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Abstract

This PhD thesis is composed of three chapters on international finance.
In the first chapter, I study the effect of exchange rates on cross-border loans to corporate borrowers in emerging economies. After a depreciation of the local currency, countries where international bank lending accounts for a greater share of corporate financing from abroad experience smaller inflows of cross-border loans. A depreciation of the local currency acts as a coordination device for international banks that face strategic complementarities in lending. This strategic complementarity is stronger for countries where international bank lending is a greater source of international financing for local borrowers. I construct a global game among international lenders to illustrate the mechanism. Moreover, using bilateral data on cross-border lending from banks headquartered in 30 countries to recipients in 29 emerging economies, I provide evidence that an economy's stronger reliance on cross-border lending amplifies the effect of exchange rate fluctuations on incoming cross-border loans.
The second chapter, co-authored with Stefan Avdjiev, Leonardo Gambacorta and Linda Goldberg, studies the shifting composition and drivers of international bank lending and international bond issuance, the two main components of global liquidity. The sensitivity of both types of flow to US monetary policy rose substantially in the immediate aftermath of the Global Financial Crisis and then partially reverted towards pre-crisis levels. Conversely, the responsiveness of international bank lending to global risk conditions declined considerably post-crisis and became similar to that of international debt securities. The increased sensitivity of international bank flows to US monetary policy has been driven mainly by the co-movement in advanced economy monetary policies. By contrast, the post-crisis fall in the sensitivity of international bank lending to global risk was mainly due to a compositional effect, driven by increases in the lending market shares of better-capitalized national banking systems. Policies and prudential instruments that reinforced lending banks' capitalization and stable funding levels reduced the volatility of international lending flows.
The third chapter, co-authored with Leonardo Gambacorta and Adrian van Rixtel, investigates the foreign funding mix of globally active banks. Using cointegration tecniques on a panel of 12 advanced economies, we detect a structural break in international bank funding at the onset of the great financial crisis. In their post-break business model, banks rely less on cross-border liabilities and, instead, tap funds from outside their jurisdictions by making more active use of their subsidiaries and branches, as well as inter-office accounts within the same banking group.

Introduction

International capital flows channel financial resources across borders to both public and private sector borrowers. As such, they are critically important for economic growth and financial stability and understanding their main drivers is crucial for both policymakers and researchers. This thesis studies the two main components of global liquidity, i.e. cross-border loans and international debt securities, as well as the cross-border funding models of banks. I focus on global financial conditions as drivers of local growth and financial stability. I show that exchange rates vis à vis the US Dollar drive the coordination failures of global banks, leading to large fluctuations on cross-border lending to emerging economies. Moreover, I study the post-crisis impact of US monetary policy and global risk conditions on international loans and debt issuance and how the changing funding business models of global banks determine evolving inter-banking group and intra-banking group cross-border flows.

In the chapter "Exchange Rates, Strategic Uncertainty and International Bank Lending", I show that when local borrowers are interdependent (e.g. when they are part of the same value chain) international banks face strategic complementarities in lending. Indeed, the greater the number of international banks that lend, the greater the number of entrepreneurs that 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 fewer alternatives to cross-border loans 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 that 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 leads to inefficient and volatile lending.

I formalize the intuition described above in a global game. Moreover, I provide empirical evidence in favor of this mechanism. My 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 vis à vis the US Dollar. In a country where cross-border loans account for 7% of total capital flows a 1% quarter-on-quarter depreciation of the local currency causes a 2.8% quarterly reduction of cross-border loans to local corporates. If, instead, loans account for 30% of total capital flows, then a 1% quarter-on-quarter depreciation of the local currency causes a 7.4% quarterly decrease of cross-border flows to non-bank borrowers.

I use the Bank for International Settlements Cosolidated Banking Statistics to capture cross-border loans. My dataset records the claims of banks headquartered in 30 countries vis à vis borrowers in 29 emerging economies in the period 2001:Q1 - 2015:Q4. The data are aggregated at the country level. I identify the combined effect of exchange rates and the relevance of cross-border lending for local borrowers 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 is equivalent to looking at the variation of lending from the same lending country to different borrowers and over time. In order to account for demand-side confounders, I use controls that account for the macroeconomic cycle and for the balance sheet characteristics of the banking sector of the borrowing country.

A remaining identification concern is that some demand-side confounders may not be observable (or they may only be imperfectly observed), so they cannot be included in the control set. To overcome this issue I follow the logic of Khwaja and Mian (2005) and Jiménez et al. (2014) and I exploit the full implications of the theoretical mechanism 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 variation (borrower-time variable) in countries where cross-border loans are a bigger source of financing (borrower-time variable) and where lending to non banks is a larger share of total lending from a particular lending country (lender-borrower-time variable). This transformation allows me to use borrower-time fixed effects to account for any demand-side confounders. As in Jiménez et al. (2014), I add triple interactions between the controls I use in my baseline estimation, the share of cross-border loans over total capital flows and the share of cross-border loans to non banks. The resulting estimate, multiplied by the average share of lending to non banks, yields statistically the same coefficient of the baseline estimation.

The chapter "The Shifting Drivers of Global Liquidity", coauthored with Stefan Avdjiev, Leonardo Gambacorta and Linda Goldberg, investigates the role of two global drivers of cross-border loans and international debt securities: US monetary policy and global risk conditions. This focus builds on the most important global drivers identified by the literature: advanced economy monetary policies, global risk aversion and global output growth (e.g. Forbes and Warnock, 2012a; Miranda-Agrippino and Rey, 2015; Cerutti, Claessens and Ratnovski, 2017; and Cerutti, Claessens and Rose, 2017). While studies generally focus on identifying the drivers, they seldom examine the how and why of evolving sensitivities to global factors. Yet, the structure and volatility of cross-border bank loan and international bond flows clearly have changed considerably in the aftermath of the Global Financial Crisis (GFC). In the immediate aftermath of the crisis, cross-border loans contracted sharply. This was followed by a feeble recovery and a second sharp contraction during the peak of the euro area crisis. By contrast, international bond issuance was relatively robust during the post-crisis period. As a consequence, the composition of global liquidity has shifted away from cross-border bank loans and towards international bonds in what has been dubbed "the second wave of global liquidity" (Shin, 2013).

In this chapter, we draw on multiple databases on global liquidity component flows from both borrower country and creditor country perspectives, distinguishing between instrument types (international debt securities versus international bank loans), and between borrowing sectors (bank versus non-bank). Using the BIS International Debt Securities (IDS) Statistics and the BIS Locational Banking Statistics (LBS), we create a quarterly panel of international bank loan and bond flows to 64 recipient countries for the period between 2000:Q1 and 2015:Q4. In addition, we use the BIS Consolidated Banking Statistics (CBS) in order to assign loans to specific national lending banking systems. Using Bankscope, we obtain information on lending banking system balance sheet characteristics. We also incorporate a range of other data on prudential instrument and monetary policy developments, from the perspective of both the borrowers and the creditor countries. Advanced economy monetary policies, as well as shadow measures that capture unconventional policies, are also incorporated into the analysis.

Our first key result is that international capital flow sensitivities to global factors have changed considerably since the GFC. Advanced economy monetary policy, proxied by US monetary policy, became a more potent driver of both cross-border loan and international bond flows. The estimated policy impacts peaked in 2013 and then partially retraced toward pre-crisis levels while remaining elevated. Meanwhile, the sensitivity of cross-border bank loan flows to global risk conditions declined considerably post-crisis and became similar to the respective risk sensitivity observed for international bond flows. In fact, international bank loan and bond flows became more similar in terms of their responsiveness to global factors after the GFC. Overall, aggregate global liquidity flows (the sum of international bank loan and bond flows) have become more sensitive to US monetary policy and less sensitive to global risk.

The second set of results shows that post-crisis shifts in sensitivities of international bank loan and bond flows to global factors, observed from the borrower perspective, arise from a combination of changes in the country composition of lending banking systems and from changes in the behavior of the creditors involved in international financial flows. Working across multiple databases, we show an increase in the responsiveness of flows from individual lending banking systems to US monetary policy. We also find evidence of a compositional shift toward national lending banking systems with lower sensitivity to global risk conditions.

We drill deeper into the type of variation observed to investigate the contributions of a range of prudential measures, bank business model features, and monetary regimes in the creditor countries. We find that the features of financial intermediaries that previously have been shown to stabilize domestic bank lending response to liquidity risk, like bank capital ratios and deposit funding, also support expansion of international market share relative to weaker peer country systems and help explain changing behaviors. National banking systems that were better capitalized before the GFC experienced smaller post-crisis rises in sensitivity to US monetary policy and larger increases in international lending shares. Higher ex-ante shares of deposits in total funding and of locally booked claims in total foreign claims were also associated with larger increases in international lending market shares. Tighter local reserve requirements pre-crisis were associated with relative expansions of international market shares in the post crisis period.

The chapter "Changing Business Models in International Bank Funding" looks at the liability side of global banks and studies how they obtain cross-border funding. Global banking has expanded markedly during the past decades, in terms of both cross-border activities and local entry into banking sectors overseas (Merck et al., 2012). This process has occurred in parallel with the globalization of international trade and was driven by changes in the regulatory environment and in macroeconomic and financial conditions (Lane and Milesi-Ferretti, 2008; Goldberg, 2009).

The rapid advance of global banking has also had important repercussions for funding and liquidity management at the institutions involved. Financial globalization has allowed banks to tap funding sources across borders, allowing them to diversify away from traditional funding sources to international interbank markets (Fender and McGuire, 2010). McGuire and Von Peter (2009) show that the rapid expansion of foreign claims of banks in general and of European banks in particular in the years prior to the 2007-2009 great financial crisis was mirrored in a sharp increase in foreign liabilities, reflecting a growing dependence on cross-border funding. Shin (2012) documents how European banks financed their global activities by tapping US wholesale funding markets and using their inter-office accounts to channel US dollar-denominated funding to their head offices.

The globalization of banking was sharply interrupted by the great financial crisis, which prompted an important retrenchment in banks' international activities and exposures, especially in cross-border funding markets. The crisis led to major restructurings of banks' business and funding models and to changes in their international strategies. Moreover, cross-border bank linkages proved to be important transmission channels of the crisis, propagating funding shocks across borders (i.e. from one core funding market to others) and from advanced to emerging market economies (Cetorelli and Goldberg, 2011). Adjustments in business and funding models were, in many cases, reinforced by the subsequent 2010-2012 euro area financial crisis.

These factors clearly show that the funding models of globally active banks play an important role in banking crises and leverage cycles. Using the BIS international banking statistics, this chapter tests for the existence of structural breaks in bank funding models. In particular, we analyze the evolution of bank funding across borders by distinguishing the two key components of foreign liabilities, i.e. cross-border liabilities and funding obtained by banks' overseas offices (local liabilities). Moreover, we break down cross-border liabilities by lending sector (bank-related or unrelated – and non-banks) in order to compare intragroup flows (i.e. cross-border liabilities from related banks) with liabilities obtained externally.

The empirical analysis is performed in two steps. First, we use a log-linearisation of the balance sheet identity that links local and cross-border liabilities in order to test for the presence of a structural break in bank funding models (Koch, 2014). To do so, we use a panel vector error correction model for banks headquartered in 12 advanced economies that exploits the non-stationarity of cross-border funding. Second, we study the adjustment dynamics of such a long-run relationship by means of a panel vector error correction model that includes a number of weakly exogenous economic determinants. Our main conclusions are as follows. Following the first episodes of turbulence in the interbank market (after 2007:Q2), globally active banks increased their reliance on funding from branches and subsidiaries abroad, and cut back on funding obtained directly by headquarters (cross-border funding). In particular, banks reduced cross-border funding from unrelated banks – e.g. those that are not part of the same banking group – and from non-bank entities. At the same time, they increased intragroup cross-border liabilities in an attempt to make more efficient use of their internal capital markets. Crucially, these changes are long-run phenomena, reflecting a shift in the funding model of banks.

These results contribute importantly to both research and policy debates around global liquidity and local stabilization. One pertinent question is whether the enhanced diversification across financing types will have different consequences in the case of future stress episodes, as well as in normal periods. This is an especially pertinent issue if, ex-ante, bank loan and debt securities financing agents are subject to distinct degrees of leverage and balance sheet constraints. I show that pre-crisis borrowers experienced more global factor sensitivity in cross border loans than in international debt securities. As a consequence, international debt securities remained relatively robust during the global financial crisis. Post-crisis, the sensitivities of both types of financing have become more similar.

Another question is how stabilization challenges across countries borrowing internationally evolve in post-crisis periods and when the synchronization of business cycles across countries is enhanced. The range of evidence I provide suggests that the large increases in sensitivities to US monetary policy post GFC may have been a transitory phenomenon, whereas the declines in global liquidity sensitivity to risk measures may be more persistent. At least in international bank flows, behavioral changes in the period immediately following the GFC were driven largely by the convergence in advanced economy monetary policies. These transitory effects gradually weakened when the monetary policies of advanced economies started to diverge in 2013. More persistent effects may come from the increased market shares of better-capitalized lending banking systems, whose international lending tends to be less responsive to fluctuations in global risk conditions. The implications would be that evolving global drivers also change the scope for monetary autonomy and prudential policies options for borrowing countries. Moreover, a potentially important consequence of the focus on capital and stable funding in creditor countries are reduced amplitudes of global liquidity surges and waves as observed by borrowers.

Finally, my thesis stresses the importance of US Dollar fluctuations for local corporate financing and for local financial stability. Appreciations of the US Dollar can have disruptive effects on the inflow of loans from global banks to local corporates. Moreover, the effects on financial stability are not only linked to the stock of loans that local corporates obtain from global banks, but also on the relevance of loans as opposed to other types of international capital flows.

1. Exchange Rates, Strategic Uncertainty and International Bank Lending

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 have a currency mismatch in their balance sheet. This paper shows that after a depreciation of the local currency, countries where international bank lending accounts for a greater share of corporate financing from abroad will experience smaller inflows of cross-border loans. A depreciation of the local currency acts as a coordination device for international banks that face strategic complementarities in lending. This strategic complementarity is stronger for countries where international bank lending is a greater source of international financing for local borrowers. I construct a global game among international lenders to illustrate the mechanism. Moreover, using bilateral data on cross-border lending from banks headquartered in 30 countries to recipients in 29 emerging economies, I provide evidence that an economy's stronger reliance on cross-border lending amplifies the effect of exchange rate fluctuations on incoming cross-border loans.

1.1 Introduction

Over the period 2001 - 2015, cross-border lending accounted for a significant fraction of international capital flows to emerging economies (Figure 1.1). 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 emerging market corporate borrowers because they complement the activity of domestic banks and of other international investors (Bank for International Settlements, 2011a and 2011b). Cross-border loans are mostly issued to non-bank borrowers and in US Dollars (Figures 1.2 and 1.3). The link between cross-border loans and exchange rates has been studied (e.g. Bruno and Shin, 2015a,b) but this is the first paper to highlight a multiplier effect of coordination failures among international lenders.

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.

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, international 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 international banks that lend, the greater the number of entrepreneurs that 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 fewer alternatives to cross-border loans 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 that 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 leads to inefficient lending[1].

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

This paper formalizes the intuition described above in a global game. Moreover, it provides empirical evidence in favor of this mechanism. My 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 7% of total capital flows a 1% quarter-on-quarter depreciation of the local currency causes a 2.8% quarterly reduction of cross-border loans to local corporates. If, instead, loans account for 30% of total capital flows, then a 1% quarter-on-quarter depreciation of the local currency causes a 7.4% quarterly decrease of cross-border flows to non-bank borrowers. Figure 1.7 shows the time-varying pattern of these sensitivities for six major emerging economies. I do not record this effect when the borrowers are banks or the public sector. It is important to stress that all my results are in *percentage* terms. The following example illustrates the point. Take two countries whose corporates receive 100 USD millions in cross-border loans. Suppose the size of the economy of the two countries is the same, but 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 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 millions, while corporates in B still get 97.2 USD millions. Therefore, even if the stock of cross-border loans to both country is the same, their relevance vis à vis other international capital flows determines the *percentage* effect of a depreciation.

I use a dataset compiled by the Bank for International Settlements to capture cross-border loans. 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. Moreover, it provides a breakdown of borrowers by 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 appropriate 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[2]. Under such a model, Bruno and Shin (2015a) argue that the effects of local exchange rates on local corporate borrowers (who bear the

[2]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 borowers (Bruno and Shin, 2015a), except for the influence that the currency risk has on the borrowers' solvency risk.

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 rates and the relevance of cross-border lending for local borrowers 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 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 my variables of interest (local exchange rate variation and local relevance of cross-border lending). Therefore, I use demand side controls that account for the macroeconomic cycle and for the balance sheet characteristics of the banking sector of the borrowing country. The local macroeconomic controls include the lending rate, real GDP, sovereign ratings and a measure of financial openness. The local banking sector controls include the level of domestic lending, average domestic bank size, the average capital ratio (a measure of solvency), the average deposit ratio (a measure of liquidity) and two average profitability ratios: net interest to total assets and interest revenues over total revenues. The latter is also an indicator of the business models of local banks - higher interest revenues over total revenues indicate a more traditional business model.

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 I follow the logic of Khwaja and Mian (2005) and Jimènez et al. (2014) and I exploit the full implications of 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 variation (borrower-time variable) in countries where cross-border loans are a bigger source of financing (borrower-time variable) and where lending to non banks is a larger share of total lending from a particular lending country (lender-borrower-time variable). This transformation allows me to use borrower-time fixed effects to account for any demand-side confounders. As in Jimènez et al. (2014), I add triple interactions between the controls I use in my baseline estimation, the share of cross-border loans over total capital flows and the share of cross-border loans to non banks. The resulting estimate, multiplied by the average share of lending to non banks, yields statistically the same coefficient of the baseline estimation.

This paper is the first to identify a multiplier of the effect of exchange rates on cross-border loans given by coordination failures among international lenders. By the nature of the coordination failures that I identify, this is also the first paper to point out that currency depreciations can have a stronger negative effects on incoming international bank lending in countries that rely more of lending from abroad. 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, e.g. 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 sheets and not on the stock of lending to emerging markets. Also, they do not explore the implications of strategic complementarities among banks. 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). A shift in the local exchange rate vis à vis the US Dollar can also be seen as the consequence of 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 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 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 et al. (2004); Allen et al. (2017); Goldstein and Pauzner (2005); Morris, Shin and Yildiz (2016); Allen and Gale (1998). 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 among the managers. This paper is one of the few to attempt empirical identification of strategic complementarities, the major one being Chen, Goldstein and Jiang (2010). Finally, my paper is linked to the literature on currency crises and sudden stops (Caballero and Krishnamurthy, 2001; 2003; 2004; 2005; Chang and Velasco, 2001) 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 describes my model of strategic complementarities among international lenders. Section 3 describes the dataset and the empirical methodology. Section 4 discusses the results of the empirical estimations. Section 5 concludes.

1.2 A model of strategic complementarities among international lenders

1.2.1 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_0 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_0[3]. 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, in $t = 0$ bank loans accounts 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 finanincing conditional on not having obtained a loan.[4] 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 borrowers will find alternative financing sources, given that they did not obtain a loan ($1 - \lambda_0$). 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 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_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 know that their expected return is still

[3] For simplicity, I assume that the bank can only lend in foreign currency and in Particular in US Dollars.

[4] It could very well 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.

a decreasing function of λ_0. Also, I assume that the local borrower needs to gather the 1 USD she needs from international investors. This can happen because the entrepreneur isn't able to retrieve funds from the domestic market (e.g. her project is too risky or her collateral not enough for local banks and local investors) or by the fact that the domestic market covered 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 borrower owes the bank. If the yield of the project in USD is not enough to pay back the loan with interest, the borrower will go bankrupt and the bank can appropriate the yield $Q_1(N_1, \lambda_0)\theta_1$.

Therefore, the payoff a bank receives from lending

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

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 exchange rate vis à vis the USD. An appreciation of the US Dollar (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, an appreciation of the US Dollar increases the chances that the borrower will go bankrupt and decreases the portion of the loan that the borrower can repay in $t = 1$;

- increasing in N_1, 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_0, the share of bank financing (as opposed to other sources of financing) in country E and the probability of not finding alternative sources of financing.

[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.

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:

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

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:

$$\underline{\theta_1} : \; u(1, \underline{\theta_1}, N_1, \lambda_0) = 1 + r_0$$

$$\overline{\theta_1} : \; u(1, \overline{\theta_1}, N_1, \lambda_0) = 1 + r_0$$

$\underline{\theta_1}$ 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, $N_1 = 1$). 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, $N_1 = 0$). 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, I apply the techniques developed in the global games literature (see Morris and Shin, 2003 for an introduction to the topic). I 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[6] and θ_1 is drawn from a continuously differentiable, strictly positive density $v(.)$ on the real line[7]. 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 1.5 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

[6] 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.

[7] 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 $t = 0$.

receive a signal above θ_1^* and they do not lend if and only if they receive a signal below θ_1^*.

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

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

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

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

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 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, 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): $\pi(\theta_1, N_1, \lambda_0)$ 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 thorugh local banks that are part of the same conglomerate or directly. The 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. 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 local exchange rate.

[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 $\pi(\theta_1, N_1, \lambda_0) < 0$ if $N_1 < N_1^*$ and $\pi(\theta_1, N_1, \lambda_0) > 0$ if $N_1 > N_1^*$

Assumption A3 (Strict Laplacian State Monotonicity):
$\exists!\ \theta_1^* \in \mathbb{R}_+ :\ \int_0^1 \pi\left(\theta_1^*, N_1, \lambda_0\right) dN_1 = 0.$

A3 is a strengthening of A2. $\int_0^1 \pi\left(\theta_1^*, N_1, \lambda_0\right) dN_1$ 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 $\partial\pi\left(\theta_1, N_1, \lambda_0\right)/\partial\theta_1 \geq 0$ from A2. A3 imposes that the inequality implied by A2 is strictly satisfied in a neighborhood of $\pi\left(\theta_1^*, N_1, \lambda_0\right) = 0$ when banks have Laplacian beliefs on N_1.

Assumption A4 (Limit dominance): $\exists\ \underline{\theta_1}, \overline{\theta_1} \in \mathbb{R}_+ : \pi\left(\theta_1, N_1, \lambda_0\right) < 0$ for all $N_1 \in [0,1]$ and $\theta_1 < \underline{\theta_1}$; and $\pi\left(\theta_1, N_1, \lambda_0\right) > 0$ for all $N_1 \in [0,1]$ and $\theta_1 > \overline{\theta_1}$.[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. 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, $N_1 = 1$); conversely, it must be dominant to lend when $\theta_1 > \overline{\theta_1}$ (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 ($Q_1(0, \lambda_0) > 0$). 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): $\int_0^1 h(N_1)\pi\left(\theta_1, N_1, \lambda_0\right) dN_1$ 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): $\pi\left(\theta_1, N_1, \lambda_0\right)$ 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 $h(N_1)$. 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_1, λ_0.

[9]This assumption can be strengthened as follows. Assumption A4* (Uniform Limit Dominance): $\exists\ \underline{\theta_1}, \overline{\theta_1} \in \mathbb{R}_+$ and $\varepsilon \in \mathbb{R}_{++}$ such that $\pi\left(\theta_1, N_1, \lambda_0\right) < -\varepsilon$ for all $N_1 \in [0,1]$ and $\theta_1 < \underline{\theta_1}$; and $\pi\left(\theta_1, N_1, \lambda_0\right) > \varepsilon$ for all $N_1 \in [0,1]$ 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.

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 borrowers 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-A6, where $\theta_{b,1} = \theta_1 + \sigma\varepsilon_{b,1}$, 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 $s(\theta_{b,1})$ survives iterated deletion of strictly dominated strategies in the game $L(\sigma)$, then*

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

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).

1.2.3 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^*:

$$\int_0^1 \left[(1 + R_0)\,\mathbf{1}(Q_1(N_1, \lambda_0)\theta_1^* \geq 1 + R_0) + Q_1(N_1, \lambda_0)\theta_1^*\,\mathbf{1}(Q_1(N_1, \lambda_0)\theta_1^* < 1 + R_0)\right] dN_1$$
$$= 1 + r_0$$

Define

$$\chi\left(\theta_1^*, \lambda_0\right) =$$

$$\int_0^1 \left[(1+R_0)\,\mathbf{1}(Q_1(N_1,\lambda_0)\theta_1^* \geq 1+R_0) + Q_1(N_1,\lambda_0)\theta_1^*\,\mathbf{1}(Q_1(N_1,\lambda_0)\theta_1^* < 1+R_0)\right] dN_1$$

Assume A7 and A8. Then $\chi\left(\theta_1^*, \lambda_0\right)$ depends positively on the cutoff exchange rate θ_1^* 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_1^* can be expressed as a continuously differentiable function of λ_0: $\theta_1^* = \gamma(\lambda_0)$. This function is such that*

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

When λ_0 increases, the cutoff exchange rate increases as well (and so do $\underline{\theta_1}$ and $\overline{\theta_1}$, as shown in Figure 1.6). 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.

1.2.4 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 borrowers. Building on this assumption, the model shows that i) the effect of exchange rates on cross-border lending is amplified by strategic complementarities among global lenders, ii) the strategic complementarities are stronger in countries where cross-border loans account for a larger share of total international capital flows to local corporates, iii) although this amplification effect is driven by expectations about the exchange rate tomorrow, a change in the exchange rate today drives expectations of the exchange rate tomorrow, thus driving a contemporaneous increase or decrease in cross-border loans. These three conclusions of my empirical model can be tested using data on cross-border loans to corporates in emerging economies and by making sure that a change in the exchange rate affects cross-border lending precisely through the channel specified in the model.

1.3 Data and empirical methodology

1.3.1 Data

I use the Bank for International Settlements Consolidated Banking Statistics (BIS CBS) to capture cross-border bank lending. 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 contains 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 1.1 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 1.2 shows the breakdown of cross-border loans by borrowing sector. Loans to non banks typically get the lion's share, and they constitute on average 60% of overall cross-border lending. Finally, Figure 1.3 shows the breakdown of cross-border loans to non banks 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 non banks 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, i.e. all the observations with values greater than the 95th percentile take the value of the 95th percentile and all observations with values less than the 5th percentile take the value of the 5th percentile.

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 1.1 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 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.

I use controls that include macroeconomic indicators and aggregate balance sheet characteristics of the banking system of the recipient country. I took 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 it comes 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, exchange rates are taken 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.

The sample includes a total of 29 emerging economies borrowing from a total of 30 lending countries over the time span 2001:Q1 - 2015:Q4. The 29 emerging economies are taken from the recipient countries (both advanced and emerging economies) that are part of the BIS consolidated banking statistics. In each quarter my sample covers more than 95% of all cross-border loans to emerging economies. Appendix C contains the list of the lending and the borrowing countries.

Table 1.2 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. $NBshare$ 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. 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. These are the only variables that I use that have a yearly frequency, instead of a quarterly one.

1.3.2 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 borrowers have a hard time finding alternative means of financing. The parameter λ_0 captures the extent to which borrowers in a given country rely on cross-border bank flows as opposed to other types of international capital flows. Accordingly, I 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:

$$\Delta XBL_t^{i,j} = \alpha + \beta_0 \cdot \Delta ER_t^{j,USD} + \beta_1 \cdot \Delta ER_t^{j,USD} \cdot \lambda_t^j + \varepsilon_t^{i,j} \tag{1.1}$$

Equation (1.1) 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 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 β_1 are in accordance with the mechanism in Section 2. In that case a unit percentage depreciation of the local currency 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 financing from cross-border loans (i.e. a higher λ_t^j).

