Exchange Rates, Strategic Uncertainty and International Bank Lending*

Stefano Schiaffi†

December 10, 2018

Abstract

Internationally-active banks raise wholesale funding and lend to firms abroad in US dollars, either directly or through their branches and subsidiaries. Local firms invest in local currency and are exposed to currency risk. A depreciation of the local currency vis à vis the US dollar acts as a coordination device for international banks that face strategic complementarities in lending and incomplete information about future exchange rate volatility. These strategic complementarities are stronger for countries where international bank lending is a greater source of corporate financing from abroad. I model the strategic interactions between international lenders with a global game. Moreover, using bilateral data on cross-border lending from banks headquartered in 30 countries to recipients in 29 emerging economies, I provide evidence that coordination failures in lending amplify the effect of exchange rate volatility on cross-border loans to local corporates.

JEL codes: G10, F34, G21
Keywords: International bank lending, exchange rates, global liquidity, emerging economies, strategic uncertainty, coordination failures, global games

---

*I wish to thank Stefan Avdjiev, Laura Bottazzi, Elena Carletti, Domenico Delli Gatti, Lucia Esposito, Carlo A. Favero, Leonardo Gambacorta, Luigi Iovino, Nicola Limodio, Alberto Manconi, Hannes Wagner and participants at the 2018 European Summer Meeting of the Econometric Society, as well as seminar participants at Bocconi University and the Bank of Italy for their comments and suggestions. The views expressed in this paper are those of the author only and do not necessarily reflect the views of the Bank of Italy.

†stefano.schiaffi@bancaditalia.it, https://sites.google.com/view/stefanoschiaffi, Bank of Italy, Bologna branch, Piazza Cavour 6, 40124 Bologna, Italy.

1 Introduction

Cross-border lending accounts for a significant fraction of international capital flows to emerging economies (Figure 1). It is their largest debt component and it is an important determinant of global financial conditions and economic activity. Moreover, cross-border loans are particularly important for emerging-market corporate borrowers because they complement domestic credit supply (Bank for International Settlements, 2011a and 2011b). Cross-border loans are mostly issued to private non-financial corporations and in US dollars (Figures 2 and 3). This paper models and estimates the effect of exchange rate volatility on cross-border loans to emerging-market firms when international banks face coordination failures.

Consider an emerging economy with a free-floating currency. Local firms fund themselves in US dollars (USD) from international banks and they invest in entrepreneurial projects in local currency. If the local currency depreciates, the dollar value of the firms' assets shrinks and the firms' solvency decreases. As a consequence, upon observing a local currency depreciation, international lenders cut down credit to local corporates.

Moreover, local firms are interdependent, i.e. the probability of success of each individual project increases with the number of other firms that receive financing (Bebchuck and Goldstein, 2011). This positive interconnection implies that international banks face strategic complementarities in lending because the expected return of lending to a local firm increases in the number of other international banks lending to other local firms. These strategic complementarities in lending are stronger when local firms have fewer alternatives to cross-border loans to finance their projects. When this is the case, if a firm does not obtain a cross-border loan, it will probably not find alternative means of financing. Given the firms' interdependence, the likelihood of success of other projects that have been financed is smaller, so the lending decision of each individual bank has a greater impact on the payoffs of the other banks. This mechanism acts as a multiplier of the impact of exchange rate volatility on cross-border loans and it leads to inefficient levels of credit supply.

This paper formalizes the intuition described above in a global game and it provides empirical evidence in its favor. My results show that cross-border lending is more vulnerable to exchange rate volatility in countries where the loan share of corporate financing from abroad is greater. Depending on this loan share, a 1% depreciation of the local currency can cause a reduction in cross-border loans that varies between 2.8 and 7.4 percentage points. It is important to stress that all my results are in *percentage* terms. The following example illustrates the point. Take two countries, A and B, in which firms receive a total of 100 USD billions in cross-border loans. Suppose that in country A loans account for 30% of total international capital flows to local corporates, while in country B they only account for 7%. A 1% depreciation of the local currency will cause a decrease of 7.4% in cross-border loans to corporates in A and of just 2.8% to corporates in B. Corporates in A now receive 92.6 USD billions, while corporates in B still get 97.2 USD billions. Therefore, even if the stock of cross-border loans to both countries is the same, their relevance vis à vis other international capital flows determines the *percentage* effect of a depreciation.

I take data on cross-border loans from the Bank for International Settlements Consolidated Banking Statistics. My dataset records the claims of banks headquartered in 30 countries vis à vis borrowers in 29 emerging economies. The data are aggregated at the country level and they are broken down by borrowing sector: banks, non banks (including non-financial corporations, exporting and importing firms, leveraged non-bank financials and households) and the public sector (government, central banks and regional development banks). The scope and depth of the dataset provides several advantages. First, I exploit the bilateral nature of the dataset to control for demand and supply effects using time-varying fixed effects. Second, the dataset consolidates positions of subsidiary banks into the positions of the parent bank. This characteristic is important because it controls for what Bruno and Shin (2015a) have dubbed a double-decker global lending model, whereby local banks rely on international banks for financing and then channel those funds to local corporates[1]. Under such a model, Bruno and Shin (2015a) argue that the effects of local exchange rate volatility on local corporate borrowers (who bear the currency risk) are passed on to local banks and from them to their parent international bank (if they have one). My data consolidate the positions of foreign affiliates into the claims of the parent foreign banks, so my measure of cross-border lending also includes lending from local banks that are controlled by a foreign bank. Thus, I can capture all the channels through which a shock to the local exchange rate can propagate to international lenders.

I identify the combined effect of exchange rate volatility and the relevance of cross-border lending for local firms in two complementary ways. In my baseline model, I use lender-time and lender-borrower fixed effects. These effects control for any time-varying supply-side confounders, as well as any time-invariant confounders related to the business models of banks from a specific lending country to a specific borrowing country. This estimation

[1]Local banks lend in US dollar or in local currency. They typically lend in local currency to the non-tradable sector and in US dollar to the tradable sector (Caballero and Krishnamurthy, 2005). However, they tend to match assets and liabilities in US dollars so that most of the currency risk is borne by the corporate borrowers (Bruno and Shin, 2015a), except for the influence that the currency risk has on the borrowers' solvency risk.

is equivalent to looking at the variation of lending from the same lending country to different firms and over time. However, demand-side confounders cannot be accounted for by using fixed effects, because they would absorb my variables of interest (local exchange rate volatility and local relevance of cross-border lending). Drawing on the literature on pull factors in international capital flows (e.g. Avdjiev et al., 2017), I use demand-side controls that account for the macroeconomic cycle and for the banking sector characteristics of the country where the borrowing firms are located.

A remaining identification concern is that some demand-side confounders might not be observable and cannot be included in the control set. To overcome this issue I follow Khwaja and Mian (2005) and Jiménez et al. (2014). I exploit the theoretical mechanism in Section 2 in order to transform the variable of interest and make it vary not only along the borrower and time dimensions, but also along the lender dimension. I estimate the differential effect of exchange rate volatility (borrower-time variable) in countries where cross-border loans are a bigger source of corporate financing (borrower-time variable) and where lending to firms is a larger share of total lending from a particular lending country (lender-borrower-time variable). This transformation allows the use borrower-time fixed effects to account for any demand-side confounders.

This paper is the first to identify a multiplier of the effect of exchange rate volatility on cross-border loans due to international lenders' coordination failures. This is also the first paper to point out that currency depreciations can have a stronger negative effects on international bank lending in countries where the loan share of corporate financing from abroad is greater. The drivers of cross-border flows have been widely studied in the literature and the link between financial stability and cross-border bank flows has been explored in many papers (e.g. Obstfeld, 2012a; 2012b; Cetorelli and Goldberg, 2012a; 2012b; Rey, 2013). Bruno and Shin (2015a; 2015b) find a negative effect of a local currency depreciation on bank flows. However, the focus of Bruno and Shin (2015a)'s paper is on the effects for lending banks' balance sheets and not on credit to emerging market firms. Crucially, they do not explore the implications of strategic complementarities in lending. My paper is also linked to the literature on the transmission of advanced economy monetary policy to emerging markets (e.g. Avdjiev et al., 2017; Bräuning and Ivashina, 2018). Again, the focus on the effect of exchange rate volatility on cross-border lending to countries where firms are more or less dependent on those flows is a novelty of my paper. The mechanism that underlies the findings of my paper is a "panic" among international lenders, based on the imperfect observation of a fundamental. Thus, the paper owes much to the literature on fundamentals versus panics and in particular to Morris and Shin (1998; 2003), Allen and Gale (1998), Goldstein and Pauzner (2005), Chen, Goldstein and Jiang (2010) and Bebchuck and Goldstein (2011). My approach to proxying for strategic complementarities is similar to the one in Morris and Shin (2016), who use the fraction of assets managed by asset managers to identify strategic complementarities in the managers actions. Finally, my paper is linked to the literature on currency crises and sudden stops (Obstfeld, 1996; Caballero and Krishnamurthy, 2001; 2003; 2004; 2005; Chang and Velasco, 2001; Corsetti et al., 2004) as well as to the literature on long-term lending and deposit volatility (Choudhary and Limodio, 2017).

The structure of the paper is the following. Section 2 presents the model of coordination failures in international lending. Section 3 describes the dataset and the empirical methodology. Section 4 discusses the results of the empirical estimations. Section 5 concludes.

2 A model of international lenders' coordination failures

2.1 Set up

There are two dates, 0 and 1. In $t = 0$ each internationally-active bank (in the remainder of the Section, simply a bank) from a continuum $[0, 1]$ decides whether to lend 1 US dollar (USD) to a firm from a continuum $[0, 1]$ in country E. Both lenders and borrowers are risk-neutral. Lending yields the bank a net interest rate R_0 in $t = 1$ if the firm repays its loan and 0 otherwise. Alternatively, the bank can decide not to lend to firms in country E and to invest 1 USD in a safe bond with a net interest rate r_0[2]. If the bank lends, the firm will use the dollar to invest in a project in local currency.

Firms in country E are positively interdependent (Bebchuck and Goldstein, 2011): the yield from each entrepreneurial project is increasing in the number of other firms in the economy that also invest in entrepreneurial projects. This assumption is valid for firms belonging to the same value chain, as well as for downstream firms that rely on other firms in the economy to provide jobs so that consumers can buy their products. Competition pressures, on the other hand, are an obvious example of negative interdependence. Following Bebchuck and Goldstein (2011), I assume that, overall, the positive effects of interdependence outweigh the negative ones. Since firms need financing in order to invest, the yield of each single project is increasing in the number of firms that obtain financing.

[2]For simplicity, I assume that the bank can only lend in US dollars.

In $t = 0$ bank loans account for a fraction $\lambda_0 \in [0, 1]$ of total corporate financing from abroad (which includes foreign direct investment, portfolio investment and other types of instruments). A corporate borrower that does not obtain a bank loan (because not all banks in the continuum $[0, 1]$ may eventually decide to lend) will obtain financing from abroad with probability $1 - \lambda_0$. Notice that $1 - \lambda_0$ is a conditional probability. It is the probability of finding alternative sources of financing conditional on not having obtained a loan.[3] Hence, the yield of each project will depend positively on the fraction of banks lending ($N_1 \in [0, 1]$) and on the probability that firms will find alternative financing, given that they did not obtain a loan ($1-\lambda_0$). [4] Also, I assume that the local firm needs to gather the 1 USD it needs from international sources. This can happen because the entrepreneur isn't able to retrieve funds in the domestic market (e.g. her project is too risky or her collateral not enough for local banks and local investors) or because of the fact that the domestic market can provide only a fraction of the funds she needs.

Summing up, in $t = 1$ the project yields[5] $Q_1(N_1, \lambda_0)$, where the yield Q_1 is a function of N_1 and λ_0. Remember that the yield of the project is in local currency. The exchange rate between the currency of country E and USD in $t = 1$ is $\theta_1 \in \mathbb{R}_{++}$. θ_1 is the nominal exchange rate vis à vis the US dollar, or how many USD a unit of the local currency can buy. An increase of θ_1 can be interpreted as a weakening of the US dollar vis à vis the local currency. Knowing the payoff structure of the corporate borrower, the bank knows that its loan will be entirely repaid with interest only if

$$Q_1(N_1, \lambda_0)\theta_1 \geq 1 + R_0$$

where the left-hand side is the payoff of the project in USD and the right-hand side is the amount the firm owes the bank. If the yield of the project in USD is not enough to pay back the loan with interest, the firm goes bankrupt and the bank can appropriate the yield

[3] It could be that the probability of finding alternative sources of financing is low because the country is unable to obtain other portfolio investments. This is consistent with my definition of λ_0: in a country that is unable to attract foreign investment, a low $\lambda_0$means that, conditional on not having obtained a loan, the chances that corporates obtain other foreign funding is low.

[4] Assuming that entrepreneurs gather all the funds they need from a single source is just a simplifying assumption. Suppose local entrepreneurial projects could be financed by different lenders in different proportions and suppose a bank finances a share s of the 1 USD needed by a local firm. The bank knows that the projects can bear fruit only if they are completely financed. Ceteris paribus, in a country where the share of bank financing λ_0 is high, the probability that the necessary fraction $1 - s$ can be obtained from other sources is lower. Hence, when lending an amount s banks' expected return is still a decreasing function of λ_0.

[5] As a simplifying assumption, the project yields a positive payoff with certainty, but the amount of the payoff is a function of the relevant variables of the model.

$Q_1(N_1, \lambda_0)\theta_1$.

Therefore, the payoff a bank receives from lending is

$$(1 + R_0)\,\mathbf{1}(Q_1(N_1, \lambda_0)\theta_1 \geq 1 + R_0) + Q_1(N_1, \lambda_0)\theta_1\,\mathbf{1}(Q_1(N_1, \lambda_0)\theta_1 < 1 + R_0)$$

where $\mathbf{1}(x)$ is an indicator function taking value 1 if condition x is satisfied and 0 otherwise. Thus, the payoff from lending is

- increasing in θ_1, the period-1 exchange rate vis à vis the USD. An appreciation of the US dollar (i.e. a decrease of θ_1) implies a reduction of the dollar value of corporate borrowers' assets. Therefore, an appreciation of the US dollar increases the likelihood that the firm will go bankrupt and decreases the portion of the loan that the firm can repay in $t = 1$;
- increasing in N_1, the share of banks lending to corporate borrowers in country E in period 0. This property generates strategic complementarities in lending to firms in country E;
- decreasing in λ_0, the share of bank financing (as opposed to other sources of financing) from abroad to firms in country E and the probability of not finding alternative sources of financing for a given firm in country E in period 0.

