Exchange Rates, Strategic Uncertainty and International Bank Lending

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Abstract

Internationally-active banks raise wholesale funding in US dollars and lend to borrowers abroad in US dollars. Local borrowers invest in local currency and bear the currency risk. This paper shows that, conditional on a depreciation of the local currency, countries where international bank lending is an important source of corporate financing will experience smaller inflows of cross-border loans with respect to other countries. A depreciation of the local currency acts as a coordination device for international banks that face strategic complementarities in lending. This payoff complementarity is stronger for countries where international bank lending is a relevant source of financing for local borrowers. We construct a global game among international lenders to illustrate the mechanism. Moreover, using bilateral BIS data on cross-border lending from banks headquartered in 30 countries to recipients in 30 emerging economies, we provide evidence that an economy's stronger reliance on cross-border lending amplifies the effect of exchange rate shifts on incoming cross-border loans.

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

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1 Introduction

Consider an emerging economy with a local currency and an exchange rate vis à vis the US dollar. Local corporate borrowers fund themselves in US dollars from international banks and they invest in entrepreneurial projects in local currency. If the local currency depreciates, local corporates see the asset side of their balance sheet shrink with respect to their liability side. Upon observing a depreciation, international lenders expect that local borrowers will have a greater chance to go bankrupt and therefore a smaller chance of being able to repay their loan, so they decide to reduce the stock of lending to borrowers in that country. We show that this effect can by magnified by the share of corporate financing from abroad accounted for by cross-border loans.

When local borrowers are interdependent, i.e. the probability of success of each individual project increases with the number of other entrepreneurs that receives financing, banks face strategic complementarities in lending because they find it more convenient to lend if other international banks also lend. Indeed, the greater the number of banks that lend, the more entrepreneurs will receive financing and the greater the chance that each individual project will be successful, allowing the entrepreneur to pay back her loan with interest. These strategic complementarities among banks are stronger when local borrowers have less alternatives to cross-border lending to finance their projects. Indeed, when this is the case, each international bank knows that if it doesn't finance a particular project, chances are the entrepreneur will not find alternative means of financing. Given the interdependence of the entrepreneurs, the chances of success of other projects that have been financed will be smaller, so the choice of each individual bank will have a greater impact on the payoffs of the other banks. This mechanism acts as a multiplier of the impact of exchange rates on cross-border loans and it lead to inefficient lending[1].

Over the period 2001:Q1 - 2015:Q4, cross-border lending accounted for an average of 17% of total international capital flows. They are their largest debt component, followed by international debt securities. Therefore, they are important determinants of global financial conditions and worldwide economic activity. Moreover, they are particularly important for

[1]This claim is a known characteristic of any global game. See Morris and Shin (2003) and Section 2 for more details.

emerging market corporate borrowers because they complement the activity of domestic banks. (Bank for International Settlements, 2011a and 2011b). However, cross-border loans are the most volatile component of capital flows to emerging markets (Pagliari and Hannan, 2017), making the study of its causes an important policy issue.

This paper uses a dataset compiled by the Bank for International Settlements to capture cross-border loans. The dataset records the claims of banks headquartered in 30 countries vis à vis borrowers in 30 emerging markets. The data are aggregated at the country level. Moreover, it provides a breakdown of borrowers by sector: banks, non banks (including large non-financial corporations, exporting and importing firms and leveraged non-bank financials) and the public sector (government, central banks and regional development banks). The scope and depth of the dataset provides several advantages. First, we exploit the bilateral nature of the dataset to control for demand and supply effects using appropriate time-varying fixed effects. Second, it is the unique dataset that 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. Under such a model, Bruno and Shin (2015a) argue that the effects of local exchange rates 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). Our data consolidate the positions of foreign affiliates into the claims of the parent foreign banks, so our measure of cross-border lending also includes lending from local banks that are controlled by a foreign bank. Thus, we can capture all the channels through which a shock to the local exchange rate can propagate to international lenders.

We identify the combined effect of exchange rates and the relevance of cross-border lending for local corporates in two complementary ways. First, we use lender-time and lender-borrower fixed effects. These effects isolate 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 is equivalent to looking at the variation of lending from the same lending country to different borrowers and over time. However, demand-side confounders cannot be accounted for by using fixed effects, because they would absorb our variables of interest (local exchange rate variation and local relevance of cross-border lending). Therefore, we use a full set of demand side controls that account for the macroeconomic cycle and for the balance sheet characteristics of the banking sector of the borrowing country. We took the balance sheet characteristics from Bankscope and we aggregated them by country. They include measures of the solvency, liquidity, profitability and business models of the banking sector of the recipient country.

A remaining identification concern is that some demand-side confounders might not be observable, so they cannot be included in the control set. To overcome this issue we follow the logic of Khwaja and Mian (2005) and we exploit the full implications of the theoretical mechanism we wish to identify 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. We estimate the differential effect of exchange rate variation (borrower-time variable) in countries where cross-border loans are a bigger source of financing (borrower-time variable) and where lending to non-financial corporates is a larger share of total lending from a particular lending country (lender-borrower-time variable). This transformation allows us to use borrower-time fixed effects to account for any possible demand side confounders. This approach is equivalent to exploiting the variation over time and across borrowers and across lenders[2]. The resulting estimate, multiplied by the average share of lending to non-financial corporates across different lenders, yields statistically the same coefficient of the estimation performed with demand-side controls.

Our results show that countries that rely more on cross-border lending as a fraction of total international capital flows are more vulnerable to fluctuations in the local exchange rate. In a country where cross-border loans account for 17% of total capital flows (the sample mean), a 1% quarter-on-quarter depreciation of the local currency causes a 4.8% quarterly reduction on cross-border loans to corporate borrowers. If the share of total flows account by loans increases to 50%, then a 1% quarter-on-quarter depreciation of the local currency causes a 10.7% quarterly decrease of cross-border flows to corporate borrowers. For a share of 71%, the maximum recorded in our sample, the effect goes up to 14.4%. We do not record this

[2]See Figure B1 in the Appendix for a review of the variation in the data suppressed by different kinds of fixed effects.

effect when the borrowers are banks or the public sector.

The drivers of cross-border flows have been widely studied in the literature. Moreover, the link between financial stability and cross-border bank flows has been explored in many papers like Miranda-Agrippino and Rey (2015); Rey (2013); Obstfeld (2012a, 2012b); Gourinchas and Obstfeld (2012); Schularick and Taylor (2012); Cetorelli and Goldberg (2012a, 2012b). Bruno and Shin (2015a, 2015b) find a negative effect of a depreciation of the local currency on incoming bank flows. However, the focus of Bruno and Shin(2015a)'s paper is on the effects for lending banks' balance sheet and not on the stock of lending to emerging markets. Moreover, the focus of this paper, i.e. coordination failures and inefficient levels of lending after a depreciation of the local currency, is a completely new topic. The paper is also linked to the literature on the transmission of advanced economy monetary policy to emerging markets (e.g Avdjiev et al., 2017). A shift in the local exchange rate vis à vis the dollar can also be see as the consequence to a US monetary policy shift. Again, the focus on the effect of exchange rates on cross-border lending to countries more or less dependent on those flows is a novelty. The mechanism that underlies the findings of the paper is nothing but a "panic" among international lenders, based on the imperfect observation of a signal of the fundamental. Thus, the paper owes much to the literature on fundamentals versus panics and in particular to Morris and Shin (1998, 2003); Diamond and Dybvig (1983); Chari and Jagannathan (1988); Obstfeld (1996); Corsetti, Dasgupta, Morris and Shin (2002); Allen, Carletti, Leonello and Goldstein (2017); Goldstein and Pauzner (2005); Morris, Shin and Yildiz (2016); Allen and Gale (1998). Our approach to proxying for strategic complementarities is similar to the one in Morris and Shin (2014), who use the fraction of assets managed by asset managers to identify strategic complementarities among the managers. This paper is one of the very few to attempt empirical identification of strategic complementarities, the major one being Chen, Goldstein and Jiang (2010). Finally, our paper is linked to the literature on uncertainty in macroeconomics. Examples include Bloom (2009); Bloom, Baker and Davis (forthcoming); Ng, Jurado and Ludvigson (2015); Bekaert, Hoerova and Lo Duca (2013); Caggiano, Castelnuovo and Groshenny (2014); Bachman, Elstner and Sims (2013); Rossi and Sekhposyan (2015), Mueller,Tahbaz-Salehi and Vedolin (2017). However, this literature is focused on uncertainty regarding the fundamentals. This paper, instead, stresses the importance of strategic uncertainty (i.e. uncertainty about what the other players will do) on top of fundamental uncertainty.