Equation (1.1) 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 (1.1) 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 1% *ceteris paribus*?" To answer this question, I 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 (Gabaix and Maggiori, 2015). Any variable that affects exchange rates and that also affects cross-border bank flows is a confounder in equation (1.1). I 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. 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 borrowers 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:

$$\begin{aligned}\Delta XBL_t^{i,j} = \alpha^{i,j} + \alpha_t^i + \beta_0 \cdot \Delta ER_t^{j,USD} + \beta_1 \cdot \Delta ER_t^{j,USD} \cdot \lambda_t^j \\ + \gamma_0' \cdot X_t^j + \gamma_1' \cdot X_t^j \cdot \lambda_t^j + \varepsilon_t^{i,j}\end{aligned} \tag{1.2}$$

$\alpha^{i,j}$ 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 borrowers 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, controlling for the lending rate means controlling 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 without controlling for the lending rate 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 (1.2) 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 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 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 from abroad. 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[10]in US Dollars, international banks do

[10]Remember that cross-border loans are consolidated, so inter-office positions between banks in the

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 always 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 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 non banks as opposed to local unrelated banks or the public sector. 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 non banks as opposed to unrelated banks. Non banks in A will have a greater chance of receiving funding from international banks and a lower chance of getting funding from domestic banks than non banks in B. Hence, international banks lending to non banks in A know that if they fail to provide credit, non banks 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, $NBshare_t^{i,j}$ varies along the i, j, and t dimensions. Therefore, I can create a triple interaction term $\Delta ER_t^{j,USD} \cdot \lambda_t^j \cdot NBshare_t^{i,j}$ that also varies along the three dimensions of my dataset. This approach is equivalent to exploiting the combined variation over time , across borrowers and across lenders[11]. I can now estimate the following equation:

$$\begin{aligned} \Delta XBL_t^{i,j} = \alpha^{i,j} + \alpha_t^i + \alpha_t^j + \beta_1 \cdot \Delta ER_t^{j,USD} \cdot \lambda_t^j \cdot NBshare_t^{i,j} \\ + \gamma_1' \cdot X_t^j \cdot \lambda_t^j \cdot NBshare_t^{i,j} + \varepsilon_t^{i,j} \end{aligned} \tag{1.3}$$

My coefficient of interest β_1 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 non-bank borrowers account for a larger share of total cross-border lending. Equation (1.3) 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 Jimï¿œnez et al. (2014) and I introduce the borrowing-country

same conglomerate are canceled out. Lending from the foreign affiliates is lending from the whole conglomerate.

[11]See Figure 1.B.1 in the Appendix for a review of the variation in the data suppressed by different kinds of fixed effects.

controls of equation (1.2) interacted with λ_t^j and $NBshare_t^{i,j}$. 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 among international banks. 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, my imprecise measurement of strategic complementarities should imply potentially bigger effects than the ones I find.

1.4 Results - strategic uncertainty as a multiplier of exchange rate effects on cross-border loans

Table 1.3 shows the results of estimating equation (1.1) 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 my variables of interest. It is the starting point for the subsequent identification, which will establish what part of the correlations in Table 1.3, if any, is a causal effect. I add no controls and no fixed effects. The standard errors are unadjusted.

Column (1) provides evidence of a positive 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 0.18 (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 non banks, 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 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 1.3 are encouraging, but the lack of behavioral difference across sectors is not in accordance with my model.

Table 1.4 shows the results of estimating equation (1.2), again with a borrowing sector breakdown: non banks, banks and the public sector. The coefficients shown in Table 1.4

are estimates of the causal effect of exchange rates 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 borrowers and over time. I account for these using borrowing-country controls. Table 1.B.5 shows the full regression coefficients.

The results are very different from those of Table 1.3, except for the sign of the coefficients. Column (1) shows that the causal effect of exchange rates 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) 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. Column (2) contains the key result. A 1% depreciation causes a 5.08% decrease in cross-border loans to non banks in a country where λ is equal to 0.18. Importantly, the percentage effect is larger whenever the relevance of cross-border loans for non-bank borrowers is larger. Figure 1.7 shows the time-varying effect of a 1% depreciation of the local currency on cross-border loans to non banks 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 , generally between 3 and 5 percentage points. Among the countries showed in Figure 1.7, 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 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 non bank 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 the conseuqnce of the logic behind the model in Section 2. Keep in mind that the BIS consolidated debt statistics that I 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 1.4 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 1.4 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.

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 1.8 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 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 1.4 and Figure 1.7 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 a question 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 assess the consequences of depreciating its currency. 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 1.4 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 1.5 shows the results of estimating equation (1.3). 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 (1.2). 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 are stronger whenever lending is a higher share of international capital flows. However, as showed also by the results in Table 1.4, 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 1.5 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 (1.3).

The share of cross-border lending accounted for by non-bank borrowers has a sample average of about 60% (see Table 1.2). Setting this share equal to its sample average and setting λ equal to its sample average of 0.18, the additional causal 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 1.4 once I set λ equal to 0.18, i.e. 3.68%. I conclude that the estimates presented in Table 1.4 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 non bank financing in the recipient country.

1.4.1 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 1.B.2). 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 (1.2) dropping the first nine years and using the sample 2010:Q1 - 2015:Q4. Table 1.B.1 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. 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 non banks. This incremental effect points out that international capital flows have become more flighty after the crisis and the multiplier effect of strategic complementarities among banks has strengthened. Anyway, the sign, significance and magnitude of the results in table 1.B.1 are very similar to those in Table 1.4.

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. At the cost of incurring in more sever data limitations, I can compute the same measure using cross-border loans to non-bank borrowers and total liabilities held by non-bank borrowers. Table 1.B.3 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. Table 1.B.4 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.

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 rates 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 embedded in the strategic complementarities 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 (1.2) 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 1.B.6 shows the estimation results. Exchange rates appear not to have a significant effect 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 rates on portfolio flows is not amplified by coordination failures among portfolio investors, as captured by λ^{PI}. It appears that such an amplification mechanism pertains to loans only. As a final note, it should be noted that, 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.

1.5 Conclusions

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. In a country where cross-border lending is a greater component of corporate financing from abroad (including from local banks owned by parent banks headquartered abroad), a depreciation of the local exchange rate causes a stronger percentage decrease in incoming cross-border loans. 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 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 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 a policy institution may consider a devaluation of the local currency (among other things). 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 fluctuations, for local corporate financing and for local financial stability. Appreciations of the US Dollar can have disruptive effects on the inflow of loans from global banks. This paper stresses that 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.

Bibliography

[1] Allen, F., E. Carletti, I. Goldstein and A. Leonello, (2017), "Government Guarantees and Financial Stability", European Central Bank Working Paper Series 2032.

[2] Allen, F. and D. Gale, (1998), "Optimal Financial Crises", Journal of Finance 53, 1245-1284.

[3] Avdjiev, S., L. Gambacorta, L. S. Goldberg, S. Schiaffi, (2017), "The Shifting Drivers of Global Liquidity", NBER Working Paper No. 23565.

[4] Bank for International Settlements, (2011a), "Global Liquidity - Concept, Measurement and Policy Implications", CGFS Papers, Bank for International Settlements, n 45.

[5] 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.

[6] 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.

[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), 1811-1843.

[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] Gourinchas, P.-O. and M. Obstfeld, (2012), "Stories of the Twentieth Century for the Twenty-First", American Economic Journal: Macroeconomics, 4(1), 226-65.

[25] Jimènez, 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.

[26] 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.

[27] 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.

[28] Miranda-Agrippino, S. and H. Rey, (2015), "World Asset Markets and the Global Financial Cycle", NBER Working Paper 21722.

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

[30] 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.

[31] 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.

[32] Morris, S., H. S. Shin and M. Yildiz, (2016), "Common Belief Foundations of Global Games", Journal of Economic Theory, Elsevier, vol. 163(C), pages 826-848.

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

[34] Obstfeld, M., (2012a), "Financial Flows, Financial Crises, and Global Imbalances", Journal of International Money and Finance, 31, 469-480.

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

[36] 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.

[37] Schularick, M. and A. M. Taylor, (2012), “Credit Booms Gone Bust: Monetary Policy, Leverage Cycles, and Financial Crises, 1870-2008”, American Economic Review 102, 1029-6.

Table 1.1: 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 1.2: Summary statistics

	Observations	Mean	SD	Min	Max
Bilateral data					
ΔCross-border loans[1]					
to all sectors	38158	3.931	28.514	-47.618	85.714
to non banks	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
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	0.182	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 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 1.3: 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]	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 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. Standard errors in parentheses. *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

Table 1.4: 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]	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

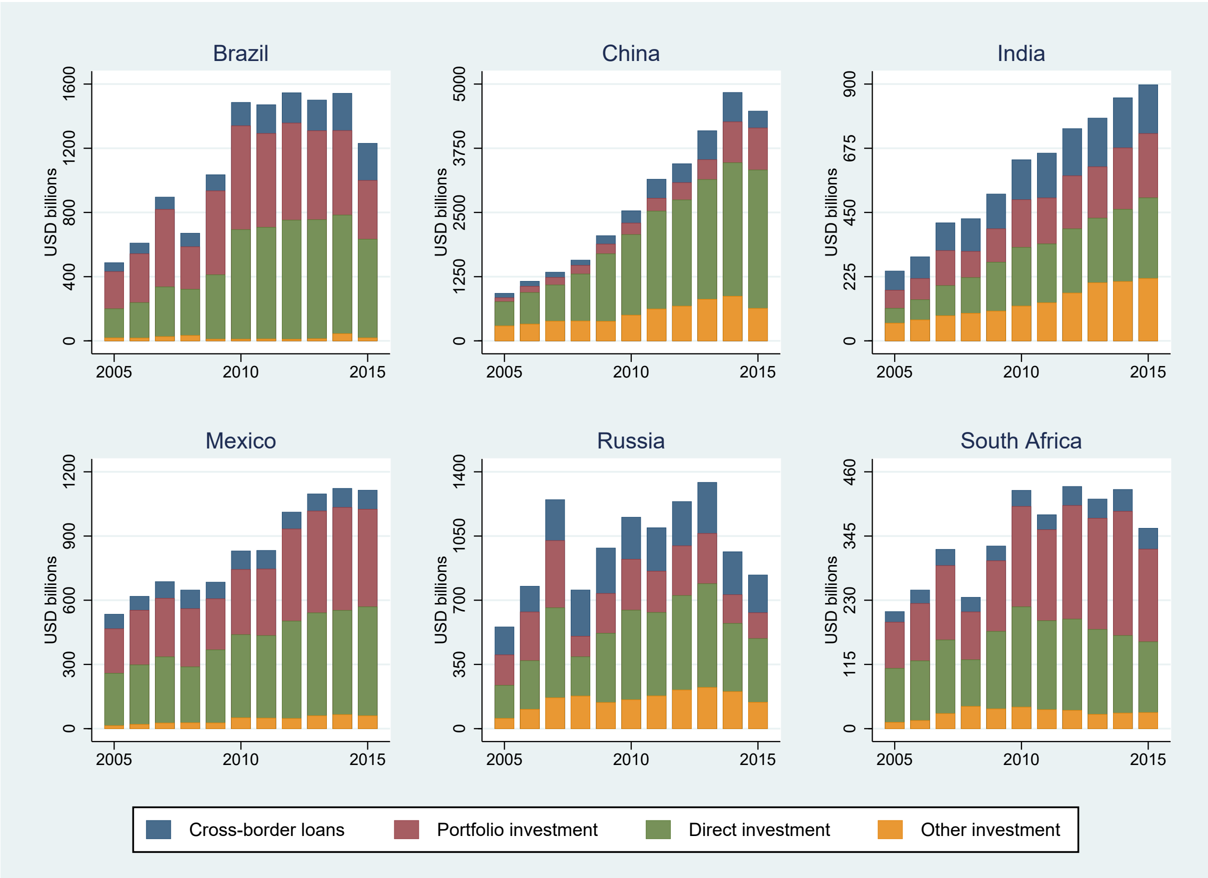
Notes: The sample includes quarterly data for 30 lending countries, 29 borrowing countries (emerging economies) over the period 2001:Q1 - 2015:Q4. [1] Quarterly growth rate (%). [2]Cross-border lending over total capital flows. Borrowing-country controls include ΔLending rate, ΔReal GDP, ΔSovereign ratings, Chinn-Ito index, ΔSize, ΔETA, ΔDEPtoTA, ΔNETINTtoTA, ΔINTREVtoTOTREV as well as their interaction with λ. 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 1.5: 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^2 * NBshare[3]	-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

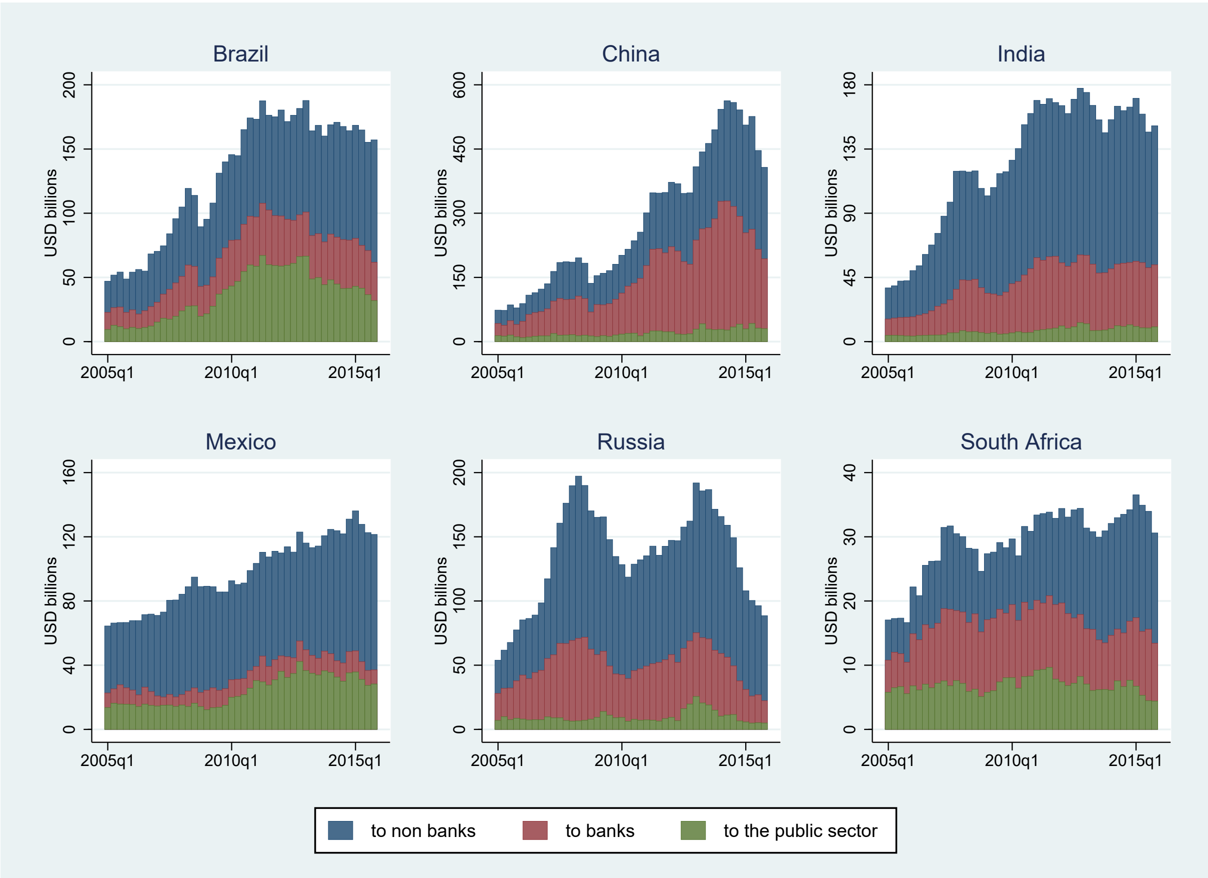
Notes: The sample includes quarterly data for 30 lending countries, 29 borrowing countries (emerging economies) over the period 2001:Q1 - 2015:Q4. [1] Quarterly growth rate (%). [2]Cross-border lending over total capital flows. [3]Cross-border loans to non banks over total cross-border loans. Borrowing-country controls include ΔLending rate, ΔReal GDP, ΔSovereign ratings, Chinn-Ito index, ΔSize, ΔETA, ΔDEPtoTA, ΔNETINTtoTA, ΔINTREVtoTOTREV, each interacted with λ and NBshare. See Table B5 for the full estimation table with coefficients of the control variables. 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 1.1: Composition of international capital flows - selected emerging countries



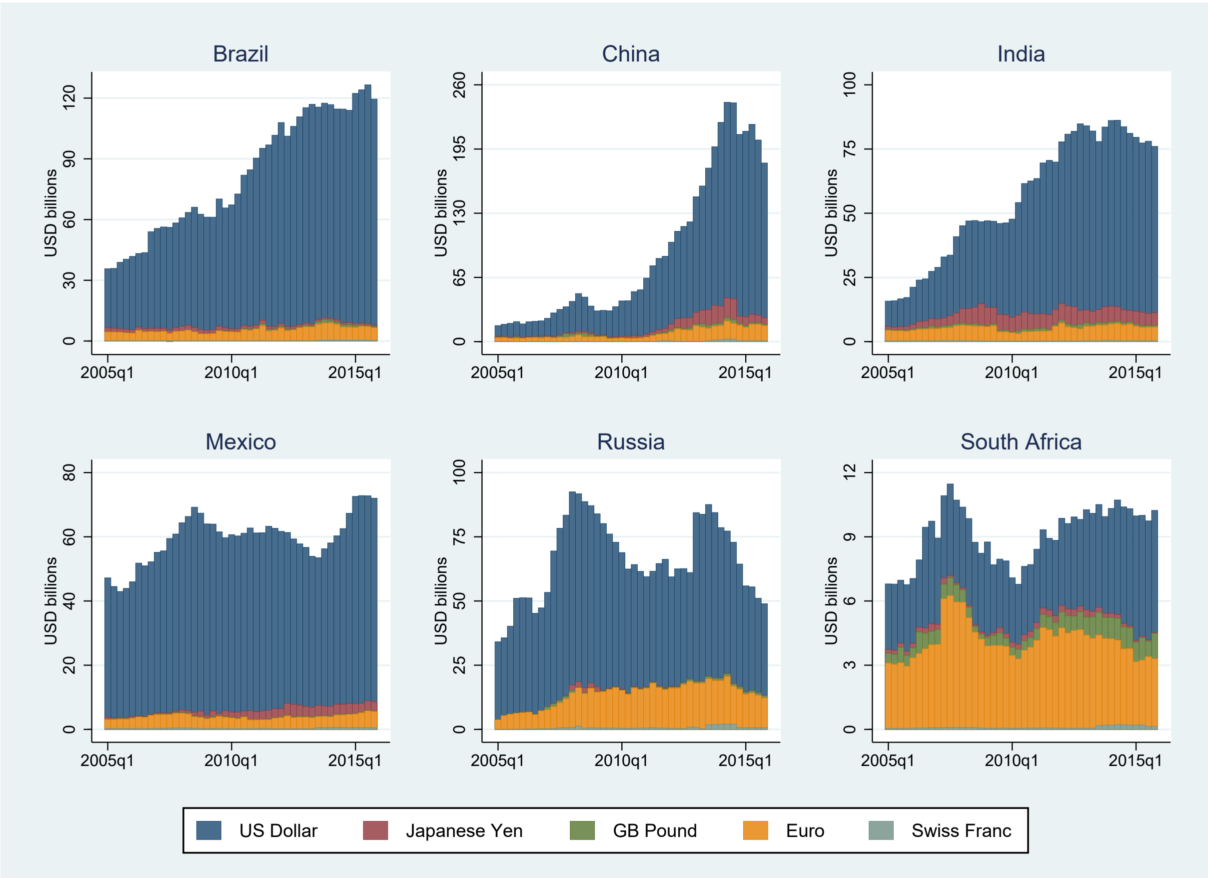
Source: International Monetary Fund, international financial statistics

Figure 1.2: Breakdown of cross-border loans by borrowing sector - selected emerging countries



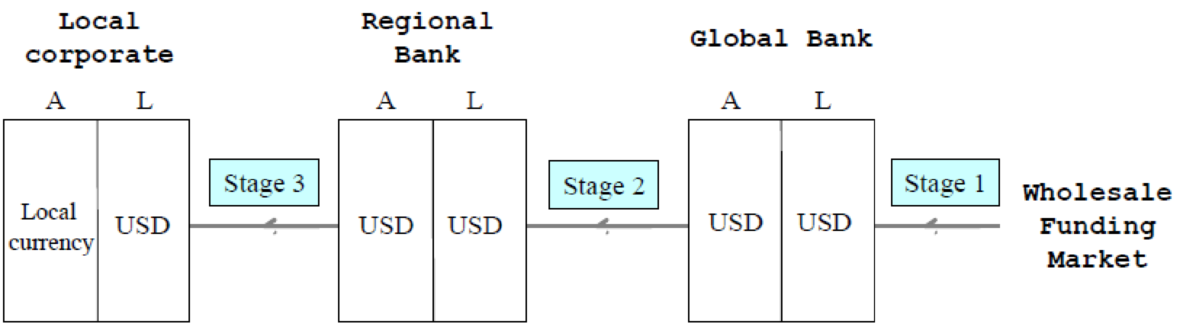
Source: Bank for International Settlements, locational banking statistics

Figure 1.3: Currency breakdown of cross-border loans to non banks - selected emerging countries



Source: Bank for International Settlements, locational banking statistics

Figure 1.4: Structure of international bank lending



Source: Bruno and Shin (2015a)

Figure 1.5: Timing of the model

$t = 0$

- *Banks observe an idiosyncratic signal $\theta_{1,b}$ of the exchange rate between the currency of country E and USD in $t = 1$.*
- *Banks decide whether to lend or not to corporate borrowers in country E with a net interest rate R. They lend in US dollars.*
- *Firms in E that obtain funding invest in a risky project in local currency. The project yields $Q(N, 1/\lambda)$ with probability α.*

$t = 1$

- *Corporate borrowers in E observe the outcome of the project.*
- *If the yield of the project is large enough firms pay back their loans to banks.*

Figure 1.6: Effect of λ on the equilibrium cutoff exchange rates

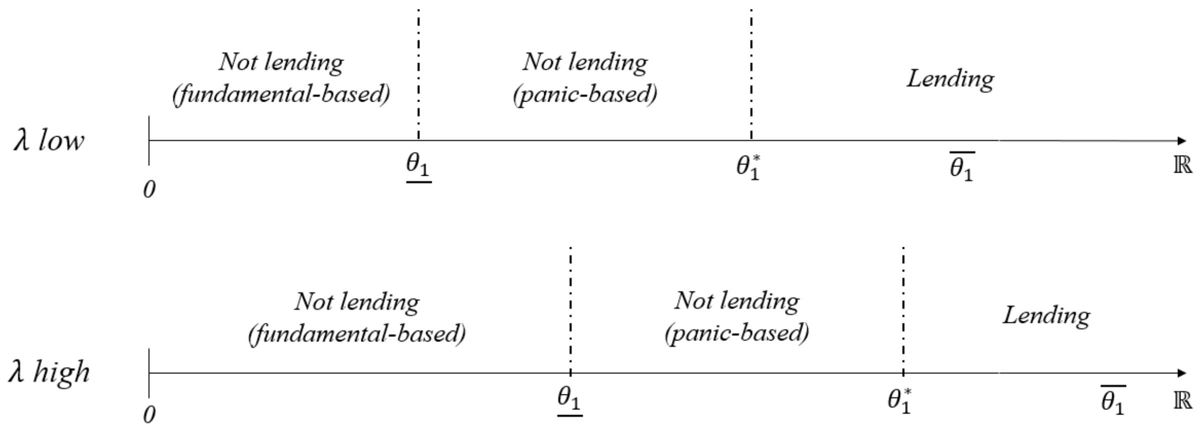
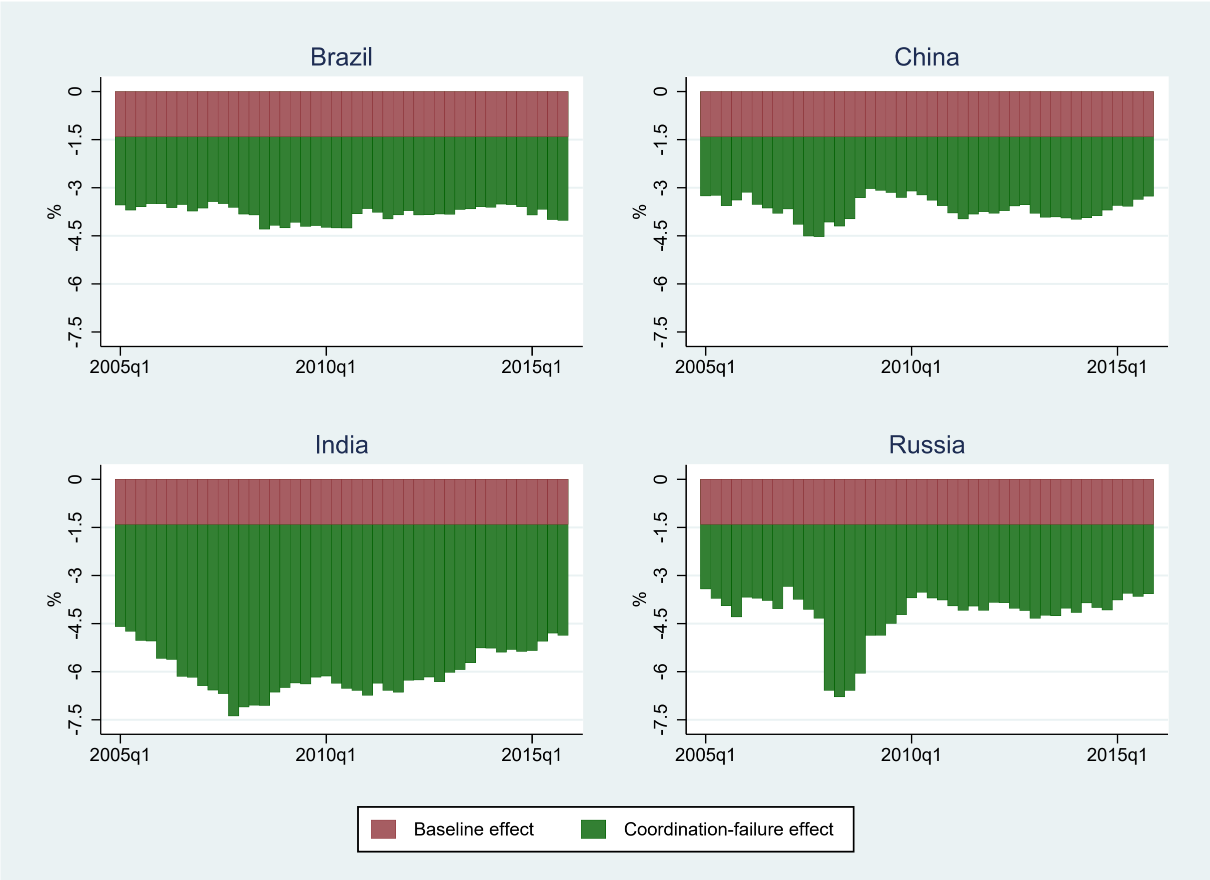
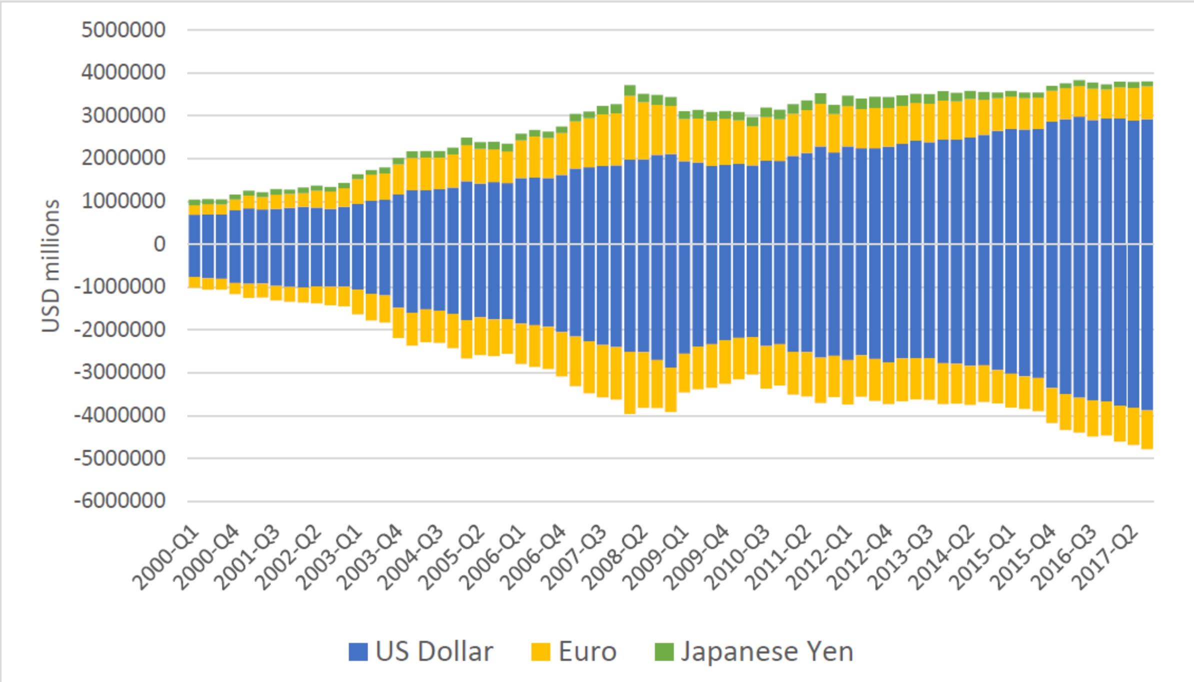


Figure 1.7: Effect of a 1% currency depreciation on cross-border loans to non banks. The time variation is due to the time-varying relevance of cross-border loans for non-bank financing, which acts as a multiplier - selected emerging countries



Source: author's calculations

Figure 1.8: Foreign currency local assets (+) and liabilites (-) of banks in emerging economies



Source: Bank for International Settlements, locational banking statistics

Appendix 1.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[12]:

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

$\pi^*_\sigma(\theta_{b,1}, k, \lambda)$ 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 if and only if

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

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

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

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

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

$\underline{\xi}_{n+1}$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 $\pi^*_\sigma(\theta_{b,1}, k, \lambda)$ is increasing in $\theta_{b,1}$ 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 $\pi^*_\sigma(\underline{\xi}, \underline{\xi}, \lambda) = \pi^*_\sigma(\overline{\xi}, \overline{\xi}, \lambda) = 0$. The remainder of the proof shows that the unique x that solves $\pi^*_\sigma(x, x, \lambda) = 0$ is θ^*.