For ease of notation, define the action "Lend" as action 1 and action "Not lend" as action 0. The payoff function of the bank is as follows:

$$u(1, \theta_1, N_1, \lambda_0)$$
$$= (1 + R_0)\,\mathbf{1}(Q_1(N_1, \lambda_0)\theta_1 \geq 1 + R_0) + Q_1(N_1, \lambda_0)\theta_1\,\mathbf{1}(Q_1(N_1, \lambda_0)\theta_1 < 1 + R_0)$$

$$u(0, \theta_1, N_1, \lambda_0) = 1 + r_0$$

As a first step, suppose that the exchange rate in $t = 1$, i.e. θ_1, is distributed according to a pdf $h(.)$ and that its realization is common knowledge in $t = 0$. Then, equilibrium play would be characterized by the following two thresholds (Morris and Shin, 2003):

$$\underline{\theta}\,(\lambda_0) : \; u(1, \underline{\theta}, 1, \lambda_0) = 1 + r_0$$

$$\overline{\theta}\,(\lambda_0) : \; u(1, \overline{\theta}, 0, \lambda_0) = 1 + r_0$$

$\underline{\theta}(\lambda_0)$ is the level of realized θ_1 below which not lending is a dominant action regardless of what the other banks do (i.e. even if they all lend, $N_1 = 1$). Conversely, $\overline{\theta}(\lambda_0)$ is the level above which lending is a dominant action, regardless of what the other banks do (i.e. even if none of them lends, $N_1 = 0$). For a given λ_0, when $\theta_1 \in \left(\underline{\theta}(\lambda_0), \overline{\theta}(\lambda_0)\right)$ there are two equilibria. In one equilibrium, all banks lend in $t = 0$. In the other equilibrium none does.

To overcome the problem of multiplicity, I apply the techniques developed in the global games literature[6]. I assume that the realization of θ_1 is not common knowledge in $t = 0$. Instead, each bank b receives an idiosyncratic signal about θ_1:

$$\theta_{b,0} = \theta_1 + \sigma\varepsilon_{b,0}$$

where $\varepsilon_{b,1}$ is identically and independently distributed across banks according to the continuous distribution function $g(.)$ with support on the real line[7] and θ_1 is drawn from a continuously differentiable, strictly positive density $v(.)$ on the real line. A reasonable assumption is to set $v(.) = N(\theta_0, .)$, so that it is common knowledge that the exchange rate in $t = 1$ has mean equal to the realization of the exchange rate in $t = 0$. One interpretation of this information structure is that all banks have some common information about the possible realization of θ_1, but they also have idiosyncratic information from their research departments and forecasting models, generating the different predictions embodied in the θ_b's. Figure 4 sums up the timing of the model.

Notice that variables denoted with a 0 subscript are variables whose realization is observed by banks before they make their lending decision in $t = 0$. They include r_0, R_0, λ_0 and θ_0. Variables denoted with a 1 subscript, instead, are variables unknown to banks at the time of their lending decision. They include N_1 and θ_1.

Given the structure of the payoffs and the information structure, there is a unique equilibrium and a cutoff exchange rate θ^* such that banks lend in $t = 0$ if and only if they receive a signal above θ^* and they do not lend if and only if they receive a signal below θ^*.

2.2 Assumptions and equilibrium uniqueness

This subsection spells out the precise assumptions that guarantee equilibrium uniqueness. Some of them have already been loosely defined in Section 3 for the sake of smoother exposition. Appendix A contains the formal proof of uniqueness.

[6] See Morris and Shin, 2003 for an introduction to the topic.

[7] With small changes in the terminology, the argument will extend to the case where g(.) has support on some bounded interval of the real line.

Define

$$\begin{aligned}\pi\left(\theta_1, N_1, \lambda_0\right) &= u(1, \theta_1, N_1, \lambda_0) - u(0, \theta_1, N_1, \lambda_0) \\ &= (1 + R_0)\, \mathbf{1}(Q_1(N_1, \lambda_0)\theta_1 \geq 1 + R_0) \\ &+ Q_1(N_1, \lambda_0)\theta_1\, \mathbf{1}(Q_1(N_1, \lambda_0)\theta_1 < 1 + R_0) - (1 + r_0)\end{aligned}$$

i.e. the difference between the payoff of action 1 and the payoff of action 0.

Assumption A1 (Action monotonicity):
$\pi\left(\theta_1, N_1, \lambda_0\right)$ is nondecreasing in N_1.[8]

A1 implies that there are strategic complementarities in lending. The utility from choosing a particular action (lend or not lend) is higher when other banks also choose the same action. In my model, this property stems from the fact that a project yields a higher expected return if other firms are also financed. This assumption finds grounding in the literature (Bebchuck and Goldstein, 2011) and it accounts for the intuitive fact that firms in non trivial business sectors need other upstream and downstream firms to bring a final product to the market. When some of these other firms are not financed, the likelihood of the final product reaching consumers is lower and so is the expected yield of the entrepreneurial project of a given firm in the value chain.

Assumption A2 (State monotonicity):
$\pi\left(\theta_1, N_1, \lambda_0\right)$ is nondecreasing in θ_1.

Global banks raise wholesale US dollar funding and then lend to local corporates in other jurisdictions in US dollars, either through local banks that are part of the same conglomerate or directly. The local firms have a currency mismatch, financing local currency assets with US dollar borrowing. When the local currency depreciates vis à vis the dollar, the dollar value of the firms' assets decreases. Even if the entrepreneurial project pays off an amount Q_1 in local currency, when the local currency depreciates the amount Q_1 may not be enough to repay the bank loan that firms received in the previous period. Hence, the expected return that banks have from lending is a non-decreasing function of the exchange rate.

Assumption A3 (Strict Laplacian state monotonicity):
$\exists!\ \theta^* \in \mathbb{R}_+ :\ \int_0^1 \pi\left(\theta^*, N_1, \lambda_0\right) dN_1 = 0.$

[8] This assumption can be weakened as follows. Assumption A1* (Action Single Crossing): for each $\theta_1 \in \mathbb{R}$, there exists $N_1^* \in \mathbb{R} \bigcup \{-\infty, +\infty\}$ such that $\pi\left(\theta_1, N_1, \lambda_0\right) < 0$ if $N_1 < N_1^*$ and $\pi\left(\theta_1, N_1, \lambda_0\right) > 0$ if $N_1 > N_1^*$

A3 is a strengthening of A2. $\int_0^1 \pi(\theta^*, N_1, \lambda_0)\, dN_1$ is the difference in expected payoffs when the bank has Laplacian beliefs on the share of banks that will lend (N_1), i.e. it believes N_1 to be uniformly distributed on the $[0,1]$ interval. I know that $\partial\pi(\theta_1, N_1, \lambda_0)/\partial\theta_1 \geq 0$ from A2. A3 imposes that the inequality implied by A2 is strictly satisfied in a neighborhood of $\pi(\theta^*, N_1, \lambda_0) = 0$ when banks have Laplacian beliefs on N_1.

Assumption A4 (Limit dominance):
$\exists\, \underline{\theta}(\lambda_0), \overline{\theta}(\lambda_0) \in \mathbb{R}_+ : \pi(\theta_1, N_1, \lambda_0) < 0$ for all $N_1 \in [0,1]$ and $\theta_1 < \underline{\theta}(\lambda_0)$; and $\pi(\theta_1, N_1, \lambda_0) > 0$ for all $N_1 \in [0,1]$ and $\theta_1 > \overline{\theta}(\lambda_0)$.[9]

A4 states that not lending must be dominant for low enough values of period 1's exchange rate and lending must be dominant for high enough values of period 1's exchange rate. The thresholds depend on λ_0. Given the state monotonicity in A2, A4 is equivalent to assuming that it must be dominant not to lend when $\theta_1 < \underline{\theta}(\lambda_0)$ (i.e. even if all banks lend, $N_1 = 1$); conversely, it must be dominant to lend when $\theta_1 > \overline{\theta}(\lambda_0)$ (i.e. even if no other bank lends, $N_1 = 0$). This assumption implies that, even if corporate borrowers in country E are interdependent, individual projects still have an expected return greater than zero when no other firm is financed, however small ($Q_1(0, \lambda_0) > 0$). Given λ_0, if the exchange rate in $t = 1$ is particularly favorable, i.e. higher than $\overline{\theta}(\lambda_0)$, then the firm will be able to repay its loan in USD. Knowing this, if banks could observe θ_1 without noise in $t = 0$, they would lend regardless of what other banks do. A specular argument holds for $\underline{\theta}(\lambda_0)$ and it requires that project returns be bounded upwards, so that a sufficiently strong depreciation of the local currency will make local firms unable to repay their loans in USD.

Assumption A5 (Idiosyncratic signals):
Banks receive idiosyncratic signals $\theta_{b,0} = \theta_1 + \sigma\varepsilon_{b,0}$. θ_1 has distribution $v(N_{0,}.)$ (the prior) and the signals $\theta_{b,0}$ have a conditional distribution $g(.)$. $\int_{-\infty}^{\infty} z g(z) dz$ is well defined.

A5 describes the information structure of the fundamental of the game. The distribution of period-1 exchange rate is centered around period-0's exchange rate. In period 0, bank b observes its own idiosyncratic signal of period-1 exchange rate, $\theta_{b,0}$. The distribution of signals $g(.)$ is know to all banks in period 0 and it admits a finite expected value.

[9] This assumption can be strengthened as follows. Assumption A4* (Uniform Limit Dominance): $\exists\, \underline{\theta}(\lambda_0), \overline{\theta}(\lambda_0) \in \mathbb{R}_+$ and $\varepsilon \in \mathbb{R}_{++}$ such that $\pi(\theta_1, N_1, \lambda_0) < -\varepsilon$ for all $N_1 \in [0,1]$ and $\theta_1 < \underline{\theta}(\lambda_0)$; and $\pi(\theta_1, N_1, \lambda_0) > \varepsilon$ for all $N_1 \in [0,1]$ and $\theta_1 > \overline{\theta}(\lambda_0)$. A4* strengthens A4 by requiring that the payoff gain from not lending be uniformly positive for sufficiently low values of $\theta_1$and that the payoff from lending be uniformly positive for sufficiently high values of θ_1.

Assumption A6 (Continuity):
$\int_0^1 h(N_1)\pi(\theta_1, N_1, \lambda_0)\, dN_1$ is continuous with respect to the exchange rate θ_1 and density $h(.)$.

Assumption A7 (Differentiability of payoffs):
$\pi(\theta_1, N_1, \lambda_0)$ is continuously differentiable.

A6 and A7 are technical assumptions. A6 is about the continuity of payoffs with respect to the exchange rate θ_1 and to the distribution of beliefs over the behavior of other banks $h(N_1)$. A7 implies that payoffs have continuous partial derivatives in θ_1, N_1, λ_0.

Assumption A8 (Monotonicity with respect to the share of bank lending):
$\pi(\theta_1, N_1, \lambda_0)$ is nonincreasing in λ_0.

A8 states that higher shares of bank lending over total corporate financing from abroad will (weakly) decrease the payoff of lending. This assumption formalizes in one line the concept that firms in country E have a higher chance of finding alternative sources of financing if international lending is a smaller share of overall corporate financing in country E. By strategic complementarity, the expected yield of the project financed with an international loan depends positively on the probability that other firms can find alternative financing if they are denied an international loan. This probability is equal by assumption to $1 - \lambda_0$.

Denote $L(\sigma)$ the incomplete information game satisfying A1-A8.

Proposition 1. *Let θ^* be defined as in A3. For any $\delta > 0$, $\exists\, \overline{\sigma} > 0$ such that for all $\sigma < \overline{\sigma}$, if strategy $s(\theta_{b,0})$ survives iterated deletion of strictly dominated strategies in the game $L(\sigma)$, then*

$$s(\theta_{b,0}) = \begin{cases} Not\ lend & for\ all \quad \theta_{b,0} \leq \theta^* - \delta \\ Lend & for\ all \quad \theta_{b,0} \geq \theta^* + \delta \end{cases}$$

Proposition 1 establishes that if signals aren't too widely distributed across banks ($\sigma < \overline{\sigma}$), then there is unique rationalizable equilibrium. In equilibrium banks will not lend upon observing a signal below the cutoff θ^* and they will lend otherwise.

2.3 Characterization of the cutoff exchange rate

The cutoff θ^* is defined as in A3 such that a bank that receives a signal equal to θ^* must be indifferent between lending and not lending in $t = 0$. Moreover, this particular bank must have uniform (a.k.a Laplacian) beliefs over the share of banks that lend in $t = 0$.

This characterization imposes that banks be completely agnostic as to the share of banks that will lend. Define

$$\chi\left(\theta^*, \lambda_0\right)$$
$$\equiv \int_0^1 \left[(1+R_0)\,\mathbf{1}(Q_1(N_1,\lambda_0)\theta^* \geq 1+R_0) + Q_1(N_1,\lambda_0)\theta^*\,\mathbf{1}(Q_1(N_1,\lambda_0)\theta^* < 1+R_0)\right] dN_1$$

The following equation implicitly pins down θ^*:

$$\chi\left(\theta^*, \lambda_0\right) = 1 + r_0$$

Assume A7 and A8. Then $\chi\left(\theta^*, \lambda_0\right)$ depends positively on the cutoff exchange rate θ^* and negatively on the share λ_0 of corporate financing from abroad accounted for by cross-border loans.

Proposition 2: *Assume A1-A8. Then θ^* can be expressed as a continuously differentiable function of λ_0: $\theta^* = \gamma(\lambda_0)$. This function is such that*

$$\frac{d\theta^*}{d\lambda_0} = -\frac{\partial\chi\left(\theta^*, \lambda_0\right)}{\partial\lambda_0} \Big/ \frac{\partial\chi\left(\theta^*, \lambda_0\right)}{\partial\theta_1^*} \geq 0$$

When λ_0 increases, the cutoff exchange rate increases as well (and so do $\underline{\theta}$ and $\overline{\theta}$, as shown in Figure 5). Therefore, as λ_0 increases banks will decide not to lend even if they receive higher signals of the future exchange rate. This result is a crucial point of the paper. Conditional on a depreciation of the local currency, countries where international bank lending is an important source of corporate financing from abroad (high λ_0) will experience smaller inflows of cross-border loans.

2.4 From the model to the empirical section

My model posits that an appreciation of the US dollar vis à vis the local currency has a negative effect on the amount of cross-border loans to local corporates through an increase in the solvency risk of local firms. Building on this assumption, the model shows that i) the negative effect of a local depreciation vis à vis the US dollar on cross-border lending is amplified by strategic complementarities in lending; ii) the strategic complementarities are stronger for lending to firms located in countries where cross-border loans account for a larger share of total corporate financing from abroad; iii) this amplification effect is driven by expectations about the future exchange rate and expectations about banks' lending behavior; iv) these beliefs are pinned down by the observation of today's exchange rate.

These conclusions are tested in the remaining part of the paper using data on cross-border loans to corporates in emerging economies.

3 Data and empirical methodology

3.1 Data

I take cross-border loans from the Bank for International Settlements Consolidated Banking Statistics (BIS CBS). The CBS contain the worldwide consolidated positions of internationally-active banking groups headquartered in reporting countries. The data include the claims of banks' foreign affiliates but exclude intragroup positions, similarly to the consolidation approach followed by banking supervisors. For example, the positions of an Italian bank's subsidiary located in Poland are consolidated in the CBS with those of its parent and included in the positions of Italian banks. The CBS contain data from banks headquartered in 30 countries. The data are aggregated at the country level. On the borrowing side, I focus on a set of 29 emerging economies for which the data coverage is sufficiently large. Table 1 shows the typical lenders and borrowers of cross-border loans. Cross-border loans are typically supplied by internationally-active banks, which tend to be relatively large. The typical non-bank borrowers are large non-financial corporations, export/import firms and leveraged non-bank financials. Local banks, the government sector, central banks and international organizations (including international development banks) are the remaining institutions on the borrowing side. Figure 2 shows the breakdown of cross-border loans by borrowing sector. Loans to firms typically get the lion's share, and they constitute on average 60% of overall cross-border lending. Finally, Figure 3 shows the breakdown of cross-border loans to firms by currency. The vast majority of cross-border loans issued by international banks are in US dollars, accounting on average for 75% of the total. In my analysis I consider cross-border loans to all sectors, as well as to banks, to firms and to the public sector separately. In order to get rid of extreme values, I compute quarterly growth rates and I winsorize them at the 90% level.