2 A model of strategic complementarities among international lenders

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 corporate borrower from a continuum $[0, 1]$ in country E. Both lenders and borrowers are risk-neutral. Lending yields the bank a net interest rate R in $t = 1$ if the borrower repays its loan and 0 otherwise. Alternatively, the bank can decide not to lend to borrowers in country E and to invest 1 USD in a safe bond with a net interest rate r. If the bank lends, the borrower will use the dollar to invest in a project in local currency.

Firms in country E are interdependent (Bebchuck and Goldstein, 2011). The yield from each entrepreneurial project is dependent on how many other firms in the economy also invest in entrepreneurial projects. For example, think of firms belonging to the same value chain. Since firms need financing in order to invest, the yield of each single project is increasing in the number of firms that obtain financing. Bank loans are not the only source of financing in country E. Instead, bank loans accounts for a fraction $\lambda \in [0, 1]$ of total corporate financing from abroad (which includes foreign direct investment, international debt securities and other 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 external financing with probability $1/\lambda$. Hence, the yield of each project will depend positively on the fraction of banks lending ($N \in [0, 1]$) and on the probability that borrowers will find alternative financing sources ($1/\lambda$). Assuming that entrepreneurs gather all the fund 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 borrower. 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 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 know that their expected return is still a decreasing function of λ.

Summing up, in $t=1$ the project yields

$$\begin{cases} Q(N,1/\lambda) & w.p.\ \alpha \\ 0 & otherwise \end{cases}$$

where the yield Q is a function of N and $1/\lambda$. 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 $\theta_1 \in \mathbb{R}_{++}$. Define θ_1 as the strength of the local currency, or how many USD a unit of the local currency can buy. Knowing the payoff structure of the corporate borrower, the bank knows that its loan will be repaid only if

$$\alpha Q(N,1/\lambda)\theta_1 \geq 1+R$$

where the left-hand side is the expected payoff of the project in USD and the right-hand side is the amount the borrower owes the bank. Conditional on the bank giving the loan, the expected return of the bank is

$$\mu\left(\theta_1,N,\lambda\right)\left(1+R\right)$$

where $\mu\left(\theta_1,N,\lambda\right)$ is defined as $Prob(\alpha Q(N,1/\lambda)\theta_1 \geq 1+R)$. This probability is

- increasing in θ_1, the strength of the local currency vis à vis the USD. A depreciation of the local currency (i.e. a decrease of θ_1) implies a reduction in the dollar value of the asset side of the balance sheet of corporate borrowers. Therefore, a depreciation of the local currency increases the likelihood that the borrower will go bankrupt and will not repay the loan in $t=1$;

- increasing in N, the share of banks lending to corporate borrowers in country E. This property generates strategic complementarities among banks in their decision of lending to borrowers in country E;

- decreasing in λ, the share of bank financing (as opposed to other sources of financing) in country E and the inverse of the probability of finding alternative sources of financing.

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:

$$u(1, \theta_1, N, \lambda) = \mu(\theta_1, N, \lambda)(1 + R)$$

$$u(0, \theta_1, N, \lambda) = 1 + r$$

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

$$\underline{\theta_1} : \ \mu(\theta_1, 1, \lambda)(1 + R) = 1 + r$$

$$\overline{\theta_1} : \ \mu(\theta_1, 0, \lambda)(1 + R) = 1 + r$$

$\underline{\theta_1}$ is the level of realized exchange rate below which not lending is a dominant action regardless of what the other banks do (i.e. even if they all lend, $N = 1$). Conversely, $\overline{\theta_1}$ 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, $N = 0$). When $\theta_1 \in \left(\underline{\theta_1}, \overline{\theta_1}\right)$ 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, We apply the techniques developed in the global games literature (see Morris and Shin, 2003 for an introduction to the topic). We assume that the realization of θ_1 in $t = 0$ is not common knowledge. Instead, each bank b receives an idiosyncratic, noisy signal about θ_1:

$$\theta_{b,1} = \theta_1 + \sigma\varepsilon_{b,1}$$

where $\varepsilon_{b,1}$ is identically and independently distributed across banks according to the continuous distribution function $g(.)$ with support on the real line[3] and θ_1 is drawn from a continuously differentiable, strictly positive density $v(.)$ on the real line[4]. 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 2 sums up the timing of the model.

Given the structure of the payoffs and the information structure, there is a unique equilibrium and a cutoff exchange rate θ_1^* such that banks lend in $t = 0$ if and only if they receive a signal above θ_1^* and they do not lend if and only if they receive a signal below θ_1^*.

2.2 Assumptions and equilibrium uniqueness

This subsection spells out the precise assumptions that guarantee equilibrium uniqueness (Morris and Shin, 2003). 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.

Define

$$\begin{aligned}\pi\left(\theta_1, N, \lambda\right) &= u(1, \theta_1, N, \lambda) - u(0, \theta_1, N, \lambda) \\ &= \mu\left(\theta_1, N, \lambda\right)(1 + R) - (1 + r)\end{aligned}$$

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

Assumption A1 (Action monotonicity): $\pi\left(\theta_1, N, \lambda\right)$ is nondecreasing in N.[5]

A1 implies that the are are strategic complementarities among banks. The utility from choosing a particular action (lend or not lend) is higher when other banks also choose the

[3]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.

[4]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 $t = 0$. This assumption of persistence is not relevant at all for the theoretical theory, but it will be important in the empirical Section of the paper.

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

same action. In our 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, 2003) 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): $\pi(\theta_1, N, \lambda)$ is nondecreasing in θ_1.

Typically, the global banking system has a double-decker structure (Bruno and Shin 2015a,b). Global banks raise wholesale US dollar funding and then lend to local banks in other jurisdictions. The local banks draw on cross-border funding to lend to their local borrowers. Although banks are hedged in their currency exposure, the ultimate local borrowers has a currency mismatch, financing local currency assets with US dollar borrowing. When the local currency depreciates, the liability side of local borrowers expands. In our model, we abstract from the double-decker model and we assume that global banks lend directly to corporate borrowers. Even if the entrepreneurial project pays off an amount Q in local currency, when the local currency depreciates that amount 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 local exchange rate.

Assumption A3 (Strict Laplacian State Monotonicity): $\exists!\ \theta_1^* \in \mathbb{R}_+ : \int_0^1 \pi(\theta_1^*, N, \lambda)\, dN = 0$.

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

Assumption A4 (Limit dominance): $\exists\ \underline{\theta_1}, \overline{\theta_1} \in \mathbb{R}_+ : \pi(\theta_1, N, \lambda) < 0$ for all $N \in [0,1]$ and $\theta_1 < \underline{\theta_1}$; and $\pi(\theta_1, N, \lambda) > 0$ for all $N \in [0,1]$ and $\theta_1 > \overline{\theta_1}$.[6]

[6] This assumption can be strengthened as follows. Assumption A4* (Uniform Limit Dominance): $\exists\ \underline{\theta_1}, \overline{\theta_1} \in$

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. Given the state monotonicity in Assumption A2, Assumption A4 is equivalent to assuming that it must be dominant not to lend when $\theta_1 < \underline{\theta_1}$ (i.e. even if all banks lend, $N = 1$); conversely, it must be dominant to lend when $\theta_1 > \overline{\theta_1}$ (i.e. even if no other bank lends, $N = 0$). 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 ($Q(0, 1/\lambda) > 0$). If the exchange rate in $t = 1$ is particularly favorable, i.e. higher than $\overline{\theta_1}$, 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 $\underline{\theta_1}$ and it requires that project returns be bounded upwards, so that a sufficiently strong depreciation of the local currency will make local borrowers unable to repay their loans in USD.

Assumption A5 (Continuity): $\int_0^1 h(N)\pi(\theta_1, N, \lambda)\, dN$ is continuous with respect to the exchange rate θ_1 and density $h(.)$.

Assumption A6 (Finite Expectations of Signals): $\int_{-\infty}^{\infty} zg(z)dz$ is well defined.

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

Assumptions A5, A6 and A7 are technical assumptions. A5 is about the continuity of the payoffs with respect to the exchange rate θ_1 and to the distribution of beliefs over the behavior of other banks $h(N)$. A6 requires that noise be distributed according to a pdf $g(.)$ that admit a finite expected value. A7 implies that payoffs have continuous partial derivatives in θ_1, N, λ.