Write $\Psi^*_\sigma(N, \theta_{b,1}, k)$ 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 $\theta_{b,1}$[13].

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

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

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

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 I can rewrite $\pi^*_\sigma(\theta_{b,1}, k, \lambda)$ in terms of $\psi^*_\sigma(N, \theta_{b,1}, k)$[14]

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

so that when $\theta_{b,1} = k$ 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” qualifica-

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

[14]As in footnote 13, 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 $g\left(\frac{\theta_{b,1}-k+\sigma G^{-1}(1-N)}{\sigma}\right) = \psi^*_\sigma(N, \theta_{b,1}, k)$.

tion 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 $N(\theta_{b,1})$ 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 k (the cutoff)[15]:

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

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:

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

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

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

[15] 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 $\dfrac{prob(\theta_{b,1} \mid \theta_1)\, prob(\theta_1)}{prob(\theta_{b,1})}$. Hence, using the terminology of Section 3 for the various distributions involved and keeping in mind that $\theta_{b,1} = \theta_1 + \sigma\varepsilon_b$, $v(\theta_1 \mid \theta_{b,1}) = \dfrac{g(\varepsilon_b)\, v(\theta_1)}{\int g(\varepsilon_b)\, v(\theta_1)\, d\theta_1} = \dfrac{g\left(\dfrac{\theta_{b,1}-\theta_1}{\sigma}\right) v(\theta_1)}{\int g\left(\dfrac{\theta_{b,1}-\theta_1}{\sigma}\right) v(\theta_1)\, d\theta_1}$. 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 $g(\theta_{b,1} > k) = g(\theta_1 + \sigma\varepsilon_b > k) = g\left(\varepsilon_b > \dfrac{k-\theta_1}{\sigma}\right) = 1 - G\left(\dfrac{k-\theta_1}{\sigma}\right)$, where $G(.)$ is the cdf of $g(.)$.

$\overline{\pi}_{\sigma}(\theta_{b,1})$ is an upper bound on $\pi_{\sigma}(\theta_{b,1},k,\lambda)$ for all k. Also, $\overline{\pi}_{\sigma}(\theta_{b,1})$ is continuous in σ. Setting σ to 0 I get $\overline{\pi}_0(\theta_{b,1})=\overline{\pi}(\theta_{b,1})$, so $\overline{\pi}_0(\theta_{b,1})=-\epsilon$ for all $\theta_{b,1}\leq\underline{\theta}_{b,1}$. Moreover[16],

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

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

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

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

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

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

[16] The full derivation is as follows

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

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

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

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

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 I did in Lemma 1, I 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, I 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 θ_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 1.B: Additional tables and charts

Table 1.B.1: 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]	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 1.B.2: 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 1.B.3: 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]	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 non banks over total capital flows to non banks. 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 1.B.4: 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$^{1}_{t-1}$	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 1.B.5: Effect of exchange rate variation on cross-border loans - controls shown (continues on the next page)

	ΔCross-border loans[1]			
	(1)	(2)	(3)	(4)
	to all sectors	to non banks	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)
ΔLending rate	0.074	-0.041	0.080	0.233
	(0.085)	(0.079)	(0.193)	(0.146)
ΔDomestic lending[1]	0.005	0.241	0.980	0.153
	(0.185)	(0.343)	(2.393)	(2.146)
ΔReal GDP[1]	0.093***	0.077***	0.177***	0.032
	(0.031)	(0.027)	(0.060)	(0.054)
ΔSovereign ratings[3]	0.998**	0.916**	0.689	0.634
	(0.453)	(0.404)	(0.973)	(0.775)
Chinn-Ito index[4]	-3.757***	-4.155***	-4.949***	-1.799*
	(0.564)	(0.529)	(1.258)	(0.977)
ΔSize[5]	-0.714**	-0.697***	-0.397	-0.774
	(0.300)	(0.261)	(0.594)	(0.495)
ΔETA[6]	-5.774	-12.816***	8.833	2.317
	(5.288)	(4.740)	(11.023)	(9.049)
ΔDEPtoTA[7]	0.383	-2.366	5.857	3.392
	(3.522)	(3.143)	(7.090)	(6.252)
ΔNETINTtoTA[8]	4.720	-10.319	9.657	18.833
	(9.454)	(8.456)	(19.529)	(15.661)
ΔINTREVtoTOTREV[9]	2.545	0.725	3.126	1.882
	(2.043)	(1.837)	(4.179)	(3.493)
⋮	⋮	⋮	⋮	⋮

⋮	⋮	⋮	⋮	⋮
ΔLending rate * λ^2	0.163	0.704*	-0.427	-0.995
	(0.448)	(0.420)	(1.021)	(0.773)
ΔDomestic lending[1] * λ^2	0.034	0.214	-0.727	-0.176
	(0.248)	(0.920)	(3.241)	(0.572)
ΔReal GDP[1] * λ^2	0.136	0.011	0.233	0.166
	(0.122)	(0.113)	(0.245)	(0.201)
ΔSovereign ratings[3] * λ^2	-2.035	-2.319	3.958	-3.953
	(2.247)	(2.042)	(4.771)	(3.871)
Chinn-Ito index[4] * λ^2	6.171***	7.524***	3.721	3.759
	(1.520)	(1.411)	(3.393)	(2.575)
ΔSize[5] * λ^2	5.391***	4.373**	3.991	4.470
	(1.977)	(1.726)	(4.000)	(3.282)
ΔETA[6] * λ^2	17.564	52.450*	-48.972	-43.493
	(31.989)	(29.089)	(68.305)	(54.607)
ΔDEPtoTA[7] * λ^2	-15.556	-0.958	-42.051	-29.252
	(18.857)	(16.338)	(40.794)	(33.500)
ΔNETINTtoTA[8] * λ^2	13.072	79.420*	11.649	-98.684
	(51.032)	(44.811)	(107.979)	(83.081)
ΔINTREVtoTOTREV[9] * λ^2	-13.503	-6.233	-9.209	-7.637
	(11.023)	(9.910)	(22.191)	(18.736)
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. [3]Long-term foreign currency sovereign rating, average across 3 agencies (Standard and Poor's, Moody's and Fitch). [4]Measure of financial openness developed in Chinn and Ito (2008). [5]Logarithm of the average size of domestic banks. [6]Equity to total assets. [7]Deposits to total assets. [8]Net interest to total assets. [9]Interest revenues to total revenues. 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 1.B.6: Effect of exchange rate variation on cross-border loans - interaction with the share of lending to non banks - controls shown

	ΔCross-border loans[1]			
	(1)	(2)	(3)	(4)
	to all sectors	to non banks	to banks	to public sector
ΔExchange rate[1] * λ^2 * NB[10]	-30.271	25.105**	-95.858	15.671
	(18.091)	(11.952)	(72.556)	(29.537)
ΔLending rate * λ^2 * NB[10]	1.170*	0.533	2.901	1.769***
	(0.580)	(0.833)	(1.829)	(0.623)
ΔDomestic lending[1] * λ^2	0.031	0.244	-0.437	-0.246
	(0.545)	(0.817)	(1.347)	(0.279)
ΔReal GDP[1] * λ^2 * NB[10]	-0.453	1.403***	-2.947**	-0.795
	(0.547)	(0.486)	(1.249)	(1.069)
ΔSov. ratings[3] * λ^2 * NB[10]	-0.930	-4.221	6.265	1.769
	(2.619)	(4.670)	(12.802)	(12.179)
Chinn-Ito index[4] * λ^2 * NB[10]	-12.800***	13.750**	-52.957***	-25.229***
	(4.409)	(5.148)	(9.226)	(7.677)
⋮	⋮	⋮	⋮	⋮

⋮	⋮	⋮	⋮	⋮
ΔSize[5] * λ^2 * NB[10]	4.904	4.855	3.779	11.258
	(3.650)	(3.001)	(11.334)	(8.136)
ΔETA[6] * λ^2 * NB[10]	-0.167	51.214	103.516	157.225
	(47.848)	(37.272)	(164.354)	(93.945)
ΔDEPtoTA[7] * λ^2 * NB[10]	12.997	-21.927	172.599	20.505
	(27.810)	(14.462)	(121.109)	(50.613)
ΔNETINT[8] * λ^2 * NB[10]	-123.137*	112.085	-347.172*	-344.585*
	(64.474)	(76.257)	(193.228)	(172.664)
ΔINTREV[9] * λ^2 * NB[10]	-4.077	11.329	-82.283	19.540
	(17.913)	(17.164)	(51.297)	(29.983)
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

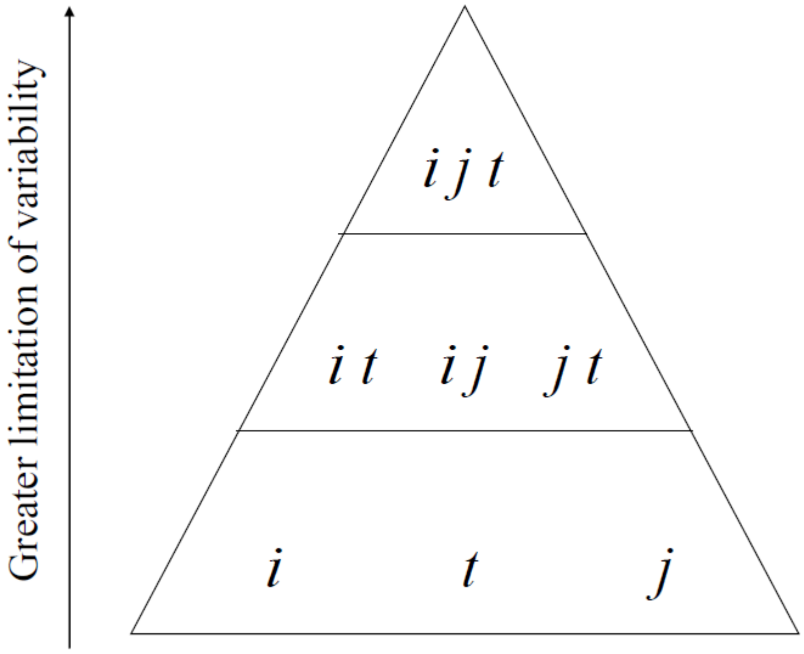
Notes: The sample includes quarterly data for 30 lending countries, 29 borrowing countries (emerging economies) over the period 2001:Q1 - 2015:Q4. [1]Quarterly growth rate (%). [2]Cross-border lending over total capital flows. [3]Long-term foreign currency sovereign rating, average across 3 agencies (Standard and Poor's, Moody's and Fitch). [4]Measure of financial openness developed in Chinn and Ito (2008). [5]Logarithm of the average size of domestic banks. [6]Equity to total assets. [7]Deposits to total assets. [8]Net interest to total assets. [9]Interest revenues to total revenues. [10]Cross-border loans to non-banks over cross-border loans to all sectors. 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. *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

Table 1.B.6: Effect of exchange rate variation on direct investment and portfolio investment

	(1)	(2)
	ΔDirect investment[1]	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. *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

Figure 1.B.1: Fixed effects and variation allowed in the data



- 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

Appendix 1.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).

2. The Shifting Drivers of Global Liquidity *(joint with Stefan Avdjiev, Leonardo Gambacorta and Linda Goldberg)*

Abstract
The post-crisis period has seen a considerable shift in the composition and drivers of international bank lending and international bond issuance, the two main components of global liquidity. The sensitivity of both types of flow to US monetary policy rose substantially in the immediate aftermath of the Global Financial Crisis, peaked around the time of the 2013 Fed "taper tantrum", and then partially reverted towards pre-crisis levels. Conversely, the responsiveness of international bank lending to global risk conditions declined considerably post-crisis and became similar to that of international debt securities. The increased sensitivity of international bank flows to US monetary policy has been driven mainly by the co-movement in advanced economy monetary policies. As those policies started to diverge in 2013, these transitory effects gradually weakened. By contrast, the post-crisis fall in the sensitivity of international bank lending to global risk was mainly due to a compositional effect, driven by increases in the lending market shares of better-capitalized national banking systems. Policies and prudential instruments that reinforced lending banks' capitalization and stable funding levels reduced the volatility of international lending flows.

2.1 Introduction

International capital flows channel financial resources across borders to both public and private sector borrowers. Their two largest debt components, cross-border bank loans and international bond issuance, are the main elements of global liquidity (Bank for International Settlements, 2011a and 2011b). As such, they are critically important for economic growth and financial stability and understanding their main drivers is crucial for both policymakers and researchers (Passari and Rey, 2017). The existing empirical literature has established that global (push) and local (pull) factors are both important drivers of cross-border bank loans and international bond issuance. Among pull factors, the literature has identified recipient country output growth, sovereign credit risk, and the degree of capital account openness. The most important global drivers identified by the literature have been advanced economy monetary policies, global risk aversion and global output growth (e.g. Forbes and Warnock, 2012a; Miranda-Agrippino and Rey, 2015; Cerutti, Claessens and Ratnovski, 2017; and Cerutti, Claessens and Rose, 2017).

While studies generally focus on identifying the drivers, they seldom examine the how and why of evolving sensitivities to global factors. Yet, the structure and volatility of cross-border bank loan and international bond flows clearly have changed considerably in the aftermath of the Global Financial Crisis (GFC). In the immediate aftermath of the crisis, cross-border loans contracted sharply. This was followed by a feeble recovery and a second sharp contraction during the peak of the euro area crisis. By contrast, international bond issuance was relatively robust during the post-crisis period. As a consequence, the composition of global liquidity has shifted away from cross-border bank loans and towards international bonds in what has been dubbed "the second wave of global liquidity" (Shin, 2013). Meanwhile, events such as the "taper tantrum" in 2013, when the Federal Reserve signalled it would start tapering its bond buying program, were marked by especially sharp changes in some capital flows to emerging markets (Khatiwada, 2017). Graph 2.1 contains a summary of the behaviour of the various types of flow at the global level for bank and nonbank borrowers. An extensive literature (reviewed in the next section) discusses the vulnerability of borrowing countries to international surges and retrenchments, and the potential policy tools available for containing excessive changes.

In this paper, we start by replicating the main findings of the existing literature about the main drivers of international capital flows. This gives us a good point of departure to investigate the changes in sensitivities of the main components of global liquidity to global drivers (risk and advanced economy monetary policy) during the post-crisis period. We drill down into observed changes, test for their proximate reasons, and distinguish between persistent versus transitory drivers. To achieve these ends, we complement the existing literature by looking at the data from a different perspective and in a more comprehensive way. In particular, we draw on multiple databases on global liquidity component flows from both borrower country and creditor country perspectives, distinguishing between instrument types (international debt securities versus international bank loans), and between borrowing sectors (bank versus non-bank). Using the BIS International Debt Securities (IDS) Statistics and the BIS Locational Banking Statistics (LBS), we create a quarterly panel of international bank loan and bond flows to 64 recipient countries for the period between 2000:Q1 and 2015:Q4. In addition, we utilise the BIS Consolidated Banking Statistics (CBS) in order to assign loans to specific national lending banking systems. Using Bankscope, we obtain information on lending banking system balance sheet characteristics. We also incorporate a range of other data on prudential instrument and monetary policy developments, from the perspective of both the borrowers and the creditor countries. Advanced economy monetary policies, as well as shadow measures that capture unconventional policies, are also incorporated into the analysis.

After replicating the types of global factor and local factor results documented in prior studies, our analytical contributions centre around three main sets of results. Our first key result is that international capital flow sensitivities to global factors have changed considerably since the GFC. Advanced economy monetary policy, proxied by US monetary policy, became a more potent driver of both cross-border loan and international bond flows. The estimated policy impacts peaked in 2013 and then partially retraced toward pre-crisis levels while remaining elevated. Meanwhile, the sensitivity of cross-border bank loan flows to global risk conditions declined considerably post-crisis and became similar to the respective risk sensitivity observed for international bond flows. In fact, international bank loan and bond flows became more similar in terms of their responsiveness to global factors after the GFC. Overall, aggregate global liquidity flows (the sum of international bank loan and bond flows) have become more sensitive to US monetary policy and less sensitive to global risk.

The second set of results shows that post-crisis shifts in sensitivities of international bank loan and bond flows to global factors, observed from the borrower perspective, arise from a combination of changes in the country composition of lending banking systems and from changes in the behaviour of the creditors involved in international financial flows. Working across multiple databases, we show an increase in the responsiveness of flows from individual lending banking systems to US monetary policy. We also find evidence of a compositional shift toward national lending banking systems with lower sensitivity to global risk conditions.

We drill deeper into the type of variation observed to investigate the contributions of a range of prudential measures, bank business model features, and monetary regimes in the creditor countries. We find that the features of financial intermediaries that previously have been shown to stabilize domestic bank lending response to liquidity risk, like bank capital ratios and deposit funding, also support expansion of international market share relative to weaker peer country systems and help explain changing behaviours. National banking systems that were better capitalized before the GFC experienced smaller post-crisis rises in sensitivity to US monetary policy and larger increases in international lending shares. Higher ex-ante shares of deposits in total funding and of locally booked claims in total foreign claims were also associated with larger increases in international lending market shares. Tighter local reserve requirements pre-crisis were associated with relative expansions of international market shares in the post crisis period.

Even post-GFC there has been a significant evolution of creditor sensitivities to global risk and US monetary policy. Within the post-GFC period, we tie this evolution to the roles of banking sector performance metrics and relative monetary policy stances across advanced economies. High sensitivities to US monetary policy post-GFC are tied to the relative path of expected US monetary policy vis-'a-vis that of other major advanced economies, proxied using two-year interest rate futures data. In particular, sensitivity in cross-border loans is enhanced in the years immediately following the crisis, consistent with an interpretation that US monetary policy served as a stronger indicator of global monetary policy in a period of low growth across advanced economies. This effect unwound as a perception took hold of greater policy divergence across advanced economies starting in 2013. Proxies for the business models of creditor banking systems played less of a role of in this evolution.

These results contribute importantly to both research and policy debates around global liquidity and local stabilization. One pertinent question is whether the enhanced diversification across financing types will have different consequences in the case of future stress episodes, as well as in normal periods. This is an especially pertinent issue if, ex-ante, bank loan and debt securities financing agents are subject to distinct degrees of leverage and balance sheet constraints. We show that pre-crisis borrowers experienced more global factor sensitivity in cross border loans than in international debt securities. As a consequence, international debt securities remained relatively robust during the global financial crisis. Post-crisis, the sensitivities of both types of financing have become more similar.

Another question is how stabilization challenges across countries borrowing internationally evolve in post-crisis periods and when the synchronization of business cycles across countries is enhanced. The range of evidence we provide across econometric exercises suggests that the large increases in sensitivities to US monetary policy post GFC may have been a transitory phenomenon, whereas the declines in global liquidity sensitivity to risk measures may be more persistent. At least in international bank flows, behavioural changes in the period immediately following the GFC were driven largely by the convergence in advanced economy monetary policies. These transitory effects gradually weakened when the monetary policies of advanced economies started to diverge in 2013. More persistent effects may come from the increased market shares of better-capitalized lending banking systems, whose international lending tends to be less responsive to fluctuations in global risk conditions. The implications would be that evolving global drivers also change the scope for monetary autonomy and prudential policies options for borrowing countries. Moreover, a potentially important consequence of the focus on capital and stable funding in creditor countries are reduced amplitudes of global liquidity surges and waves as observed by borrowers.

The remainder of the paper is organised into six sections. Section 2 reviews relevant findings of the existing literature on global liquidity and its drivers, also focusing on differences between banks and non-banks as creditors and debtors. Section 3 presents the econometric methodology that we employ in respective empirical investigations. Section 4 describes the data. Section 5 provides the empirical results and related discussion. Section 6 presents robustness tests. Section 7 concludes.

2.2 Previous literature

Global liquidity and drivers have been explored in a number of related studies. The most extensive previous literature is on international capital flows. The second strand of literature is more explicitly focused on global liquidity, international debt securities versus loans, and constraint differences across banks and non-banks. The third thread of literature addresses international monetary policy spillovers, covering the transmission channels through banks and capital markets, interest rate and asset price co-movements, and broader issues around the structure of the international monetary system and policy instrument availability.

The large literature on the drivers of capital flows focuses most extensively on emerging markets, and more recently considers advanced economies also as destinations of capital. Surges in cross-border flows to EMEs reflect improved macroeconomic fundamentals of the borrowing country (pull and local factors) and more favourable global conditions of a primarily cyclical nature (push and global factors). Examples of such studies include those by Calvo et al. (1993), Ghosh and Ostry (1993), Fernandez-Arias (1996), Taylor and Sarno (1997), and Chuhan et al. (1998)[1].

The emphasis of the literature then shifted specifically to understanding gross (as opposed to net) international flows and distinguishing across different institutional participants. Portes and Rey (2005) show that information frictions and technology matter for the relative stability of gross flows. Broner et al. (2013) show the higher volatility in gross

[1]See Koepke (2015) for a comprehensive summary of the literature in the drivers of capital flows to EMEs.

flows than in net flows, specifically in the context of business cycles and crises. Forbes and Warnock (2012b) present a systematic framework for analysing capital flows whereby extreme episodes are classified into four categories: surges, stops, flight and retrenchment. This work carefully documents how the most extreme capital flows episodes are driven by global factors, notably global risk aversion. Milesi-Ferretti and Tille (2011) document heterogeneity in the behaviour of various capital flows components during the Global Financial Crisis, emphasizing the dominant contraction of international banking flows and the relative stability of foreign direct investment. Post-crisis declines in bank-based cross-border lending, particularly by euro area banks, have been described in some analysis as financial deglobalization (Rose and Wieladek, 2011; Forbes et al., 2015) or "the great cross-border bank deleveraging" (Cerutti and Claessens, 2017; Bussi'ere et al., 2016). The explanations provided include weaker economic activity; capital controls and the slower pace of liberalization; deleveraging, and risk aversion (CGFS 2011).

Related research uses micro-banking data to explore international financial linkages. Cetorelli and Goldberg (2012a), working with bank-specific data, show that contractions in international lending by global banks during the crisis were related to balance sheet shocks through holdings of asset-backed commercial paper. Contractions in some cases are shown to be magnified by policy interventions. Across UK banks, prudential policies and unconventional monetary policy in the form of a funding for lending scheme jointly contributed to a retrenchment of cross-border lending with differential effects across banks (Forbes, Reinhardt and Wieladek, 2017). More broadly, across countries prudential policy effects on international bank flows were associated with contractions in some cases and expansions elsewhere (Buch and Goldberg, 2017). Some countries with banks that were well-capitalized pre-crisis expanded international activities post-crisis (see Damar and Mordel, 2017 for the case of Canada among).

The actual channels of transmission that drive these co-movements have been identified by heterogeneity across bank-balance sheets. Cetorelli and Goldberg (2012b) show bank transmission through internal capital markets and heterogeneity in shock transmission to countries depending on their global bank-specific importance in lending and funding activity. Bruno and Shin (2015b) point to a direct role for balance sheet valuation by banks, as monetary policy spillovers drive cross-border bank capital flows and the US dollar exchange rate through the banking sector. Bruno and Shin (2015a) demonstrate that episodes of appreciation of the US dollar are associated with deleveraging of global banks and an overall tightening of global financial conditions. Banks also have been shown to have shifted their treatment of their sovereign exposures pre- versus post-crisis, later having more risk assigned to these positions and posing different constraints (Acharya et al., 2013; Farhi and Tirole, 2016; De Grauwe and Ji, 2013). Banks have more pronounced bank lending channel responses to liquidity risk when they have low levels of capitalization and low deposit funding shares (Cornett et al. 2011; Buch and Goldberg, 2015).

A parallel and rapidly growing literature on the main drivers of global liquidity emphasizes specific global financial factors. Miranda-Agrippino and Rey (2015) argue that one global factor explains an important part of the variance of a large cross section of returns of risky assets and interpret this factor as time-varying market-wide risk aversion linked to US monetary policy. Similar main drivers are documented by Cerutti, Claessens and Ratnovski (2017) and include US monetary policy, global uncertainty (proxied by the VIX), the exchange rate value of the US dollar, and European bank conditions. Non-bank financial intermediations also have recently received attention.

Another type of shift occurred in the composition of international capital flows worldwide, as the first phase of global liquidity through banks was replaced to some degree by a second phase of global liquidity through corporate bond financing, particularly for emerging market borrowers (Shin, 2013)[2]. Chung et al. (2016) link the evolution of global monetary aggregates to the financial activities of non-financial corporations (NFCs), with the non-core liabilities of NFCs reflecting global credit conditions and predicting global trade and growth. McCauley et al. (2015) find that unconventional monetary policy contributed to shifting the balance of dollar credit transmission from global banks to global bond investors, demonstrating a negative relationship between the term premium on 10-year Treasury bonds and international bond issuance during the post-crisis period.

Finally, the long literature on international monetary policy spillovers, with its focus on short-term interest rate co-movement and the constraints on stabilization policies posed by the international monetary trilemma, is directly relevant for analysis of global liquidity drivers. Obstfeld, Shambaugh and Taylor (2005) show that monetary policy rates across a large sample of countries can closely track advanced economy policy rates, particularly those of countries playing a central role in the international monetary system. The form of exchange rate and monetary regimes in place influences the degree of co-movement, although greater near term autonomy can come from some restrictions on international capital movements (Klein and Shambaugh, 2008) and lower levels of banking globalization (Goldberg 2013). Prudential policy instruments are argued to potentially afford countries relief from international capital flow movements (Rey, 2013), although the evidence to date on consequences for flows through global banks is mixed and not yet large in magnitude[3].

Collectively these papers show the importance for global liquidity and interest rate co-

[2]These observations pertain to volumes of cross-border flows, not to co-movements of asset prices. During this same broad period, co-movements in international asset prices continue to be at least as strong and sensitive to global risk sentiment and liquidity conditions as pre-crisis state. This type of evidence does not support de-globalization.

[3]Extensive discussion and cross-country evidence is provided in the March 2017 volume of the International Journal of Central Banking in which a range of country and cross country studies document experiences through global banks and hosted affiliates of foreign banks. Buch and Goldberg (2017) provide a meta-analysis of findings.

movements of constraints on different types of institutions, the shifts in importance of these institutions, and the scope for policy responses to international financial flows. Our study takes an integrated approach by studying the flows through banks and non-banks as borrowers and lenders. We analyse the effects of key global liquidity drivers, including risk and advanced economy monetary policy, and tests conjectures about why and how these effects change over time. Our analysis ties together the dynamism in the effects of different global factors, showing the roles of micro-banking characteristics, composition of creditors, monetary policy regimes, and prudential policies of both borrowers and creditors.