In order to measure the relevance of cross-border lending as opposed to other capital flows for each borrowing country, I take data on the international investment positions (IIP) vis à vis the countries in my sample from the IMF WB international financial statistics. Gross IIP consist of the following main categories: 1. Direct investment 2. Portfolio Investment 3.

Financial derivatives and employee stock options 4. Other investment. Other investment includes: a. Loans b. Other accounts payable. c. Trade credit d. Other equity. Figure 1 shows the evolution over time of different types of capital flows for six emerging economies. Financial derivatives, employee stock options, trade credit, other equity and other accounts payable are lumped together into "other investments". For each borrowing country, I sum the incoming cross-border loans from all lending countries (from the BIS CBS dataset) and I divide this total by the total capital flows to that country (i.e. the sum of items 1 to 4 above). The result is a measure of the parameter λ in Section 2. This parameter captures the loan share of corporate financing from abroad in a given country and, following the mechanism of Section 2, the extent of strategic complementarities in lending.

I use controls that include macroeconomic indicators and aggregate balance sheet characteristics of the banking system of the recipient country. I take the balance sheet characteristics from Avdjiev et al. (2017). They are aggregated at the country level from bank-level data taken from Bankscope. They include the average capital ratio (a measure of solvency), the average deposit ratio (a measure of liquidity), the average bank size in logs and two profitability ratios: net interest to total assets and interest revenues over total revenues. The macroeconomic indicators are the level of domestic lending, the local lending rate, sovereign credit ratings, the Chinn-Ito index of financial openness (Chinn and Ito, 2008) and local GDP growth. The latter measures overall economic performance. Sovereign ratings proxy for the role of country risk and the perceived creditworthiness of borrowers by country. They are the average across three agencies (Standard and Poor's, Moody's and Fitch) of long-term foreign currency sovereign ratings. The Chinn-Ito index gauges the degree of capital account openness. It is normalized to be between 0 and 1, as in Avdjiev et al. (2017). The lending rate controls for the profitability of lending and is taken from the International Monetary Fund International Financial Statistics. I take the level of domestic lending from the BIS Long Series on Total Credit to the Private Non-Financial Sector.

Finally, I take exchange rates from the BIS long series on US dollar bilateral nominal exchange rates. The exchange rates are transformed to reflect how many US dollars a unit of the local currency can buy. Thus, an increase in the exchange rate reflects a depreciation of the US dollar vis à vis the local currency. All the variables have quarterly frequency, except the balance-sheet controls which have yearly frequency.

The sample includes lending to firms located in 29 emerging economies from banks headquartered in 30 countries. The data are aggregated at the country level. The time span is 2001:Q1 - 2015:Q4. My sample covers more than 95% of all cross-border loans to firms in emerging economies. Appendix C contains the list of all the countries in the sample.

Table 2 contains the summary statistics of the variables described above. The mean of the quarterly growth rate of cross-border loans is about 4% and it varies depending on the borrowing sector. The standard deviation varies from 27% and 58% depending on the borrowing sector, making cross-border loans very volatile. $FirmShare$ measures the share of cross-border loans that are extended to firms, as opposed to unrelated banks or the public sector. On average it is around 60%. The borrowing-country variables are the exchange rate quarterly growth rate, the loan share λ of international capital flows to firms and the macroeconomic and banking sector balance sheet controls. The exchange rate has an average quarterly growth rate of -0.3%, with a standard deviation of 5.1%. λ has an average of about 0.18 and it varies between 0 and 0.71, highlighting the importance of cross-border loans with respect to other international capital flows. The balance sheet controls are in first year-on-year difference.

3.2 Empirical methodology

The model described in Section 2 shows that exchange rate volatility has a larger effect on cross-border loans if domestic firms have limited access to alternative means of financing. The parameter λ_0 captures the extent to which firms in a given country rely on cross-border lending as opposed to other types of international capital flows. Accordingly, I define λ_t^j as

$$\lambda_t^j = \frac{\sum_i XBL_t^{i,j}}{IntCap_t^j}$$

i.e. the share of international capital flows to country j in quarter t that is accounted for by bank loans. Consider the following baseline specification:

$$\Delta XBL_t^{i,j} = \alpha + \beta_0 \cdot \Delta ER_t^{j,USD} + \beta_1 \cdot \Delta ER_t^{j,USD} \cdot \lambda_t^j + \beta_2 \cdot \lambda_t^j + \varepsilon_t^{i,j} \tag{1}$$

Equation (1) has the growth rate of cross border bank loans from country i to country j ($\Delta XBL_t^{i,j}$) on the left-hand side and the growth rate of the exchange rate between the currency of country j and US dollars ($\Delta ER_t^{j,USD}$) on the right-hand side. The exchange rate is defined as the amount of dollars a unit of the currency of country j can buy: an appreciation of the US dollar decreases the exchange rate. The growth rate of the exchange rate enters the equation as a stand-alone variable as well as multiplied by the share of corporate financing through cross-border loans (λ_t^j). As a first step in the analysis, this estimation establishes the sign and magnitude of the correlation between exchange rate volatility and cross-border bank loans, as well as the possible dependence of this correlation upon the parameter λ_t^j. Positive estimates of the coefficients β_0 and β_1 are in accordance with the model in Section 2. In that case a depreciation of the local currency would be correlated with a percentage fall in cross-border loans to firms in country j. Such a percentage fall in lending would be stronger in countries with a higher loan share of corporate financing from abroad (i.e. a higher λ_t^j).

Equation (1) leaves identification aside. Exchange rates are an equilibrium phenomenon, and the mechanism that determines them is an open field of research (Gabaix and Maggiori, 2015). Any variable that affects exchange rates and that also affects cross-border bank flows is a confounder in equation (1). I divide the possible confounders into the following four categories. The first category contains all supply-side confounders. These are all variables contained in $\varepsilon_t^{i,j}$ that vary along the i and t dimensions. They include both static and time-varying characteristics of the lending-country banking system, as well as the monetary policy stance of the lending country or the growth rate of its economy. The second category contains all demand-side confounders. These are all variables contained in $\varepsilon_t^{i,j}$ that vary along the j and t dimensions. They include the static and time-varying characteristics of the borrowing-country banking system, its monetary policy stance and macroeconomic performance. The third category contains all global factors. Global factors vary only along the t dimension. They include the global economic cycle, risk aversion and monetary policy stance. The fourth category includes the structural characteristics of the relationship between lenders in country i and borrowers in country j. These vary along the i and j dimensions but are independent of time. They include the business models that banks headquartered in country i employ when lending to firms in country j, as well as geographic and linguistic preferences (e.g. Spanish banks lending to firms in Latin America).

The bilateral nature of the data is very important for identification. The first, third and fourth categories of confounders can be dealt with using appropriate fixed effects. The second step in the estimation of the following equation:

$$\begin{aligned} \Delta XBL_t^{i,j} = \alpha^{i,j} + \alpha_t^i + \beta_0 \cdot \Delta ER_t^{j,USD} + \beta_1 \cdot \Delta ER_t^{j,USD} \cdot \lambda_t^j \\ + \beta_2 \cdot \lambda_t^j + \gamma_0' \cdot X_t^j + \beta_4 \cdot \gamma_1' \cdot X_t^j \cdot \lambda_t^j + \varepsilon_t^{i,j} \end{aligned} \tag{2}$$

$\alpha^{i,j}$ are fixed effects that account for all time-invariant demand or supply factors. Moreover, they account for any structural lending relationship between lenders in i and firms in j.

Hence, I do away with confounders in the fourth category, as well as the time-invariant confounders in the first and second category. α_t^i are fixed effects that account for all time-varying supply factors, as well as for all global factors that vary only along the t dimension. Hence, the combination of the two types of fixed effects allows to control for all the four categories above, with the important exception of time-varying demand confounders. Since the variables of interest ($\Delta ER_t^{j,USD}$ and λ_t^j) vary along the j and t dimensions, I cannot use fixed effects that also vary along those two dimensions because they would absorb them. I need to spell out specific controls, that I include in the vector X_t^j. The controls enter the equation both as stand-alone variables and interacted with λ_t^j.

The controls include the borrowing-country domestic lending and lending rate, real GDP growth, an index of the openness of financial markets, sovereign ratings, as well as a set of balance sheet characteristics of the local banking sector. The macroeconomic drivers are typical pull drivers in the international finance literature (Avdjiev et al., 2017). In particular, the lending rate controls for the investment opportunities channel. A loosening of the borrowing country monetary policy is accompanied by a depreciation of the local currency and a decrease in the lending rate. Hence, a decrease in incoming cross-border loans after a currency depreciation could just be the result of lower returns from investing in the country. The aggregate balance sheet items provide an assessment of the size, business models, liquidity, solvency and profitability of the local banking sector. The rationale for including the latter set of controls is that lending from local banks and lending from international banks could display a degree of substitutability. The balance sheet items are the aggregate capital ratio (solvency), the aggregate deposit ratio (liquidity), the average bank size and two profitability ratios: net interest to total assets and interest revenues over total revenues. The latter is also an indicator of the business models because the higher interest revenues over total revenues, the more traditional the business model of the banking sector is. Standard errors are clustered at the lender-time level.

While equation (2) includes an extensive set of borrowing-country controls, a remaining identification issue is the possible presence of non-observable demand confounders. The size and direction of the possible bias depends on the relevant confounders and it is not possible to determine them a priori. Given these concerns, the ideal estimation strategy would be to include borrower-time fixed effects in the equation to account for all demand-side confounders and do away with any possible confounder from the four categories above. Before doing that, however, I need to transform the cross-sectional variation of my variables of interest. Instead of varying only along the borrowing-country dimension, I must have them vary along both the borrowing and the lending-country dimensions (as well as time).

I follow the intuition in Khwaja and Mian (2005) and I exploit the mechanism described in Section 2 to come up with a n identifiable transformation. The effect of exchange rate volatility on cross-border loans to firms is stronger when firms have a smaller chance of finding alternative means of financing from abroad. This probability is captured by the loan share λ_t^j of international capital flows to firms in country j. When lending to unrelated banks[10] in US dollars, international banks do not face the concrete possibility of not being paid back after a local currency depreciation. Local unrelated banks lend to local corporates either in US dollars or in local currency but they insure against currency risk, so that currency risk is always borne by the local corporate borrower. Therefore, cross-border lending to unrelated banks is independent of exchange rate volatility[11]. Define $FirmShare_t^{i,j}$ as the share of cross-border lending from country i to country j in quarter t that goes to local firms as opposed to local unrelated banks or the public sector. Ceteris paribus, an increase in $FirmShare_t^{i,j}$ will exacerbate the combined effect of $\Delta ER_t^{j,USD}$ and λ_t^j. Suppose the same exchange rate depreciation happened in two countries, A and B, with exactly the same λ_t^j and with the same total stock of cross-border lending from international banks. Call this stock $S_t^{i,j}$. Now suppose that in A international banks lend a higher share of $S_t^{i,j}$ to firms as opposed to unrelated banks. Firms in A will have a greater chance of receiving funding from international banks and a lower chance of getting funding from domestic banks than firms in B. Hence, international banks lending to firms in A know that if they fail to provide credit, firms in A will have a harder time finding alternative means of financing. Given their interdependence, they will have a smaller chance of reaping profits from their project and a smaller chance of repaying their debt to international lenders. The strategic complementarities in lending are then stronger in A than in B.

Crucially, $FirmShare_t^{i,j}$ varies along the i, j and t dimensions. Therefore, I can create a triple interaction term $\Delta ER_t^{j,USD} \cdot \lambda_t^j \cdot FirmShare_t^{i,j}$ that also varies along the three dimensions of my dataset. This approach is equivalent to exploiting the combined variation

[10]Remember that cross-border loans are consolidated, so inter-office positions between banks in the same conglomerate are canceled out. Lending from the foreign affiliates is lending from the whole conglomerate.

[11]This assumption may not hold in the event of a extreme local depreciation. Buying insurance against extreme depreciations is likely to be too costly for many local banks in emerging economies. Moreover, moral hazard induced by state bailouts in the case of major depreciations decreases the incentive to insure against them.

over time , across borrowers and across lenders. I can now estimate the following equation:

$$\Delta XBL_t^{i,j} = \alpha^{i,j} + \alpha_t^i + \alpha_t^j \tag{3}$$
$$+\beta_0 \cdot \Delta ER_t^{j,USD} \cdot FirmShare_t^{i,j} + \beta_1 \cdot \Delta ER_t^{j,USD} \cdot \lambda_t^j \cdot FirmShare_t^{i,j}$$
$$+\beta_2 \cdot \lambda_t^j \cdot FirmShare_t^{i,j} + \beta_3 \cdot FirmShare_t^{i,j} + \gamma_1' \cdot X_t^j \cdot \lambda_t^j \cdot FirmShare_t^{i,j} + \varepsilon_t^{i,j}$$

Given (3), the marginal effect of exchange rate volatility on cross-border loans to firms in emerging economies, as a function of strategic complementarities and the firm share of cross-border loans is

$$\frac{\partial \Delta XBL_t^{i,j}}{\partial \Delta ER_t^{j,USD}} \left(\lambda_t^j, FirmsShare_t^{i,j}\right) = \left(\beta_0 + \beta_1 \cdot \lambda_t^j\right) \cdot FirmShare_t^{i,j}$$

The coefficient of interest is β_1. It captures the additional effect of exchange rate volatility on cross-border loans in countries where loans account for a larger share of international capital flows and where cross-border lending to local firms account for a larger share of total cross-border lending. When β_1 is positive, stronger strategic complementarities in lending for global banks lending to firms in country j are reinforced by a greater share of lending to firms as opposed to unrelated banks and the government and they act as an amplifying effect of exchange rate volatility on cross-border loan growth to corporates in j. Equation (3) now includes fixed effects that account for all the four categories of confounders described above, including time-varying demand confounders captured by α_t^j. I lose the possibility of identifying the coefficient on the stand-alone $\Delta ER_t^{j,USD}$, but I no longer need to include any stand-alone demand-side controls. However, I follow Jiménez et al. (2014) and I introduce the borrowing-country controls of equation (2) interacted with λ_t^j and $FirmShare_t^{i,j}$. In accordance with the focus of my analysis and the variation in my data, I multi-cluster standard errors at the time, lending-country and borrowing-country level.

It is worth stressing that in all my empirical estimations I assume that λ_t^j, i.e. the ratio of cross-border loans to total capital flows, is a good proxy for the strength of strategic complementarities in lending. This claim is supported by my model and it is similar in spirit to Morris and Shin (2016). As any proxy, mine is subject to measurement error. Although this is a legitimate concern, measurement error produces an attenuation bias on the estimates, shrinking them towards zero. Therefore, if anything, the imprecise measurement of strategic complementarities should imply potentially bigger effects than the ones I find.

4 Results - coordination failures as a multiplier of exchange rate volatility on cross-border loans

Table 3 shows the results of estimating equation (1) for cross-border loans to different types of borrowers: firms[12], banks and the public sector, as well as the overall effect on the combined flows. The standard errors are unadjusted.