Assumption A8 (Monotonicity with respect to the share of bank lending): $\pi(\theta_1, N, \lambda)$ is nonincreasing in λ.

A8 states that higher shares of bank lending over total corporate financing will (weakly) decrease the payoff of lending. This assumption formalizes in one line the concept that borrowers in country E have a higher chance of finding alternative sources of financing if

$\mathbb{R}_+$ and $\varepsilon \in \mathbb{R}_{++}$ such that $\pi(\theta_1, N, \lambda) < -\varepsilon$ for all $N \in [0, 1]$ and $\theta_1 < \underline{\theta_1}$; and $\pi(\theta_1, N, \lambda) > \varepsilon$ for all $N \in [0, 1]$ and $\theta_1 > \overline{\theta_1}$. 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.

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 $1/\lambda$.

Denote $L(\sigma)$ the incomplete information game satisfying A1-A6, where $\theta_{i,1} = \theta_1 + \sigma\varepsilon_{i,1}$, θ_1 has distribution $v(.)$ (the prior) and signals have conditional distribution $g(.)$.

Proposition 1. *Let θ_1^* be defined as in A3. For any $\delta > 0$, $\exists\, \overline{\sigma} > 0$ such that for all $\sigma < \overline{\sigma}$, if strategy $s\left(\theta_{i,1}\right)$ survives iterated deletion of strictly dominated strategies in the game $L(\sigma)$, then*

$$s\left(\theta_{i,1}\right) = \begin{cases} Not\ lend & for\ all \quad \theta_{1,i} \leq \theta_1^* - \delta \\ Lend & for\ all \quad \theta_{1,i} \geq \theta_1^* + \delta \end{cases}$$

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_1^* and they will lend otherwise. The proof is in Appendix A and follows Morris and Shin (2003).

2.3 Characterization of the cutoff exchange rate

The cutoff θ_1^* is defined as in A3 such that a bank that receives a signal equal to θ_1^* 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. The following equation implicitly defines θ_1^*:

$$\int_0^1 \mu\left(\theta_1^*, N, \lambda\right)(1 + R)dN = 1 + r$$

It is interesting to characterize the relationship between θ^* and λ. Define $\int_0^1 \mu\left(\theta_1^*, N, \lambda\right)dN =$

$\chi(\theta_1^*, \lambda)$. Then θ_1^* is equivalently defined by

$$\chi(\theta_1^*, \lambda) = \frac{1+r}{1+R}$$

Assume A7 and A8. Then $\chi(\theta_1^*, \lambda)$ depends positively on the cutoff exchange rate θ_1^* and negatively on the share of corporate financing accounted for by cross-border loans λ.

Proposition 2: *Assume A1-A8. Then θ_1^* can be expressed as a continuously differentiable function of λ: $\theta_1^* = \gamma(\lambda)$. This function is such that*

$$\frac{d\theta_1^*}{d\lambda} = -\frac{\partial\chi(\theta_1^*, \lambda)}{\partial\lambda} / \frac{\partial\chi(\theta_1^*, \lambda)}{\partial\theta_1^*} \geq 0$$

When λ increases, the cutoff exchange rate increases as well (and so do $\underline{\theta_1}$ and $\overline{\theta_1}$, as shown in Figure 3). Therefore, as λ 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 (high λ) will experience smaller inflows of cross-border loans.

3 Data and empirical methodology

3.1 Data

We use the Bank for International Settlements Consolidated Banking Statistics (BIS CBS) to capture cross-border bank lending. The CBS contains 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 – which in other datasets, and notably the World Bank international banking statistics, as well as the BIS locational banking statistics - are included in the positions of banks in Poland – are consolidated in the CBS with those of its parent and included in the positions of Italian banks. The CBS contains data from banks headquartered in 30 countries. The data are aggregated at the country level. On the borrowing side, we focus on a set of 30 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. Large non-financial corporations are important players on the borrowing side of the cross-border bank loan market, which also channels funds to export/import firms and leveraged non-bank financials. The government sector, central banks and international organizations (including international development banks) are the remaining institutions on the borrowing side.

In order to measure the relevance of cross-border lending as opposed to other capital flows for each borrowing country, We take data on the international investment positions (IIP) vis à vis the countries in oursample from the IMF WB international financial statistics. Gross IIP consist of the following categories: 1. Foreign direct investment (FDI) 2. Portfolio Investment 3. Financial derivatives and employee stock options 4. Other investment. Other investment includes: a. Loans and Deposits from banks b. Loans and Deposits from non-banks c. Trade credit d. Other payables/receivables. For each borrowing country, We sum the incoming cross-border loans from all lending countries and we 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 importance of cross-border loans for the borrowing country's credit market and, following the mechanism of Section 2, the extent of strategic complementarities among international banks.

We use controls that include macroeconomic indicators and aggregate balance sheet characteristics of the banking system of the recipient country. The balance sheet items are the aggregate capital ratio (solvency), the aggregate deposit ratio (liquidity), the average bank size in logs and two profitability ratios: net interest to total assets and interest revenues over total revenues. These data are aggregated from bank-level data taken from Bankscope. The macroeconomic indicators are 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 the role of country risk and the perceived creditworthiness of borrowers by country. The Chinn-Ito index gauges the degree of capital account openness.

Finally, exchange rates are taken from the BIS long series on US dollar bilateral nominal exchange rates. The exchange rates are transformed to reflect the strength of the local currency, i.e. how many US dollars a unit of the local currency can buy. Thus, an increase in the exchange rate reflects an appreciation of the local currency.

The sample includes a total of 30 emerging economies borrowing from a total of 30 lending countries over the time span 2001:Q1 - 2015:Q4. The 30 emerging economies are taken from a total of 64 recipient countries (including also advanced economies) that are part of the BIS consolidated banking statistics. Appendix C contains the list of the lending and the borrowing countries.

Table 2 contains the summary statistics of the variables described above. The bilateral data are the cross-border loans and their transformations. We take percentage growth rates of the stocks of cross-border loans. The mean is about 1%, depending on the borrowing sector. The standard deviation varies from 7.5% to 11% quarterly variation, making cross-border loans rather volatile. $NBshare$ measures the share of cross-border loans that go to non-bank borrowers. On average it is around 60%. The borrowing-country variables are the exchange rate quarterly growth rate, the share λ of cross-border loans to total capital flows and the macroeconomic and banking sector balance sheet controls. λ has an average of about 0.17 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 difference. The sovereign ratings are the long term foreign currency sovereign rating, averaged across 3 agencies (S&P, Moody's and Fitch). They are in first difference.

3.2 Empirical methodology

The mechanism described in Section 2 suggests that exchange rate variations may have a larger effect on incoming cross-border loans if domestic corporate borrowers have a hard time finding alternative means of financing. The parameter λ captures the extent to which corporate borrowers in a given country rely on cross-border bank flows as opposed to other types of international capital flows. Accordingly, We define λ_t^j as the share of international capital flows to country j in quarter t that is accounted for by bank loans. Consider the following baseline specification:

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

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 strength of the local currency, i.e. the amount of dollars a unit of the currency of country j can buy. The growth rate of the exchange rate appears 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 rates and cross-border bank loans, as well as the possible dependence of this correlation upon the parameter λ_t^j. $\beta_0 + \beta_1 \lambda_t^j$ captures such correlation. Positive estimates of the coefficients β_0 and $\beta_1$are in accordance with the mechanism in Section 2. In that case a unit percentage depreciation of the local currency (i.e. a decrease in $\Delta ER_t^{j,USD} < 0$) would be correlated with a percentage fall in cross-border loans to country j. Such a percentage fall would be stronger in countries with a higher share of corporate financing from cross-border loans (i.e. a higher λ_t^j).

Equation (1) leaves identification aside. The estimated parameters are correlations and they can be expected to hold on average upon observing a large enough sample of the variables in the equation. However, the estimates in equation (1) don't provide an answer to the following question: "what would happen to cross-border loans to country j if the local currency depreciated by 5% *ceteris paribus*?" To answer this question, we need to take any possible confounder into account. Exchange rates are an equilibrium phenomenon, and the mechanism that determines them is an open field of research (e.g. Gabaix and Maggiori, 2015). Any variable that affects exchange rates and that also affects cross-border bank flows is a confounder in equation (1). We can 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. These can be 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, therefore they equally affect countries i and j. 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 in country j. For instance their preference for lending through branches or through subsidiaries, or even directly from the headquarters through the interbank market.

