\*/\* is significant at the 1%, 5%, and 10% levels, respectively. The larger value of each coefficient pair in absolute terms is marked in bold.