Column (1) provides evidence of a positive correlation between exchange rate volatility and loans to all sectors. Moreover, this correlation is a positive function of the relevance of cross-border lending for the recipient country, λ. For a country with a λ equal to 0.18 (approximately the sample mean of λ), a 1% variation in the exchange rate is associated to a 21.2% variation in cross-border lending to all sectors. Columns (2) to (4) provide similar estimates for the borrowing sector breakdowns: a 1% variation in the exchange rate is associated with a 16.1% variation in lending to firms, a 27.6% variation in lending to banks and a 23.4% variation in lending to the public sector. Notice that the association between cross-border flows and exchange rate volatility is an increasing function of λ for all types of lenders. This is in contrast with the mechanism described in Section 2, whereby only loans to firms should display strategic complementarities because of the currency mismatch in the firms' balance sheet. Therefore, the sign and magnitudes of the correlations in Table 3 are encouraging, but the lack of behavioral difference across sectors is not in accordance with my model.

Table 4 shows the results of estimating equation (2), again with a borrowing sector breakdown: firms, banks and the public sector. The coefficients shown in Table 4 are estimates of the effect of exchange rate volatility on cross-border loans. Identification is achieved through lender-borrower, lender-time fixed effects and borrower-time controls. The fixed effects control for any confounder from the supply side, as well as for any influence of global factors and time-invariant borrowing country characteristic. The remaining set of confounders that cannot be controlled through fixed effects are those that vary across borrowing countries and over time. I account for these using borrowing-country controls[13].

The results are very different from those of Table 3, except for the sign of the coefficients. Column (1) shows that the effect of exchange rate volatility on cross-border lending to all sectors is positive, significant and large. A 1% depreciation of the exchange rate causes a 4.91% quarterly decrease in lending from international banks to all sectors. Columns (2)

[12] Non-financial corporations.

[13] Full estimation results including all the controls are available upon request.

to (4) reveal that the incremental effect of exchange rate volatility as a function of λ is a property of lending to firms only, in accordance with the model in Section 2. Column (2) contains the key result. A 1% depreciation brings about a 5.08% decrease in cross-border loans to firms in a country where λ is equal to 0.18, its cross-country average. Importantly, the percentage effect is larger whenever the loan share of corporate financing from abroad is larger. Figure 6 shows the time-varying effect of a 1% depreciation of the local currency on cross-border loans to firms as a function of λ for selected large emerging economies. Depending on the country, the impact of exchange rate volatility varies more or less over time, generally between 3 and 5 percentage points. Among the countries showed in Figure 6, India displays a stronger effect on average (-6.01%), as well as the strongest effect in 2007:Q4 (-7.37%). The weakest effect is displayed by South Africa in 2010:Q4 (-2.70%). The effect is rather stable over time (as a result of the stability of λ over time) for Brazil, China, Mexico and South Africa. In India, the impact of exchange rate volatility on cross-border lending increased consistently until the outbreak of the great financial crisis (2007:Q4) and then it decreased. Russia saw a surge of relevance of cross-border lending to firms in 2008 and an increase in the impact of exchange rate volatility on these flows accordingly.

Column (3) shows that lending to banks is not affected by exchange rate volatility. This is an expected result and it is the consequence of the logic behind the model in Section 2. The BIS consolidated debt statistics include the claims of banks' foreign affiliates but exclude intragroup positions. Therefore, lending to banks in column (3) of Table 4 is actually lending to unrelated banks, which is not subject to exchange rate volatility per se. Indeed the double-decker structure of international bank lending (Bruno and Shin, 2015a) is such that interbank lending is mostly denominated in US dollars (Figure 7) and, even when it isn't, local banks insure themselves against currency risk. Therefore, exchange rate volatility does not affect lending from an international bank to a local unrelated bank, because it does not affect the likelihood of future repayment. That concern will fall solely upon the local unrelated bank lending to local firms.

To expand on the double-decker structure of global lending and on currency risk, notice that, while local banks typically borrow in US dollars, they lend locally either in local currency or in US dollars. Typically, they lend in local currency to small companies or to companies that produce non-tradables and they lend in US dollars to large or exporting firms which can provide a collateral that small and non-tradable producing firms don't have (Caballero and Krishnamurthy, 2004; 2005). Local banks do hold currency risk through two channels: when they lend in local currency to local firms, provided that they fund this lending in US dollars from global banks (direct channel, due to a currency mismatch in the banks' balance sheet); and when they lend in US dollars to large firms, because large firms have a currency mismatch whenever they borrow in US dollars but invest in local currency (indirect channel through the corporates' solvency risk, due to a currency mismatch in the corporates' balance sheet). Following Bruno and Shin, 2015a, I assume that local banks' currency risk is predominantly due to the indirect channel, because local banks tend to match assets and liabilities in foreign currency and, specifically, in US dollars so that the direct channel is typically shut down. Using data from the Bank for International Settlements Locational Banking Statistics, Figure 8 shows the aggregate currency breakdown of local banks' balance sheet in emerging economies. Assets in US dollars are largely and consistently backed by liabilities in US dollars over time.

Column (4) shows that lending to the public sector after a negative shock to exchange rates is not affected. Indeed, lending in foreign currency to the public sector is mostly composed of foreign currency liabilities held by the borrowing country's central bank. In many emerging economies where there is significant foreign exchange activity, but under-developed financial markets, the central bank may provide foreign currency facilities to its commercial banks and it may finance them with lending from international banks or with swap agreements with the US Federal Reserve. When the likelihood of the borrowing country's default is small, international lending to central banks is not affected by exchange rate volatility.

Table 4 and Figure 6 establish that the effect of an exogenous shock to exchange rates on cross-border lending to firms increases with λ. However, what drives λ? This is a question that this paper does not address. This share may be a consequence of a number of factors, including the legal framework of the country that may impede or encourage direct foreign investment, or the level of development of internal capital markets, that may impede or encourage portfolio investment as well as affect the structure of the domestic credit supply. Taking all this as a given, what are the negative consequences of a currency depreciation for local corporate financing? The estimates in Table 4 provide an answer to this question.

A remaining identification concern is due to the fact that some unobservable borrowing-country characteristics may act as confounders. Table 5 shows the results of estimating equation (3)[14]. The equation includes borrower-time fixed effects in order to control for any observable or unobservable time-varying borrowing country characteristics that may act as confounders in equation (2). The triple interaction is positive and significant only for lending to firms. The estimation exploits the joint variation along the lender, borrower

[14] Full estimation results including all the controls are available upon request.

and time dimensions. Following the mechanism described in Section 2, strategic complementarities among international banks are stronger whenever lending is a higher share of international capital flows. However, as showed also by the results in Table 4, this mechanism holds only for lending to firms. Therefore, the higher the share of total lending that goes to firms, the stronger the strategic complementarities. Crucially, the share of cross-border lending to firms over total cross-border lending varies along the lender, borrower and time dimensions. Thus, the triple interaction term in Table 5 also varies along all the three dimensions, which allows the use of a comprehensive set of fixed effects. Notice that the share of cross-border lending accounted for by lending to firms should exacerbate the strategic complementarities in lending, but there is no reason to believe that it will also affect the stand-alone coefficient of exchange rate volatility. Thus, the direct impact of exchange rate volatility will remain unidentified in equation (3).

The share of cross-border lending accounted for by firms has a sample average of about 60% (see Table 2). Setting this share equal to its sample average and setting λ equal to its sample average of 0.18, the additional effect of a 1% variation in the exchange rate is equal to 2.71%. This number is very close to and statistically indistinguishable from the interaction term in Table 4 once I set λ equal to 0.18, i.e. 3.68%. I conclude that the estimates presented in Table 4 are reliable estimates of the effect of exchange rate volatility on cross-border lending.

4.1 Robustness

I check for the robustness of the results presented above along several dimensions. These include the sample size, different methods of computing the parameter λ and different timing between left-hand-side and right-hand-side variables. I also check whether similar results hold for other types of international capital flows, namely direct investment and portfolio investment.

The time span used for the main results is 2001:Q1 - 2015:Q4. This sample is sufficiently long but it comes with two drawbacks. The first is that some countries have series of cross-border lending and total international liabilities (used to compute λ) that are not available at the beginning of the sample. Moreover, it is often the case that total international liabilities are available at a yearly frequency at the beginning of the sample and they become quarterly only later on (see Table B1). This may have an impact on the calculation of λ, which is quarterly and has quarterly cross-border lending at the numerator. The second drawback is that the original sample encompasses the great financial crisis, which may cause breaks in the parameters and in the series of interest. In order to address both concerns, I estimate equation (2) dropping the first nine years and using the sample 2010:Q1 - 2015:Q4. Table B2 presents the results. Column (2) shows that the effect of exchange rate volatility on cross-border lending to firms is much stronger after the great financial crisis. On average (i.e. with λ equal to its sample mean of 0.18), a 1% depreciation causes a 10.2% fall in cross-border loans to firms. This incremental effect points out that international capital flows have become more flighty after the crisis and the multiplier effect of strategic complementarities in lending has strengthened. In any case, the sign, significance and magnitude of the results in table B2 are very similar to those in Table 4.

In the main estimations, λ is computed as total cross-border loans to country j in quarter t divided by the total foreign liabilities held by borrowers in country j and in quarter t. This is a measure of the relevance of cross-border lending for the financing of all borrowers in a given country. At the cost of incurring in more sever data limitations, I can compute the same measure using cross-border loans to firms and total liabilities held by firms. Table B3 presents the results. The two coefficients of interest are robust to this specification.

The quarterly exchange rate used for the main estimations is the quarterly average of the daily exchange rates. Given that in Section 2 banks observe the exchange rate at the beginning of the quarter and decide whether to lend or not, an alternative could be to use the last monthly exchange rate in the previous quarter, as available in the BIS long series on US dollar bilateral nominal exchange rate. Table B4 presents the results. Although the significance of the two coefficients for loans to all sectors disappears, the two coefficients of interest for loans to firms (column 2) are still significant and their magnitude is similar to that of the main results.

Previous literature (Caballero and Krishnamurthy, 2004; 2005), as well as anecdotal experience from the Asian financial crisis of the late 90's, underline the role of exchange rate volatility in driving the ebb and flow of capital flows to emerging economies. Although my paper focuses on loans, it is interesting to see whether exchange rates play a role for foreign direct investment and foreign portfolio investment in my empirical setting. In particular, it is interesting to check whether the amplification mechanism due to strategic complementarities in lending among global banks has a natural correspondent for direct and portfolio investment. To check for that, I create a new λ^{DI} and a new λ^{PI} as the ratio of direct investment and portfolio investment to total international capital flows respectively and I estimate equation (2) using WB/IMF International Financial Statistics on Direct Investment and Portfolio Investment to the 29 emerging economies in my original sample instead of cross-border loans. Table B5 contains the estimation results. Exchange rate volatility doesn't have a significant impact on direct investment, as the cost of disinvestment is higher for longer term direct investment. Instead a local depreciation has a negative effect on portfolio investment, which is more volatile and sensitive to short-term macroeconomic conditions (Kirabaeva and Razin, 2010). Crucially, the effect of exchange rate volatility on portfolio flows is not amplified by strategic complementarities in lending, as captured by λ^{PI}. Such an amplification mechanism pertains to loans only. As a final note, since the data on direct and portfolio investment are not bilateral and they refer to the recipient country only, I can only use time and borrower fixed effects, which may weakness identification.

5 Conclusions

This paper models and estimates the effects of a shock to an emerging market exchange rate vis à vis the US dollar on cross-border lending to local firms. Strategic complementarities in lending and incomplete information about future exchange rate volatility cause coordination failures among global banks lending to local firms, either directly or through their branches and subsidiaries. This paper is the first to highlight and identify this mechanism.

This finding is particularly important from a policy perspective, both from the local and from the global point of view. A local currency depreciation can be undertaken by policy makers for a variety of reasons, for example to boost exports and decrease interest payments on debt due to overspending on imports. This paper highlights a caveat to doing that. The greater the reliance of the country's firms on cross-border lending (or on lending from local banks that are part of an international conglomerate), the greater the percentage decrease in international loans to the country's firms after a local currency depreciation, in what amounts to a multiplier effect.

Finally, the paper stresses the importance of global financial conditions, and in particular US dollar volatility, for local corporate financing and for local financial stability. Appreciations of the US dollar can have disruptive effects on lending from global banks. The effects on financial stability are not only linked to the stock of loans that local corporates get from global banks, but also on the relevance of loans as opposed to other forms of international capital flows.

References

[1] Allen, F. and D. Gale, 1998, “Optimal Financial Crises”, Journal of Finance 53, 1245-1284.

[2] Avdjiev, S., L. Gambacorta, L. S. Goldberg, S. Schiaffi, 2017, “The Shifting Drivers of Global Liquidity”, NBER Working Paper No. 23565.

[3] Bank for International Settlements, 2011a, “Global Liquidity - Concept, Measurement and Policy Implications”, CGFS Papers, Bank for International Settlements, n 45.

[4] Bank for International Settlements, 2011b, “Global Liquidity: Insights from the BIS Statistics”, note for a meeting of the G20 Sub-Working Group on global liquidity management, 25 March.

[5] Bebchuk, L. A. and I. Goldstein, 2011, “Self-Fulfilling Credit Market Freezes”, Review of Financial Studies, Society for Financial Studies, vol. 24(11), pages 3519-3555.

[6] Bräuning, F. and V. Ivashina, 2018, "U.S. Monetary Policy and Emerging Market Credit Cycles", NBER Working Papers 25185, National Bureau of Economic Research, Inc.

[7] Bruno, V. and H. S. Shin, 2015a, "Cross-Border Banking and Global Liquidity," Review of Economic Studies, Oxford University Press, vol. 82(2), pages 535-564.

[8] Bruno, V. and H. S. Shin, 2015b, "Capital Flows and the Risk-Taking Channel of Monetary Policy," Journal of Monetary Economics, Elsevier, vol. 71(C), pages 119-132. Carlsson, Hans, and Eric van Damme, 1993, “Global games and equilibrium selection”, Econometrica 61, 989 – 1018.

[9] Caballero, R. and A. Krishnamurthy, 2001, “International and Domestic Collateral Constraints in a Model of Emerging Market Crises,” Journal of Monetary Economics 48, 513-548.

[10] Caballero, R. and A. Krishnamurthy, 2003, “Excessive Dollar Debt: Underinsurance and Domestic Financial Underdevelopment,” Journal of Finance April, 58(2), pp. 867-893.

[11] Caballero, R. and A. Krishnamurthy, 2004, “Smoothing Sudden Stops,” Journal of Economic Theory 119(1), November, 104-127.

[12] Caballero, R. and A. Krishnamurthy, 2005, “Exchange Rate Volatility and the Credit Channel in Emerging Markets: A Vertical Perspective” International Journal of Central Banking, (1)1, May, 207-245.

[13] Cetorelli, N. and L. S. Goldberg, 2012a, “Liquidity management of U.S. Global Banks: Internal Capital Markets in the Great Recession”, Journal of International Economics 88, 299-311.

[14] Cetorelli, N. and L. S. Goldberg, 2012b, “Banking Globalization and Monetary Transmission”, Journal of Finance 67(5), 1811ñ1843.

[15] Chari, V. V., and R. Jagannathan, 1988, “Banking Panics, Information and Rational Expectations Equilibrium”, Journal of Finance 43, 749-760.