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. Therefore, the second and main step in the empirical analysis in given by the following equation:

$$\Delta XBL_t^{i,j} = \alpha^{i,j} + \alpha_t^i + \beta_0 \cdot \Delta ER_t^{j,USD} + \beta_1 \cdot \Delta ER_t^{j,USD} \cdot \lambda_t^j + \gamma' \cdot X_t^j + \varepsilon_t^{i,j} \tag{2}$$

$\alpha^{i,j}$ are fixed effects that account for all time-invariant demand or supply factors. Moreover, they accounts for any structural lending relationship between lenders in i and borrowers in j. Hence, we 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, we cannot use fixed effects that also very along those two dimensions because they would absorb them. We need to spell out specific controls, that we include in the vector X_t^j.

The controls are the borrowing country real GDP growth, an index of the openness of financial markets, sovereign ratings, as well as a full 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., 2007). 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 if 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 level.

While equation (2) includes an extensive set of borrowing-country controls, a remaining identification concern is that β_0 and β_1 may still be biased estimates of the effect of exchange rate fluctuations on cross-border loans due to time-varying demand-side confounders that are not included in the vector X_t^j because they are not observable. The size and direction of the possible bias depends on the confounder one has in mind 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, we need to transform the cross-sectional variation of our variables of interest. Instead of varying only along the borrowing-country dimension, we must have them vary along both the borrowing ans the lending country dimensions (as well as time). We follow the intuition in Khwaja and Mian (2005) and we exploit the mechanism described in Section 2 to come up with a meaningful transformation. The effect of exchange rates on cross-border bank flows is stronger when corporate borrowers have a smaller chance of finding alternative means of financing. This probability is captured by the share λ_t^j of international capital flows to country j accounted for by cross-border loans. When lending to unrelated banks[7]international banks do not face currency risk. The local banks lend to local corporates in local currency, but they insure against currency risk so that the latter is born by the

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

corporate borrowers. Therefore, cross-border lending to unrelated banks is independent of exchange rate variation (as confirmed by the findings in Section 4). Define $NBshare_t^{i,j}$ as the share of cross-border lending from country i to country j in quarter t that goes to local corporates as opposed to local unrelated banks. Ceteris paribus, an increase in $NBshare_t^{i,j}$ 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 corporates as opposed to banks. Corporates in A will have a greater chance of receiving funding from international banks and a lower chance of getting funding from domestic banks than corporates in B. Hence, international banks lending to corporates in A know that if they fail to provide credit, corporates 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 among international lenders are then stronger in A than in B.

Crucially, the share $NBshare_t^{i,j}$ of cross-border lending from country i to country j in quarter t that goes to local corporates as opposed to local banks varies along the i, j, and t dimensions. Therefore, we can create a triple interaction term $\Delta ER_t^{j,USD} \cdot \lambda_t^j \cdot NBshare_t^{i,j}$ that also varies along the three dimensions of our dataset. We can now estimate the following equation:

$$\Delta XBL_t^{i,j} = \alpha^{i,j} + \alpha_t^i + \alpha_t^j + \beta_1 \cdot \Delta ER_t^{j,USD} \cdot \lambda_t^j \cdot NBshare_t^{i,j} + \varepsilon_t^{i,j} \tag{3}$$

Our coefficient of interest β_1 is akin to a "difference in difference in difference" estimator. It captures the additional effect of exchange rates on cross-border loans in countries where loans account for a larger share of international capital flows and where cross-border lending to local corporates borrowers account for a larger share of total cross-border lending. Equation (3) now includes fixed effects that account for all the four categories of confounders described above, including time-varying demand confounders captured byα_t^j. We lose the possibility of idenitifying the coefficient on the stand-alone $\Delta ER_t^{j,USD}$, but we no longer need to include any demand-side controls.

4 Results - relevance of cross-border lending for corporate borrowers as a multiplier of exchange rate effects

Table 3 shows the results of estimating equation (1) for cross-border loans to different types of borrowers: non-banks, banks and the public sector, as well as the overall effect on the combined flows. This regression illustrates the correlation between our variables of interest. It is the starting point for the subsequent identification, which will establish what part of the correlations in Table 3, if any, is a causal effect. We add no controls and no fixed effects. The standard error are unadjusted.

Column (1) provides evidence of a negative correlation between exchange rates 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 0.17 (approximately the sample mean of λ), a 1% variation in the exchange rate is associated to a 20.1% 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 a 15.7% variation in lending to non banks, a 27.9% variation in lending to banks and a 23.7 % variation in lending to the public sector. Notice that the association between cross-border flows and exchange rates 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 non banks should display strategic complementarities because of the currency mismatch in the borrowers' balance sheet. Hence, 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 our model.

Table 4 shows the results of estimating equation (2), again with a borrowing sector breakdown: non-banks, banks and the public sector. The coefficients shown in the Table 4 are no longer correlations, but they are estimates of the causal effect of exchange rates on cross-border loans. The identification is achieved in two ways. First, there are lender-borrower fixed effects and borrower-time fixed effects. Second, there are borrower-time controls. The fixed effects control for any confounder from the supply side: variation is only allowed across borrowers and over time. Notice that the fixed effects also control for any influence of global factors (i.e. variables that vary only along the t dimension and are independent of a specific borrower i and a specific lender j) like the global monetary policy stance or global risk aversion (Avdjiev et al. 2017), as well as for any influence of time-invariant borrowing country characteristic. The remaining set of confounders that cannot be controlled through fixed effects are those that vary across borrowers and over time. Since these dimensions of variation are the same as the variables of interest (the exchange rate between the borrowing country's currency and USD and the relevance of cross-border lending for the financing of local corporates), borrower-time fixed effects would make the coefficients on exchange rates not identifiable. Therefore, we are left with adding relevant controls in the form of borrowing country time-varying characteristics. Table B.4 shows the full regression coefficients.

The results are very different from those of Table 3, except for the sign of the coefficients. Column (1) shows that the causal effect of exchange rates on cross-border lending is positive, significant and large. Importantly, the percentage effect is larger whenever the relevance of cross-border loans for corporate borrowers is larger. Moreover, both the stand-alone coefficient and the interaction with λ are smaller than the correlations presented in Table 3. For a country with a λ equal to 0.17, a 1% depreciation of the exchange rate causes a 6.85% quarterly decrease in lending from international banks to all sectors. Columns (2) to (4) reveal that the incremental effect of exchange rates as a function of λ is a property of lending to non banks only, in accordance with the model of Section 2. Figure 4 shows the time-varying effect of a 1% variation in the exchange rate as a function of λ for selected large emerging economies. Depending on the country, the impact of exchange rates varies more or less over time and it generally stays between 3 and 5 percentage points. Among those showed in Figure 4, the impact is strongest in India in 2007:Q4 (6.98%) and weakest in South Africa in 2010:Q4 (3.08%). 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 rates 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 for corporate borrowers in 2008 and an increase in the impact of exchange rates on these flows accordingly.

Column (3) shows that lending to banks is not affected by exchange rate variation. This is an expected result and it is a result of the logic behind the model in Section 2. Keep in mind that the BIS consolidated debt statistics that we use to recover cross-border lending 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 headquartered in the borrowing country. Lending to unrelated banks is not subject to exchange rate movements per se. Indeed, as Figure 1 shows, the double-decker structure of international lending is such that bank to bank relationship are conducted in US dollars, and even when they aren't banks insure themselves against the currency risk. Therefore, if an international bank lends to an unrelated bank, the international bank does not concern itself with exchange rate movements, because they do not affect the chance that its loan will be repaid in the future. That concern will fall upon the local unrelated bank. If lending is to banks in the same conglomerate, then the probability that the local bank will get its money back is relevant for the parent. Hence the importance of including claims of banks' foreign affiliates, as the dataset used in this paper does.

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 underdeveloped 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. As it is the case for lending to banks, when lending to central banks, international banks do not need to concern themselves about future exchange rate movements because the central bank will lend in foreign currency to domestic banks, that will lend to domestic corporate borrowers, who will bear the currency risk. The relationship between international banks and the central bank is free of currency risk concerns.