2.3 Empirical strategy

The empirical strategy implemented has three main parts. The starting point is the international capital flow and global liquidity specification whereby international financial flows are explained by global (push) and country-specific (pull) drivers. We replicate findings from that literature as a baseline before delving into differences in sensitivities to global (and other) factors over time, as well as across different borrower groups (banks and non-banks) and across different types of financing instrument (international claims and international debt securities). After having identified significant changes in patterns pre- and post- global financial crisis, the second part of the empirical strategy focuses on the pre- versus post patterns of changes in global liquidity sensitivity to global factors, with a specific set of tests for changes in the composition versus the behaviour of creditors. The patterns of composition and behaviour then are related to ex ante balance sheet conditions and regulatory policies of lending banking systems. The last part of the empirical strategy relates period-by-period time variation in the effects of advanced economy monetary policy and risk sensitivity to evolving creditor bank balance sheet characteristics and to degrees of divergence across monetary policies of advanced economies.

2.3.1 Baseline analysis

The baseline model for global and local factors in international capital flows follows the literature by introducing push global factors and pull local factors, and is given by:

$$\begin{aligned} GrRateY_t^j = {} & \beta_1 \Delta FFR_t + \beta_2 logVIX_t + \beta_3 \Delta logGlobalGDP_t \\ & + \beta_4 \Delta SovRating_t^j + \beta_5 ChinnIto_t^j + \beta_6 \Delta logGDP_t^j + \mu^j + \varepsilon_t^j \end{aligned} \tag{2.1}$$

where j denotes country and t is time. Our baseline specification considers the issue of international capital flows and global liquidity drivers from the perspective of the borrowing country. Global liquidity is divided into component cross-border flows by instrument and by type of borrower, with these components explored separately and in aggregate. For our analysis, Y_t^j can be cross-border loans - to all sectors, to banks, to non-banks - or international debt securities - issued by all sectors, by banks or by non-banks. As is standard in the literature, the model is expressed in stationary variables to avoid problems of spurious correlations. The international flows on the left-hand side of the equation are expressed in growth rates. The right-hand-side of the equation contains three global liquidity drivers - the US federal funds rate (as a gauge for the stance of US monetary policy), the VIX (as a measure global risk conditions) and global GDP (as an indicator of global economic activity). As the US federal funds rate does not reflect all of the monetary policy interventions for the post GFC period, we use the Wu-Xia shadow rate measure (Wu and Xia, 2016) as a proxy to reflect both conventional and unconventional monetary policies[4]. The local factors corresponding to borrowing country j and flow type include 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. The Fed funds rate and the sovereign ratings are in first differences, while local and global GDP are in growth rates. The Chinn-Ito index is in levels and the VIX enters the equation in logs[5]. The model is estimated under the assumption that the two key global liquidity drivers, the Fed funds rate and the VIX, are exogenous when controlling for local and global GDP, government ratings and degree of financial openness.

As both anecdotal evidence and the literature discussion of phases of financial globalization hint at the presence of a possible structural break around the global financial crisis, we modify the full time period approaches of the literature and allow for shifts in the drivers of global liquidity. Rather than exogenously imposing a particular break date, we conduct a formal search for an endogenous structural break in the parameters of the model. Using the tools developed in Bai (1994, 1997), Kurozumi (2002) and Carrion-i-Silvestre and Sans‘o (2006), for each quarter T starting in 2007:Q1, we estimate the following equation:

$$GrRateY_t^j = \beta' X_t^j + \mu^j + I(t \geq T)(\kappa + \gamma' X_t^j) + \varepsilon_t^j \tag{2.2}$$

[4]As there are multiple shadow policy rates available in the literature, we perform extensive robustness checks using alternative indicators of U.S. monetary policy. The main findings are robust to alternative proxies.

[5]The Chinn-Ito index is only available at an annual frequency. We have tested the robustness of the results by using a quarterly linear interpolation of the Chinn-Ito index and by eliminating the index from the regressions. In both cases, the main results of the study remain qualitatively similar.

where

$$X_t^j = \left(\Delta FFR_t, logVIX_t, \Delta logGlobalGDP_t, \Delta SovRating_t^j, ChinnIto_t^j, \Delta logGDP_t^j\right)'$$

and $I(t \geq T)$ is an indicator function that takes the value 1 when t≥T and 0 otherwise. Notice that for each candidate break date T, all the parameters of equation (3.2) are different. For each type of cross-border flow Y and each quarter T we can compute the sum of squared residuals of the regression in order to get a sequence $SSR^Y_{T(T\geq 2007:Q1)}$. The most likely candidate for the break is the date that minimizes the sequence, hence maximizing the fit of the model: $T^Y_{break} = argmin_{(T\geq 2007:Q1)} SSR^Y_T$.

Once we detect the endogenous date for the break (T^Y_{break}), we re-estimate the baseline model with the appropriate break dummy and use a Wald test on κ and γ' to determine whether the break is statistically significant. The vector β' captures the sensitivities of international financial flows to the drivers in X_t^j before the break. The sum $\beta' + \gamma'$ captures the post-break sensitivities.

Given our special interest in the sensitivities of international loan and bond flows to US monetary policy and global risk conditions, we then conduct an additional closer investigation of the evolution of the respective estimated coefficients. In particular, we examine the hypothesis that the post-crisis paths of the above sensitivities may have been altered before and after the 2013 taper tantrum. For this purpose we sequentially estimate equation (2) with the appropriate break date, starting with the sample 2000:Q1 – 2013:Q1 and adding one quarter at time until we reach our full sample (2000:Q1 – 2015:Q4). This procedure generates a distinct set of parameter estimates for each sample-end quarter from 2013:Q1 through 2015:Q4. This allows us to track how sensitivities to US monetary policy and global risk conditions have evolved during that period. As with the baseline analysis, for this approach to time variation Y_t^j can be cross-border loans to all sectors, to banks, to non-banks, can be international debt securities issued by all sectors, by banks or by non-banks.

2.3.2 Decomposing the post-crisis shifts in sensitivities

The global liquidity series exploration described in section 3.1 utilizes gross flows data from the perspective of borrowers in countries indexed by j. As the specifications introduce controls for local drivers of liquidity, the evolution of estimated global factor coefficients β_1 and β_2 , on advanced economy monetary policy and risk, are associated with creditors. In particular, changes in estimated β_1 and β_2 are attributable to a combination of shifts in the composition of international creditors (a compositional component) and shifts in the sensitivity of flows from country creditors vis-a-vis advanced economy monetary policy and risk metrics (a behavioural component). For any class of creditor and borrower type, the aggregate sensitivities of international bank lending flows to global factors (β_1 and β_2) can be expressed as weighted averages of the national creditor-specific sensitivities to global factors (β_1^i and β_2^i). While this observation is general, as we have and analyse detailed information from the perspective of creditor banking systems at the country level (but do not have creditor data for international debt securities financing, our derivation of the decomposition takes the perspective of international bank lending.

We start by re-writing specification (3.1) as:

$$\frac{S_t^j}{S_{t-1}^j} - 1 = \beta_1 \Delta FFR_t + \beta_2 logVIX_t + \beta_3 \Delta logGlobalGDP_t \\ + \beta_4 \Delta SovRating_t^j + \beta_5 ChinnIto_t^j + \beta_6 \Delta logGDP_t^j + \mu^j + \varepsilon_t^j \tag{2.3}$$

where S_t^j is the outstanding stock of international bank lending to the residents of country j at the end of period t. The national banking system-specific counterpart to specification (3.1) is then written as:

$$\frac{S_t^{i,j}}{S_{t-1}^{i,j}} - 1 = \beta_1^i \Delta FFR_t + \beta_2^i logVIX_t + \beta_3^i \Delta logGlobalGDP_t \\ + \beta_4^i \Delta SovRating_t^j + \beta_5^i ChinnIto_t^j + \beta_6^i \Delta logGDP_t^j + \mu^{i,j} + \varepsilon_t^{i,j} \tag{2.4}$$

Expanding and simplifying yields:

$$\frac{S_t^j}{S_{t-1}^j} - 1 = \frac{\sum_i S_t^{i,j}}{\sum_i S_{t-1}^{i,j}} - 1 = \sum_i \left(\frac{S_t^{i,j}}{S_{t-1}^{i,j}} \frac{S_{t-1}^{i,j}}{\sum_i S_{t-1}^{i,j}} \right) - 1 = \sum_i w_{t-1}^{i,j} \left(\frac{S_t^{i,j}}{S_{t-1}^{i,j}} - 1 \right) \tag{2.5}$$

where the weight for each banking system $w_{t-1}^{i,j} = \frac{S_{t-1}^{i,j}}{\sum_i S_{t-1}^{i,j}}$ equals the respective share of the outstanding stock of flows for which it accounts. Combining (3.4) and (3.5), the baseline regression specification implies that the sensitivities to the federal funds rate (β_1) and to the VIX (β_2) can be expressed as weighted averages of the respective sensitivities (β_1^i) and (β_2^i) for the individual lending national banking systems:

$$\beta_1 = \sum_i w_{t-1}^{i,j} \beta_1^i \qquad \beta_2 = \sum_i w_{t-1}^{i,j} \beta_2^i \tag{2.6}$$

The compositional component is captured by the w_1^i's and w_2^i's and the behavioral component is captured by the β_1^i's and the β_2^i's. The compositional factors w_1^i's and w_2^i's are directly observable and can be obtained from the data on bilateral international claims. Meanwhile, the behavioral factors β_1^i's and β_2^i's are estimated using a variant of the baseline specification. Using this approach, we pivot from the borrowing country perspective taken in section 3.1 to instead using data from the creditor country perspective. The BIS consolidated banking statistics (CBS) is a dataset from the creditor country perspective that contains information on banks' international claims defined as the sum of cross-border claims and local claims denominated in foreign currencies. The data is bilateral and contains information on the nationality of the lending banks i and on the residence of the borrower j. By lending country i and for estimation periods corresponding to those defined in our first stage of the analysis (pre-break period and post break periods), the baseline model is estimated similarly to model (3.1), to generate lending country specific estimates of behavioural factors β_1^i's and β_2^i's. Thus, we observe the creditor country history of changes in sensitivities and the precision of estimates of those sensitivities for global liquidity flows through international banks to both bank and non-bank counterparties.

2.3.3 Identifying the determinants of the post-crisis behavioural and compositional changes

The third main empirical element of our analysis is a further investigation into the changing drivers of global liquidity. We conduct a diff-in-diff analysis that compares the pre- and post-crisis sensitivities to global factors and the shares of national banking system lenders. The analysis considers which pre-crisis characteristics of banking systems and policies are associated with changes to outcomes post-crisis.

Among the potential drivers of the structural changes in creditor country shares in global liquidity and creditor behaviours are bank balance sheet conditions and regulatory policies. The bank conditions include the initial (pre-crisis) level of bank capitalization and other ex-ante balance sheet characteristics. Bank capital acts as a buffer against contingencies triggered by monetary policy shocks and can limit the effect of a credit crunch in a crisis characterized by increased global uncertainty and volatility (Gambacorta and Shin, 2016). We construct ex ante balance sheet characteristics at the national banking system level by using bank-level Bankscope data, aggregated at the country level and corresponding to averages over dates included in specific estimation periods. We test whether the shifts in sensitivities and weights have been driven by the use of specific prudential policy tools using the IBRN Prudential Instruments Database from the perspective of lending countries as described in Cerutti, Correa, Fiorentino and Segalla (2017). This database covers prudential instruments such as capital requirements, loan-to-value limits, local currency reserve requirements, and interbank exposure limits.

We test for the main drivers of the shift in sensitivities to global factors by estimating regressions in which the changes in the estimated coefficients are regressed on a set of pre-crisis variables. In particular, we estimate the following regressions:

$$(\beta^i_{1,k,PostBreak} - \beta^i_{1,k,PreBreak}) = \gamma'_1 F^i_{2008} + \zeta'_1 P^i_{2008} + \theta_{1,k} + \varepsilon^i_{1,k} \tag{2.7}$$

$$(\beta^i_{2,k,PostBreak} - \beta^i_{2,k,PreBreak}) = \gamma'_2 F^i_{2008} + \zeta'_2 P^i_{2008} + \theta_{2,k} + \varepsilon^i_{2,k} \tag{2.8}$$

where $(\beta^i_{1,k,PostBreak} - \beta^i_{1,k,PreBreak})$ is the difference in coefficients for ΔFFR and $(\beta^i_{2,k,PostBreak} - \beta^i_{2,k,PreBreak})$ is the difference in the coefficients for$logVIX$ taken from equation (3.4), estimated for lending country i and borrowing sector k (banks, non-bank private sector and public sector). $\theta_{1,k}$ and $\theta_{2,k}$ are vectors of borrowing sector fixed effects. The vector F^i_{2008} includes two banking system indicators: i) the capital-to-asset ratio; ii) the average bank size. The vector P^i_{2008} represents the prudential stance and it includes a range of prudential instruments. We use pre-break characteristics in order to limit endogeneity issues. Since the dependent variable in those regressions is a function of estimated coefficients, each with an associated standard error around it, we use meta-regressions techniques[6].

We likewise examine the drivers of the shifts in lending banking system weights in flows to bank and non-bank borrowers, applying a similar regression specification to $(w^i_{k,PostBreak} - w^i_{k,PreBreak})$:

$$(w^i_{k,PostBreak} - w^i_{k,PreBreak}) = \gamma'_w F^i_{2008} + \zeta'_w P^i_{2008} + \chi'_w B^i_{2008} + \theta_{w,k} + \varepsilon^i_{w,k} \tag{2.9}$$

where B^i_{2008} is a vector containing the following additional pre-break banking system indicators: i) the deposit-to-total funding ratio, ii) the ratio of net interest income to total income, iii) the ratio of local claims to foreign claims.

2.3.4 Examining the drivers of the evolution of post-crisis sensitivities

The final part of our empirical analysis takes a time series approach in order to identify the main drivers of the evolution of post-crisis sensitivities. We conjecture that this evolution may be influenced by the overall advanced economy monetary policy stance and by the characteristics of the creditor national banking systems. One possible driver of the post-crisis evolution in sensitivities could be the degree of monetary policy convergence among advanced economies (AEs). The reaction to U.S. monetary policy as a global

[6] The meta-regression allows for residual statistical heterogeneity in the results of different estimation (between-study variance) by assuming that the true effects follow a normal distribution around the linear predictor (Stanley and Jarrell, 1989). The meta-regression can be formally defined as:$y_i|\theta_i \sim N(\theta_i, \sigma^2_i)$, where $\theta_i \sim N(x_i\beta, \tau^2)$ therefore: $y_i \sim N(x_i\beta, \sigma^2_i + \tau^2)$, where β is the vector of estimated effects of study characteristics. This type of equation is estimated by weighted least-squares, in which the weight of each estimated coefficient depends inversely of its variance and corresponds to the inverse of the sum of two standard deviations (σ^2,τ^2).

liquidity driver could be especially pronounced if it is a signal for a broader based set of expansionary policies across AE countries. In the period between the global financial crisis and the 2013 Fed taper tantrum, there was considerable convergence between the monetary policies of advanced economies, all of which were conducting various forms of quantitative easing to stimulate the real economy. In 2013 the Federal Reserve signalled that it would start tapering its bond buying program. As the central banks of other advanced economies, most notably the European Central Bank and the Bank of Japan, did not follow suit, the monetary policies of advanced economies diverged through the end of our estimation period in 2015. Thus, we conjecture that the sensitivities of the main global liquidity components to of US monetary policy could be stronger during the convergence period and weaker as policy diverges.

We also conjecture that banking system characteristics, such as lenders' dominant business models and profitability, may have also driven the post-crisis evolution in sensitivities. Institutions engaging mainly in commercial banking activities have lower costs and more stable profits than those more heavily involved in capital market activities, mainly trading. Also, retail banking has gained ground post-crisis, reversing a pre-crisis trend (Roengpitya et al., 2017)[7]. The willingness to lend to riskier counterparties is particularly strong in low interest rate environments, especially when these are likely to be sustained. Thus, we conjecture that reach for yield behaviours, a push factor in global liquidity, may be stronger for the banking systems that had more depressed profitability and return on assets.

This last section of empirical results thus examines the relevance of lending banking system characteristics and the degree of divergence among advanced economies' monetary policies by interacting the respective variables with the coefficients of ΔFFR and $logVIX$ in equation (3.2). The resulting model is:

$$\begin{aligned} GrRateY_t^j = \beta' X_t^j + \left[\nu + \eta' \begin{pmatrix} \Delta FFR \\ logVIX \end{pmatrix}_t \right] polDiv_t \qquad (2.10) \\ + \left[\rho + \xi' \begin{pmatrix} \Delta FFR \\ logVIX \end{pmatrix}_t \right] Prof_t^j + \mu^j + I\left(t \geq T_{break}^{Y}\right) * \\ * \left\{ \kappa + \gamma' X_t^j + \left[\omega + \chi' \begin{pmatrix} \Delta FFR \\ logVIX \end{pmatrix}_t \right] polDiv_t + \left[\delta + \phi' \begin{pmatrix} \Delta FFR \\ logVIX \end{pmatrix}_t \right] Prof_t^j \right\} + \varepsilon_t^j \end{aligned}$$

where $polDiv_t$ is a proxy for the monetary policy divergence between the US and other

[7]The link between business models and lending is developed, among others, in Lamers et al. (2016) and Martinez-Miera and Repullo (2015).

advanced economies; $Prof_t^j$ is a weighted average of a proxy for the business models of banking systems lending to country j. The weights are given by equation (3.5). The time-varying, borrowing-country-specific post-crisis sensitivity to ΔFFR is captured by $\beta_1 + \eta_1 polDiv_t + \xi_1 Prof_t^j + \gamma_1 + \xi_1 PolDiv_t + \phi_1 Prof_t^j$.

2.4 Data

We utilize three databases to capture the main components of global liquidity: the BIS Locational Banking Statistics (LBS), the BIS International Debt Securities Statistics (IDSS), and BIS Consolidated Banking Statistics (CBS). The BIS LBS captures the outstanding claims and liabilities of internationally active banks located in 44 BIS LBS reporting countries[8] against counterparties residing in more than 200 countries. Banks record their positions on an unconsolidated basis, including intragroup positions to capture international flows between offices of the same banking group. The data are compiled following principles that are consistent with balance of payments statistics. The LBS statistics capture around 95% of all cross-border interbank business (Bank for International Settlements, 2015). At the same time, the counterparty sector breakdown available in the BIS LBS enables us also to distinguish between cross-border bank lending to bank and non-bank borrowers. These data series capture the international flows to bank and non-bank borrowers from the borrower perspective. The BIS CBS are mainly used in our analysis creditor for the bank perspective. We use them to compute lender-specific sensitivities to the global factors, as well as the relative importance of lending countries for a given borrowing country in terms of capital flows. The BIS IDSS data capture borrowing in money and bond markets. International debt securities (IDS) are defined as those issued in a market other than the local market of the country where the borrower resides (Gruić and Wooldridge, 2012). They encompass what market participants have traditionally referred to as foreign bonds and eurobonds. The sample used for the empirical analysis consists of quarterly data from Q1 2000 to Q4 2015. On the borrowing side, we focus on a set of 64 countries, which includes both, Advanced Economies (AEs) and Emerging Market Economies (EMEs). On the bank lending side, we use data on the positions of all 44 BIS LBS and 31 CBS reporting countries[9].

The typical lenders and borrowers connected by each flow type differ considerably in composition and size, as illustrated within Table 2.1. Cross-border loans are typically supplied by internationally-active banks, which tend to be relatively large. Meanwhile,

[8] The complete list of BIS LBS reporting countries is provided at http://www.bis.org/statistics/rep_countries.htm.

[9] The complete lists of all borrowing countries and lending national banking systems are available in Annex B.

the creditors in international debt securities markets are usually non-bank financial intermediaries, such as pension funds, insurance companies, money market mutual funds, and hedge funds. The variation on the borrower side is even greater. International bond issuance by non-banks tends to be dominated by sovereigns and large non-financial corporates. The latter are also 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.

There are three global factors in our analysis. Global real GDP growth measures global economic activity. The second global factor is changes in stance of US monetary policy. The empirical literature discussed in Section 2 mainly corresponds to the period prior to the introduction of unconventional monetary policy and exclusively uses a short-term policy rate. However, this approach may not be appropriate for the full post-crisis period. Monetary policy at the zero lower bound is a defining feature of the post-crisis period, and changes in communications, interest on effect reserves and quantity easing actions became more instrumental. Accordingly, there is extensive debate on whether a single metric can convincingly serve as a sufficient statistic for changes in U.S. monetary conditions. For our purposes, we use the Wu-Xia policy measure (Wu and Xia, 2016) as a baseline for the "US FFR". By this construct, the effective US Federal Funds target rate is used prior to Q4 2008 and the Wu-Xia estimates of the shadow Federal Funds rate are used from Q1 2009 through end of 2015 (Graph 2.2, left panel). While a number of alternative shadow rates have been constructed, all shadow rates are sensitive to the underlying modelling assumptions utilized. Changes in shadow policy rates have been documented to be highly correlated across a number of the alternative shadow rate series. We conduct robustness analysis (section 6) using alternatives, showing the robustness of our results.

The third global factor is a measure of global risk conditions. Following the global liquidity literature, we utilize the VIX index of the implied volatility in S&P500 stock index option prices from Chicago Board Options Exchange (CBOE). We obtain very similar results when using the Bekaert, Engstorm and Xu (2017) risk index, as the two measures are strongly positively correlated (Graph 2.2, right panel).

Three borrowing country variables (pull factors) are included in baseline specifications: local real GDP growth, sovereign ratings, and the degree of financial openness. For each borrowing country, the sovereign ratings variable is defined as the average ratings across the three major credit ratings agencies (S&P, Moody's and Fitch). The degree of financial openness is captured by the Chinn-Ito index (Chinn and Ito, 2008), normalized between 0 and 1.

The IBRN Prudential Instruments dataset covers widely-used prudential instruments, keeping track of the intensity of their usage in 64 countries between 2000 and 2014 at a quarterly frequency. The instruments that are covered are: general capital requirements, sector-specific capital requirements (split into real estate credit, consumer credit, and other), interbank exposure limits, concentration limits, loan-to-value (LTV) ratio limits, and (local currency and foreign currency) reserve requirements. We focus on the three prudential policy instruments that have been shown to have the largest impact on international bank lending: loan-to-value ratio caps, capital requirements and local currency reserve requirements (Avdjiev et al., 2017; and Buch and Goldberg, 2017)[10].

The balance sheet characteristics of national banking systems are constructed using Bankscope data. We obtain the balance sheet items of interest for the set of internationally active banks that report to the BIS consolidated banking statistics, and then aggregate bank-level characteristics to national banking system-wide variables, using weighted averages across the individual banks of a given nationality. Data are adjusted for mergers and acquisitions to correct for balance sheet jumps that are unrelated to lending (Brei et al., 2013). We gather data on i) capital to total assets, ii) average bank size, iii) deposits to total assets, iv) net interest income over total income, v) net interest income to total assets.

Two bank business model measures are considered: i) an income diversification ratio (defined as net interest income to total income); ii) net interest income to total assets. The first indicator ranges from 0 to 1 and indicates the fraction of a bank's profitability that derives from traditional intermediation activity (i.e. lending and deposits). If a bank has a large portion of non-interest income (trading income, fees and commissions for services) than this indicator tends lower values. The second indicator is the return per unit of assets that derives from traditional intermediation activity. It represents the profitability of intermediated assets that is obtained by the bank getting deposits and supplying loans.

As a proxy for monetary policy divergence among advanced economies, we take the difference between the 2-year futures on the policy rate for the United States and the average of the 2-year futures for the United Kingdom, Switzerland, Japan and a group of "core" Eurozone countries (Austria, Belgium, Germany, Finland, France, the Netherlands, Spain)[11].

[10] Cerutti et al. (2017) provide an extensive discussion of the properties of the quarterly changes in these prudential instruments and the cumulative changes over time.

[11] Summary statistics for the explanatory variables used in our empirical analysis are presented in Table 2.A.1 in Annex A. Graph 2.A.3 shows the advanced economy monetary policy divergence indicator.

2.5 Evidence on global liquidity drivers

2.5.1 Baseline results

Our empirical investigation begins with the baseline specification in equation (3.1) as a way to replicate prior global liquidity results. The estimated coefficients for the entire sample 2000:Q1 – 2015:Q4, presented in Table 2.2, are largely in line with those obtained in the existing literature. Using data on international bank flows and international debt securities issuance from the bank and non-bank debtor perspective, the results from the baseline model indicate that an increase in global risk conditions (measured by the VIX) has a negative and strongly statistically significant effect on all flows we examine. The US federal funds rate has a sharply negative impact on cross-border bank loans. Its estimated impact on international debt securities is also negative, albeit only marginally statistically significant. Local factors are also statistically significant drivers. Borrowing countries with higher GDP growth rates and with better sovereign credit ratings tend to attract more cross-border loans. Meanwhile, the degree of financial openness, as reflected in the Chinn-Ito index, has a positive (and statistically significant) effect on the international bond flows, especially to banks.

As described in Section 3.1 we formally test whether the above estimated coefficients from equation (3.1) are stable over time. Rather than exogenously imposing an ad-hoc break date, we test for its presence and exact timing endogenously. We find that the most likely break date for both cross-border loan flows and international bond flows is 2009:Q1. Wald (or Chow) tests on the coefficients κ and γ' in equation (3.2) indicate that the break is statistically significant for the global liquidity components that we examine[12].

Table 2.3 summarizes the estimated sensitivities to the main global drivers (the VIX and the federal funds rate) during the pre-break and the post-break periods, respectively. Two sets of estimates are provided for the post-crisis period – one for the full sample (ending in Q4:2015) and one for a sub-sample ending in Q1:2013. The latter set of results allows us to examine whether the 2013 Fed taper tantrum marked a turning point in the post-crisis sensitivities to global factors.

The results confirm that the relationship between the main global factors and international capital flows has changed profoundly since the Global Financial Crisis. Sensitivities of all flow types to US monetary policy increased sharply between the GFC and the taper tantrum. This is true for all flow types we examine and for all borrowing sectors. The impact of US monetary policy on cross-border loans, which was already negative and statistically significant during the pre-crisis period, rose even further in the immediate aftermath of the GFC. More concretely, while prior to the crisis a 25-basis point decline in

[12] Test results are available upon request.

the federal funds rate was associated with an 80-basis point rise in the quarterly growth rate of cross-border bank lending, in the aftermath of the crisis was associated with a 202-basis point increase in the same growth rate. The respective negative impact on international bond issuance, which was not statistically significant prior to the crisis, also increased considerably after the GFC. In quantitative terms, the impact of a 25-basis point drop in the federal funds rate on international bond issuance surged from 36 basis points before the crisis to 202 basis points after the crisis.

Following the 2013 taper tantrum, sensitivities to US monetary policy reverted towards their respective pre-crisis levels, especially for cross-border loans. Once the sample is extended to include the post-taper tantrum period, a 25-basis point decline in the federal funds rate becomes associated with a 92-basis point increase in the quarterly growth rate of cross-border bank loans, a level of responsiveness much closer to the one observed prior to the crisis. The responsiveness of international bond flows also reverted, but not by as much. Nonetheless, all the impact of changes in US monetary policy on all flow types remained negative and highly statistically significant.

The post-crisis period also is characterized by a substantial decline in the sensitivity of cross-border bank loans to global risk conditions. The estimated effect of the VIX, which was negative and highly statistically significant prior to the crisis, weakened considerably by Q1:2013 and even became insignificant by the end of the sample (in Q4:2015). Whereas prior to the crisis a one-standard deviation increase in the VIX was associated with a 134-basis point contraction in the quarterly growth rate of cross-border bank lending, after the crisis it only caused an 11-basis point decline in the same growth rate. These findings are in line with the argument of Shin (2016) that the VIX has lost its power as a barometer of banks' appetite for leverage since the GFC.The post-crisis evolution of the sensitivities of aggregate global liquidity flows (i.e. the sum of international bank loans and bond flows) was in line with the respective evolutions for the main global liquidity components. Namely, the responsiveness of aggregate flows to US monetary policy rose sharply between the GFC and the 2013 taper tantrum. It subsequently reverted towards pre-crisis levels, but remained at relatively high levels. By contrast, aggregate global liquidity flows became much less sensitive to global risk since the GFC.