[16] Chang, R. and A. Velasco, 2001, “A Model of Financial Crises in Emerging Markets,’ Quarterly Journal of Economics, Volume 116, No. 2 , May.

[17] Chen, Q., I. Goldstein and W. Jiang, 2010, "Payoff Complementarities and Financial Fragility: Evidence from Mutual Fund Outflows", Journal of Financial Economics, Elsevier, vol. 97(2), pages 239-262, August.

[18] Chinn, M. D. and H. Ito, 2008, “A New Measure of Financial Openness”, Journal of Comparative Policy Analysis, 10(3), 309-322.

[19] Choudhary, M. A. and N. Limodio, 2017, “Deposit Volatility, Liquidity and Long-Term Investment: Evidence from a Natural Experiment in Pakistan”, IGIER working paper n. 613

[20] Corsetti, G., A. Dasgupta, S. Morris and H. S. Shin, 2004, “Does One Soros Make a Difference? A theory of Currency Crises with Large and Small Traders”, Review of Economic Studies 71, 87-113.

[21] Diamond, D. W. and P. H. Dybvig, 1983, “Bank runs, deposit insurance, and liquidity”, Journal of Political Economy 91, 401-419.

[22] Gabaix, X. and M. Maggiori, 2015, “International Liquidity and Exchange Rate Dynamics”, The Quarterly Journal of Economics, Oxford University Press, vol. 130(3), pages 1369-1420.

[23] Goldstein, I. and A. Pauzner, 2005, “Demand Deposit Contracts and the Probability of Bank Runs”, Journal of Finance 60, 1293—1328.

[24] Jiménez, G., S. Ongena, J.-L. Peydró and J. Saurina, 2014, "Hazardous Times for Monetary Policy: What Do Twenty-Three Million Bank Loans Say About the Effects of Monetary Policy on Credit Risk-Taking?", Econometrica, 82: 463–505.

[25] Khwaja, A. J. and A. Mian, 2005, "Do Lenders Favor Politically Connected Firms? Rent Provision in an Emerging Financial Market", The Quarterly Journal of Economics, Oxford University Press, vol. 120(4), pages 1371-1411.

[26] Kirabaeva, K. and A. Razin, 2010, "Composition of International Capital Flows: A Survey", in Gerard Caprio (ed.) The Evidence and Impact of Financial Globalization, Vol. 3, pp. 105-119. Oxford: Elsevier Inc.

[27] Morris, S. and H. S. Shin, 1998, "Unique Equilibrium in a Model of Self-Fulfilling Currency Attacks", American Economic Review 88, 587-597.

[28] Morris, S. and H. S. Shin. 2003, "Global Games: Theory and Applications", In Advances in Economics and Econometrics (Proceedings of the Eighth World Congress of the Econometric Society), edited by M. Dewatripont, L. Hansen, and S. Turnovsky, 1:56-114. Cambridge University Press.

[29] Morris, S. and H. S. Shin, 2016, "Risk-Premium Shifts and Monetary Policy: A Coordination Approach", In: Woodford, M., Saravia, D., Albagli, E. (Eds.), Monetary Policy through Asset Markets: Lessons from Unconventional Measures and Implications for an Integrated World. Banco Central de Chile.

[30] Obstfeld, M., 1996, "Models of Currency Crises with Self-Fulfilling Features", European Economic Review 40, 1037-1047.

[31] Obstfeld, M., 2012a, "Financial Flows, Financial Crises, and Global Imbalances", Journal of International Money and Finance, 31, 469ñ480.

[32] Obstfeld, M., 2012b, "Does the Current Account Still Matter?", American Economic Review, 102(3), 1-23.

[33] Rey, H., 2013, "Dilemma not Trilemma: The Global Financial Cycle and Monetary Policy Independence", Proceedings of the Federal Reserve Bank of Kansas City Economic Symposium at Jackson Hole.

Table 1: Cross-border loans: typical lenders and borrowers

	Typical Lenders	**Typical Borrowers**	***Notes***
Cross-border loans to banks	Internationally-active banks	Banks (all sizes)	*Interbank market (unsecured and repo)*
Cross-border loans to non-banks	Internationally-active banks	Large non-financial corporates; exporting/importing firms; Leveraged non-bank financials	*Syndicated loan market; trade credit; project financing*
Cross-border loans to the public sector	Internationally-active banks	The general government sector, central bank sector and international organisations (including multilateral development banks)	*Public non-bank financial institutions and public corporations are not included. They belong to the "non-banks" category*

Table 2: Summary statistics

	Observations	Mean	SD	Min	Max
	Panel A: Bilateral variables				
ΔCross-border loans[1]					
to all sectors	38158	3.931	28.514	-47.618	85.714
to firms	35758	3.961	27.411	-45.383	84.615
to banks	31307	9.756	53.599	-66.667	161.111
to the public sector	22992	7.914	49.004	-67.901	160.016
FirmShare[2]	38360	0.593	0.295	0	1
	Panel B: Borrowing-country variables				
ΔExchange rate[1]	50670	-0.391	5.102	-52.923	19.554
lambda[3]	50890	0.182	0.110	0.000055	0.711
ΔLending rate	44610	-0.177	3.00	-50.881	53.521
ΔReal GDP[1]	46200	3.998	3.785	-17.215	18.529
ΔSovereign Ratings[4]	50790	0.033	0.263	-3.678	2.429
Chinn-Ito Index[5]	50318	0.582	0.331	0	1
ΔSize[6]	50430	0.049	0.451	-5.675	0.920
ΔETA[7]	50430	0.00035	0.027	-0.149	0.173
ΔDEPtoTA[8]	50430	-0.0024	0.037	-0.213	0.239
ΔNETINTtoTA[9]	50430	-0.00019	0.014	-0.129	0.112
ΔINTREVtoTOTREV[10]	50430	0.0012	0.065	-0.325	0.328

Notes: The sample includes quarterly data for 30 lending countries, 29 borrowing countries (emerging economies) over the period 2001:Q1 - 2015:Q4. [1]Quarterly growth rate (%). [2]Cross-border loans to firms over total cross-border loans. [3]Cross-border lending over total capital flows. [4]Long-term foreign currency sovereign rating, average across 3 agencies (Standard and Poor's, Moody's and Fitch). [5]Measure of financial openness developed in Chinn and Ito (2008). [6]Logarithm of the average size of domestic banks. [7]Equity to total assets. [8]Deposits to total assets. [9]Net interest to total assets. [10]Interest revenues to total revenues.

Table 3: Correlation between exchange rate volatility and cross-border lending growth rates

	ΔCross-border loans[1]			
	(1)	(2)	(3)	(4)
	to all sectors	to firms	to banks	to the public sector
ΔExchange rate[1]	15.176***	11.569***	21.504***	18.604***
	(1.835)	(1.650)	(3.645)	(2.995)
ΔExchange rate[1] * λ^2	33.677***	24.858***	33.709**	30.012**
	(8.628)	(7.802)	(16.989)	(13.855)
Constant	1.044***	0.958***	1.003***	0.345***
	(0.044)	(0.040)	(0.087)	(0.073)
Observations	38,058	35,668	31,218	22,960
R-squared	0.017	0.013	0.009	0.014

Notes: The Table shows the estimates of the relevant parameters in Equation The sample includes quarterly data for 30 lending countries, 29 borrowing countries (emerging economies) over the period 2001:Q1 - 2015:Q4. [1] Quarterly growth rate (%). [2]Cross-border lending over total capital flows. The regression includes the level of λ. Standard errors in parentheses. The *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

Table 4: Effect of exchange rate volatility on cross-border loans

	ΔCross-border loans[1]			
	(1)	(2)	(3)	(4)
	to all sectors	to firms	to banks	to the public sector
ΔExchange rate[1]	4.912**	1.404***	8.192	11.872
	(2.135)	(0.196)	(7.385)	(9.560)
ΔExchange rate[1] * λ^2	13.183	20.457***	-13.665	14.740
	(10.053)	(6.603)	(20.130)	(16.376)
Borrowing-country controls	Yes	Yes	Yes	Yes
Lender·borrower FE	Yes	Yes	Yes	Yes
Lender·time FE	Yes	Yes	Yes	Yes
Observations	32,831	30,820	26,753	19,851
R-squared	0.166	0.173	0.123	0.152

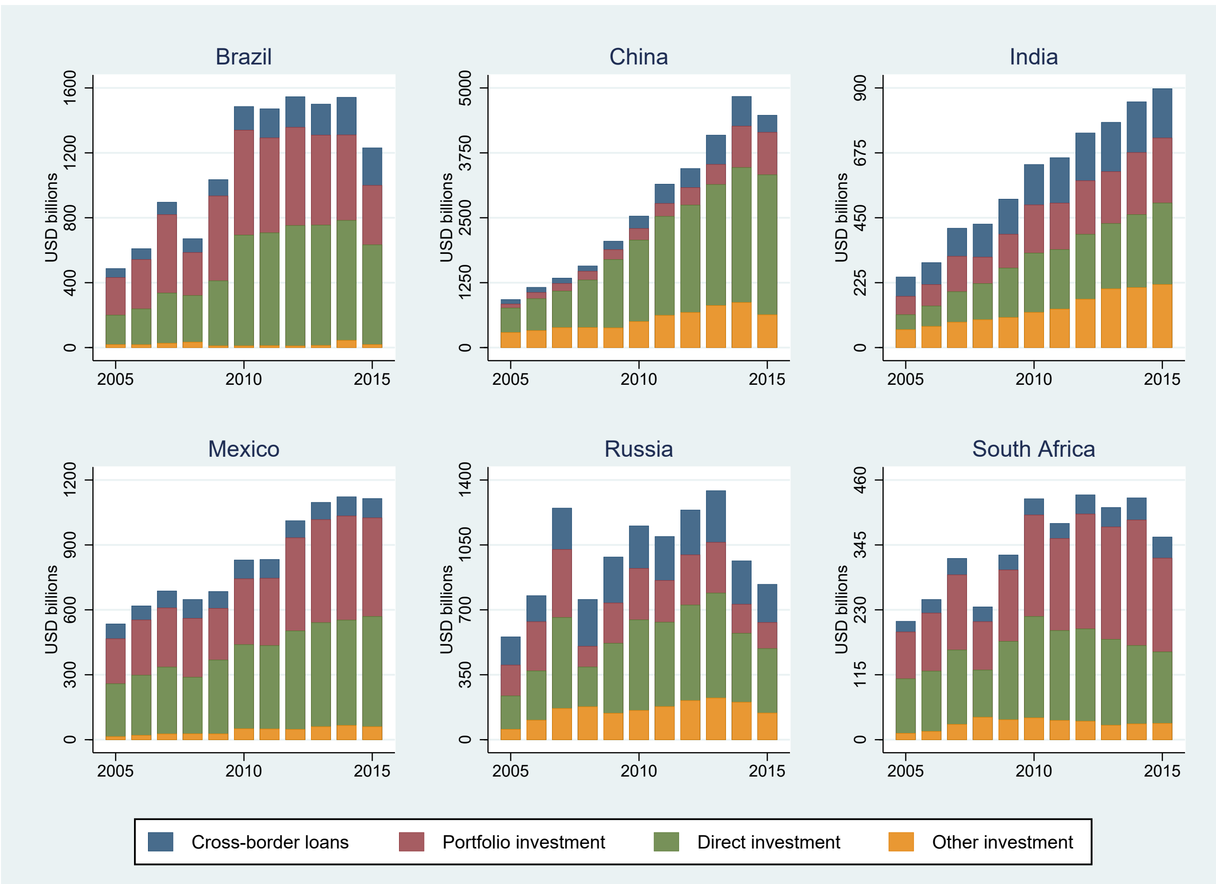
Notes: The sample includes quarterly data for 30 lending countries, 29 borrowing countries (emerging economies) over the period 2001:Q1 - 2015:Q4. [1] Quarterly growth rate (%). [2]Cross-border lending over total capital flows. Borrowing-country controls include ΔLending rate, ΔReal GDP, ΔSovereign ratings, Chinn-Ito index, ΔSize, ΔETA, ΔDEPtoTA, ΔNETINTtoTA, ΔINTREVtoTOTREV as well as their interaction with λ. The regression includes the level of λ. The regression also includes lender-borrower and lender-time fixed effects. Standard errors are clustered by lender-time. *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

Table 5: Effect of exchange rate volatility on cross-border loans - interaction with the share of lending to firms

	ΔCross-border loans[1]			
	(1)	(2)	(3)	(4)
	to all sectors	to firms	to banks	to the public sector
ΔExchange rate[1] * FirmShare[2]	-2.994	0.355	-4.653	-4.258
	(4.044)	(3.621)	(8.155)	(6.956)
ΔExchange rate[1] * λ^3 * FirmShare[2]	-30.271	25.105**	-95.858	15.671
	(18.091)	(11.952)	(72.556)	(29.537)
Borrowing-country controls	Yes	Yes	Yes	Yes
Lender·borrower FE	Yes	Yes	Yes	Yes
Lender·time FE	Yes	Yes	Yes	Yes
Borrower·time FE	Yes	Yes	Yes	Yes
Observations	31,471	30,662	25,903	19,576
R-squared	0.231	0.240	0.206	0.239

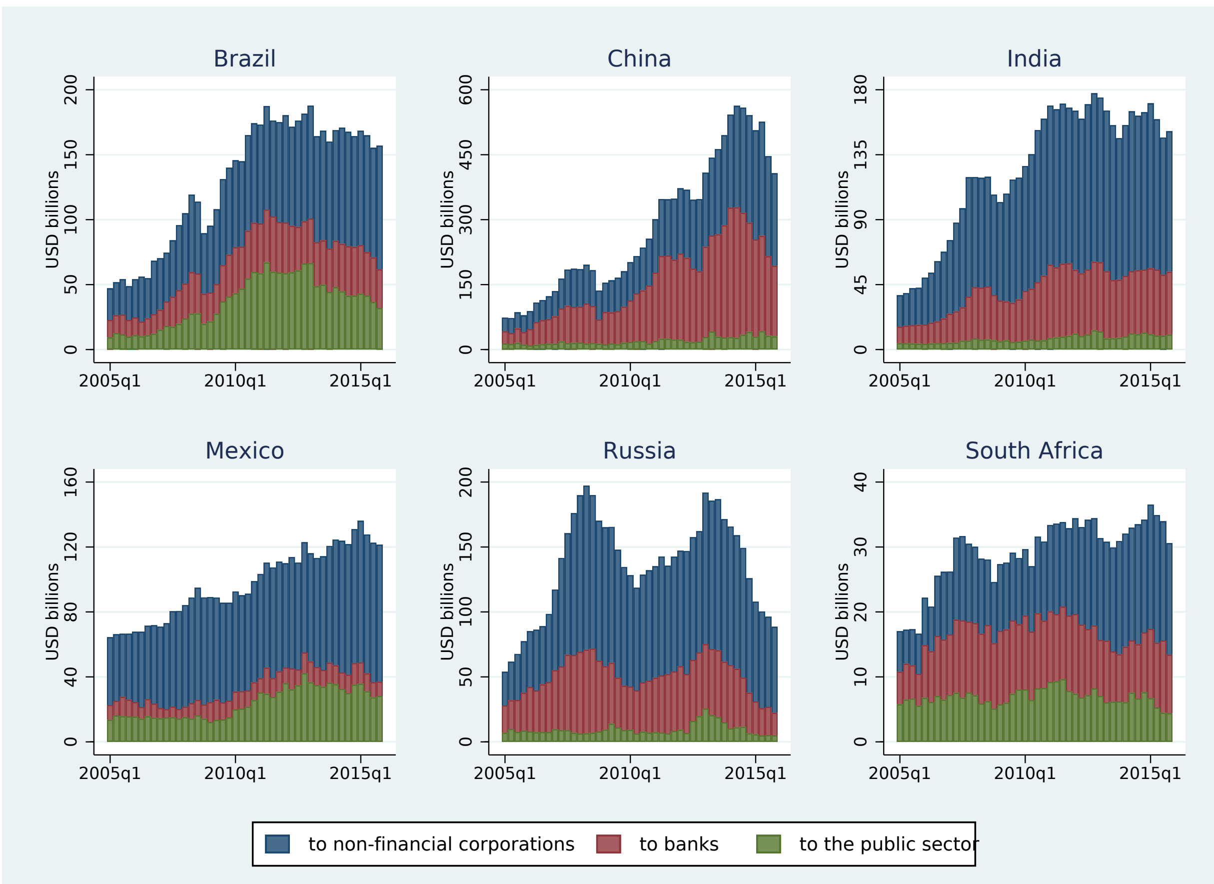
Notes: The sample includes quarterly data for 30 lending countries, 29 borrowing countries (emerging economies) over the period 2001:Q1 - 2015:Q4. [1] Quarterly growth rate (%). [2]Cross-border loans to firms over total cross-border loans. [3]Cross-border lending over total capital flows. Borrowing-country controls include ΔLending rate, ΔReal GDP, ΔSovereign ratings, Chinn-Ito index, ΔSize, ΔETA, ΔDEPtoTA, ΔNETINTtoTA, ΔINTREVtoTOTREV, each interacted with λ and FirmShare. The regression includes the level of λ. The regression includes the interaction of λ and FirmShare, the level of FirmShare and the interaction of ΔExchange rate and FirmsShare. The regression also includes lender-borrower, lender-time and borrower-time fixed effects. Standard errors are multi clustered at the lender, borrower and time levels. *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