Table 4 and Figure 4 establish that the effect of an exogenous shock to exchange rates on cross-border lending to non banks increases with λ. However, what drives λ? This is an interesting question, but one that this paper does not address. The approach adopted in the paper is the one of a policy maker in an emerging country, having to decide, for instance, whether to depreciate its currency in order to boost exports. The policy maker takes for given (as do international banks) what percentage of all international capital flows to non banks is accounted for by cross-border lending in that particular country. 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. 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) as a way to overcome the issue. The equation includes borrower-time fixed effects in order to control for any observable or unobservable time-varying borrowing country characteristics that may have acted as confounders in equation (2). The triple interaction is positive and significant only for non-bank borrowers. The estimation exploits the joint variation along the lender, borrower and time dimensions. Following the mechanism described in Section 2, strategic complementarities among international banks when lending to corporate borrowers 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 when lending to non banks. Therefore, the higher the share of total lending that goes to non banks, the stronger the strategic complementarities. Crucially, the share of cross-border lending to non banks 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 non banks should exacerbate the strategic complementarities among banks, but there is no reason to believe that it will also affect the stand-alone coefficient on the exchange rate. Thus, it does not make sense to interact the exchange rate with $NBshare$ and the stand-alone impact of the exchange rate will remain unidentified in equation (3).

The share of cross-border lending accounted for by non-bank borrowers 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 0.17, the additional causal effect of a 1% variation in the exchange rate is equal to 3.92%, which is very close to and statistically indistinguishable from the same effect as presented in Table 4, i.e. 3.02%. We conclude that the estimates presented in Table 4 are reliable estimates of the causal effect of exchange rate variations on cross-border lending as a function of the relevance of cross-border lending for corporate financing in the recipient country.

4.1 Robustness

We 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.

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. 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, we estimate equation (2) dropping the first ten years using the sample 2010:Q1 - 2015:Q4. Table B1 presents the results. Column (2) shows that the effect of exchange rate variation on cross-border lending to non-banks is much stronger after the great financial crisis. In a typical country (i.e. with λ equal to its sample mean of 0.17), a 1% depreciation causes a 7.6% fall in cross-border loans to non banks. This incremental effect points to international capital flows having become more flighty after the crisis and the multiplier effect of strategic complementarities among banks has increased. In any case, the sign, significance and magnitude of the results in table B1 are very similar to those in Table 4.

In the main results, 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 and, as a consequence, for corporate borrowers. At the cost of incurring in more sever data limitations, we can compute the same measure using cross-border loans to corporate borrowers and total liabilities held by corporate borrowers. Table B2 presents the results. The two coefficients of interest are robust to this specification.

The quarterly exchange rate used for the main results 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. All the right-hand -side controls should also be lagged. Table B3 presents the results. Although the significance of the two coefficients for loans to all sectors disappears, the two coefficients of interest for loans to non banks (column 2) are still significant and their magnitude is similar to that of the main results.

5 Conclusion

This paper has modeled and estimated the consequences of a shock to an emerging market exchange rate vis à vis the US dollar on cross-border lending to local borrowers. When cross-border lending is an important component of corporate financing from abroad (including from local banks owned by parent banks headquartered abroad), then a depreciation of the local exchange rate has a proportionally stronger effect on international bank lending. This effect is due to coordination failures among international banks in the face of strategic uncertainty, i.e. the uncertainty that each bank has on the actions of the other banks.

This finding is particularly important from a policy perspective. A local currency depreciation can be undertaken by policy makers for a variety of good reasons. For example, a small country may peg its currency to a convertible currency for convenience in trade. Over time, the local currency typically tends to become overvalued, but local governments tolerate it because an overvalued currency makes imports cheaper than they would be if the currency were correctly priced. However, the overvaluation makes the country's exports more expensive and hence less attractive to foreign buyers. Over time, the country tends to earn less, spend more and go into debt. Moreover, if the economy is mainly based on agriculture, a smaller market for agricultural export and receiving low prices domestically because of competition from imports induces the farmers to stop production and seek employment in overcrowded cities, where they become the source of other social and economic problems. This is a typical situation where an international organization like the International Monetary fund can intervene and advise on a devaluation of the local currency (among other things). This paper highlights a caveat to doing that. If the country's firms and households rely heavily on cross-border lending (or on lending from local banks that are part of an international conglomerate), then a currency depreciation will be followed by an outflow of bank capital that is proportionally bigger the bigger the firms' reliance on foreign credit, in what amounts to a multiplier effect.

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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
Bilateral data					
ΔCross-border loans[1]					
to all sectors	39317	0.986	8.653	-9.782	12.473
to non banks	36850	0.912	7.505	-8.442	11.017
to banks	32167	0.915	15.485	-18.182	20.833
to the public sector	23828	0.304	11.065	-13.499	15.113
NBshare[2]	38360	0.593	0.295	0	1
Borrowing-country data					
ΔExchange rate[1]	50670	-0.391	5.102	-52.923	19.554
lambda[3]	50890	0.174	0.110	0.000055	0.711
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, 30 borrowing countries (emerging economies) over the period 2001:Q1 - 2015:Q4. [1]Quarterly growth rate (%). [2]Cross-border loans to non banks 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 fluctuations and cross-border lending growth rates

	ΔCross-border loans[1]			
	(1)	(2)	(3)	(4)
	to all sectors	to non banks	to banks	to the public sector
ΔExchange rate[1]	14.869***	11.331***	21.020***	18.509***
	(1.827)	(1.643)	(3.636)	(2.972)
ΔExchange rate[1] * λ^2	35.127***	25.993***	35.909**	30.684**
	(8.596)	(7.772)	(16.957)	(13.761)
Constant	1.072***	0.980***	1.036***	0.398***
	(0.043)	(0.039)	(0.086)	(0.071)
Observations	39,217	36,760	32,078	23,796
R-squared	0.016	0.012	0.008	0.013

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

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

	ΔCross-border loans[1]			
	(1)	(2)	(3)	(4)
	to all sectors	to non banks	to banks	to the public sector
ΔExchange rate[1]	3.394*	1.788***	5.746	11.414
	(2.005)	(0.657)	(4.009)	(9.250)
ΔExchange rate[1] * λ^2	20.337**	17.808***	7.597	16.372
	(9.345)	(5.971)	(17.650)	(14.699)
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, 30 borrowing countries (emerging economies) over the period 2001:Q1 - 2015:Q4. [1] Quarterly growth rate (%). [2]Cross-border lending over total capital flows. Borrower-country controls include ΔReal GDP, ΔSovereign ratings, Chinn-Ito index, ΔSize, ΔETA, ΔDEPtoTA, ΔNETINTtoTA, ΔINTREVtoTOTREV. See Table B4 for the full estimation table with coefficients of the control variables. 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 variation on cross-border loans - Interaction with the share of lending to non-banks

	ΔCross-border loans[1]			
	(1)	(2)	(3)	(4)
	to all sectors	to non banks	to banks	to the public sector
ΔExchange rate[1] * λ * NBshare	-22.639	38.509**	-9.592	-8.536
	(15.871)	(14.976)	(37.290)	(29.340)
Lender·borrower FE	Yes	Yes	Yes	Yes
Lender·time FE	Yes	Yes	Yes	Yes
Borrower·time FE	Yes	Yes	Yes	Yes
Observations	34,261	33,353	28,344	21,357
R-squared	0.227	0.233	0.194	0.234

Notes: The sample includes quarterly data for 30 lending countries, 30 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 also includes lender-borrower and lender-time and borrower-time fixed effects. Standard errors are clustered by lender-time. *** p<0.01, ** p<0.05, * p<0.1.