There has been some convergence in the global factor sensitivities of the two main global liquidity components. Table 2.4 shows the difference between the sensitivities of cross-border loans and international debt securities to the global factors, before and after the GFC. In the pre-crisis period, the differences were mostly negative and significant, indicating that cross-border loans were significantly more sensitive than international debt securities to both global risk conditions and US monetary policy. In the post-crisis period, most differences are no longer statistically significant, signalling that the two types of flows have become more similar in their responsiveness to global factors.

2.5.2 Decomposing the shifts in sensitivities to global factors

As described in Section 3.2, the shifts in the sensitivities of external flows to global factors can be decomposed into a compositional component and a behavioural component. The factors that capture the composition of lending national banking systems (the w_1^i's and the w_2^i's) are directly observable and are obtained from the CBS matrix of bilateral stocks of international claims. Meanwhile, the factors that capture the behavioural component, i.e. the national banking system-specific sensitivities to global factors (the β_1^i's and the β_2^i's) are obtained as the estimated coefficients on the respective global factors in the national banking system-specific regressions presented in equation (3.6).

Graph 2.3 presents the lending national banking system weights for the pre- and post-crisis periods. It illustrates that the post-crisis period has seen a pullback from the relative share of euro area banks in international lending and an expansion by banks from advanced economies outside the euro area. Most notably, there have been sizeable declines in the international lending shares of German, Belgian and Dutch banks, while the international presence of US, UK and Japanese banks has grown significantly during the same period. The above general pattern tends to hold for international lending to bank, non-bank and public borrowers.

Having obtained the pre- and post-crisis lender-specific weights and lender-specific sensitivities to global drivers, we estimate the contributions of the behavioural components (the first terms on the right-hand side of equations (3.7) and (3.8)) and compositional components (the second terms on the right-hand side of equations (3.7) and (3.8)) to the shifts in sensitivities from the perspective of borrowers. Recall that a borrower can experience a changing sensitivity of financing flows to global factors if there is an evolution in the composition of creditors, where the creditors have distinct sensitivities, and if there is an evolution of the behavioural sensitivities of creditors. The results from the decompositions of borrower sensitivities into the composition and behaviour of creditors are summarized in Graph 2.4.

The behavioural component dominates the shifts in realized borrower sensitivities to US monetary policy (Graph 2.4, left-hand panel). For all three borrowing sectors, the estimated contributions of the behavioural component are negative (i.e. they increase the absolute value of the estimated sensitivity). The contributions of the behavioural component dominate the respective contributions of the compositional component. These results show strongly that the post-crisis increases in the sensitivity of international bank lending flows to US monetary policy are driven by increase in the sensitivities of individual banking systems rather than by a shift in the composition of international lending from less to more sensitive banking systems.

The decomposition of the sensitivities to the VIX show that the contributions of the compositional component are all positive and much larger than their counterparts for the US monetary policy sensitivities (Graph 2.4, right-hand panel). The behavioural component is not as dominant as in the case of US monetary policy. The behavioural component plays a significant role only for lending to the public sector. When it comes to lending to the non-bank private sector and interbank lending, the overall declines in sensitivities to the VIX are clearly driven by the compositional component.

The sensitivities of international bank lending flows to the public sector increase considerably during the post-crisis period vis-‘a-vis both the US monetary policy and the VIX. These results could be interpreted as evidence that banks have adjusted treatment of sovereign risk since the crisis. Such an interpretation would be consistent with evidence that banks treated (most of) their sovereign exposures as virtually risk-free before the crisis, but started to assess sovereign risk in a more realistic manner after the crisis (Acharya et al., 2013; Farhi and Tirole, 2016; De Grauwe and Ji, 2013).

2.5.3 Determinants of the post-crisis shifts in sensitivities and weights

As a key issue is uncovering the main drivers of the shift in the lender-specific sensitivities to global factors, the next set of results provide insights in a diff-in-diff framework by regressing the change in the (pre- and post-break) coefficients on a small set of potential explanatory (pre-crisis) variables per equations (3.7) and (3.8). The results for changes in the sensitivities to US monetary policy $\beta^i_{1,k,PostBreak} - \beta^i_{1,k,PreBreak}$ are reported in Columns (I) – (III) of Table 2.5. Banking systems that were better capitalised pre-GFC experienced a smaller change in the sensitivity of their international lending to US monetary policy in the post-crisis period[13]. This result is in line with the strand of literature which argues that well-capitalised banks are perceived as less risky by depositors and other bank creditors, have easier access to funding, and are, consequently less affected by fluctuations in funding costs (Gambacorta and Shin, 2016). The result also accords with cross-country evidence that liquidity risk transmission internationally is weaker for banks with more capital and more stable funding sources[14].

We examine the robustness of the above result to controlling for various measures of the prudential policy stance at the time of the structural break. It turns out that the statistical significance of the banks' capitalization levels is robust to controlling not only for

[13]Since the differences between the (pre- and post-break) estimated parameters tend to be negative, a positive value of the coefficients in the meta-regressions implies a smaller change in the (pre- and post-break) sensitivities.

[14]Strahan et al. (2011) has similar findings in a domestic lending setting in response to liquidity risk changes. Buch and Goldberg (2015) and related studies of the International Banking Research Network published in IMF Economic Review 2015 provide related evidence for international claims.

the cumulative prudential measure index (Column I), but also to controlling for the cumulative loan-to-value ratio cap index (Column II) and cumulative local currency reserve index (Column III). None of the above three cumulative prudential control variables is statistically significant[15].

The right-hand panel (Columns IV – VI) of Table 2.5 investigates the determinants of the structural break in the sensitivity of international bank lending to global risk. The dependent variable in those specifications is $(\beta^i_{1,k,PostBreak} - \beta^i_{1,k,PreBreak})$ (estimated from equation (3.8)), for lending country i and borrowing sector k. As in the case of the sensitivities to US monetary policy, the main determinant of the changes in the sensitivities to global risk also appears to be the capitalization level of the respective national banking system. The better capitalized a given banking system was at the time of the structural break, the more likely it was that the sensitivity of its international lending to global risk declined during the post-crisis period.

The results indicate the cumulative index for local reserve requirements is also a statistically significant determinant of the post- versus pre- changes in the global liquidity sensitivities to global risk. Jurisdictions with tighter local reserve requirements at the time of the break experienced a smaller change in the sensitivity of their cross-border lending to global risk. By contrast, the cumulative prudential measure index and the cumulative loan-to-value ratio cap index are not statistically significant for the risk effects.

We next examine the main drivers of the shifts in the composition of international lending (approximated by the lending weights defined above) between the pre- and the post-crisis periods. We estimate equation (3.9), in which the difference in lending national banking system weights before and after the break $(w^i_{k,PostBreak} - w^i_{k,PreBreak})$ is regressed on a set of pre-crisis business model indicators. The dependent variable can be visualised as the differences in the pre- and the post-crisis weights displayed in the histograms in Graph 2.3.

The results, reported in the first column of Table 2.6, indicate that banking systems that were more likely to gain market share during the post-crisis period were those that were ex-ante better capitalized. International lending weights also increased for banking systems that had higher shares of deposits funding and total income from traditional sources of intermediation activity, as well as for those with a larger portion of foreign lending booked locally by foreign subsidiaries. The result that links cross-border lending expansion to deposit ratios is interesting as market funding was under stress during the global financial crisis. The ratio of deposits to total liabilities is typically used to measure a bank's contractual strength. Banks that have a large deposit base suffer lower adjustment

[15] Graph 2.A.1 shows the evolution of the three prudential policy indices. We could not include the cumulative index for capital requirements measure since all policy actions for that measure have taken place during the post-crisis period (middle panel).

costs in their funding (Berlin and Mester, 1999).

Our results are consistent with research concluding that a key transmission channel of the crisis was the dislocation in bank funding markets. Amiti et al. (2016) find that banks which relied more on wholesale funding and cross-currency swaps found themselves unable to roll over their positions during the most severe quarters of the crisis. Gambacorta and Marques (2011) find that the proportion of deposit funding was a key element in assessing banks' ability to withstand adverse shocks. The results also accord with findings of the IBRN research initiative on the impact of prudential policy on international bank lending (see Buch and Goldberg, 2017). Spillovers of interbank exposure limits through foreign bank affiliates differ in degree across banks not only in relation to banks' illiquid asset shares, but also with respect to deposit shares, and the internal capital market positions with their parent banks.

The results on the role of the ratio of interest income to total income are interesting, as this measure is a proxy for the importance of traditional intermediation activities. The positive coefficient on this ratio indicates that banking systems whose business model relied more on traditional intermediation activities experienced an increase in their share of the supply of global liquidity. These findings accord with the empirical literature pointing to the vulnerability of banks involved in capital market activities, as opposed to commercial market activities, to shifts in global economic conditions (Roengpitya et al., 2014).

We find that banking systems with higher local lending are more resilient and have increased their lending weight at the expense of banking systems with a different business model. The ratio of local claims over foreign claims indicates the business model used by a banking system to lend abroad. The higher the ratio of local to foreign claims, the more a banking system relies on its subsidiaries and branches abroad as opposed to obtaining foreign claims by dealing with borrowers directly from its headquarters. Local claims have been relatively stable after the crisis, because banks have reduced foreign lending by cutting down operations from their headquarters (Gambacorta and van Rixtel, 2013). Indeed, the latter require a well-functioning wholesale and interbank market, which are very vulnerable to global uncertainty. De Haas and van Horen (2013) find that banks reduced credit less to markets where they operated a subsidiary and where they were integrated into a network of domestic co-lenders.

These results do not change when controlling for various prudential policy measures. The only prudential tool that is statistically significant is the cumulative index for local reserve requirements (Column III): jurisdictions that experienced a tightening in local reserve requirements in the pre-crisis period expanded their cross-border lending by more during the post-crisis period.

2.5.4 Drivers of the time variation in the post-crisis period

While the previous empirical exercises examined the difference between the pre- and post-crisis period, our next and even deeper analysis of the data reveals considerable variation in parameters of interest across global factors through the post-crisis period. Graphs 2.5 and 2.6 display the evolution of the estimated sensitivities to global factors during the post-crisis period. For perspective, the graphs include in each panel a black line designates the pre-crisis estimates of comparable sensitivities.

The post-crisis evolution of the sensitivity to US monetary policy is quite uniform across instruments and borrowing sectors (Graph 2.5). It is strongest right before the start of the US taper tantrum and becomes gradually weaker afterwards. By the end of our sample, sensitivities remain stronger than during the pre-crisis period for all but one flow types.

The sensitivity to global risk conditions (in absolute value) gradually decreases (see Graph 2.6). Notably, even though sensitivity of global liquidity flows is still significantly lower than zero in mid-2013, this is not the case at the end of our sample. In the case of cross-border loans, the sensitivity to global risk conditions is significantly weaker in the post-crisis period than in pre-crisis. It is interesting to note that the sensitivity of international debt securities to the VIX is almost always not different to zero, with the only exception for bonds issued by non-banks.

As discussed in Section 3.3, our conjecture is that the evolution of post-crisis sensitivities may be a function of multiple factors. The first one is the degree of monetary policy convergence among advanced economies. During periods in which the monetary policies of advanced economies move together, a unit change in the federal funds rate could, all else the same, have a larger impact on cross-border bank lending than during periods of divergence. In the former case, changes in the stance of US monetary policy could have a signalling effect about upcoming matching moves by other AE monetary policy authorities. This effect could amplify the consequences of changes in the federal funds rate for cross-border bank lending.

The second factor could derive from banking system characteristics. Lenders' dominant business models and profitability could affect the responsiveness of their cross-border lending to global factors. In particular, the low-interest rate environment in the post-crisis period may have affected banks that rely primarily in interest income in a different manner from banks with less traditional business models.

The results for testing the role of monetary policy divergence between the US and other advanced economies, and of a weighted average of a proxy for the business models of banking systems lending to country j are shown in Table 2.7. The monetary policy divergence metric plays a large and highly significant role in driving the sensitivity of international bank lending flows to US monetary policy within the early post-crisis period and contributes to a weakened sensitivity of these international flows post 2013. By contrast, the country banking system characteristics (proxied in the table by the relevance of traditional intermediation activity) do not appear to be a significant driver of the post-crisis evolution of global factor sensitivities in the majority of the examined cases.

The above set of results has important policy implications. To the extent that the post-crisis convergence of the monetary policies of advanced economies was only a temporary phenomenon, the dramatic increase in sensitivities to US monetary policy may not persist. By contrast, the compositional effect of international lending shares shifting towards better capitalised banking systems, which would naturally lead to more stable bank lending flows, is likely to be much more persistent.

2.6 Robustness

We conduct three sets of robustness checks. First, we re-estimate all of our benchmark specifications using alternative shadow federal funds rates. Second, we run all bond flow regressions using an alternative international bond flow measure. Third, we test if our main findings are similar for advanced economies versus emerging markets.

2.6.1 Alternative measures of US monetary policy

The baseline results for the sensitivities to US monetary policy are in part obtained using a constructed measure of the federal funds rate (i.e. a shadow policy rate). The Wu-Xia shadow rate used in the benchmark analysis (Wu and Xia, 2016) is generated by a multi-factor term structure model and assumed to be a linear function of three latent variables which follow a VAR (1) process. The latent factors and the shadow rate are estimated with the extended Kalman filter. The model used by Wu and Xia (2016) is in discrete time and is not prone to the numerical approximation errors associated with alternative shadow rates.

However, the evolving shadow rates literature has several alternative measures, each with its own advantage and disadvantages (for a discussion of trade-offs among the alternative measures, see Lemke and Vladu (2017). For robustness, we consider two alternative shadow rates. The measure developed by Krippner (2014) is based on a two state-variable shadow yield curve model estimated using the iterated extended Kalman filter on month-end US yield curve data from 1985 with times to maturity spanning 0.25 to 30 years. The measure developed by Bauer and Rudebusch (2016) replaces the affine short-rate specification of standard dynamic term structure models with an identical affine process for an unobserved shadow short rate. Among the three alternative shadow policy rates, the Wu-Xia shadow rate that we use in our benchmark analysis tends to be somewhere in between the two alternative shadow rates that we use in our robustness checks[16].

Table 2.A.2 in Annex A reports our baseline estimations using the two alternative shadow rates by Krippner (2014) and Bauer and Rudebusch (2016). The coefficients of the alternative shadow rates are still negative and significant, consistently with the results we obtain using the Wu-Xia rate in Table 2.2.

As a further robustness check, we estimate our baseline model using two-year US Treasury bond rates instead of shadow rate estimates. This allows us to test the sensitivity of our main results to replacing the model-based shadow rates with rates that are based on hard market data. Table 2.A.3 in Annex A shows the estimated coefficients when the two-year US Treasury bond rate series is used instead of shadow rate series. The qualitative pattern of the main coefficients is the same as the one in our benchmark specification (see Table 2.2).

2.6.2 Alternative international bond flow measures

Our benchmark regressions use international debt securities as measure of bond flows. International debt securities are defined as those issued in a market other than the local market of the country where the borrower resides (Gruić and Wooldridge, 2012). For most borrowing countries and sectors, the universe of international debt securities tends to largely overlap with the universe of debt securities held by external investors. That said, the match is not perfect in all cases for two main reasons. First, securities issued in foreign markets may be purchased and held by domestic residents. Second, domestically issued debt securities could be bought by external investors.

We check the robustness of our results by replacing the international debt securities series used in our benchmark regressions with data on portfolio debt from the Balance of Payments. More concretely, we define our alternative dependent variable as the quarterly growth rate of the respective (gross) outstanding IIP stocks[17].

As in our baseline results in Table 2.2, the estimated impact of US monetary policy and global uncertainty on portfolio debt flows is negative and statistically significant (Table 2.A.4 in Annex A). This result characterizes aggregate flows and their main sectoral (bank and non-bank) components. As in our baseline estimates, borrower-country GDP growth, sovereign ratings and financial openness have a positive effect on debt securities inflows.

[16] This is the case for both levels (Graph 2.A.2, left-hand panel) and first differences (Graph 2.A.2, right-hand panel).

[17] The exact series we use is 'Portfolio Investment Debt, Liabilities' (Line 79led).

2.6.3 Advanced economies versus emerging markets

In order to further investigate the main drivers of the above changes in sensitivities for different borrowers, we split the sample of borrowers in sub-samples of those from Advanced Economies (AEs) versus Emerging Market Economies (EMEs). The results reveal that the sharp increases in the post-crisis sensitivities of international capital flows to the federal funds rate characterize both AE and EME borrowers[18]. That said, the increases in the impact of the federal funds rate are more dramatic in the case of AEs. For IDS issued by AE borrowers, sensitivity to the federal funds rate has increased by a factor of four and has switched from being insignificant to being highly significant. The increase in the estimated impact of the VIX on IDS appears to be driven primarily by borrowers in EMEs.

appears to be driven primarily by borrowers in EMEs. This country-type split also reveals important differences between AE and EME borrowers in the relative importance of global versus local factors. Global factors were much more important drivers of flows to EMEs than local factors in the pre-crisis period[19]. The opposite was true for flows to AEs. Post-crisis, global factors emerged as the main drivers of flows to AEs, while the importance of the local factors for flows to EMEs grew considerably.

2.7 Conclusions

The analysis of the drivers of global liquidity is critically important to understanding macroeconomic stabilization, growth, and interconnectedness of advanced and emerging market economies. In the aftermath of the global financial crisis, the composition of international capital flows shifted away from bank lending and towards international debt securities. Moreover, there has been a post-crisis redistribution in lending shares across major national banking systems. These dramatic changes raise once more a range of questions about the drivers of global liquidity in the post-crisis international financial system, and the ways that potentially sharp surges and waves might be moderated.

We document important changes that have occurred in the sensitivity to global factors across the main components of global liquidity, cross-border bank loans and international debt securities. Using the BIS international banking and international debt securities statistics for a large panel of countries over 16 years, we find that the impact of US monetary policy changes on all major types of international financial flows to borrowers

[18] The split sample results are presented in Table 2.A.5 reported in Annex A.

[19] Table 2.A.6 presents the contributions to regression explanatory power of the global versus local factors for AEs and EMs.

increased dramatically after the GFC. In the meantime, the responsiveness of cross-border loan flows to global risk conditions has declined significantly.

We show that borrowers experienced these altered sensitivities because of changes that took place in both the composition of creditors and in the behaviour of these creditors. Composition matters since international creditors have distinct characteristics and a change in the distribution of those creditors carries over into the effective sensitivity of flows observed by borrowers. Behavioural changes by international creditors are also important, as some bank business models became more sensitive to US monetary policy and less sensitive to global risk conditions.

The post-crisis rise in the sensitivity of international bank lending flows to US monetary policy was driven mainly by increases in the sensitivities of individual banking systems, dominating the effects from a shift in the composition of international lending from less to more sensitive banking systems. Conversely, compositional changes were primarily responsible for the decline in the sensitivity of international bank lending to global risk conditions. National banking systems that were ex ante better capitalized experienced smaller increases in sensitivities to US monetary policy and larger increases in their market shares in international lending. Higher ex ante shares of deposits in total funding and local claims in foreign claims were also associated with larger increases in international lending market share. Certain prudential policy measures, such as local currency reserve requirements, were also associated with gains in the relative stability of international loan supply.

By utilizing a number of alternative perspectives made possible by the BIS international banking statistics, we show that the post-crisis evolution of the sensitivities of international bank flows to global push factors appears to be driven by a combination of transitory drivers and others that are potentially more persistent. The increases in the sensitivities of individual banking systems to US monetary policy were largely driven by the convergence in advanced economy monetary policies that took place in the immediate aftermath of the GFC. As the monetary policies of advanced economies started to diverge in 2013, these transitory effects gradually weakened. By contrast, the effects related to the increased market shares of better-capitalized lending banking systems, which tend to be less responsive to fluctuations in global risk conditions, could turn out to be more persistent.

Overall, our analysis makes important contributions by investigating the dynamism in global liquidity drivers, as well as international monetary policy spillovers and risk effects. This dynamism, not previously explored in depth, is relevant for debates on the use and potential efficacy of capital controls, prudential instruments, and even the autonomous use of monetary policy. Regardless of the degree of integration with international financial markets, funding flows may be more responsive when policy cycles of advanced economies are more aligned. Funding flows through global banks appear to be less volatile for banks with greater capital buffers, more traditional funding models, and when global banks utilize local affiliates to a greater degree in their international lending. The results demonstrate that initiatives to make banking systems more robust in advanced countries, for example through prudential instrument changes and policies aimed at boosting capitalisation and stable funding levels, have had the positive side effect of reducing the amplitude of fluctuations in some forms of international capital flows to both advanced and emerging markets. Such policies complement the debates over borrower country macroprudential policies and capital flow management instruments. Open questions still remain around the behaviour of international debt securities, and await both richer data and more research on these financing flows.

Bibliography

[1] Acharya, V. V., P. Shnabl and G. Suarez (2013) "Securitization without risk transfer," Journal of Financial Economics, 107(3), 515-536.

[2] Amiti M., P. McGuire and D. Weinstein (2016) “Supply and demand-side factors in global bank credit”, Third BIS-CGFS workshop on research on global financial stability: the use of BIS international banking and financial statistics, Basel, 7 May.

[3] Avdjiev, S., C. Koch, P. McGuire and G. von Peter (2017) “International prudential policy spillovers: A Global Perspective“, International Journal of Central Banking, 13(2), 5-33.

[4] Bai, J. (1994) “Least squares estimation of a shift in linear processes”, Journal of Time Series Analysis, 15 (5), 453–472.

[5] Bai, J. (1997) “Estimation of a change point in multiple regression models”, Review of Economics and Statistics, 79 (4), 551–563.

[6] Bai, J. (1994) “Least squares estimation of a shift in linear processes”, Journal of Time Series Analysis, 15 (5), 453–472. Bai, J. (1997) “Estimation of a change point in multiple regression models”, Review of Economics and Statistics, 79 (4), 551–563.

[7] Bank for International Settlements (2011a) "Global liquidity - concept, measurement and policy implications," CGFS Papers, Bank for International Settlements, n 45.

[8] 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.

[9] Bank for International Settlements (2015) “Introduction to BIS statistics.” BIS Quarterly Review, September, 49-56.

[10] Bauer, M. D. and G. D. Rudebusch (2016) ”Monetary Policy Expectations at the Zero Lower Bound," Journal of Money, Credit and Banking, Blackwell Publishing, 48(7), 1439-1465.

[11] Berlin, M. and L. Mester (1999) “Deposits and relationship lending”, Review of Financial Studies, 12 (3), 579–607.

[12] Brei, M., L. Gambacorta, and G. von Peter (2013) “Rescue Packages and Bank Lending”, Journal of Banking and Finance, 37(2), 490-505.

[13] Broner, F., T. Didier, A. Erce, and S. L. Schmukler (2013) “Gross Capital Flows: Dynamics and Crises.” Journal of Monetary Economics 60(1), 113-133.

[14] Bruno, V. and H. S. Shin (2015a) “Cross-border banking and global liquidity” Review of Economic Studies, 82(2), 535—564.

[15] Bruno, V. and H. S. Shin (2015b) “Capital flows and the risk-taking channel of monetary policy” Journal of Monetary Economics, 71, 119-132.

[16] Buch C. M. and L. S. Goldberg (2015) "International Banking and Liquidity Risk Transmission: Lessons from Across Countries," IMF Economic Review, Palgrave Macmillan; International Monetary Fund, 63(3), 377-410.

[17] Buch, C. M. and L. S. Goldberg (2017) “Cross-border prudential policy spillovers: How much? How important? Evidence from the international banking research network,” International Journal of Central Banking, 505-558 (March).

[18] Bussi‘ere, M., J. Schmidt and N. Valla (2016) “International Financial Flows in the New Normal: Key Patterns (and Why We Should Care)”, CEPII Policy Brief, March.

[19] Carrion-i-Silvestre, J.L. and A. Sans‘o (2006) “Testing the null of cointegration with structural breaks”, Oxford Bulletin of Economics and Statistics, 68 (5), 623–646.

[20] Cerutti, E. and S. Claessens (2017) “The Great Cross-Border Bank Deleveraging: Supply Constraints and Intra-Group Frictions,” Review of Finance, 21 (1), 201-236.

[21] Cerutti, E., R. Correa, E. Fiorentino, E. Segalla (2017) “Changes in prudential policy instruments: a new cross-country database”. International Journal of Central Banking, March, 477-503.

[22] Cerutti, E., S. Claessens and L. Ratnovski (2017) “Global Liquidity and Drivers of Cross- Border Bank Flows.” Economic Policy 32 (89): 81-125.

[23] Cerutti, E., S. Claessens S. and A.K. Rose (2017) “How important is the financial cycle? Evidence from capital flows”, BIS Working Papers 661.

[24] 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(2), 299-311.

[25] Cetorelli, N. and L. S. Goldberg (2012b) "Banking Globalization and Monetary Transmission," Journal of Finance, American Finance Association, 67(5), 1811-1843.

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

[27] Chuhan, P., S. Claessens and N. Mamingi (1998) "Equity and Bond Flows to Latin America and Asia: the Role of Global and Country Factors." Journal of Development Economics 55(2), 439-463.

[28] Chung, K., J-E Lee, E. Loukoianova, H. Park and H. S. Shin (2015)"Global liquidity through the lens of monetary aggregates," Economic Policy, 30(82), 231-290.

[29] Cornett, M. M., J. J. McNutt, P. E. Strahan and H. Tehranian (2011) "Liquidity risk management and credit supply in the financial crisis," Journal of Financial Economics, 101(2), 297-312.

[30] Damar H. E. and A. Mordel (2017) "International Banking and Cross-Border Effects of Regulation: Lessons from Canada," International Journal of Central Banking, 13(2), 35-64.

[31] De Grauwe, P. and Y. Ji (2013) "Self-fulfilling crises in the Eurozone: An empirical test" Journal of International Money and Finance, 34, 15-36.

[32] De Haas, R. and N. Van Horen (2013) "Running for the Exit? International Bank Lending During a Financial Crisis" Review of Financial Studies, 26 (1), 244-285.

[33] Fahri, E. and J. Tirole (2016) "Deadly Embrace: Sovereign and Financial Balance Sheets Doom Loops" Review of Economic studies, forthcoming.

[34] Fernandez-Arias, E. (1996) "The new wave of private capital inflows: Push or pull?," Journal of Development Economics, 48(2), 389-418.

[35] Forbes, K. J. and F. E. Warnock (2012a) "Capital flow waves: Surges, stops, flight, and retrenchment," Journal of International Economics, 88(2), 235-251.

[36] Forbes, K. J. and F. E. Warnock (2012b) "Debt- and Equity-Led Capital Flow Episodes", in Capital Mobility and Monetary Policy, edited by Miguel Fuentes and Carmen M. Reinhart. Santiago: Central Bank of Chile. Also available as NBER Working Paper 18329.

[37] Forbes, K. J., M. Fratzscher and R. Straub (2015) "Capital-flow management measures: What are they good for?", Journal of International Economics, 96(S1), S76-S97.

[38] Forbes, K. J., D. Reinhardt and T. Wieladek (2017) “The Spillovers, Interactions, and (Un)Intended Consequences of Monetary and Regulatory Policies”, Journal of Monetary Economics, Volume 85, Pages 1-136 January.

[39] Gambacorta, L. and D. Marques (2011) “The bank lending channel: lessons from the crisis”, Economic Policy, 26(66), 135–82.

[40] Gambacorta, L. and A: van Rixtel (2013) “Structural bank regulation initiatives: Approaches and implications”, BIS Working Papers 412.

[41] Gambacorta, L. and H. S. Shin (2016) "Why bank capital matters for monetary policy," Journal of Financial Intermediation, forthcoming.

[42] Ghosh A. R. and J. D. Ostry (1994) "Export Instability and the External Balance in Developing Countries," IMF Staff Papers, 41(2), 214-235.

[43] Goldberg L. S. (2013) "Banking Globalization, Transmission, and Monetary Policy Autonomy," Sveriges Riksbank Economic Review, November, 161-193.

[44] Gruić, B. and P. Wooldridge (2012) "Enhancements to the BIS debt securities statistics", BIS Quarterly Review, December, 63-76.

[45] Harbord, R. and J. Higgins (2008) “Meta regression in Stata”, The Stata Journal, 8(4), 493–519.