Figure 1: Composition of international capital flows - selected emerging countries



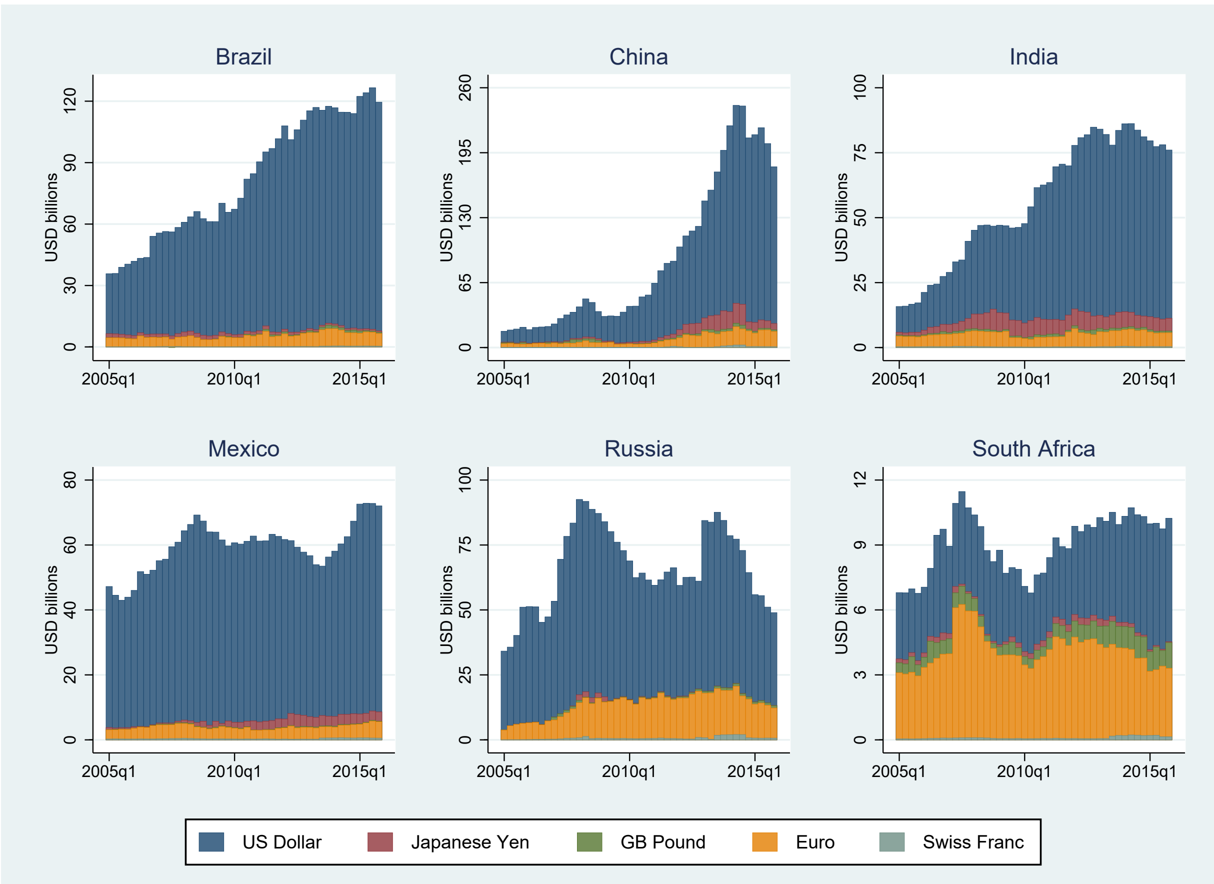
Source: International Monetary Fund, international financial statistics

Figure 2: Breakdown of cross-border loans by borrowing sector - selected emerging countries



Source: Bank for International Settlements, locational banking statistics

Figure 3: Currency breakdown of cross-border loans to non-financial corporations - selected emerging countries



Source: Bank for International Settlements, locational banking statistics

Figure 4: Timing of the model

t = 0

- *Global banks observe an idiosyncratic signal of the exchange rate between the currency of country E and USD in t = 1. They also observe the loan share of corporate financing from abroad.*
- *Global banks decide whether to lend or not to corporate borrowers in country E with an (exogenous) net interest rate R. They lend in US dollars.*
- *Firms in E that obtain funding invest in a risky project in local currency.*

t = 1

- *Corporate borrowers in E observe the outcome of the project.*
- *If the dollar value of the yield of the project is large enough firms pay back their loans with interest.*

Figure 5: Effect of λ on the equilibrium cutoff exchange rates

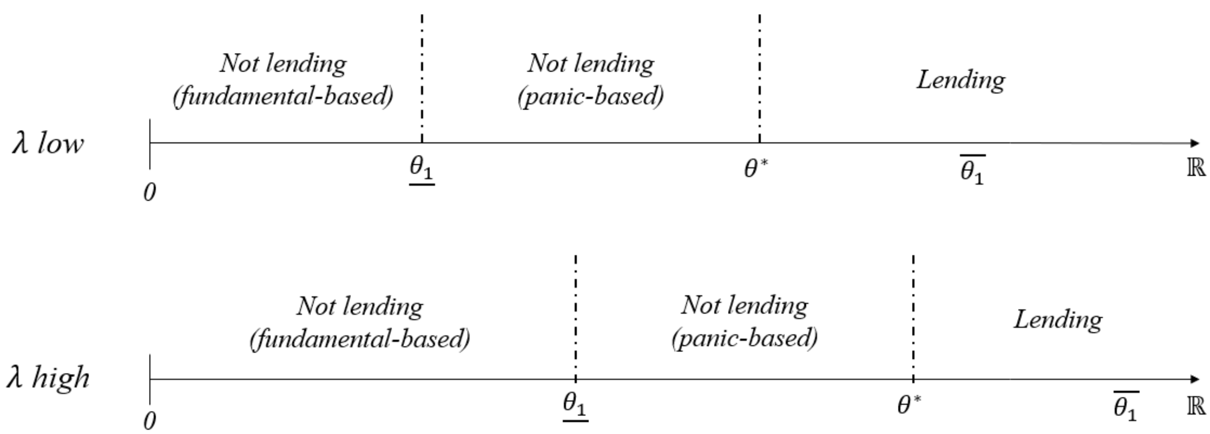
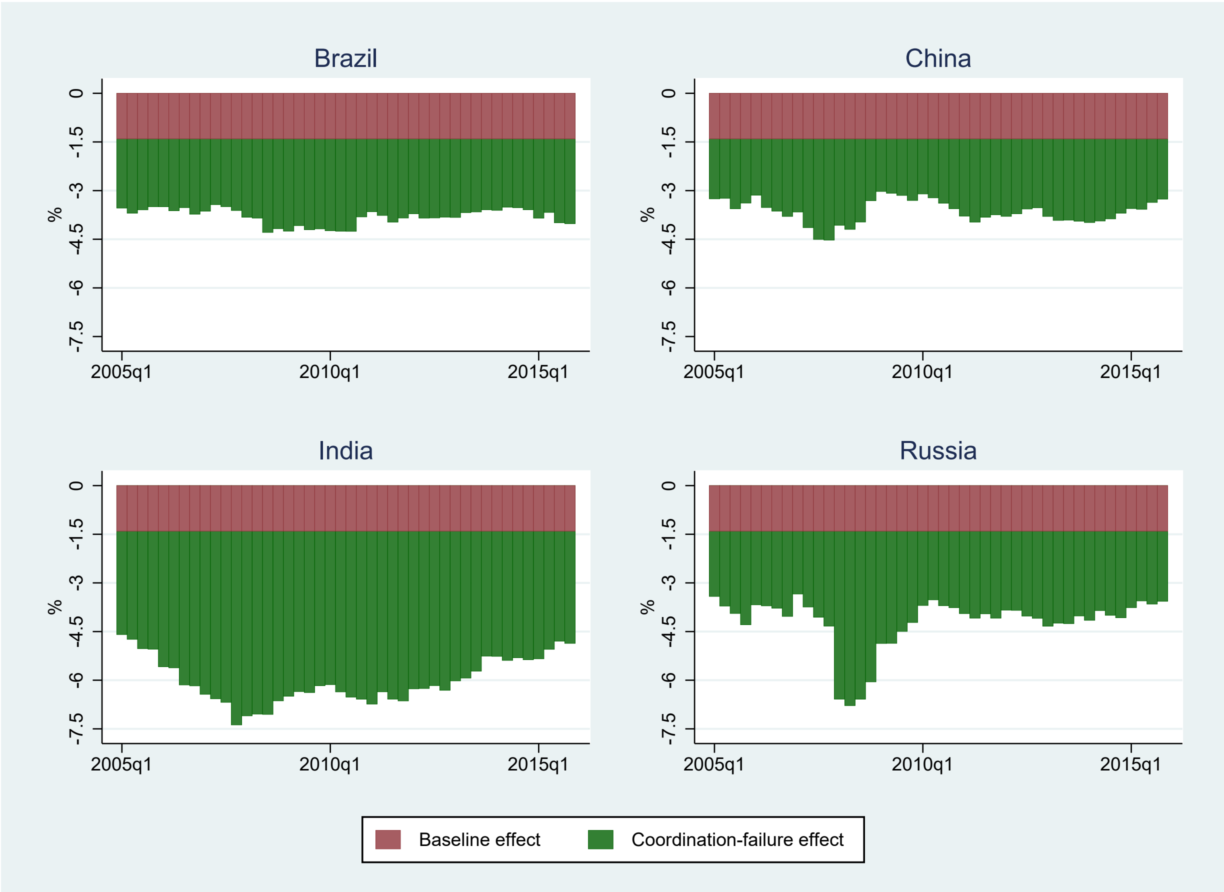
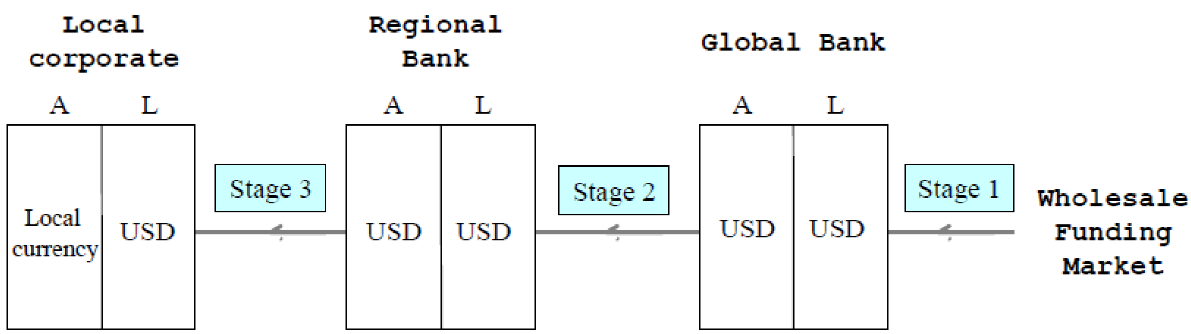


Figure 6: Effect of a 1% currency depreciation on cross-border loans to non-financial corporations - selected emerging countries



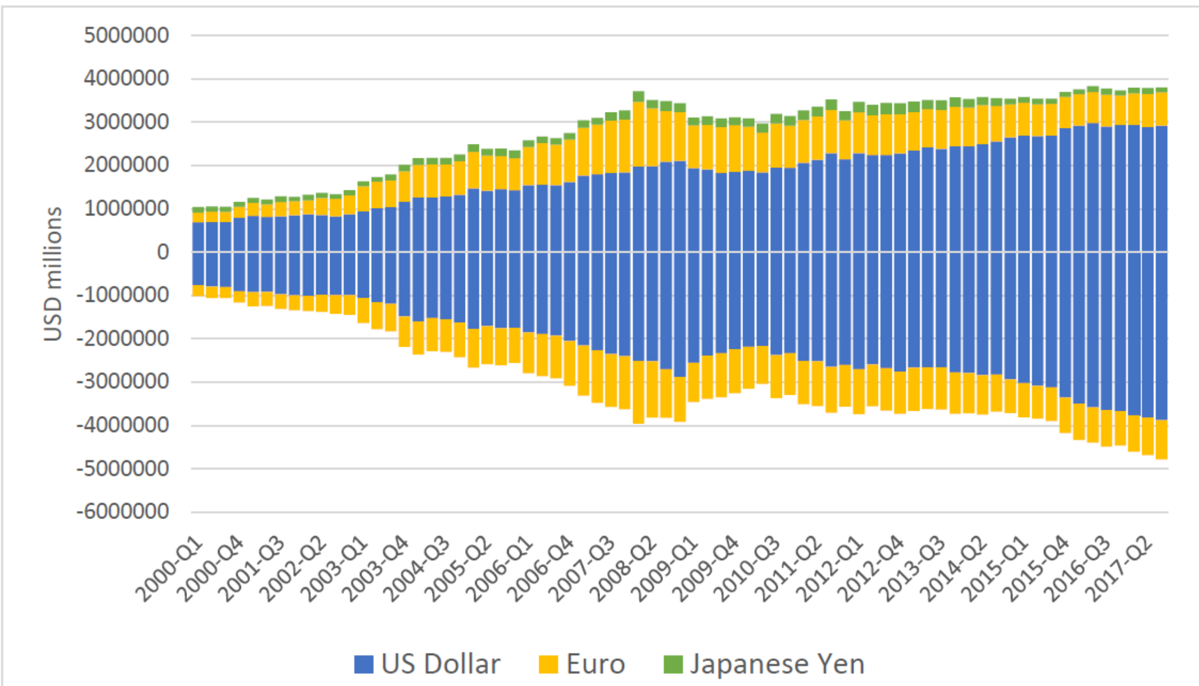
Source: author's calculations

Figure 7: Structure of international bank lending



Source: Bruno and Shin (2015a)

Figure 8: Foreign currency local assets (+) and liabilites (-) of banks in emerging economies



Source: Bank for International Settlements, locational banking statistics

Appendix A: Proofs

Proof of Proposition 1

The proof will show the first part of the proposition, i.e. $s(\theta_{b,0}) = 0$ for all $\theta_{b,0} < \theta^* - \delta$. The second part, i.e. $s(\theta_{b,0}) = 1$ for all $\theta_{b,0} > \theta^* + \delta$, holds by a symmetric argument. It is convenient to divide the proof into three lemmas. The first lemma will prove equilibrium uniqueness for an equivalent game with two simplifying assumptions: banks hold a uniform prior over the future exchange rate θ_1 and signals enter the utility function in lieu of the actual realizations. Removing these two assumptions, the second lemma shows that if the variance of signals across banks is sufficiently small, upon observing a sufficiently small signal it is optimal not to lend. The third lemma shows that, if the variance of signals across banks is sufficiently small, it is optimal not to lend upon observing a signal precisely below the cutoff θ^*. In particular, Lemma 3 shows convergence to the optimal strategy of Lemma 1.