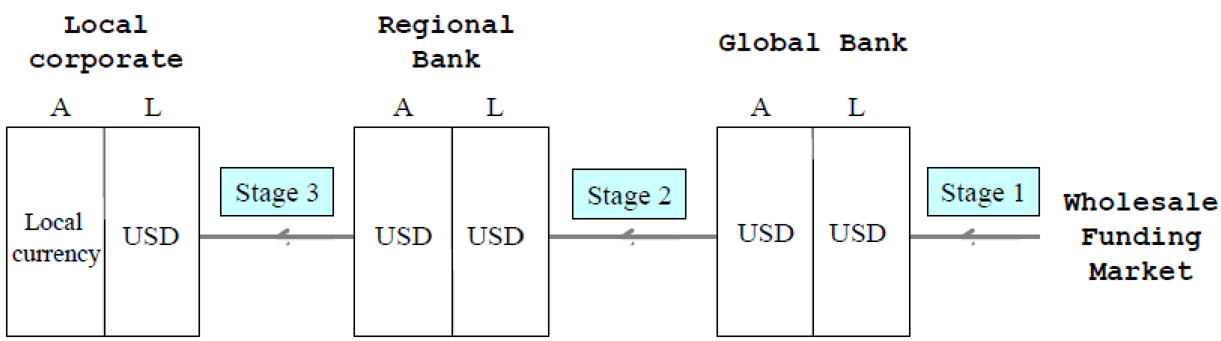


Figure 1: Structure of international bank lending

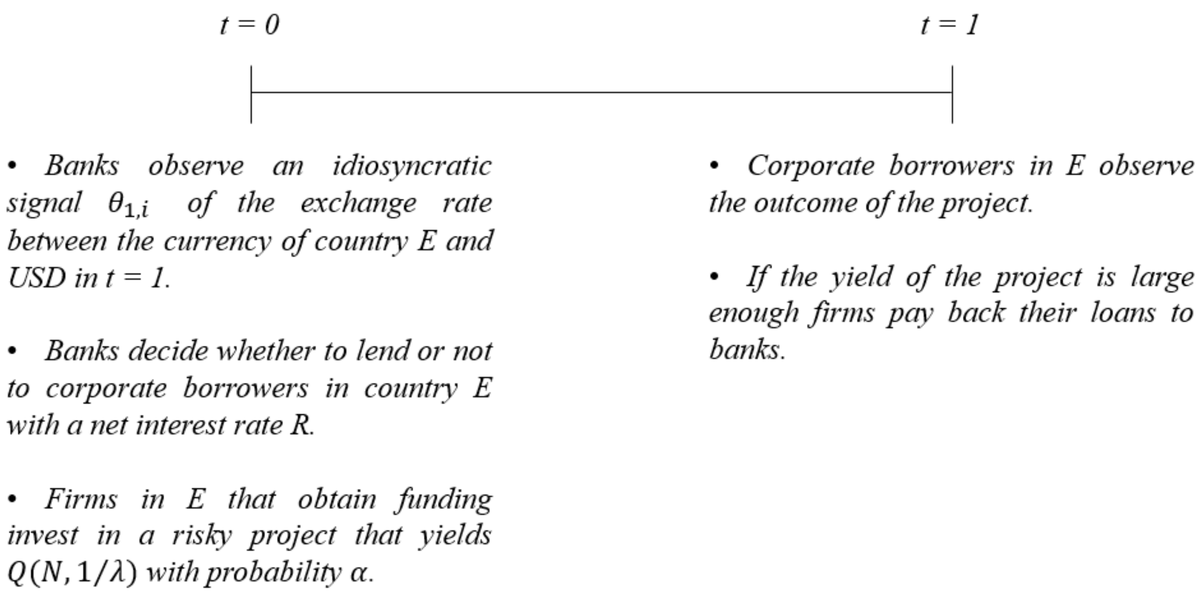


Figure 2: Timing of the model

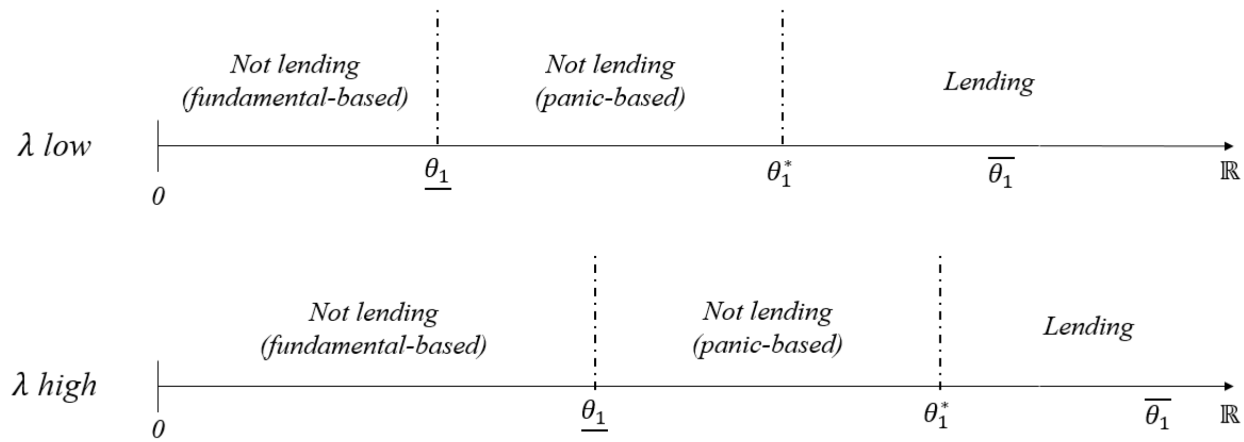


Figure 3: Effect of λ on the equilibrium cutoff exchange rates

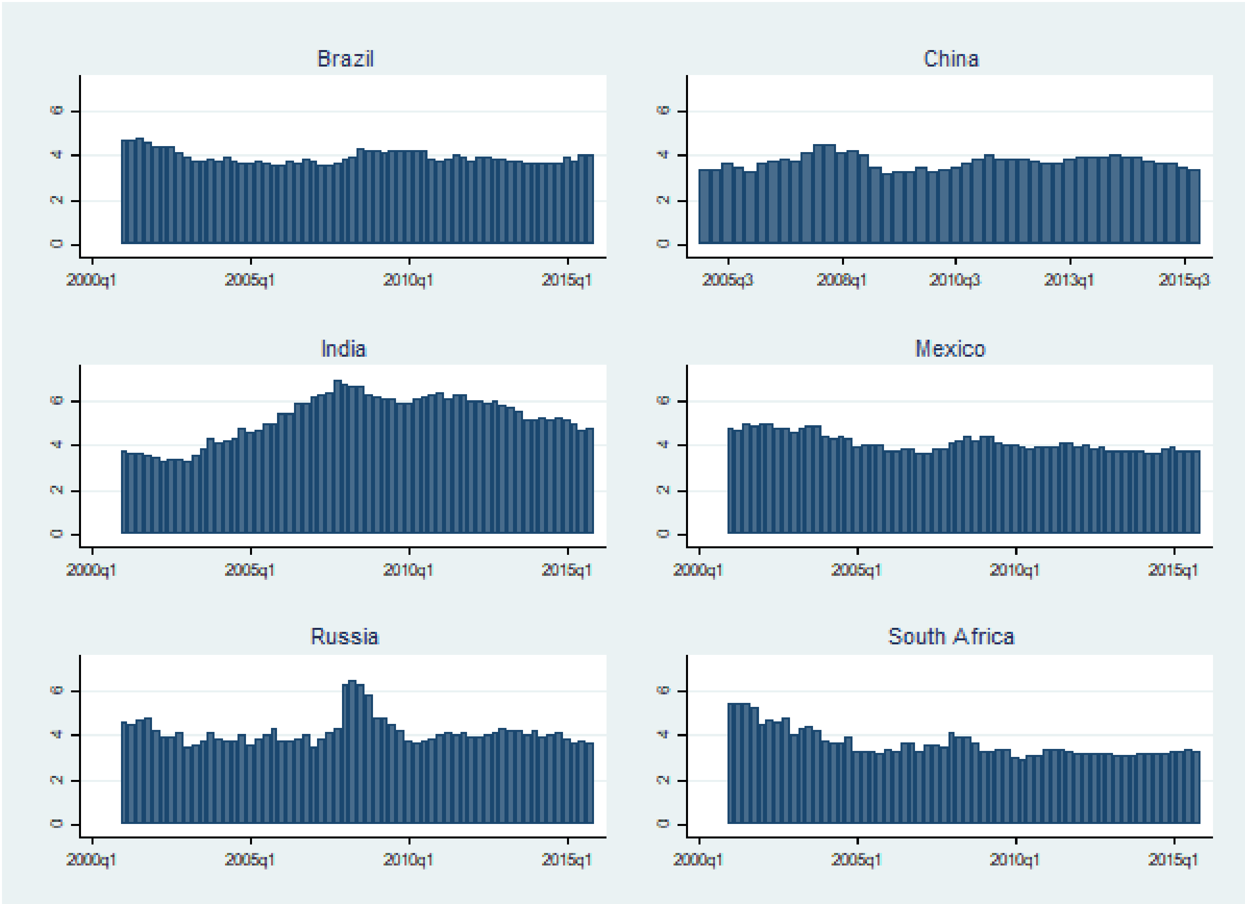


Figure 4: Effect of a 1% exchange rate variation on cross-border loans to the non-financial sector of selected emerging countries (%)

Appendix A: Proofs

Proof of Proposition 1

The proof will show the first part of the proposition, i.e. $s(\theta_{b,1}) = 0$ for all $\theta_{b,1} < \theta^* - \delta$. The second part, i.e. $s(\theta_{b,1}) = 1$ for all $\theta_{b,1} > \theta^* + \delta$, 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 $s(\theta_{b,1}) = 0$ for all $\theta_{b,1} < \theta^*$ and $s(\theta_{b,1}) = 1$ for all $\theta_{b,1} > \theta^*$.