[46] Huettner, F. and M. Sunder (2012) “Axiomatic arguments for decomposing goodness of fit according to Shapley and Owen values,” Electronic Journal of Statistics, 6, 1239-1250.

[47] Khatiwada, S. (2017) “Quantitative Easing by the Fed and International Capital Flows”, Graduate Institute Geneva Working Paper, January.

[48] Klein, M. W. and J. C. Shambaugh (2008) "The dynamics of exchange rate regimes: Fixes, floats, and flips," Journal of International Economics, 75(1), 70-92.

[49] Koepke, R. (2015) “What Drives Capital Flows to Emerging Markets? A Survey of the Empirical Literature.” IIF Working Paper.

[50] Krippner, L. (2014) “Measuring the stance of monetary policy in conventional and unconventional environments”, CAMA Working Paper 6.

[51] Kurozumi, E. (2002) “Testing for stationarity with a break”, Journal of Econometrics, 108(1), 63–99.

[52] Lamers M., F. Mergaerts, E. Meuleman and R. Vander Vennet (2016) “The Trade-Off between Monetary Policy and Bank Stability,” National Bank of Belgium Working Paper 308.

[53] Leiderman L., C. Reinhart and G. Calvo (1992) "Capital Inflows and Real Exchange Rate Appreciation in Latin America; The Role of External Factors," IMF Working Papers 62.

[54] Lemke W. and A. L. Vladu (2017) “Below the zero lower bound: a shadow-rate term structure model for the euro area,” ECB Working Paper Series 1991.

[55] Martinez-Miera D. and R. Repullo (2015) “Search for Yield” CEPR discussion paper 10830.

[56] McCauley, R., P. McGuire and V. Sushko (2015): "Global dollar credit: links to US monetary policy and leverage", Economic Policy, 30(82), 187-229.

[57] Milesi-Ferretti, G., and C. Tille (2011) “The Great Retrenchment: International Capital Flows during the Global Financial Crisis.” Economic Policy 26(66), 289-346.

[58] Miranda-Agrippino, S. and H. Rey (2015) “World Asset Markets and the Global Financial Cycle”, NBER Working Paper 21722.

[59] Obstfeld, M., J. C. Shambaugh and A. M. Taylor (2005) “The Trilemma in History: Tradeoffs Among Exchange Rates, Monetary Policies, and Capital Mobility," The Review of Economics and Statistics, 87(3), 423-438.

[60] Passari, E. and H. Rey (2015) "Financial Flows and the International Monetary System." The Economic Journal 125, 675-698.

[61] Portes, R. and H. Rey (2005) "The determinants of cross-border equity flows," Journal of International Economics, 65(2), 269-296.

[62] 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.

[63] Roengpitya R., N. Tarashev and K. Tsatsaronis (2017) "Bank business models: popularity and performance," BIS Working Paper Series, 682.

[64] Rose, A. and T. Wieladek (2011) “Financial Protectionism: the First Tests”, NBER Working Paper 17073.

[65] Shin, H. S. (2013) “The Second Phase of Global Liquidity and Its Impact on Emerging Economies”. Keynote address at the Federal Reserve Bank of San Francisco Asia Economic Policy Conference, November 3-5.

[66] Shin, H. S. (2016) “The bank/capital markets nexus goes global”, speech at the London School of Economics and Political Science, London, 15 November.

[67] Stanley, T. D. and S. B. Jarrell (1989) “Meta-regression analysis: A quantitative method of literature surveys”, Journal of Economic Surveys, 19(3) 299-308.

[68] Taylor, M. P. and L. Sarno (1997) “Capital Flows to Developing Countries: Long-and Short- Term Determinants.” The World Bank Economic Review, 11(3), 451-470.

[69] Wu, J. C. and F. D. Xia (2016) "Measuring the Macroeconomic Impact of Monetary Policy at the Zero Lower Bound," Journal of Money, Credit and Banking, Blackwell Publishing, 48(3), 253-291.

Table 2.1: Typical Lenders and Borrowers

	Typical Lenders	**Typical Borrowers**	***Notes***
Cross-border loans (XBL) to banks	Internationally-active banks	Banks (all sizes)	*Interbank market (unsecured and repo)*
Cross-border loans (XBL) to non-banks	Internationally-active banks	Large non-financial corporates; exporting/importing firms; Leveraged non-bank financials	*Syndicated loan market; trade credit; project financing*
International debt securities (IDS) issued by banks	Pension funds; Insurance companies; MMMFs; Hedge funds	Large and mid-sized banks	*Smaller investor base than for IDS issued by non-banks*
International debt securities (IDS) issued by non-banks	Pension funds; Insurance companies; MMFs; Hedge funds	Non-financial corporates; governments; Insurance companies	*Broader investor base than for IDS issued by banks*

Table 2.2: Locational baseline regressions (by borrowing country)

	Dependent variable: ΔCross-border loans †			Dependent variable: ΔInternational debt securities ‡		
Explanatory variables	All	to banks	to non-banks	All	by banks	by non-banks
ΔFed funds rate (1)	-1.95***	-2.48***	-1.86***	-1.76***	-2.26**	-1.44**
	(0.38)	(0.58)	(0.34)	(0.66)	(0.95)	(0.69)
Log(VIX)	-2.75***	-2.51***	-3.10***	-2.31***	-5.22***	-1.49*
	(0.59)	(0.96)	(0.62)	(0.75)	(1.77)	(0.83)
ΔReal GDP	0.54***	0.57***	0.50***	0.09	0.20	0.08
	(0.09)	(0.12)	(0.08)	(0.10)	(0.24)	(0.13)
ΔSovereign rating (2)	2.80***	4.37***	0.02	0.56	-1.50	0.30
	(1.06)	(1.40)	(0.84)	(0.85)	(2.82)	(1.05)
Chinn-Ito index (3)	-1.35	-3.03	0.30	8.11***	10.72**	4.87
	(1.79)	(2.87)	(1.85)	(2.89)	(4.61)	(3.03)
ΔReal global GDP	0.50***	0.81***	0.34**	0.00	-0.18	-0.15
	(0.16)	(0.24)	(0.16)	(0.26)	(0.79)	(0.30)
Observations	3,327	3,327	3,327	3,327	2,961	3,326
R-squared	0.11	0.07	0.08	0.05	0.03	0.03

Notes: The sample includes quarterly data for 64 recipient countries over the period 2000:Q1 - 2015:Q4. The regressions include a full set of country fixed effects. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. † to borrowers in country j. ‡ issued by borrowers in country j. (1) Effective federal funds rate for the period 2001:Q1 – 2008:Q4, Wu-Xia Shadow rate for the period 2009:Q1 – 2015:Q4. (2) Long term foreign currency sovereign rating, average across 3 agencies (S&P, Moody's and Fitch). (3) Measure of financial openness developed in Chinn and Ito (2008).

Table 2.3: Locational baseline regressions (by borrowing country) with structural breaks

	Dependent variable: ΔCross-border loans †			Dependent variable: ΔInternational debt securities ‡			Dependent variable: ΔTotal cross-border flows (loans and debt securities)		
	All	to banks	to non-banks	All	by banks	by non-banks	All	to banks	to non-banks
Pre-break									
ΔFF (1)	-3.19***	-3.44***	-3.42***	-1.42	-1.26	-0.90	-2.07***	-2.57***	-2.09***
	(0.49)	(0.81)	(0.56)	(1.03)	(1.36)	(1.20)	(0.36)	(0.71)	(0.37)
VIX (2)	-3.94***	-4.43***	-4.36***	-1.09	-5.63**	-0.21	-3.11***	-4.09***	-2.70***
	(0.94)	(1.63)	(1.07)	(1.28)	(2.66)	(1.56)	(0.67)	(1.39)	(0.69)
Post-break - up to 2013:Q1									
ΔFF (1)	-8.07***	-10.79***	-6.16***	-8.17***	-20.23	-8.00***	-7.96***	-11.50***	-6.44***
	(1.336)	(2.088)	(1.188)	(2.510)	(12.75)	(2.542)	(1.00)	(1.96)	(0.93)
VIX (2)	-2.68**	-2.12	-2.87***	-3.07**	-5.60	-2.51*	-3.14***	-2.73*	-2.88***
	(1.071)	(1.671)	(1.063)	(1.476)	(5.225)	(1.517)	(0.83)	(1.61)	(0.79)
Post-break - up to 2015:Q4									
ΔFF (1)	-3.68***	-5.56***	-2.29***	-5.19***	-9.82***	-4.88***	-4.37***	-5.84***	-3.85***
	(0.71)	(1.02)	(0.72)	(0.92)	(3.79)	(0.93)	(0.47)	(0.84)	(0.49)
VIX (2)	-0.32	0.77	-0.99	-1.55	-1.25	-0.83	-1.18*	0.41	-1.13*
	(0.81)	(1.27)	(0.77)	(1.06)	(3.12)	(1.04)	(0.60)	(1.18)	(0.58)

Notes: The sample includes quarterly data for 64 recipient countries over the period 2000:Q1 - 2015:Q4. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. † to borrowers in country j. ‡ issued by borrowers in country j. (1) Effective federal funds rate for the period 2001:Q1 – 2008:Q4, Wu-Xia Shadow rate for the period 2009:Q1 – 2015:Q4. (2) Log(VIX). The regressions include ΔReal GDP, ΔSovereign Ratings, Chinn-Ito Index, ΔReal Global GDP and their interaction with a break dummy that takes value 1 after the break date (2009:Q1). The regressions also include a full set of country fixed effects.

Table 2.4: Convergence between loan and bond sensitivities

	Coefficients (XBL[†]) – Coefficients (IDS[‡])		
Explanatory variables	All	to banks	to non-banks
Pre-break			
ΔFed funds rate (1)	-1.77*	-2.18*	-2.52**
	(1.14)	(1.58)	(1.32)
Log(VIX)	-2.85**	1.20	-4.14**
	(1.59)	(3.12)	(1.89)
Post-break			
ΔFed funds rate (1)	1.51	4.25	2.59**
	(1.16)	(3.92)	(1.18)
Log(VIX)	1.23	2.02	-0.15
	(1.33)	(3.37)	(1.29)

Notes: The sample includes quarterly data for 64 recipient countries over the period 2000:Q1 - 2015:Q4. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. [†] cross-border loans to borrowers in country j. [‡] international debt securities issued by borrowers in country j. (1) Effective federal funds rate for the period 2001:Q1 – 2008:Q4, Wu-Xia Shadow rate for the period 2009:Q1 – 2015:Q4. The regressions include ΔReal GDP, ΔSovereign Ratings, Chinn-Ito Index, ΔReal Global GDP and a break dummy that takes value 1 after the break date (2009:Q1). The regressions also include a full set of country fixed effects.

Table 2.5: Drivers of the shifts in lender-specific sensitivities

	Dependent variable: Structural change in the coefficient for ΔFed funds rate $\beta_1^{PostBreak} - \beta_1^{PreBreak}$			Dependent variable: Structural change in the coefficient for Log(VIX) $\beta_2^{PostBreak} - \beta_2^{PreBreak}$		
Explanatory variables	(I)	(II)	(III)	(IV)	(V)	(VI)
Pre-break Capital ratio (2008)	0.41**	0.31*	0.35*	0.53**	0.67***	0.46**
	(0.19)	(0.189)	(0.19)	(0.25)	(0.24)	(0.23)
Pre-break Average bank size (2008)	1.38***	1.46***	1.29**	-0.76	-0.82	-0.56
	(0.50)	(0.52)	(0.51)	(0.77)	(0.78)	(0.72)
Pre-break Prudential index (2008)	-0.47			0.57		
	(0.31)			(0.44)		
Pre-break LTV index (2008)		-1.27			-0.87	
		(0.80)			(1.089)	
Pre-break Local reserve requirement index (2008)			-0.83			3.30***
			(0.74)			(0.99)
Sectoral fixed effects	yes	yes	yes	yes	yes	yes
Observations	87	87	87	87	87	87
Q (1)	279.41	285.33	286.36	256.62	254.91	236.59
Degrees of Freedom test Q	81	81	81	81	81	81
I^2 (2)	0.71	0.72	0.72	0.69	0.68	0.66
τ^2 (3)	14.67	15.47	15.51	32.73	32.31	26.24
Adjusted R-squared	20.51	17.81	17.72	17.76	16.81	28.76

Note: Coefficients are obtained from the baseline model with structural breaks (equation (2)). This model is estimated for each of the available 29 lending countries (we excluded South Korea for which data are not available in the pre-break period) and for three different borrowers: banks, public sector and non-banks. We obtain therefore 29*3=87 observations. Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1. (1) The Q Measure evaluates the level of homogeneity/heterogeneity among studies. It is calculated as the weighted squared difference of the estimated effects with respect to the mean. The statistical distribution of this measure follows a $\chi 2$ distribution. The null hypothesis of the test assumes homogeneity in the effect sizes. (2) This percentage represents the magnitude of the level of heterogeneity in effect sizes and it is defined as the percentage of the residual variation that it is attributable to between study heterogeneity. It is defined as the difference between the Q measure and the degrees of freedom divided by the Q measure. Although there can be no absolute rule for when heterogeneity becomes important, Harbord and Higgins (2008) tentatively suggest adjectives of low for I2 values between 25% and 50%, moderate for 50%-75% and high for values larger than 75%. (3) $\tau 2$ is a measure of population variability in effect sizes. It depends positively on the observed heterogeneity (Q measure) and its difference with respect to the degrees of freedom. The expected value of Q measure under the null hypothesis of homogeneity is equal to the degrees of freedom; a homogeneous set of studies will result in this statistic equal to zero. Under the presence of heterogeneity this estimate should be different from zero.

Table 2.6: Drivers of the shifts in lender-specific weights

	Dependent variable: Change in the lending national banking system weights $w^{Postbreak} - w^{PreBreak}$			Dependent variable: Change in the lending national banking system weights $w^{Postbreak} - w^{PreBreak}$		
Explanatory variables	(I)	(II)	(III)	(IV)	(V)	(VI)
Pre-break Capital ratio (2008)	0.14*	0.12**	0.07*	0.21**	0.15**	0.09*
	(0.04)	(0.02)	(0.03)	(0.05)	(0.03)	(0.03)
Pre-break Average bank size (2008)	0.31	0.27	0.29	0.51	0.42	0.43
	(0.20)	(0.19)	(0.18)	(0.20)	(0.19)	(0.19)
Pre-break Prudential index (2008)	-0.10			-0.29**		
	(0.05)			(0.07)		
Pre-break LTV index (2008)		-0.13			-0.43*	
		(0.10)			(0.14)	
Pre-break Local reserve requirement index (2008)			0.45**			0.51**
			(0.08)			(0.10)
Pre-break Deposits to total assets ratio (2008)				0.04**	0.02**	0.01**
				(0.00)	(0.00)	(0.00)
Net interest income over total income (2008)				59.48*	32.23*	19.15*
				(19.54)	(17.56)	(10.70)
Local claims over Foreign claims (2008)				2.53*	2.86*	3.41**
				(0.81)	(0.83)	(0.78)
Sectoral fixed effects	yes	yes	yes	yes	yes	yes
Observations	87	87	87	75	75	75
Adjusted R-squared	0.05	0.04	0.07	0.14	0.11	0.13

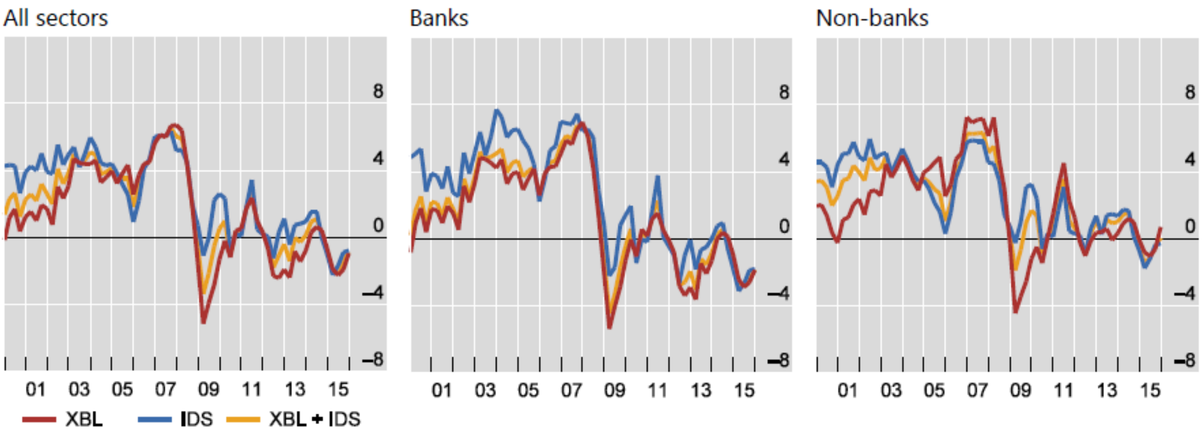
Note: The dependent variable is the difference in lending national banking system weights, expressed in percentage terms. Weights are available for 29 lending countries (we excluded South Korea for which data are not available in the pre-break period), while Local claims over Foreign claims are available for 25 countries (not for Chile, Hong Kong, Luxemburg and Mexico) and for three different borrowers: banks, public sector and non-banks. We obtain therefore 25*3=75 observations in the last three columns. Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1.

Table 2.7: Monetary Policy Divergence and Banking Net Interest Share in Time Varying Sensitivities

	ΔCross-border loans			ΔInternational debt securities		
Explanatory variables	All	Banks	Non-banks	All	Banks	Non-banks
Post-break						
ΔFFR (1)	-8.41***	-11.19***	-7.16***	-7.16**	-23.63	-6.79**
	(1.99)	(2.94)	(1.94)	(3.245)	(15.95)	(3.20)
Log(VIX)	-4.78***	-4.04	-4.27***	-5.77**	-12.57**	-5.24*
	(1.45)	(2.47)	(1.31)	(2.64)	(5.60)	(2.72)
ΔFFR*NETINTtoTA (2)	-1.120	2.79	-3.24	8.30*	30.28*	7.62
	(3.39)	(4.73)	(3.15)	(4.78)	(15.51)	(4.92)
Log(VIX)*NETINTtoTA	1.24	2.27	-0.62	6.29	11.99	7.22
	(1.83)	(2.75)	(1.44)	(5.20)	(9.93)	(5.38)
ΔFFR*PolicyDivergence (3)	8.59***	7.30**	10.21***	0.389	4.09	0.76
	(2.54)	(3.26)	(2.65)	(3.02)	(9.46)	(3.12)
Log(VIX)*PolicyDivergence (3)	10.26***	10.95***	8.28***	3.46	14.97	3.34
	(2.40)	(3.88)	(2.36)	(3.189)	(9.39)	(3.27)
Other controls (4)						
Observations	3,327	3,327	3,327	3,327	2,961	3,326
R-squared	0.18	0.12	0.11	0.08	0.05	0.05
Country FE	yes	yes	yes	yes	yes	yes

Notes: The sample includes quarterly data for 64 recipient countries over the period 2000:Q1 - 2015:Q4. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. † to borrowers in country j. ‡ issued by borrowers in country j. (1) Effective federal funds rate for the period 2001:Q1 – 2008:Q4, Wu-Xia Shadow rate for the period 2009:Q1 – 2015:Q4. (2) Net interest to total assets. (3) Difference between the 2-year futures on the policy rate for the United States and the average of the 2-year futures for the United Kingdom, Switzerland, Japan and a group of "core" Eurozone countries (Austria, Belgium, Germany, Finland, France, the Netherlands, Spain). (4) The regressions include ΔReal GDP, ΔSovereign Ratings, Chinn-Ito Index, ΔReal Global GDP. Please note that both pre-break and post-break coefficients enter independently and interacted with net interest to total assets and monetary policy divergence metrics. For the sake of brevity, only Post-Break coefficients are reported in the table. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

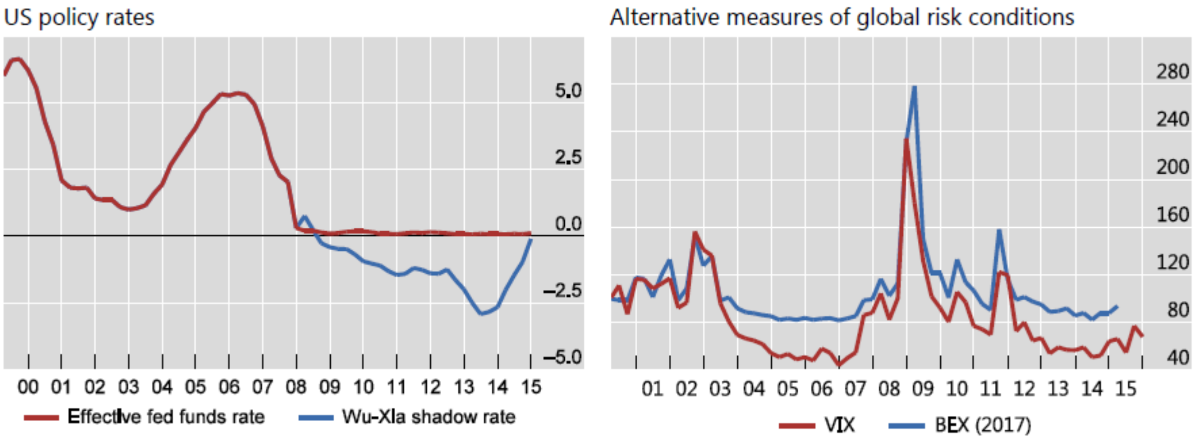
Figure 2.1: External debt flows, all borrowers



XBL = Cross-border loans: Quarterly Growth Rate$_t$ = (Outstanding Stock$_t$ / Outstanding Stock$_{t-1}$)-1; IDS = International Debt Securities: Quarterly Growth Rate$_t$ = (Outstanding Stock$_t$ / Outstanding Stock$_{t-1}$)-1.

Sources: BIS Locational Banking Statistics by residence; BIS International Debt Securities Statistics.

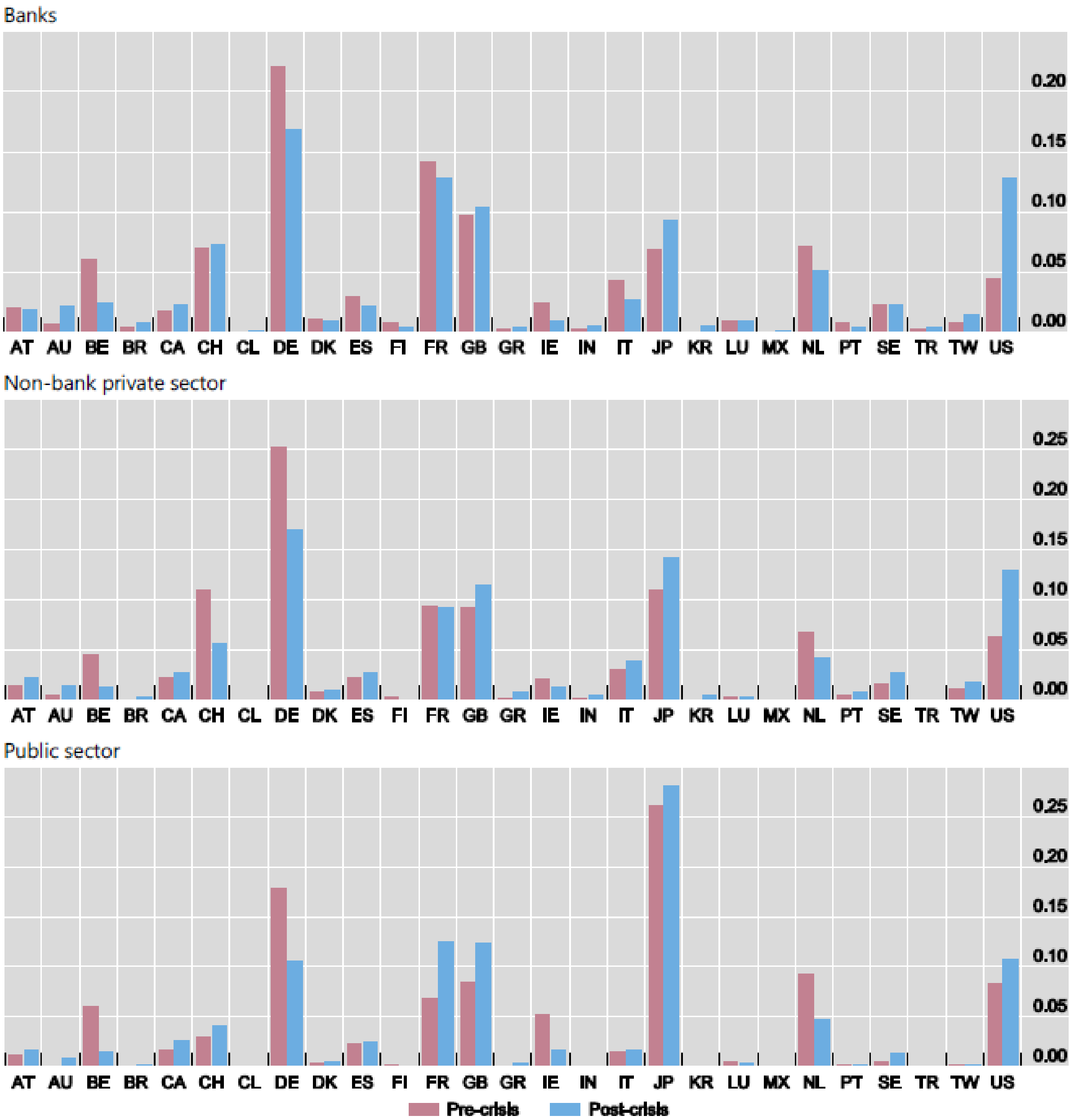
Figure 2.2: US policy rates and measures of global risk conditions



BEX (2017) = Bekaert, Engstorm and Xu (2017).

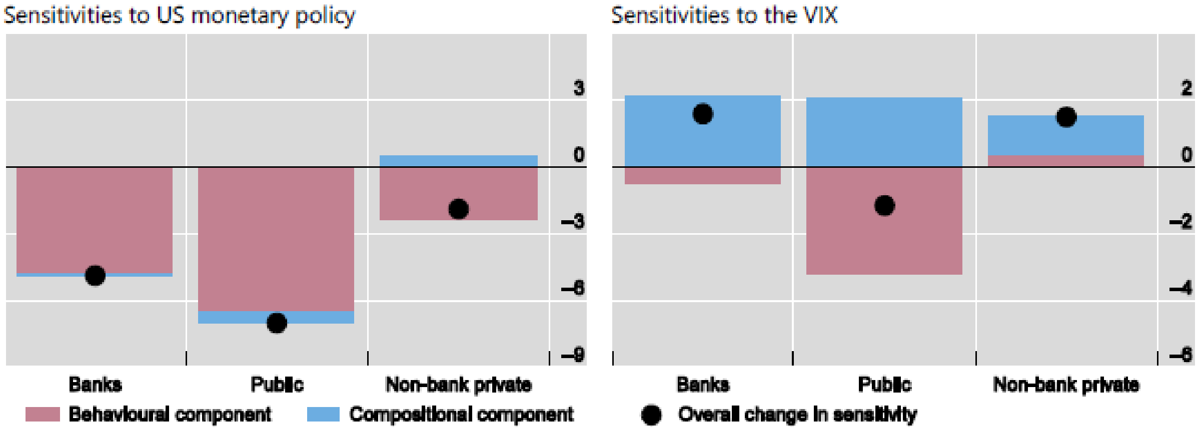
Sources: Bekaert, Engstorm and Xu (2017); Wu and Xia (2015); Datastream.