Lemma 1. Let A1 to A5 be satisfied. Let θ^* be defined as in A3. The essentially unique strategy surviving iterated deletion of strictly dominated strategies satisfies $s(\theta_{b,0}) = 0$ for all $\theta_{b,0} < \theta^*$ and $s(\theta_{b,0}) = 1$ for all $\theta_{b,0} > \theta^*$.

Proof of Lemma 1. Write $\pi^*_\sigma(\theta_{b,0}, k, \lambda)$ for the expected payoff of choosing action 1 as opposed to action 0 when a bank has observed signal $\theta_{b,0}$ and knows that all other banks will choose action 0 if they observe a signal below k[15]:

$$\pi^*_\sigma(\theta_{b,0}, k, \lambda) = \int_0^{+\infty} g\left(\frac{\theta_{b,0} - \theta_1}{\sigma}\right) \pi\left(\theta_1, 1 - G\left(\frac{k - \theta_1}{\sigma}\right), \lambda\right) d\theta_1$$

$\pi^*_\sigma(\theta_{b,0}, k, \lambda)$ is continuous in k and $\theta_{b,0}$, increasing in $\theta_{b,0}$ and decreasing in k. Moreover, $\pi^*_\sigma(\theta_{b,0}, k, \lambda) < 0$ if $\theta_{b,0} < \underline{\theta}$ and $\pi^*_\sigma(\theta_{b,0}, k, \lambda) > 0$ if $\theta_{b,0} > \overline{\theta}$.

By induction, a strategy survives n rounds of iterated deletion of strictly dominated strategies if and only if

$$s(\theta_{b,0}) = \begin{cases} 0 & if\ \theta_{b,0} < \underline{\xi}_n \\ 1 & if\ \theta_{b,0} > \overline{\xi}_n \end{cases}$$

[15]See footnote 8 for an explanation of the components of this equation, keeping in mind that here I am assuming a uniform prior: $v(\theta_{b,0}) = I_{[0,1]}$

where $\underline{\xi}_0 = 0$, $\overline{\xi}_0 = +\infty$ and $\underline{\xi}_n$, $\overline{\xi}_n$ are defined inductively by

$$\underline{\xi}_{n+1} = min\left\{\theta_{b,0} : \pi^*_\sigma\left(\theta_{b,0}, \underline{\xi}_n, \lambda\right) = 0\right\}$$

$$\overline{\xi}_{n+1} = max\left\{\theta_{b,0} : \pi^*_\sigma\left(\theta_{b,0}, \overline{\xi}_n, \lambda\right) = 0\right\}$$

$\underline{\xi}_{n+1}$is the lowest signal such that choosing 0 with cutoff $\underline{\xi}_n$ is still an optimal strategy. $\overline{\xi}_{n+1}$is the highest signal such that choosing 1 with cutoff $\overline{\xi}_n$ is still an optimal strategy. Crucially, $\underline{\xi}_n$and $\overline{\xi}_n$ are increasing and decreasing sequences respectively because $\underline{\xi}_0 = 0 < \underline{\theta}_1 < \underline{\xi}_1$ and $\overline{\xi}_0 = +\infty > \overline{\theta}_1 > \overline{\xi}_1$ and $\pi^*_\sigma\left(\theta_{b,0}, k, \lambda\right)$ is increasing in $\theta_{b,0}$ and decreasing in the cutoff k. Therefore, $\underline{\xi}_n \to \underline{\xi}$ and $\overline{\xi}_n \to \overline{\xi}$ as $n \to \infty$. Since π^*_σ is continuous, by construction I must have $\pi^*_\sigma\left(\underline{\xi}, \underline{\xi}, \lambda\right) = \pi^*_\sigma\left(\overline{\xi}, \overline{\xi}, \lambda\right) = 0$. The remainder of the proof shows that the unique x that solves $\pi^*_\sigma\left(x, x, \lambda\right) = 0$ is θ^*.

Write $\Psi^*_\sigma\left(N, \theta_{b,0}, k\right)$ for the probability that a bank assigns to proportion less than N of the other banks observing a signal greater than k if it has observed signal $\theta_{b,0}$[16].

$$\Psi^*_\sigma\left(N, \theta_{b,0}, k\right) = \int_{-\infty}^{k-\sigma G^{-1}(1-N)} g\left(\frac{\theta_{b,0} - \theta_1}{\sigma}\right) d\theta_1$$

Changing variables to $z = \frac{\theta_{b,0} - \theta_1}{\sigma}$,

$$\begin{aligned}\Psi^*_\sigma\left(N, \theta_{b,0}, k\right) &= \int_{\frac{\theta_{b,0}-k}{\sigma} + G^{-1}(1-N)}^{+\infty} g\left(z\right) dz \\ &= 1 - G\left(\frac{\theta_{b,0} - k}{\sigma} + G^{-1}\left(1 - N\right)\right)\end{aligned}$$

If $\theta_{b,0} = k$ then $\Psi^*_\sigma\left(N, \theta_{b,0}, k\right) = N$, hence the corresponding pdf $\psi^*_\sigma\left(N, \theta_{b,0}, k\right)$ must be a uniform.

[16]If the true state is θ_1, the proportion of players observing a signal greater than k is equal to $Prob\left(\theta_{b,0} \geq k\right) = 1 - Prob\left(\theta_1 + \sigma\varepsilon_{b,0} \leq k\right) = 1 - G\left(\frac{k-\theta_1}{\sigma}\right)$.This proportion is greater than N if $1 - G\left(\frac{k-\theta_1}{\sigma}\right) \geq N$, i.e. $\theta_1 \leq k - \sigma G^{-1}\left(1 - N\right)$.

To complete the proof, notice that I can rewrite $\pi^*_\sigma(\theta_{b,0},k,\lambda)$ in terms of $\psi^*_\sigma(N,\theta_{b,0},k)$[17]

$$\pi^*_\sigma(\theta_{b,0},k,\lambda) = \int_0^{+\infty} g\left(\frac{\theta_{b,0}-\theta_1}{\sigma}\right)\pi\left(\theta_1, 1-G\left(\frac{k-\theta_1}{\sigma}\right),\lambda\right)d\theta_1$$
$$= \int_0^1 \psi^*_\sigma(N,\theta_{b,0},k)\,\pi\left(k-\sigma G^{-1}(1-N),N,\lambda\right)dN$$

so that when $\theta_{b,0}=k$ I have

$$\pi^*_\sigma(k,k,\lambda) = \int_0^1 \pi(\theta_1,N,\lambda)\,dN$$

By A3, I conclude that $\pi^*_\sigma(k,k,\lambda)=0$ implies $k=\theta^*$. Note that the "essential" qualification in the statement of the lemma refers to the non-uniqueness of the equilibrium when the private signal is exactly equal to the cutoff θ^*.

■

Now assume a general prior $v(.)$ and let exchange rates, not their signals, enter the utility function. Write $N(\theta_{b,0})$ for the proportion of players observing signal $\theta_{b,0}$ and choosing action 1. Write $\pi_\sigma(\theta_{b,0},k,\lambda)$ for the highest possible expected gain from choosing action1 as opposed to action 0 for a bank that has observed signal $\theta_{b,0}$ and knows that all the other banks will choose action 0 if they observe signals less than k (the cutoff)[18]:

$$\pi_\sigma(\theta_{b,0},k,\lambda) = \max_{\{N:N(x)=0\,\forall\,x<k\}} \frac{\int_0^{+\infty} v(\theta_1)g\left(\frac{\theta_{b,0}-\theta_1}{\sigma}\right)\pi\left(\theta_1,1-G\left(\frac{k-\theta_1}{\sigma}\right),\lambda\right)d\theta_1}{\int_0^{+\infty} v(\theta_1)g\left(\frac{\theta_{b,0}-\theta_1}{\sigma}\right)d\theta_1}$$

[17] As in footnote 6, the proportion N of banks choosing action 1 upon observing signal $\theta_{i,1}$when the cutoff is k is equal to $Prob(\theta_{b,0}\geq k) = 1-G\left(\frac{k-\theta_1}{\sigma}\right)$. Hence, $\theta_1 = k-\sigma G^{-1}(1-N)$ and $g\left(\frac{\theta_{b,0}-\theta_1}{\sigma}\right)$ can be rewritten as a function of N as $g\left(\frac{\theta_{b,0}-k+\sigma G^{-1}(1-N)}{\sigma}\right) = \psi^*_\sigma(N,\theta_{b,0},k)$.

[18] In order to understand this expression it is useful to break it down into pieces. $E[\pi(\theta_1,N,\lambda)\mid\theta_{i,1}] = \int_0^{+\infty}\pi(\theta_1,N,\lambda)\,prob(\theta_1\mid\theta_{b,1})\,d\theta_1$. Using Bayes' theorem, I can rewrite the conditional probability $prob(\theta_1\mid\theta_{b,1})$ as $\frac{prob(\theta_{b,1}\mid\theta_1)\,prob(\theta_1)}{prob(\theta_{b,1})}$. Hence, using the terminology of Section 3 for the various distributions involved and keeping in mind that $\theta_{b,1}=\theta_1+\sigma\varepsilon_b$, $v(\theta_1\mid\theta_{b,1}) = \frac{g(\varepsilon_b)\,v(\theta_1)}{\int g(\varepsilon_b)\,v(\theta_1)\,d\theta_1} = \frac{g\left(\frac{\theta_{b,1}-\theta_1}{\sigma}\right)v(\theta_1)}{\int g\left(\frac{\theta_{b,1}-\theta_1}{\sigma}\right)v(\theta_1)\,d\theta_1}$. Finally, the expected proportion of banks choosing action 1 is the expected proportion of banks receiving a signal above the threshold k. Therefore, N is equal to $g(\theta_{b,1}>k) = g(\theta_1+\sigma\varepsilon_b>k) = g\left(\varepsilon_b>\frac{k-\theta_1}{\sigma}\right) = 1-G\left(\frac{k-\theta_1}{\sigma}\right)$, where $G(.)$ is the cdf of $g(.)$.

Lemma 2. $\exists\, \underline{\theta}_b \in \mathbb{R}$ and $\overline{\sigma}_1 \in \mathbb{R}_{++}$ such that $\pi_\sigma(\theta_{b,0}, k, \lambda) < 0$ for all $\sigma \leq \overline{\sigma}_1,\ \theta_{b,0} \leq \underline{\theta}_b$ and $k \in \mathbb{R}$.

Proof of Lemma 2. Using assumption A4*, take $\underline{\theta}_b < \underline{\theta}$ and a continuously differentiable function $\overline{\pi}:\ \mathbb{R} \to \mathbb{R}$ with $\overline{\pi}'(\theta_1) = 0$ and $\overline{\pi}(\theta_1) = -\epsilon$ for all $\theta_1 < \underline{\theta}_b$ such that $\pi(\theta_1, N, \lambda) \leq \overline{\pi}(\theta_1) \leq -\epsilon$ for all $N \in [0, 1]$. The function $\overline{\pi}$ is an upper bound on the payoff loss of choosing action 1 when the exchange rate is below $\underline{\theta}_b$. Define the expected upper bound of the payoff loss as a function of the signal observed:

$$\overline{\pi}_\sigma\left(\theta_{b,0}\right) = \frac{\int_o^{+\infty} v\left(\theta_1\right) g\left(\frac{\theta_{b,0}-\theta_1}{\sigma}\right) \overline{\pi}\left(\theta_1\right) d\theta_1}{\int_o^{+\infty} v\left(\theta_1\right) g\left(\frac{\theta_{b,0}-\theta_1}{\sigma}\right) d\theta_1}$$

Changing variables to $z = \frac{\theta_1 - \theta_{b,0}}{\sigma}$, the expression becomes

$$\overline{\pi}_\sigma\left(\theta_{b,0}\right) = \frac{\int_{-\infty}^{+\infty} v\left(\theta_{b,0}+\sigma z\right) g\left(-z\right) \overline{\pi}\left(\theta_{b,0}+\sigma z\right) dz}{\int_{-\infty}^{+\infty} v\left(\theta_{b,0}+\sigma z\right) g\left(-z\right) dz}$$

$\overline{\pi}_\sigma\left(\theta_{b,0}\right)$ is an upper bound on $\pi_\sigma(\theta_{b,0}, k, \lambda)$ for all k. Also, $\overline{\pi}_\sigma\left(\theta_{b,0}\right)$ is continuous in σ. Setting σ to 0 I get $\overline{\pi}_0\left(\theta_{b,0}\right) = \overline{\pi}\left(\theta_{b,0}\right)$, so $\overline{\pi}_0\left(\theta_{b,0}\right) = -\epsilon$ for all $\theta_{b,0} \leq \underline{\theta}_b$. Moreover[19],

$$\left.\frac{d\overline{\pi}_\sigma}{d\sigma}\left(\theta_{b,1}\right)\right|_{\sigma=0} = \left[\int_{-\infty}^{+\infty} zg(-z)dz\right] \frac{\overline{\pi}'\left(\theta_{b,1}\right)}{v\left(\theta_{b,1}\right)}$$

Then, by assumption A6 (finite expectations of signals), $\frac{d\overline{\pi}_\sigma}{d\sigma}\left(\theta_{b,0}\right) = 0$ for all $\theta_{b,0} \leq \underline{\theta}_b$. Thus, $\exists\, \overline{\sigma} \in \mathbb{R}_{++}$ such that $\overline{\pi}_\sigma\left(\theta_{b,0}\right) < 0$ for all $\sigma \leq \overline{\sigma}$ and $\theta_{b,0} \leq \underline{\theta}_b$.