Proof of Lemma 1. Write $\pi^*_\sigma(\theta_{b,1}, k, \lambda)$ for the expected payoff of choosing action 1 as opposed to action 0 when a bank has observed signal $\theta_{b,1}$ and knows that all other banks will choose action 0 if they observe a signal below k[8]:

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

$\pi^*_\sigma(\theta_{b,1}, k, \lambda)$ is continuous in k and $\theta_{b,1}$, increasing in $\theta_{b,1}$ and decreasing in k. Moreover, $\pi^*_\sigma(\theta_{b,1}, k, \lambda) < 0$ if $\theta_{b,1} < \underline{\theta}_1$ and $\pi^*_\sigma(\theta_{b,1}, k, \lambda) > 0$ if $\theta_{b,1} > \overline{\theta}_1$.

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

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

if and only if

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

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

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

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

$\underline{\xi}_{n+1}$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 $\pi^*_\sigma\left(\theta_{b,1},k,\lambda\right)$ is increasing in $\theta_{b,1}$ and decreasing in the cutoff k. Therefore, $\underline{\xi}_n\rightarrow\underline{\xi}$ and $\overline{\xi}_n\rightarrow\overline{\xi}$ as $n\rightarrow\infty$. Since π^*_σ is continuous, by construction we 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 $\Psi^*_\sigma\left(N,\theta_{b,1},k\right)$ 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 $\theta_{b,1}$[9].

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

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

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

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

If $\theta_{b,1} = k$ then $\Psi^*_\sigma (N, \theta_{b,1}, k) = N$, hence the corresponding pdf $\psi^*_\sigma (N, \theta_{b,1}, k)$ must be a uniform.

To complete the proof, notice that we can rewrite $\pi^*_\sigma (\theta_{b,1}, k, \lambda)$ in terms of $\psi^*_\sigma (N, \theta_{b,1}, k)$[10]

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

so that when $\theta_{b,1} = k$ we have

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

By A3, we 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 let's abandon the uniform prior and let's assume a general prior $v(.)$. Also, let exchange rates, not their signals, enter the utility function. Write $N(\theta_{b,1})$ for the proportion of players observing signal $\theta_{b,1}$ and choosing action 1. Write $\pi_\sigma(\theta_{b,1}, k, \lambda)$ for the highest possible expected gain from choosing action1 as opposed to action 0 for a bank that has observed signal $\theta_{b,1}$ and knows that all the other banks will choose action 0 if they observe signals less than

[10] 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 $Prob\,(\theta_{b,1} \geq k) = 1 - G\left(\frac{k - \theta_1}{\sigma}\right)$. Hence, $\theta_1 = k - \sigma G^{-1} (1 - N)$ and $g\left(\frac{\theta_{b,1} - \theta_1}{\sigma}\right)$ can be rewritten as a function of N as $g\left(\frac{\theta_{b,1} - k + \sigma G^{-1}(1-N)}{\sigma}\right) = \psi^*_\sigma (N, \theta_{b,1}, k)$.

k (the cutoff)[11]:

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

Lemma 2. $\exists \; \underline{\theta}_{b,1} \in \mathbb{R}$ and $\overline{\sigma}_1 \in \mathbb{R}_{++}$ such that $\pi_\sigma(\theta_{b,1}, k, \lambda) < 0$ for all $\sigma \leq \overline{\sigma}_1, \; \theta_{b,1} \leq \underline{\theta}_{b,1}$ and $k \in \mathbb{R}$.

Proof of Lemma 2. Using assumption A4*, take $\underline{\theta}_{b,1} < \underline{\theta_1}$ 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 $\theta_1 < \underline{\theta}_{b,1}$ 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 $\underline{\theta}_{b,1}$. Define the expected upper bound of the payoff loss as a function of the signal observed:

$$\overline{\pi}_\sigma\left(\theta_{b,1}\right) = \frac{\int_o^{+\infty} v\left(\theta_1\right) g\left(\frac{\theta_{b,1}-\theta_1}{\sigma}\right) \overline{\pi}\left(\theta_1\right) d\theta_1}{\int_o^{+\infty} v\left(\theta_1\right) g\left(\frac{\theta_{b,1}-\theta_1}{\sigma}\right) d\theta_1}$$

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

$$\overline{\pi}_\sigma\left(\theta_{b,1}\right) = \frac{\int_{-\infty}^{+\infty} v\left(\theta_{b,1} + \sigma z\right) g\left(-z\right) \overline{\pi}\left(\theta_{b,1} + \sigma z\right) dz}{\int_{-\infty}^{+\infty} v\left(\theta_{b,1} + \sigma z\right) g\left(-z\right) dz}$$

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

$\overline{\pi}_\sigma\left(\theta_{b,1}\right)$ is an upper bound on $\pi_\sigma(\theta_{b,1},k,\lambda)$ for all k. Also, $\overline{\pi}_\sigma\left(\theta_{b,1}\right)$ is continuous in σ. Setting σ to 0 we get $\overline{\pi}_0\left(\theta_{b,1}\right)=\overline{\pi}\left(\theta_{b,1}\right)$, so $\overline{\pi}_0\left(\theta_{b,1}\right)=-\epsilon$ for all $\theta_{b,1}\leq\underline{\theta}_{b,1}$. Moreover[12],

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

Then, by assumption A6 (finite expectations of signals), $\frac{d\overline{\pi}_\sigma}{d\sigma}\left(\theta_{b,1}\right)=0$ for all $\theta_{b,1}\leq\underline{\theta}_{b,1}$. Thus, $\exists\,\overline{\sigma}\in\mathbb{R}_{++}$ such that $\overline{\pi}_\sigma\left(\theta_{b,1}\right)<0$ for all $\sigma\leq\overline{\sigma}$ and $\theta_{b,1}\leq\underline{\theta}_{b,1}$.

■

Lemma 3. $\exists\,\overline{\sigma}_2\in\mathbb{R}_{++}$ such that $\pi_\sigma(\theta_{b,1},k,\lambda)<0$ for all $\sigma\leq\overline{\sigma}_2$, $\underline{\theta}_{b,1\leq}\theta_{b,1}<\theta^*$ and $\theta_{b,1}\leq k\leq\theta^*$.

Proof of Lemma 3. Define $\Psi_\sigma\left(N,\theta_{b,1},k\right)$ 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 $\theta_{b,1}$:

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

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

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

[12] The full derivation is as follows

$$\left.\frac{d\overline{\pi}_\sigma}{d\sigma}\left(\theta_{b,1}\right)\right|_{\sigma=0}=\left[\int_{-\infty}^{+\infty}v\left(\theta_{b,1}+\sigma z\right)g\left(-z\right)dz\right]^{-2}$$

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

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

$$\left[\int_{-\infty}^{+\infty}zg(-z)dz\right]\frac{\overline{\pi}'\left(\theta_{b,1}\right)}{v\left(\theta_{b,1}\right)}$$

For small σ the shape of the prior $v(.)$ will not matter and the posterior beliefs over N will depend only on $\frac{\theta_{b,1}-k}{\sigma}$, the normalized difference between the signal $\theta_{b,1}$and the cutoff k.

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

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

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

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

Let $\sigma \to 0$. Then $\Psi_\sigma\left(N, \theta_{b,1}, k\right) \to 1 - G\left(\frac{\theta_{b,1}-k}{\sigma} + G^{-1}\left(1-N\right)\right) = \Psi^*_\sigma\left(N, \theta_{b,1}, k\right)$, where $\Psi^*_\sigma\left(N, \theta_{b,1}, k\right)$ 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 $\theta_{b,1}$from Lemma 1. Therefore, as $\sigma \to 0$, $\pi_\sigma(\theta_{b,1}, k, \lambda) \to \pi^*_\sigma(\theta_{b,1}, k, \lambda)$ continuously, where $\pi^*_\sigma(\theta_{b,1}, k, \lambda)$ is the equivalent of $\pi_\sigma(\theta_{b,1}, k, \lambda)$ from Lemma 1, i.e. with a uniform prior and with signals in the utility function. Take $k = \theta_{b,1}$ as in Lemma 1. $\lim_{\sigma\to 0} \pi_\sigma(k, k, \lambda) = \int_0^1 \pi\left(\theta_1, N, \lambda\right) dN$. By A3, we can conclude that $\lim_{\sigma\to 0} \pi_\sigma(k, k, \lambda) = 0$ implies $k = \theta^*_1$.