Figure 2.3: Lending national banking system weights



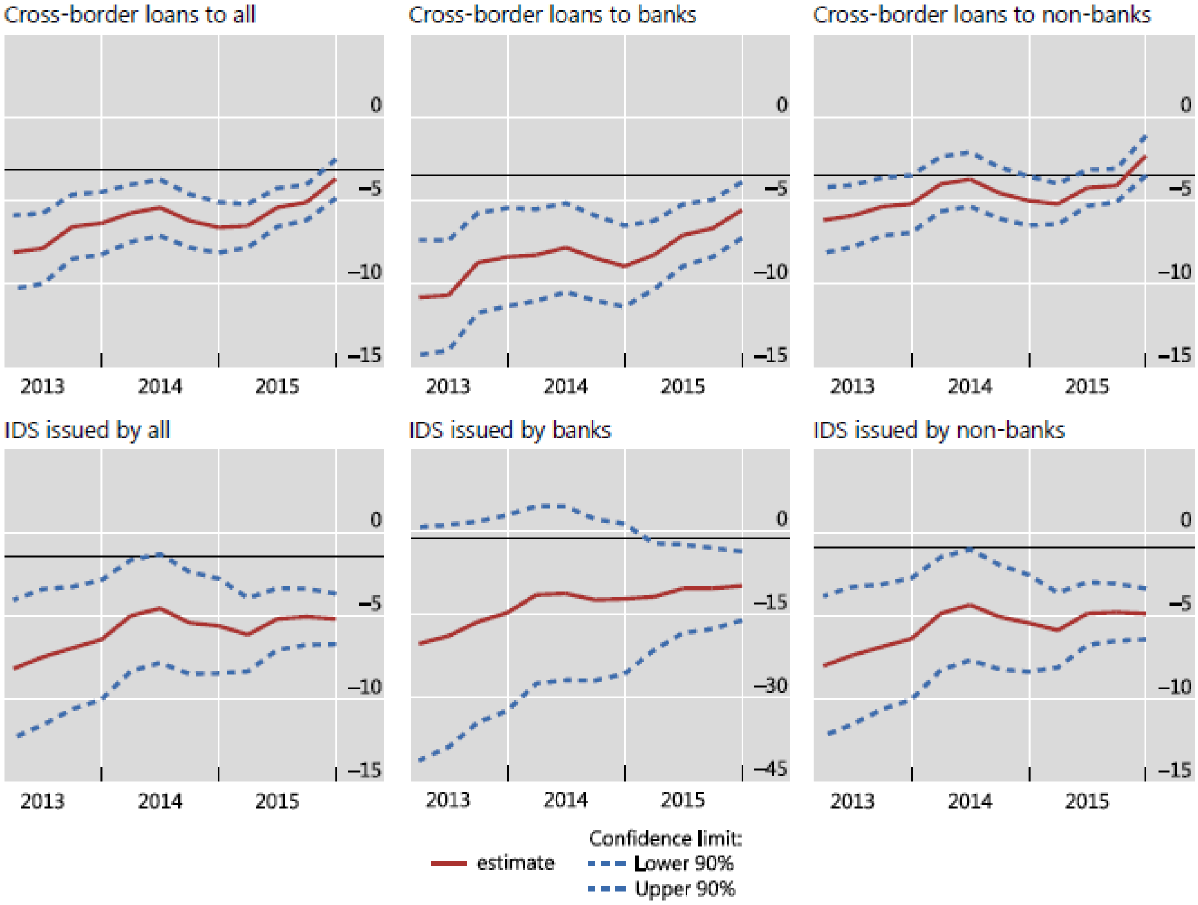
Sources: BIS consolidated banking statistics; authors' calculations.

Figure 2.4: Decomposing the shifts in the lender-specific sensitivities, by borrowing sector



Sources: BIS consolidated banking statistics; authors' calculations.

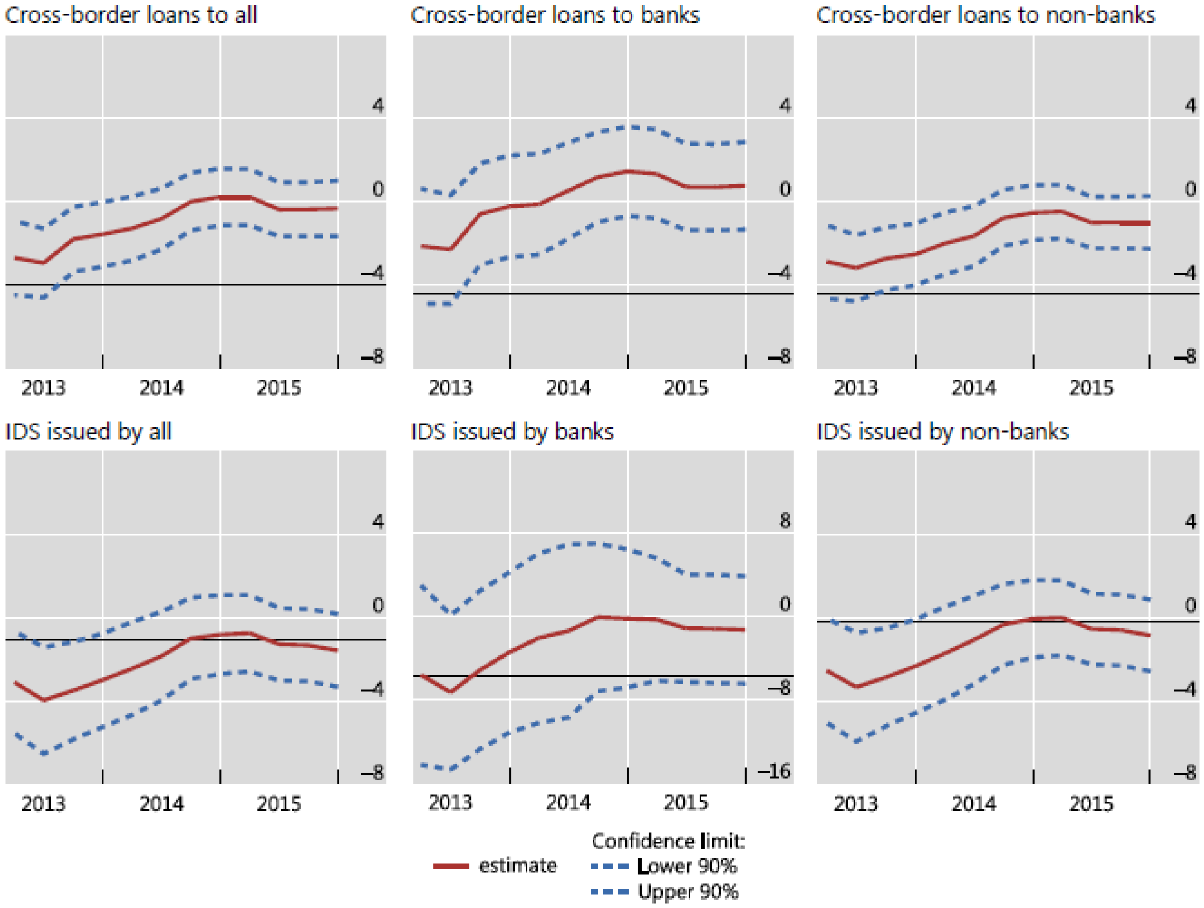
Figure 2.5: Post-break sensitivities to ΔFFR, evolution over time



The graph shows the evolution over time of sensitivities to the ΔFFR. For each quarter t, the charts show the post-break coefficient (and its 90% confidence interval) obtained by estimating the model with a sample from 2000:Q1 up to quarter t, with a break in 2009:Q1. The model includes the log(VIX), ΔReal GDP, ΔSovereign Ratings, Chinn-Ito Index, ΔReal Global GDP, ΔFFR (i.e. ΔEffective federal funds rate for the period 2001:Q1 – 2008:Q4, ΔWu-Xia Shadow rate for the period 2009:Q1 – 2015:Q4) as explanatory variables. The black line in each panel represents the pre-break estimate of the sensitivity to ΔFFR.

Sources: authors' calculations.

Figure 2.6: Post-break sensitivities to log(VIX), evolution over time



The graph shows the evolution over time of sensitivities to the log(VIX). For each quarter t, the charts show the post-break coefficient (and its 90% confidence interval) obtained by estimating the model with a sample from 2000:Q1 up to quarter t, with a break in 2009:Q1. The model includes the log(VIX), ΔReal GDP, ΔSovereign Ratings, Chinn-Ito Index, ΔReal Global GDP, ΔFFR (i.e. ΔEffective federal funds rate for the period 2001:Q1 – 2008:Q4, ΔWu-Xia Shadow rate for the period 2009:Q1 – 2015:Q4) as explanatory variables. The black line in each panel represents the pre-break estimate of the sensitivity to the log(VIX).

Sources: authors' calculations.

Appendix 2.A: Additional tables and graphs

Table 2.A.1: Descriptive statistics of the explanatory variables

Variables	Obs.	Mean	Std. Dev.	Min	Max
ΔFed fund rates (1)	4,069	-0.08	0.52	-1.73	1.00
Log (VIX)	4,069	2.97	0.34	2.40	4.07
ΔGlobal GDP	4,069	3.66	1.67	-2.49	5.75
ΔGDP	3,658	3.15	3.91	-19.30	28.10
ΔSovereign ratings (2)	3,901	0.01	0.26	-4.67	2.43
Chinn-Ito index (3)	3,872	0.74	0.32	0.00	1.00
PruC (5)	3,840	0.05	0.39	-1.00	1.00
LTV (6)	1,298	0.04	0.27	-1.00	1.00
ResReq (7)	3,840	-0.01	0.32	-3.00	5.00
CapReq (8)	3,420	0.03	0.17	0.00	1.00
CumPruC (9)	3,584	0.58	3.42	-9.00	25.00
CumLTV (10)	1,149	0.47	1.73	-3.00	8.00
CumCapReq (11)	3,192	0.16	0.41	0.00	2.00
CumResReq (12)	3,584	-0.49	1.98	-7.00	13.00
Pre-break capital ratio (13)	30	0.08	0.04	0.04	0.24
Pre-break average bank size (13)	30	14.92	1.14	12.84	17.01
Pre-break deposits to total assets (13)	30	0.75	0.10	0.53	0.94
Net interest income to total assets (14)	4,069	0.63	0.50	-3.81	2.96
Spread on 2-year futures on the policy rate (15)	4,069	1.05	0.76	0.01	3.00

Notes: The sample includes quarterly data for 64 recipient countries over the period 2000:Q1 - 2015:Q4, except for the prudential tools for which the data end in 2014:Q4. (1) Effective federal funds rate for the period 2001:Q1 – 2008:Q4, Wu-Xia Shadow rate for the period 2009:Q1 – 2015:Q4. (2) Long term foreign currency sovereign rating, average across 3 agencies (S&P, Moody's and Fitch). (3) Measure of financial openness developed in Chinn and Ito (2008). (5) Composite prudential index. (6) Caps on loan to value ratio. (7) Reserve requirements in local currency. (8) Capital requirements. (9) Cumulative composite prudential index. (10) Cumulative caps on loan to value ratio. (11) Cumulative reserve requirements in local currency. (12) Cumulative capital requirements. Each cumulative prudential index is obtained in each quarter by adding the non-cumulative prudential index up to that quarter. (13) These aggregate balance sheet characteristics of the banking sector pertain to the 30 lending countries in our sample. They refer to the end of the year 2008, right before the structural break in our model. (14) This variable is borrower-specific and is computed as the weighted average for all countries lending to a specific borrower. (15) Difference between 2-year futures contract on the US policy rate and the simple average of similar futures contracts for other advanced economies (CH, EUR, JP, UK).

Table 2.A.2: Locational baseline regressions (by borrowing country) with alternative shadow rates

	Dependent variable: ΔCross-border loans [†]			Dependent variable: ΔInternational debt securities [‡]		
Explanatory variables	All	to banks	to non-banks	All	by banks	by non-banks
ΔKrippner (1)	-1.12***	-0.77**	-1.21***	-0.81	-1.72**	-0.73
	(0.27)	(0.39)	(0.29)	(0.54)	(0.84)	(0.54)
Log(VIX)	-3.87***	-2.88**	-4.29***	-2.85***	-7.47***	-2.09**
	(0.71)	(1.16)	(0.78)	(0.99)	(2.53)	(0.97)
ΔReal GDP	0.57***	0.61***	0.53***	0.17*	0.23	0.17
	(0.07)	(0.12)	(0.07)	(0.09)	(0.27)	(0.13)
ΔSovereign rating (2)	2.11**	3.54**	-0.67	1.09	-1.94	0.86
	(1.01)	(1.38)	(0.72)	(0.76)	(3.03)	(0.96)
Chinn-Ito index (3)	-0.59	-1.89	1.08	8.43***	12.32**	5.03
	(1.83)	(2.95)	(1.86)	(2.99)	(4.83)	(3.13)
ΔReal global GDP	0.212	0.51**	0.09	-0.28	-0.57	-0.43
	(0.15)	(0.24)	(0.14)	(0.24)	(0.83)	(0.28)
Observations	3,115	3,115	3,115	3,115	2,765	3,114
R-squared	0.11	0.08	0.07	0.06	0.03	0.04
ΔBauer-Rudebusch (4)	-1.78***	-1.84***	-1.99***	-2.04**	-0.24	-1.78***
	(0.44)	(0.64)	(0.49)	(1.00)	(1.54)	(0.44)
Log(VIX)	-3.33***	-2.99***	-3.77***	-3.04***	-4.72**	-3.34***
	(0.63)	(1.04)	(0.68)	(0.78)	(2.14)	(0.63)
ΔReal GDP	0.58***	0.61***	0.53***	0.17*	0.23	0.57***
	(0.07)	(0.11)	(0.07)	(0.09)	(0.27)	(0.07)
ΔSovereign rating (2)	2.18**	3.65***	-0.59	1.21	-2.03	2.18**
	(1.00)	(1.37)	(0.74)	(0.77)	(3.01)	(1.00)
Chinn-Ito index (3)	-0.61	-1.95	1.05	8.35***	12.40**	-0.61
	(1.82)	(2.94)	(1.86)	(2.97)	(4.86)	(1.83)
ΔReal global GDP	0.33**	0.59**	0.21	-0.20	-0.39	0.33**
	(0.15)	(0.23)	(0.14)	(0.26)	(0.80)	(0.15)
Observations	3,115	3,115	3,115	3,115	2,765	3,115
R-squared	0.11	0.08	0.07	0.06	0.03	0.11

Notes: The sample includes quarterly data for 64 recipient countries over the period 2000:Q1 - 2014:Q4. The regressions include a full set of country fixed effects. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. [†] to borrowers in country j. [‡] issued by borrowers in country j. (1) Estimate of the Fed fund shadow rate based on Krippner (2014). (2) Long term foreign currency sovereign rating, average across 3 agencies (S&P, Moody's and Fitch). (3) Measure of financial openness developed in Chinn and Ito (2008). (4) Measure of the Fed fund shadow rate based on Bauer and Rudebusch (2016).

Table 2.A.3: Baseline model with 2-year US rates instead of shadow rates

	Dependent variable: ΔCross-border loans †			Dependent variable: ΔInternational debt securities ‡		
Explanatory variables	All	to banks	to non-banks	All	by banks	by non-banks
ΔFed funds rate (1)	-1.62***	-0.95	-2.41***	-0.14	-0.18	-0.16
	(0.49)	(0.77)	(0.53)	(1.16)	(1.50)	(1.28)
Log(VIX)	-2.62***	-1.46	-3.66***	-1.25	-3.84*	-0.73
	(0.68)	(1.12)	(0.73)	(0.89)	(2.14)	(0.97)
ΔReal GDP	0.53***	0.60***	0.47***	0.10	0.19	0.095
	(0.08)	(0.12)	(0.08)	(0.10)	(0.23)	(0.19)
ΔSovereign rating (2)	2.70	4.18***	0.06	0.49	-1.35	0.20
	(1.05)	(1.39)	(0.83)	(0.84)	(2.77)	(1.03)
Chinn-Ito index (3)	-1.74	-3.69	0.28	7.90***	9.94**	4.83
	(1.84)	(2.99)	(1.84)	(3.00)	(4.81)	(3.14)
ΔReal global GDP	0.37**	0.62***	0.25	-0.06	-0.18	-0.23
	(0.16)	(0.23)	(0.15)	(0.23)	(0.74)	(0.27)
Observations	3,327	3,327	3,327	3,327	2,961	3,326
R-squared	0.11	0.07	0.07	0.05	0.03	0.03

Notes: The sample includes quarterly data for 64 recipient countries over the period 2000:Q1 - 2015:Q4. The regressions include a full set of country fixed effects. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. † to borrowers in country j. ‡ issued by borrowers in country j. (1) Two-year Treasury rate. (2) Long term foreign currency sovereign rating, average across 3 agencies (S&P, Moody's and Fitch). (3) Measure of financial openness developed in Chinn and Ito (2008).

Table 2.A.4: Baseline model with alternative measures of portfolio debt flows

Explanatory variables	Dependent variable: ΔPortfolio debt flows † All	by banks	by non-banks
ΔFed funds rate (1)	-1.69***	-1.81***	-1.85***
	(0.26)	(0.50)	(0.27)
Log(VIX)	-3.08***	-4.96***	-2.56***
	(0.44)	(0.83)	(0.46)
ΔReal GDP	0.04	0.10	0.03
	(0.04)	(0.08)	(0.05)
ΔSovereign rating (2)	1.10***	2.91***	0.48
	(0.40)	(0.82)	(0.56)
Chinn-Ito index (3)	3.17**	4.81*	-0.31
	(1.31)	(2.88)	(1.31)
ΔReal global GDP	0.058	0.26	-0.01
	(0.09)	(0.18)	(0.102)
Observations	2,592	2,447	2,592
R-squared	0.07	0.07	0.05

Notes: The sample includes quarterly data for 64 recipient countries over the period 2000:Q1 - 2015:Q4. The regressions include a full set of country fixed effects. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. † growth rate of outstanding stocks of debt issued by borrowers in country j, winsorized at the 10% level. (1) Effective federal funds rate for the period 2001:Q1 – 2008:Q4, Wu-Xia Shadow rate for the period 2009:Q1 – 2015:Q4. (2) LT foreign currency, average across 3 agencies. (3) Measure of financial openness developed in Chinn and Ito (2008).

Table 2.A.5: Disentangling the effects in advanced and emerging market economies with different post-break periods

	Dependent variable: ΔCross-border loans †		Dependent variable: ΔInternational debt securities ‡	
Explanatory variables	Advanced economies	Emerging economies	Advanced economies	Emerging economies
Pre-break				
ΔFed funds rate (1)	-2.18***	-4.67***	-2.56	-0.62
	(0.66)	(0.73)	(1.88)	(0.73)
Log(VIX)	-3.98***	-4.33***	1.01	-3.92***
	(1.23)	(1.43)	(2.11)	(1.27)
Post-break (up to 2013:Q1)				
ΔFed funds rate (1)	-8.01***	-7.42***	-13.54***	-5.62***
	(1.86)	(1.78)	(4.55)	(1.86)
Log(VIX)	-2.51*	-3.29**	-0.09	-3.04*
	(1.41)	(1.56)	(2.27)	(1.84)
Post-break (up to 2015:Q4)				
ΔFed funds rate (1)	-3.51***	-2.98***	-6.80***	-4.06***
	(0.93)	(1.14)	(1.57)	(1.10)
Log(VIX)	-1.15	-0.90	0.46	-2.68**
	(1.12)	(1.07)	(1.70)	(1.27)

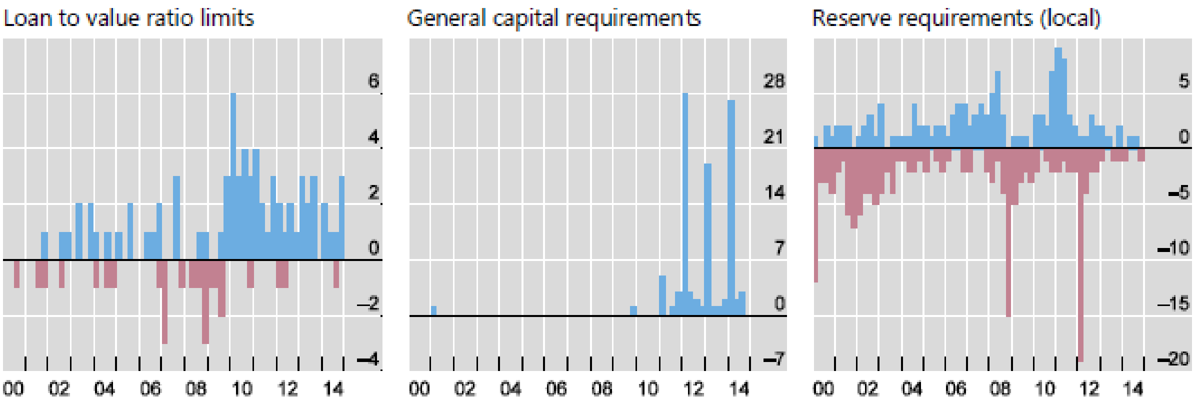
Notes: The sample includes quarterly data for 64 recipient countries (29 advanced economies and 35 emerging economies) over the period 2000:Q1 - 2015:Q4. The post-break period can have two different lengths: up to the taper tantrum (2009:Q1 - 2013:Q1) and up to the end of the sample (2009:Q1 – 2015:Q4). Robust standard errors in parentheses. *** $p<0.01$, ** $p<0.05$, * $p<0.1$. † to borrowers in country j. ‡ issued by borrowers in country j. (1) Effective federal funds rate for the period 2001:Q1 – 2008:Q4, Wu-Xia Shadow rate for the period 2009:Q1 – 2015:Q4. The regressions include ΔReal GDP, ΔSovereign Ratings, Chinn-Ito Index, ΔReal Global GDP and a break dummy that takes value 1 after the break date (2009:Q1). The regressions also include a full set of country fixed effects.

Table 2.A.6: R-squared decompositions - Locational baseline regressions (by borrowing country) with structural breaks

Region	Variables	Dependent variable: ΔCross-border loans †			Dependent variable: ΔInternational debt securities ‡		
		All	to banks	to non-banks	All	by banks	by non-banks
All countries	***Pre-break***						
	Global	54.63	51.09	60.34	65.02	51.22	70.04
	Local	45.37	48.91	39.66	34.98	48.78	29.96
	Post-break						
	Global	41.02	53.33	36.16	57.53	82.59	66.52
	Local	58.98	46.67	63.84	42.47	17.41	33.48
	Total global	51.35	51.75	56.06	60.09	68.87	67.19
	Total local	48.66	48.25	43.94	39.91	31.13	32.81
AEs	***Pre-break***						
	Global	38.26	29.78	46.89	49.56	19.03	43.10
	Local	61.74	70.22	53.11	50.44	80.97	56.90
	Post-break						
	Global	55.88	59.47	52.79	46.73	54.43	57.35
	Local	44.12	40.53	47.21	53.27	45.57	42.65
	Total global	40.99	34.56	48.10	48.01	31.81	52.93
	Total local	59.01	65.44	51.90	51.99	68.19	47.07
EMEs	***Pre-break***						
	Global	71.05	70.83	70.41	90.47	93.99	77.41
	Local	28.95	29.17	29.59	9.53	6.01	22.59
	Post-break						
	Global	23.22	42.00	9.82	71.09	83.48	59.86
	Local	76.78	58.00	90.18	28.91	16.52	40.14
	Total global	52.48	58.58	50.57	78.00	87.45	66.69
	Total local	47.52	41.42	49.43	22.00	12.55	33.31

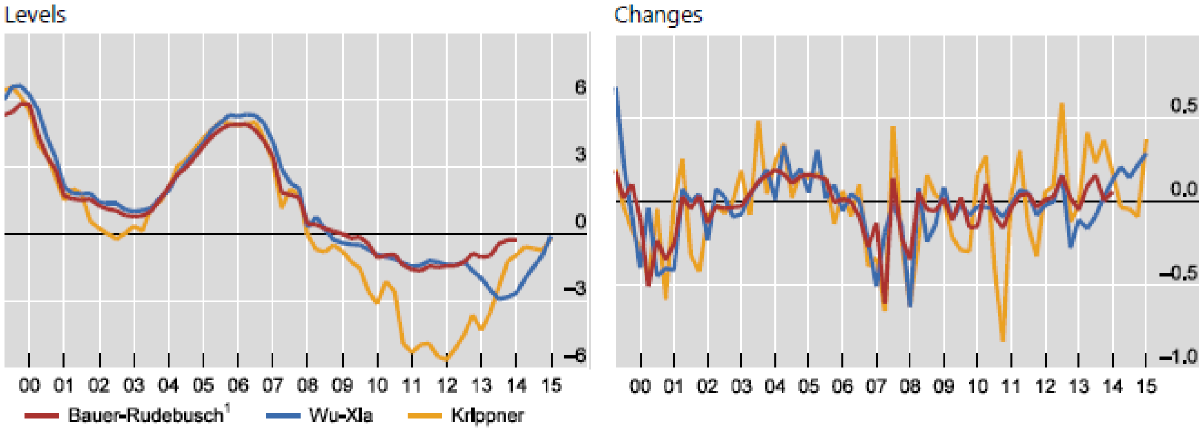
Notes: The table contains the Shapley values calculated following the methodology developed in Huettner and Sunder (2012). This measure is represented as a percentage of the overall R-squared explained by global and local variables for various types of cross-border flow pre and post-crisis. Shapley value adds the marginal contribution to the R-squared form adding regressor x_k to the model, weighted by the number of permutations represented by this submodel. The R^2 refers to a regression of one type of cross-border flow on both local and global variables. The percentages refer to the pre-break sample, the post-break sample and the overall sample. These regressions include a full set of country fixed effects. Global variables include the log(VIX), ΔReal Global GDP and ΔFFR (i.e. ΔEffective federal funds rate for the period 2001:Q1 – 2008:Q4, ΔWu-Xia Shadow rate for the period 2009:Q1 – 2015:Q4). Local variables include ΔReal GDP, ΔSovereign Ratings, the Chinn-Ito measure of financial openness. The model includes a structural break in 2009:Q1. The sample includes quarterly data for 64 recipient countries (29 advanced economies and 35 emerging economies) over the period 2000:Q1 - 2015:Q4.

Figure 2.A.1: Changes in prudential policies



Sources: IBRN Prudential Instruments Database, Cerutti et al. (2017).

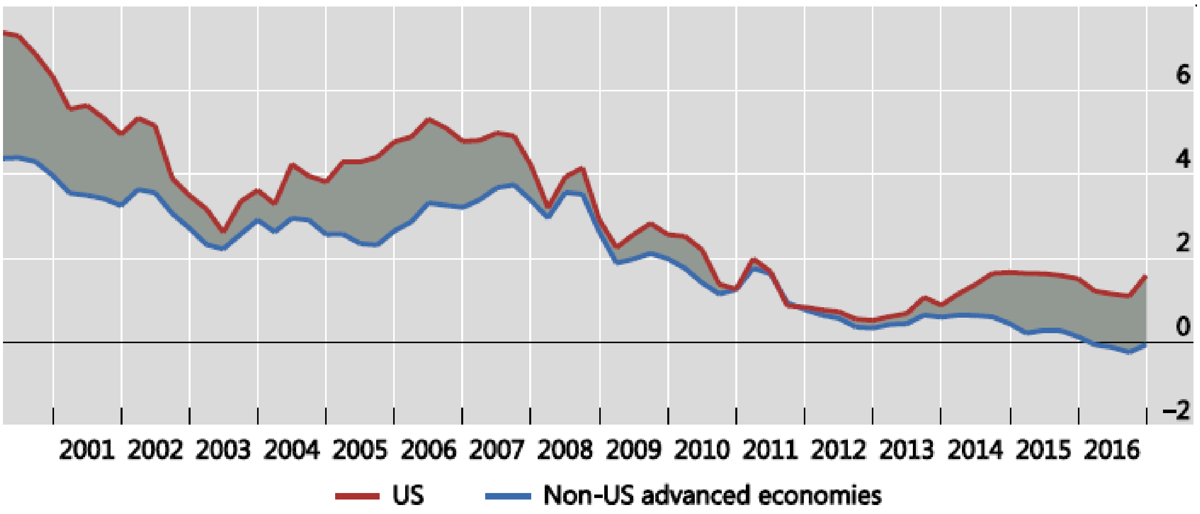
Figure 2.A.2: Shadow rates



[1] Median of 12 shadow rate estimates.

Sources: Datastream; Bauer and Rudebusch (2016); Krippner (2014); Wu and Xia (2016).

Figure 2.A.3: AE monetary policy divergence: 2-year futures on the policy rate



Non-US advanced economies equals the average of the 2-year futures for the United Kingdom, Switzerland, Japan and a group of "core" euro area countries (Austria, Belgium, Germany, Finland, France, the Netherlands and Spain).

Sources: Bloomberg; authors' calculations.