■

[19] The full derivation is as follows

$$\left.\frac{d\overline{\pi}_\sigma}{d\sigma}\left(\theta_{b,0}\right)\right|_{\sigma=0} = \left[\int_{-\infty}^{+\infty} v\left(\theta_{b,0}+\sigma z\right) g\left(-z\right) dz\right]^{-2}$$

$$\left\{\left[\int_{-\infty}^{+\infty} v\left(\theta_{b,0}+\sigma z\right) g\left(-z\right) dz\right]\left[\int_{-\infty}^{+\infty} zg(-z)\left(v'\left(\theta_{b,0}+\sigma z\right)\overline{\pi}\left(\theta_{b,0}+\sigma z\right) + v\left(\theta_{b,0}+\sigma z\right)\overline{\pi}'\left(\theta_{b,0}+\sigma z\right)\right) dz\right]\right.$$

$$\left.\left. - \left[\int_{-\infty}^{+\infty} zg(-z)v'\left(\theta_{b,0}+\sigma z\right) dz\right]\left[\int_{-\infty}^{+\infty} v\left(\theta_{b,0}+\sigma z\right) g(-z)\overline{\pi}\left(\theta_{b,0}+\sigma z\right) dz\right]\right\}\right|_{\sigma=0} =$$

$$\left[\int_{-\infty}^{+\infty} zg(-z)dz\right] \frac{\overline{\pi}'\left(\theta_{b,0}\right)}{v\left(\theta_{b,0}\right)}$$

Lemma 3. $\exists\ \overline{\sigma}_2 \in \mathbb{R}_{++}$ such that $\pi_\sigma(\theta_{b,0}, k, \lambda) < 0$ for all $\sigma \leq \overline{\sigma}_2$, $\underline{\theta}_{b\leq}\theta_{b,0} < \theta^*$ and $\theta_{b,0} \leq k \leq \theta^*$.

Proof of Lemma 3. Define $\Psi_\sigma(N, \theta_{b,0}, k)$ the probability that a bank assigns to proportion less or equal than N of the other banks observing a signal higher thank k when it has observed signal $\theta_{b,1}$:

$$\Psi_\sigma(N, \theta_{b,0}, k) = \frac{\int_{-\infty}^{k-\sigma G^{-1}(1-N)} v(\theta_1)\, g\left(\frac{\theta_{b,0}-\theta_1}{\sigma}\right) d\theta_1}{\int_{-\infty}^{+\infty} v(\theta_1)\, g\left(\frac{\theta_{b,0}-\theta_1}{\sigma}\right) d\theta_1}$$

Changing variables to $z = \frac{\theta_{b,1}-\theta_1}{\sigma}$,

$$\Psi_\sigma(N, \theta_{b,0}, k) = \frac{\int_{\frac{\theta_{b,0}-k}{\sigma}+G^{-1}(1-N)}^{+\infty} v(\theta_{b,0}-\sigma z)\, g(z)\, dz}{\int_{-\infty}^{+\infty} v(\theta_{b,0}-\sigma z)\, g(z)\, dz}$$

For small σ the shape of the prior $v(.)$ will not matter and the posterior beliefs over N will depend only on $\frac{\theta_{b,0}-k}{\sigma}$, the normalized difference between the signal $\theta_{b,0}$and the cutoff k.

From Lemma 1, remember that $N = Prob(\theta_{b,0} \geq k) = 1 - G\left(\frac{k-\theta_1}{\sigma}\right)$. Therefore, $\theta_1 = k - \sigma G^{-1}(1-N)$ and $v(\theta_1)\, g\left(\frac{\theta_{b,0}-\theta_1}{\sigma}\right)$ can be rewritten as a function $\psi_\sigma(N, \theta_{b,0}, k)$ of N :

$$\psi_\sigma(N, \theta_{b,0}, k) = \frac{v\left(k - \sigma G^{-1}(1-N)\right) g\left(\frac{\theta_{b,0}-k+\sigma G^{-1}(1-N)}{\sigma}\right)}{\int_0^1 v\left(k - \sigma G^{-1}(1-N)\right) g\left(\frac{\theta_{b,0}-k+\sigma G^{-1}(1-N)}{\sigma}\right) dN}.$$

Hence, similarly to what I did in Lemma 1, I can equivalently write $\pi_\sigma(\theta_{b,0}, k, \lambda)$ as an expectation over θ_1 or as an expectation over N:

$$\begin{aligned}\pi_\sigma(\theta_{b,0}, k, \lambda) &= \frac{\int_0^{+\infty} v(\theta_1)\, g\left(\frac{\theta_{b,0}-\theta_1}{\sigma}\right) \pi\left(\theta_1, 1 - G\left(\frac{k-\theta_1}{\sigma}\right), \lambda\right) d\theta_1}{\int_0^{+\infty} v(\theta_1)\, g\left(\frac{\theta_{b,0}-\theta_1}{\sigma}\right) d\theta_1} \\ &= \int_0^1 \psi_\sigma(N, \theta_{b,0}, k)\, \pi\left(k - \sigma G^{-1}(1-N), N\right) dN\end{aligned}$$

Let $\sigma \to 0$. Then $\Psi_\sigma(N, \theta_{b,0}, k) \to 1 - G\left(\frac{\theta_{b,0}-k}{\sigma} + G^{-1}(1-N)\right) = \Psi_\sigma^*(N, \theta_{b,0}, k)$, where $\Psi_\sigma^*(N, \theta_{b,0}, k)$ is the the probability that a bank assigns to proportion less than N of the other banks observing a signal greater than k if it has observed signal $\theta_{b,0}$ from Lemma 1. Therefore, as $\sigma \to 0$, $\pi_\sigma(\theta_{b,0}, k, \lambda) \to \pi_\sigma^*(\theta_{b,0}, k, \lambda)$ continuously, where $\pi_\sigma^*(\theta_{b,0}, k, \lambda)$ is the equivalent of $\pi_\sigma(\theta_{b,0}, k, \lambda)$ from Lemma 1, i.e. with a uniform prior and with signals in the utility function. Take $k = \theta_{b,0}$ as in Lemma 1. $\lim_{\sigma\to 0} \pi_\sigma(k, k, \lambda) = \int_0^1 \pi(\theta_1, N, \lambda)\, dN$. By A3, I can conclude that $\lim_{\sigma\to 0} \pi_\sigma(k, k, \lambda) = 0$ implies $k = \theta^*$.

■

Proof of Proposition 2.

By A7, $\chi(\theta^*, \lambda_0) = \int_0^1 \mu(\theta^*, N_1, \lambda_0)\, dN_1$ has continuous partial derivatives in θ^* and λ_0. Therefore, by the implicit function theorem, there exists a unique function $\theta^* = \gamma(\lambda_0)$ such that $\chi(\gamma(\lambda_0), \lambda_0) = \frac{1+r_0}{1+R_0}$. Moreover, the implicit function theorem guarantees that $\gamma(\lambda_0)$ is continuously differentiable and that

$$\frac{d\gamma(\lambda_0)}{d\lambda_0} = -\frac{\partial\chi(\theta^*, \lambda_0)}{\partial\lambda_0} \Big/ \frac{\partial\chi(\theta^*, \lambda_0)}{\partial\theta^*}$$

$\frac{\partial\chi(\theta^*,\lambda_0)}{\partial\lambda_0}$ is nonpositive by assumption A8. $\frac{\partial\chi(\theta^*,\lambda_0)}{\partial\theta^*}$ is nonnegative by assumption A2. Therefore, $\frac{d\gamma(\lambda_0)}{d\lambda_0} \geq 0$.

■

Appendix B: Additional tables

Table B1: Data on total international liabilities - frequency

Country	First year of yearly data	First year of quarterly data
Argentina (AR)	2001	-
Brazil (BR)	2001	2002
Bulgaria (BG)	2001	2007
Chile (CL)	1998	2008
China (CN)	2004	2011
Colombia (CO)	2000	2000
Croatia (HR)	2001	2001
Czech Republic (CZ)	2001	2004
Hong Kong (HK)	2001	2010
Hungary (HU)	2001	2001
India (IN)	2001	2006
Indonesia (ID)	2001	2014
Israel (IL)	2001	2001
Korea (KR)	2001	2001
Kuwait (KW)	2001	-
Malaysia (MY)	2001	2015
Mexico (MX)	2001	2009
Peru (PE)	2001	2001
Philippines (PH)	2001	2013
Poland (PL)	2001	2004
Romania (RO)	2001	2001
Russia (RU)	2001	2014
Saudi Arabia (SA)	2007	2012
Singapore (SG)	2001	2014
South Africa (ZA)	2001	2014
Thailand (TH)	2001	2012
Turkey (TR)	2001	2006
Ukraine (UA)	2001	2010
Uruguay (UY)	2001	2012

Table B2: Effect of exchange rate volatility on cross-border loans - restricted sample 2010:Q1 - 2015:Q4

	ΔCross-border loans[1]			
	(1)	(2)	(3)	(4)
	to all sectors	to firms	to banks	to the public sector
ΔExchange rate[1]	2.256*	2.190**	0.412	15.351
	(1.313)	(0.674)	(7.014)	(13.134)
ΔExchange rate[1] * λ^2	37.227*	44.344**	20.100	-2.092
	(19.155)	(17.594)	(40.952)	(30.886)
Borrowing-country controls	Yes	Yes	Yes	Yes
Lender·borrower FE	Yes	Yes	Yes	Yes
Lender·time FE	Yes	Yes	Yes	Yes
Observations	16,019	15,261	13,111	9,286
R-squared	0.172	0.181	0.127	0.155

Notes: The sample includes quarterly data for 30 lending countries, 29 borrowing countries (emerging economies) over the period 2010:Q1 - 2015:Q4. [1] Quarterly growth rate (%). [2]Cross-border lending over total capital flows. Borrowing-country controls include ΔLending rate, ΔReal GDP, ΔSovereign ratings, Chinn-Ito index, ΔSize, ΔETA, ΔDEPtoTA, ΔNETINTtoTA, ΔINTREVtoTOTREV as well as their interaction with λ. The regression also includes lender-borrower and lender-time fixed effects. Standard errors are clustered by lender-time. *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

Table B3: Effect of exchange rate volatility on cross-border loans - λ computed as a fraction of lending to firms only

	ΔCross-border loans[1]			
	(1)	(2)	(3)	(4)
	to all sectors	to firms	to banks	to the public sector
ΔExchange rate[1]	6.457***	4.769***	5.352	15.100
	(1.370)	(1.227)	(4.883)	(12.265)
ΔExchange rate[1] * λ^2	9.307*	6.999***	0.188	-6.650
	(5.284)	(2.158)	(10.489)	(8.708)
Borrowing-country controls	Yes	Yes	Yes	Yes
Lender·borrower FE	Yes	Yes	Yes	Yes
Lender·time FE	Yes	Yes	Yes	Yes
Observations	35,718	33,519	29,263	21,649
R-squared	0.163	0.171	0.121	0.150

Notes: The sample includes quarterly data for 30 lending countries, 29 borrowing countries (emerging economies) over the period 2001:Q1 - 2015:Q4. [1] Quarterly growth rate (%). [2]Cross-border lending to firms over total capital flows to firms. Borrowing-country controls include ΔLending rate, ΔReal GDP, ΔSovereign ratings, Chinn-Ito index, ΔSize, ΔETA, ΔDEPtoTA, ΔNETINTtoTA, ΔINTREVtoTOTREV as well as their interaction with λ. The regression also includes lender-borrower and lender-time fixed effects. Standard errors are clustered by lender-time. *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

Table B4: Effect of exchange rate volatility on cross-border loans - lagged right-hand-side variables

	ΔCross-border loans[1]			
	(1)	(2)	(3)	(4)
	to all sectors	to firms	to banks	to the public sector
ΔExchange rate$^1_{t-1}$	1.960	2.957***	10.627	3.622
	(1.908)	(0.880)	(8.099)	(3.537)
ΔExchange rate$^1_{t-1}$ * λ^2_{t-1}	11.802	17.790**	3.463	-12.821
	(9.093)	(7.518)	(18.888)	(16.254)
Borrowing-country controls	Yes	Yes	Yes	Yes
Lender·borrower FE	Yes	Yes	Yes	Yes
Lender·time FE	Yes	Yes	Yes	Yes
Observations	33,010	30,996	26,908	19,971
R-squared	0.165	0.173	0.123	0.149

Notes: The sample includes quarterly data for 30 lending countries, 29 borrowing countries (emerging economies) over the period 2001:Q1 - 2015:Q4. [1] Quarterly growth rate (%). [2]Cross-border lending over total capital flows. Borrowing-country controls include ΔReal GDP, ΔSovereign ratings, Chinn-Ito index, ΔSize, ΔETA, ΔDEPtoTA, ΔNETINTtoTA, ΔINTREVtoTOTREV. Exchange rates and λ enter the equation with one lag. The regression also includes lender-borrower and lender-time fixed effects. Standard errors are clustered by lender-time. *** p<0.01, ** p<0.05, * p<0.1.

Table B5: Effect of exchange rate volatility on direct investment and portfolio investment

	(1) ΔDirect investment[1]	(2) ΔPortfolio investment[1]
ΔExchange rate[1]	4.294	9.164**
	(5.425)	(4.126)
ΔExchange rate[1] * λ^2	10.268	-0.021
	(11.973)	(13.688)
Borrowing-country controls	Yes	Yes
Borrowing-country FE	Yes	Yes
Time FE	Yes	Yes
Observations	1,397	1,397
R-squared	0.424	0.374

Notes: The sample includes quarterly data for 29 borrowing countries (emerging economies) over the period 2001:Q1 - 2015:Q4. [1] Quarterly growth rate (%). [2]Direct investment over total capital flows (direct investment column); portfolio investment over total international capital flows (portfolio investment column). Foreign direct investment is a category of cross-border investment associated with a resident in one economy having control or a significant degree of influence on the management of an enterprise that is resident in another economy. By contrast, portfolio investment entails a share in ownership but no significant influence over the enterprise's operations. Borrowing-country controls include ΔLending rate, ΔReal GDP, ΔSovereign ratings, Chinn-Ito index, ΔSize, ΔETA, ΔDEPtoTA, ΔNETINTtoTA, ΔINTREVtoTOTREV as well as their interaction with λ. The regression also includes borrower and time fixed effects. Standard errors are clustered by borrower. *** p<0.01, ** p<0.05, * p<0.1.

Appendix C: List of countries in the dataset

Borrowing countries (29)

Argentina (AR), Brazil (BR), Bulgaria (BG), Chile (CL), China (CN), Colombia (CO), Croatia (HR), Czech Republic (CZ), Hong Kong SAR (HK), Hungary (HU), India (IN), Indonesia (ID), Israel (IL), Korea (KR), Kuwait (KW), Malaysia (MY), Mexico (MX), Peru (PE), Philippines (PH), Poland (PL), Romania (RO), Russia (RU), Saudi Arabia (SA), Singapore (SG), South Africa (ZA), Thailand (TH), Turkey (TR), Ukraine (UA), Uruguay (UY).

Lending countries (30)

Australia (AU), Austria (AT), Belgium (BE), Brazil (BR), Canada (CA), Chile (CL), Denmark (DK), Finland (FI), France (FR), Germany (DE), Greece (GR), Hong Kong SAR (HK), India (IN), Ireland (IE), Italy (IT), Japan (JP), Korea (KR), Luxembourg (LU), Mexico (MX), Netherlands (NL), Norway (NO), Portugal (PT), Singapore (SG), Spain (ES), Sweden (SE), Switzerland (CH), Taiwan (TW), Turkey (TR), United Kingdom (GB), United States (US).