■

Proof of Proposition 2.

By A7, $\chi\left(\theta^*_1, \lambda\right) = \int_0^1 \mu\left(\theta^*_1, N, \lambda\right) dN$ has continuous partial derivatives in $\theta^*_1$and λ. Therefore, by the implicit function theorem, there exists a unique function $\theta^*_1 = \gamma(\lambda)$ such that

$\chi\left(\gamma\left(\lambda\right),\lambda\right)=\frac{1+r}{1+R}$. Moreover, the implicit function theorem guarantees that $\gamma(\lambda)$ is continuously differentiable and that

$$\frac{d\gamma(\lambda)}{d\lambda}=-\frac{\partial\chi\left(\theta_1^*,\lambda\right)}{\partial\lambda}/\frac{\partial\chi\left(\theta_1^*,\lambda\right)}{\partial\theta_1^*}$$

$\frac{\partial\chi\left(\theta_1^*,\lambda\right)}{\partial\lambda}$ is nonpositive by assumption A8. $\frac{\partial\chi\left(\theta_1^*,\lambda\right)}{\partial\theta_1^*}$ is nonnegative by assumption A2. Therefore, $\frac{d\gamma(\lambda)}{d\lambda}\geq 0$.

■

Appendix B: Additional tables and charts

Table B1: Effect of exchange rate variation on cross-border loans - Restricted sample 2010:Q1 - 2015:Q4

	ΔCross-border loans[1]			
	(1)	(2)	(3)	(4)
	to all sectors	to non banks	to banks	to the public sector
ΔExchange rate[1]	1.469***	1.169***	1.018	4.699
	(0.391)	(0.278)	(6.490)	(5.935)
ΔExchange rate[1] * λ^2	45.774***	37.892***	30.866	4.275
	(16.273)	(14.566)	(35.047)	(28.325)
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, 30 borrowing countries (emerging economies) over the period 2010:Q1 - 2015:Q4. [1] Quarterly growth rate (%). [2]Cross-border lending over total capital flows. Borrower-country controls include ΔReal GDP, ΔSovereign ratings, Chinn-Ito index, ΔSize, ΔETA, ΔDEPtoTA, ΔNETINTtoTA, ΔINTREVtoTOTREV. 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 B2: Effect of exchange rate variation on cross-border loans - λ computed as a fraction of lending to non banks only

	ΔCross-border loans[1]			
	(1)	(2)	(3)	(4)
	to all sectors	to non banks	to banks	to the public sector
ΔExchange rate[1]	5.758***	4.221***	6.819	5.135
	(1.205)	(1.084)	(5.562)	(4.024)
ΔExchange rate[1] * λ^2	10.748**	6.515***	2.377	-5.745
	(4.468)	(1.640)	(8.282)	(7.001)
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, 30 borrowing countries (emerging economies) over the period 2001:Q1 - 2015:Q4. [1] Quarterly growth rate (%). [2]Cross-border lending to non banks over total capital flows to non banks. Borrower-country controls include ΔReal GDP, ΔSovereign ratings, Chinn-Ito index, ΔSize, ΔETA, ΔDEPtoTA, ΔNETINTtoTA, ΔINTREVtoTOTREV. 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 variation on cross-border loans - lagged right-hand-side variables

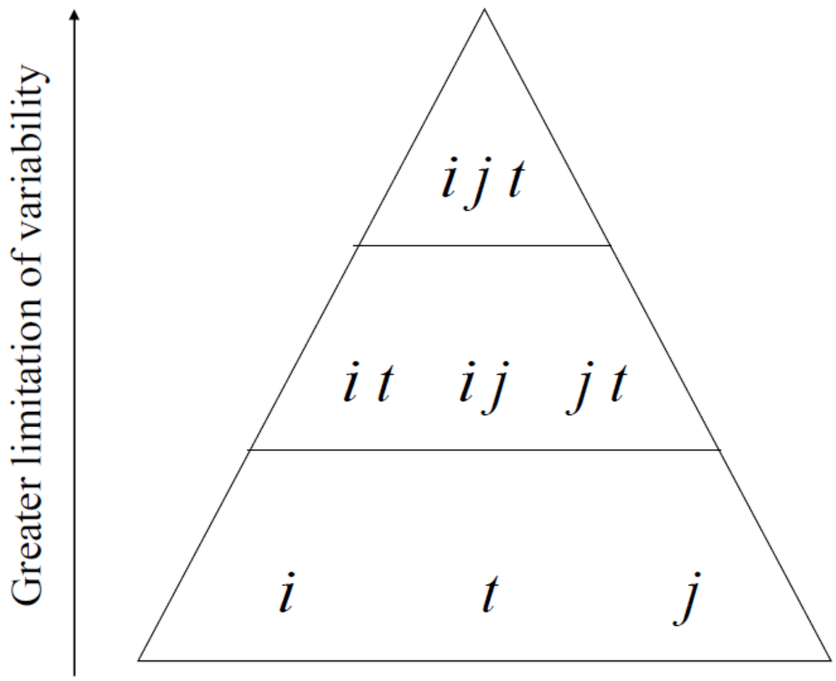
	ΔCross-border loans[1]			
	(1)	(2)	(3)	(4)
	to all sectors	to non banks	to banks	to the public sector
ΔExchange rate$^1_{t-1}$	0.715	2.758***	2.229	1.634
	(1.982)	(0.756)	(3.992)	(3.559)
ΔExchange rate$^1_{t-1}$ * λ^2_{t-1}	13.322	15.830**	1.439	-1.629
	(9.381)	(7.601)	(17.736)	(16.170)
Borrowing-country 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, 30 borrowing countries (emerging economies) over the period 2001:Q1 - 2015:Q4. [1] Quarterly growth rate (%). [2]Cross-border lending over total capital flows. Borrower-country controls include ΔReal GDP, ΔSovereign ratings, Chinn-Ito index, ΔSize, ΔETA, ΔDEPtoTA, ΔNETINTtoTA, ΔINTREVtoTOTREV. All the controls 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 B4: Effect of exchange rate variation on cross-border loans - controls shown

	ΔCross-border loans[1]			
	(1)	(2)	(3)	(4)
	to all sectors	to non financial corporations	to banks	to the public sector
ΔExchange rate[1]	0.034*	0.018	0.057	0.114***
	(0.020)	(0.019)	(0.040)	(0.032)
ΔExchange rate[1] * λ	0.203**	0.178**	0.076	0.164
	(0.093)	(0.090)	(0.177)	(0.147)
ΔReal GDP	0.122***	0.072***	0.266***	0.038
	(0.019)	(0.016)	(0.038)	(0.032)
ΔSovereign ratings (1)	0.384*	0.144	1.409***	-0.031
	(0.209)	(0.191)	(0.453)	(0.363)
Chinn-Ito index	-2.081***	-2.177***	-3.602***	-0.781
	(0.401)	(0.385)	(0.908)	(0.708)
ΔSize	0.037	-0.050	0.125	-0.226
	(0.126)	(0.115)	(0.258)	(0.217)
ΔETA	-1.524	-3.416*	3.900	-4.811
	(2.230)	(1.992)	(4.478)	(3.896)
ΔDEPtoTA	-2.138	-2.534**	-1.455	-0.971
	(1.386)	(1.202)	(2.843)	(2.394)
ΔNETINTtoTA	4.299	-0.159	13.451	-0.465
	(4.268)	(3.862)	(8.239)	(6.681)
ΔINTREVtoTOTREV	0.099	-0.395	1.666	0.745
	(0.710)	(0.641)	(1.520)	(1.203)
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 29 recipient emerging economies and 30 lending countries over the period 2001:Q1 - 2015:Q4. [1] Quarterly growth rate (%). Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.



- i FE: variation allowed along the j, t, ij, jt, it, ijt dimensions
- j FE: variation allowed along the i, t, ij, it, jt, ijt dimensions
- it FE: variation allowed along the j, jt, ij, ijt dimensions
- jt FE: variation allowed along the i, it, ij, ijt dimensions
- ij FE: variation allowed along the t, it, jt, ijt dimensions

Figure B1: Fixed effects and variation allowed in the data

Appendix C: List of countries in the dataset

Borrowing countries (30)

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), Vietnam (VN).

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).