Appendix 2.B: List of countries in the dataset

Borrowing countries (64)

Argentina (AR), Australia (AU), Austria (AT), Belgium (BE), Brazil (BR), Bulgaria (BG), Canada (CA), Chile (CL), China (CN), Colombia (CO), Croatia (HR), Czech Republic (CZ), Denmark (DK), Estonia (EE), Finland (FI), France (FR), Germany (DE), Greece (GR), Hong Kong SAR (HK), Hungary (HU), Iceland (IS), India (IN), Indonesia (ID), Ireland (IE), Israel (IL), Italy (IT), Japan (JP), Korea (KR), Kuwait (KW), Latvia (LV), Lebanon (LB), Lithuania (LT), Luxembourg (LU), Malaysia (MY), Malta (MT), Mexico (MX), Mongolia (MN), Netherlands (NL), New Zealand (NZ), Nigeria (NG), Norway (NO), Peru (PE), Philippines (PH), Poland (PL), Portugal (PT), Romania (RO), Russia (RU), Saudi Arabia (SA), Serbia (RS), Singapore (SG), Slovakia (SK), Slovenia (SI), South Africa (ZA), Spain (ES), Sweden (SE), Switzerland (CH), Taiwan (TW), Thailand (TH), Turkey (TR), Ukraine (UA), United Kingdom (GB), United States (US), Uruguay (UY), Vietnam (VN).

CBS lending bank nationalities (31)

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), Panama (PA), Portugal (PT), Singapore (SG), Spain (ES), Sweden (SE), Switzerland (CH), Taiwan (TW), Turkey (TR), United Kingdom (GB), United States (US).

3. Changing Business Models in International Bank Funding *(joint with Leonardo Gambacorta and Adrian van Rixtel)*

Abstract
This paper investigates the foreign funding mix of globally active banks. Using BIS international banking statistics for a panel of 12 advanced economies, we detect a structural break in international bank funding at the onset of the great financial crisis. In their post-break business model, banks rely less on cross-border liabilities and, instead, tap funds from outside their jurisdictions by making more active use of their subsidiaries and branches, as well as inter-office accounts within the same banking group.

3.1 Introduction

Global banking has expanded markedly during the past decades, in terms of both cross-border activities and local entry into banking sectors overseas (Merck et al., 2012). This process has occurred in parallel with the globalisation of international trade and was driven by changes in the regulatory environment and in macroeconomic and financial conditions (Lane and Milesi-Ferretti, 2008; Goldberg, 2009)[1].

The rapid advance of global banking has also had important repercussions for funding and liquidity management at the institutions involved. Financial globalisation has allowed banks to tap funding sources across borders, allowing them to diversify away from traditional funding sources to international interbank markets (Fender and McGuire, 2010). McGuire and Von Peter (2009) show that the rapid expansion of foreign claims of banks in general and of European banks in particular in the years prior to the 2007-2009 great financial crisis was mirrored in a sharp increase in foreign liabilities, reflecting a growing dependence on cross-border funding. Shin (2012) documents how European banks financed their global activities by tapping US wholesale funding markets and using their inter-office accounts to channel US dollar-denominated funding to their head offices.

The globalisation of banking was sharply interrupted by the great financial crisis, which prompted an important retrenchment in banks' international activities and exposures, especially in cross-border funding markets. The crisis led to major restructurings of banks' business and funding models and to changes in their international strategies. Moreover, cross-border bank linkages proved to be important transmission channels of the crisis, propagating funding shocks across borders (i.e. from one core funding market to others) and from advanced to emerging market economies (Cetorelli and Goldberg, 2011). Adjustments in business and funding models were, in many cases, reinforced by the subsequent 2010-2012 euro area financial crisis.

Foreign liabilities can be unstable as a funding source, because they are often used as an alternative to domestic funding. If domestic credit growth outstrips the growth in domestic retail deposits, banks may turn to foreign sources. But the ability of banks to raise cross-border funding fluctuates over time in line with "risk on/risk off" conditions in global credit markets. Moreover, banks' foreign liabilities play an important role as transmission channel in "boom-bust" global leveraging/deleveraging cycles, allowing banks to increase their debt rapidly during boom episodes and reducing it massively during

[1] Regulatory arbitrage played a key role: tighter regulations in the home country incentivised banks to expand their activities to other less regulated countries (Houston et al, 2012; Fidrmuc and Hainz, 2013; Ongena et al, 2013; Bremus and Fratzscher, 2015). Macroeconomic and financial conditions were important drivers as well. Global banking developed because of profit opportunities in destination countries, interest rate differentials and search for yield (Focarelli and Pozzolo, 2005; Blank and Buch, 2010; Rey, 2013; Bremus and Fratzscher, 2015; Bruno and Shin, 2015a; 2015b; Cerutti et al, 2015).

busts. Shin (2012) shows that cross-border banking and the fluctuating leverage of global banks are the channels through which accommodative financial conditions are transmitted across the globe. Bruno and Shin (2015a) highlight the link between exchange rates, bank leverage and financial stability.

These factors clearly show that the funding models of globally active banks play an important role in banking crises and leverage cycles. Using the BIS international banking statistics, this paper tests for the existence of structural breaks in bank funding models. In particular, we analyse the evolution of bank funding across borders by distinguishing the two key components of foreign liabilities, i.e. cross-border liabilities and funding obtained by banks' overseas offices (local liabilities). Moreover, we break down cross-border liabilities by lending sector (bank-related or unrelated – and non-banks) in order to compare intragroup flows (i.e. cross-border liabilities from related banks) with liabilities obtained externally. Figure 3.1 gives a visual representation of these different types of foreign liabilities.

The empirical analysis is performed in two steps. First, we use a log-linearisation of the balance sheet identity that links local and cross-border liabilities in order to test for the presence of a structural break in bank funding models (Koch, 2014). Second, we study the adjustment dynamics of such a long-run relationship by means of a panel vector error correction model that includes a number of weakly exogenous economic determinants. Our main conclusions are as follows. Following the first episodes of turbulence in the interbank market (after 2007:Q2), globally active banks increased their reliance on funding from branches and subsidiaries abroad, and cut back on funding obtained directly by headquarters (cross-border funding). In particular, banks reduced cross-border funding from unrelated banks – e.g. those that are not part of the same banking group – and from non-bank entities. At the same time, they increased intragroup cross-border liabilities in an attempt to make more efficient use of their internal capital markets. Crucially, these changes are long-run phenomena, reflecting a shift in the funding model of banks.

The remainder of this paper is organised as follows. Section 2 provides an overview of the literature. We discuss business models of global banking (Section 2.1) and the determinants of international bank funding (Section 2.2). Section 3 presents the data, while Section 4 discusses the empirical methodology. Section 5 describes the empirical results and robustness checks. The last section concludes.

3.2 Literature review on global banking and its sources of funding

3.2.1 Business models of global banking

Business models in global banking are generally distinguished between multinational and international banking (McCauley et al., 2010; Gambacorta and Van Rixtel, 2013)[2]. Multinational banks maintain sizeable foreign branches and subsidiaries in multiple jurisdictions, matching largely local assets and liabilities. In contrast, international banks conduct cross-border business predominantly from the country where they are headquartered or from international financial centres[3].

Banks also differ in the degree to which they manage their funding in a centralised or decentralised fashion (CGFS, 2010b). The centralised model involves the use of cross-border funding sources managed from the banks' headquarters or their offices in major financial centres. These include the use of their internal capital markets (intragroup or inter-office funding), cross-border borrowing from other banks in international interbank markets (interbank funding) and cross-border funds obtained from non-banks, such as international retail deposits or debt issued in global capital markets. Internal capital markets are important funding channels for large and globally active banks and play an important role in their international management of liquidity by adjusting funding flows between the parent banks and affiliates overseas (Cetorelli and Goldberg, 2012a and 2012b; Buch and Goldberg, 2015; De Haas and Van Lelyveld, 2010). At the same time, unlike in previous crises, research suggests that parent banks were unable to support their foreign affiliates during the great financial crisis (De Haas and Van Lelyveld, 2014). Different centrally managed international funding sources may also adjust differently in reaction to episodes of severe market stress, such as for example cross-border intragroup funding and cross-border interbank funding, i.e. cross-border funding obtained from unrelated banks. Empirical evidence suggests that cross-border intragroup funding rises when global risk increases, while cross-border funding obtained from unrelated banks displays the opposite behaviour and is withdrawn during periods of elevated global risk (Reinhardt and Riddiough, 2014).

The decentralised funding model is based on banks funding their operations locally in the foreign countries where they operate. This model is characterised by a high degree of financial autonomy, in which every subsidiary raises financing under its own name and

[2] Another classification of the organisation of global banking departs from the choice between branches and subsidiaries. We do not discuss this. Dell'Ariccia and Marquez (2010) identify different sources of risk as important determinants of this choice when expanding into new (overseas) markets.

[3] Dietrich and Vollmer (2010) show that capital requirements may affect a bank's choice of organisational structure, i.e. the choice between the cross-border international or multinational models.

according to its own credit rating (Merck et al, 2012). As a consequence, this model makes it easier for markets to accurately assign and price the risk involved in the funding; generally, the decentralised funding model displayed greater stability during the great financial crisis than the centralised one. In fact, anecdotal evidence suggests that, since the crisis, globally active banks have gradually increased their funding through local sources in foreign markets where they operate (CGFS, 2010b).

In practice, global banking business models vary considerably across countries (McCauley et al., 2010) and (2012); Gambacorta and Van Rixtel, 2013; Muñoz De La Peña and Van Rixtel, 2015). Among the major banking systems, the Spanish one is the most pronounced exponent of the "multinational and decentralised funding" model, especially in their operations vis-à-vis the UK, US and emerging market economies. Spanish banks conduct their foreign operations to these countries almost completely on a local basis, relying on cross-border operations to only a minimal extent. Other examples of this business model are the foreign operations of US banks vis-à-vis the UK and those of euro area and UK banks vis-à-vis the US and emerging market economies. In contrast, Japanese banks are a clear example of international banks, with centralised funding concentrated on their headquarters or in international financial centres, which rely predominantly on cross-border funding. In the case of Japanese banks, funding is mainly distributed to offices across the globe through inter-office transfers from their head offices in Japan.

The great financial crisis, and the subsequent euro area financial strains, impacted severely upon the funding models employed in global banking. Since the onset of the crisis, global banking has retreated significantly[4], as evidenced by a sharp decline particularly in cross-border positions, most notably in cross-border interbank funding markets (CGFS, 2010a; Garcì-Luna and Van Rixtel, 2014). In contrast, local exposures overseas have remained much more stable. While cross-border funding has declined for most major banking systems since the first quarter of 2008, cross-border operations fell the most markedly for euro area banks (Avdjiev et al., 2012). The euro area financial turmoil put additional pressure on these banks to intensify their deleveraging, as access to short- and longer-term wholesale funding markets became strained (again) and regulators imposed new capitalisation targets (BIS, 2012; Van Rixtel and Gasperini, 2013). Overall, the shift from cross-border toward local operations in global banking was triggered by the financial crisis, but regulatory changes and weaknesses in bank balance sheets also contributed significantly (Goldberg and Gupta, 2013; IMF, 2015). The different adjustment patterns between changes in cross-border and local positions have been documented by several studies (De Haas and Van Lelyveld, 2006; McCauley et al., 2012; Schnabl, 2012).

[4]A large body of research has concentrated on the explaining the drivers behind the sharp decline in global banking and the increased "home bias" of banks (Caruana and Van Rixtel, 2012; Giannetti and Laeven, 2012a and 2012b; De Haas and Van Horen, 2013; Van Rijckeghem and Weder di Mauro, 2014; Bremus and Fratzscher, 2015).

The importance of the multinational model with decentralised funding increased especially with respect to operations vis-a-vis the UK, with the local UK operations of euro area, US and Japanese banks all increasing. Some of these changes may be explained by strategic responses to the great financial crisis, such as moves by foreign banks to acquire British banks that had been bailed out by the UK government (e.g. banks headquartered abroad) and by regulatory reform (Gambacorta and Van Rixtel, 2013).

3.2.2 Economic determinants of international bank funding

So far we have discussed the various drivers that could have determined a structural shift in funding models. In this section, we analyse what are the main economic determinants of funding flows, distinguishing between pull and push factors. The distinction between pull and push factors for capital flows has been the dominant intellectual framework for classifying drivers since the focus of academic inquiry shifted to the role of external factors in the early 1990s. In particular, domestic economic performance, cost of funding, and country risk indicators for the borrowing country stand out as important pull variables. Similarly, mature economy interest rates and global risk aversion are unambiguously important push factors and have significant explanatory power for capital flows movements (Avdjiev et al., 2017; Cerutti et al., 2015).

In this paper, we define as borrowing country the country where the bank obtaining foreign liabilities is headquartered; in contrast we define as lending country the country that provides the funding, which may be supplied by the banking system and other non-banking sectors.

Among the "pull factors" we can consider domestic real output growth and the cost of funding in the borrowing country. Both are indicators of aggregate demand shifts that could influence bank activity. Moreover, the cost of funding in the borrowing country could also indicate a relative convenience to tap funds abroad. For example, Van Rixtel et al. (2015) show that cost considerations were a significant driver of debt issuance by European banks, especially in pre-crisis episodes. Hence, banks are expected to tap foreign funding markets when interest rates in those markets are lower than those in their home markets, in principle when hedged for exchange rate risk. Indeed, Blank and Buch (2010) find that larger interest rate differentials between countries increase the foreign liabilities of banks. Therefore, ceteris paribus, higher interest rates in the borrowing country represent an incentive for banks to seek more funding abroad.

A third potential pull factor that explains banks' foreign liabilities is their equity capital. Banks in the borrowing country can signal their strength by the amount of core (Tier 1) capital. Higher capital levels are associated with lower prices and higher levels of uninsured liabilities (see, for example, Ellis and Flannery, 1992, Flannery and Sorescu, 1996, Gambacorta and Shin, 2016). Hence, better capitalised banking systems should have better access to international funding markets – we expect a positive relationship between Tier 1 capital of banks in the borrowing country and their foreign liabilities. Along these lines, Berger and Bouwman (2009, 2013) provide evidence of the "risk absorption" hypothesis: larger and better capitalised banks have a greater capacity to absorb risk and hence have better access to wholesale funding markets. In particular, Altunbas et al. (2014) find that, other things being equal, banks with an equity-to-total assets ratio larger than 1 percentage point have their expected default probability reduced by 0.4%. Bank capital therefore reduces asymmetric information problems and increases banks' capacity to tap funding in foreign markets. Following a similar line, Shin (2012) argues that lending by banks and other financial intermediaries depends on their "balance sheet capacity". This capacity, in turn, depends on two things – the amount of bank capital and the degree of "permitted leverage" as implied by the credit risk of the bank's portfolio and the amount of capital that the bank keeps to meet that credit risk. Bank lending expands to fill up any spare balance sheet capacity when measured risks are low.

Among the "push factors" for banks' foreign liabilities, we consider global liquidity and risk conditions. Especially in the post-crisis period, international capital flows have been particularly sensitive to the low interest rate environment, including unconventional monetary policies. Avdjiev et al. (2017) proxy global liquidity conditions with the US federal funds target rate. More precisely, they use a combination of the effective US Federal Funds target rate prior to Q4 2008 and the Wu-Xia (2016) estimates of the shadow Federal Funds rate from Q1 2009 onwards.

A second push factor to be considered is global risk aversion, as proxied by the VIX calculated on the base of US implied stock market volatility. A higher value of the VIX is typically associated with lower funding in wholesale funding markets by banks. This can be driven both by demand (e.g. banks are more constrained in seeking funding in a higher-risk environment) and supply (e.g. investors are more reluctant to provide funding in a risky environment). Covitz et al. (2004) find that higher implied stock market volatility is negatively associated with subordinated debt issuance by US banks. Camba-Mendez et al. (2012) and Van Rixtel et al. (2015) also find a negative correlation between the VIX and European banks' bond issuance[5].

[5]The VIX plays a crucial role in investigations of the impact of risk on global financing flows. Forbes and Warnock (2012) show that a lower VIX is associated with a surge in capital flows. Rey (2013) finds that capital inflows are negatively correlated with the VIX even at a geographically disaggregated level, and that this pattern holds even when conditioned by other global factors such as the real interest rate and growth rate.

3.3 Data

We use quarterly data on foreign liabilities from the BIS international banking statistics (IBS). The IBS aggregate data on individual banks at the country level in different ways, resulting in four different databases: locational by nationality, locational by residence, consolidated on an immediate counterparty basis and consolidated on an ultimate risk basis (see Annex for more details).

In particular, we employ the locational by nationality data and, when available, consolidated data on an immediate counterparty basis. The logic driving our choice is that we want to distinguish between banking groups headquartered in different countries (i.e. nationality of reporting banks), as opposed to banking groups operating in different countries. For example, we focus on US headquartered banks which (a) in the locational data by nationality comprise US banks operating in the US and in other BIS locational reporting countries; (b) in the consolidated data comprise US banks operating in the US and in all other countries around the globe. This concept differs from resident banks that do business in the US. As both the locational and consolidated statistics follow a classification of reporting banks based on their nationality, we can combine these two datasets. At the same time, these statistics differ in several ways, most importantly due to the fact that intragroup positions are netted out and country coverage of banks' network is wider in the consolidated statistics.

We gather data on the two subcomponents of foreign liabilities: local and cross-border liabilities. Local liabilities in this context are defined as liabilities to a counterparty located in the same country where bank's foreign affiliates book the position. Local positions are reported both in foreign and local currencies. Local liabilities in foreign currencies include liability positions vis-à-vis a counterparty located in the same country as the banking office, denominated in a currency other than the domestic currency of that country. We obtain the data on these positions from the non-consolidated locational statistics but exclude domestic liabilities in foreign currency, i.e. liabilities to the residents of the parent country. Similarly, local liabilities in local currencies include liability positions vis-à-vis a counterparty located in the same country as the reporting foreign bank affiliate, denominated in the domestic currency of the country where the foreign office of the bank is located. We use data from the consolidated statistics on an immediate counterparty basis for these positions and, hence, inter-office positions are excluded. Thus, these data differ conceptually from those on local liabilities in foreign currencies, which include intragroup positions. We believe this is acceptable, as local positions in local currencies vis-à-vis related offices are very likely to be negligible. The main reason for this assumption is that local inter-office positions (or positions between related entities in the same country) are captured only if the respective counterparties are owned by the same consolidated banking parent.

Cross-border liabilities, instead, are defined as liabilities to a counterparty located in a country other than the country where the banking office that books the position is located[6]. Thus, local liabilities are held through branches and subsidiaries in foreign countries (i.e. other countries than the country where the bank is headquartered), while cross-border funding is gathered through inter-office transfers and directly from the bank's headquarters. We define foreign liabilities as the sum of local and cross-border liabilities[7]. Finally, we break down cross-border liabilities by lending sector, i.e. banks and non-banks. Moreover, we break down cross-border liabilities obtained from banks into inter-office liabilities and liabilities from unrelated banks.

We obtain our economic determinants of bank liabilities from Datastream and Bankscope. Having a push-pull model in mind, we gather data on country-specific (real GDP, three-month interbank rate, Tier 1 capital requirements) and global variables (VIX and Fed funds rate). In particular, we obtain yearly total assets and Tier 1 capital of the major banks based in each country from Bankscope. We interpolate these data to a quarterly frequency by using the total assets of banks operating in a given country as an indicator (Denton, 1971). These data are available quarterly and are published by the national central banks, as well as gathered by the BIS. Moreover, we use effective Fed funds rates until 2008:Q4 and Wu and Xia's (2016) shadow rates from 2009:Q1 to 2013:Q4.

Our sample includes 12 advanced economies (Belgium, Canada, France, Germany, Italy, Japan, the Netherlands, Spain, Sweden, Switzerland, the UK and the US for the period 2000:Q1 – 2013:Q4. Figure 3.2, left panel, gives an idea of the importance of foreign liabilities in global banks' balance sheets. It shows the ratio of foreign liabilities to total liabilities over time for the median of the sample, as well as for the 25th and 75th percentiles. Foreign liabilities represent a large percentage of the liabilities held by global banks, roughly 50%. Moreover, this proportion increased over time before the great financial crisis and it has steadily been reverting to pre-crisis levels afterwards, with the exception of a few quarters during the height of the Eurozone crisis.

Table 3.1 shows some descriptive statistics for the pooled data. It includes the different types of foreign liability used in the analysis (expressed in US dollars), as well as country-specific and global determinants.

Table 3.2 shows the Maddala and Wu (1999) and Pesaran (2007) tests for the presence of unit roots in panel time series. Both tests are valid under the null hypothesis of non-stationarity of the series. The main difference between the two is that the Pesaran test

[6]Cross-border liabilities include foreign affiliates' liabilities to the parent country.

[7]Foreign liabilities, as defined by the BIS IBS Guidelines, exclude foreign affiliates' liabilities to parent country. However, we include them in our measure of cross-border flows and we call the total of local and cross-border liabilities "foreign liabilities".

allows for cross-sectional correlation among the panel units. Both tests show that all the balance sheet variables that we consider have a unit root. The results of Table 3.2 are obtained with one lag, and no trend in the ADF regressions used to construct the test statistics, but they are robust to the inclusion of a deterministic trend and of more lags.

3.4 Methodology

Exploiting the non-stationary nature of the data, we divide the analysis into a long-run and a short-run perspective using a panel vector error correction model (VECM). The long-run analysis captures banks' equilibrium business models and we will look for endogenous breaks in them. The short run captures the economic determinants of any (temporary) shifts away from the equilibrium business model, as well as the adjustment dynamics.

3.4.1 Long-run analysis

We capture business models in foreign funding as the equilibrium percentage of foreign liabilities that banks obtain locally as opposed to cross-border, as well as the equilibrium lender breakdown of cross-border liabilities. We consider the following balance sheet identity:

$$FL_{i,t} = LL_{i,t} + XBL_{i,t} \tag{3.1}$$

where FL stands for foreign liabilities, LL for local liabilities and XBL for cross-border liabilities; the suffix i denotes the borrowing country. XBL can be further decomposed in the following way:

$$XBL_{i,t} = XBL_{i,t}^{b,rel} + XBL_{i,t}^{b,unrel} + XBL_{i,t}^{b,CB} + XBL_{i,t}^{nb} \tag{3.2}$$

where XBL^b is cross-border liabilities acquired from banks (related - $XBL^{b,rel}$, unrelated - $XBL^{b,unrel}$ or the central bank - $XBL^{b,CB}$), while XBL^{nb} is cross-border liabilities acquired from non-banks. By construction, for every country i and in every quarter t, local liabilities and cross-border liabilities must sum up to the total amount of foreign liabilities that banks hold.

If banks targeted fixed long-run proportions of local and cross-border liabilities, then we could log-linearize the balance sheet identity in (3.1) around those long-run proportions. We follow Koch (2014) and, for the moment, we assume that this is the case. We will be able to confirm this in the results section, by using cointegration tests. Differentiating the equation above and dividing both sides by the steady-state value of foreign liabilities yields (or FL_i^{SS}):

$$\frac{dFL_{i,t}}{FL_i^{SS}} = \frac{1}{FL_i^{SS}} \left(dLL_{i,t} + dXBL_{i,t} \right) \tag{3.3}$$

We multiply and divide local liabilities by its steady state value and we do the same for cross-border liabilities to obtain:

$$\frac{dFL_{i,t}}{FL_i^{SS}} = \frac{LL_i^{SS}}{FL_i^{SS}} \frac{dLL_{i,t}}{LL_t^{SS}} + \frac{XBL_i^{SS}}{FL_i^{SS}} \frac{dXBL_{i,t}}{XBL} \tag{3.4}$$

In the neighbourhood of a steady state, we can write the above differentials as differences between the variable at time t and the steady state so that, for instance, the left-hand side will read: $\frac{FL_{i,t}-FL_i^{SS}}{FL_i^{SS}}$ or $\frac{FL_{i,t}}{FL_i^{SS}} - 1$. Exploiting the fact that, in a neighbourhood of 1, x-1≈log(x), we can finally write the log-linearised version of the balance sheet identity in (3.1) as follows, using lower-case letters to denote logarithms:

$$fl_{i,t} = g_i + \alpha_i^l ll_{i,t} + \alpha_i^{xb} xbl_{i,t} + v_{i,t} \tag{3.5}$$

where α_i^l is the long-run ratio of local liabilities to foreign liabilities, α_i^{xb} is the long-run ratio of cross-border liabilities to foreign liabilities, g_i is a constant and formally equal to $fl_i^{SS} - \alpha_i^l ll_i^{SS} + \alpha_i^{xb} xbl_i^{SS}$ and$v_{i,t}$ is a random deviation from the long-run ratios in period t.

In order to make the analysis feasible, we further assume homogeneity in the long-run ratios, while allowing for heterogeneous fixed effects. The resulting long-run equation we aim to test is:

$$fl_{i,t} = g_i + \alpha^l ll_{i,t} + \alpha^{xb} xbl_{i,t} + v_{i,t} \tag{3.6}$$

This equation captures the equilibrium proportion of local and cross-border liabilities in banks' balance sheets. We can extend the analysis using the breakdown of cross-border liabilities in equation (3.2), thus obtaining a more complete relationship:

$$\begin{aligned} fl_{i,t} &= g_i + \alpha^l ll_{i,t} + \alpha^{xb,b,rel} xbl_{i,t}^{b,rel} \\ &+ \alpha^{xb,b,unrel} xbl_{i,t}^{b,unrel} + \alpha^{xb,b,CB} xbl_{i,t}^{b,CB} + \alpha^{xb,nb} xbl_{i,t}^{nb} + v_{i,t} \end{aligned} \tag{3.7}$$

The next step is to verify the possible presence of structural breaks in this long-run relationship. Following Koch (2014), we proceed as follows: a) we test for the possible presence of a long-run relationship among the variables in equation (7); b) we look for the presence of an endogenous break in the long-run relationship; c) we estimate the long-run relationship with the break found above; d) we run cointegration tests using the sample up to the break and after the break, in order to confirm the presence of cointegration.

In order to test for the presence of an endogenous break in the long-run relationship – point b) above – we employ the tools developed in Bai (1994, 1997), Kurozumi (2002), and Carrion-i-Silvestre and Sansó (2006), and used by Koch (2014) in the context of long-run balance sheet ratios. Furthermore, we use dynamic OLS (Stock and Watson, 1993) to alleviate short-sample bias concerns.

For each date T in our sample, we estimate the following long-run equation:

$$\begin{aligned} fl_{i,t} &= g_i + \alpha^l ll_{i,t} + \alpha^{xb} xbl_{i,t} \\ &+ I(t \geq T)\left(\kappa + \phi^l ll_{i,t} + \phi^{xb} xbl_{i,t}\right) \\ &+ \sum_{s=-3}^{3} \theta_s^l \Delta ll_{i,t-s} + \sum_{s=-3}^{3} \theta_s^{xb} \Delta xbl_{i,t-s} + v_{i,t} \end{aligned} \tag{3.8}$$

where $xbl_{it} = (xbl_{i,t}^{b,rel}\ xbl_{i,t}^{b,unrel}\ xbl_{i,t}^{b,CB}\ xbl_{i,t}^{nb})'$ and I(t≥T) is an indicator function that takes the value of 1 when t≥T and 0 otherwise. For each T we can compute the sum of squared residuals of the regression in order to derive a sequence SSR_T. The most likely candidate for the break is given by:

$$T_{break} = argmin_T SSR_T \tag{3.9}$$

We then estimate the long-run equation (3.8) using the break date found in (3.9) and we use a Wald test on κ, φ^l and φ^{xb} to determine whether the break is statistically significant.

Finding evidence in favour of cointegration justifies the view that banks have well-defined international funding models and that they do target long-run proportions of local and cross-border liabilities. Pedroni (1999) proposes different statistics for testing for the presence of cointegration in a panel setting. Of these statistics, some are based on pooling along the “within” (panel) dimension and some are based on pooling along the “between” (group) dimension. All test for the presence of a unit root in the regression residuals. The statistics have different small-sample behaviour, but all have an asymptotically standard normal distribution under the null hypothesis of no cointegration.

3.4.2 Short-run analysis

Despite the long-run relationship between local and cross-border liabilities, banks’ foreign funding mix could also be influenced by short-term determinants. We seek to detect the characteristics of the adjustment dynamics of the shocks to these determinants.

For each breakdown, we have two long-run equilibria, one for each of the pre- and post-break subsamples. We follow Koch (2014) in selecting the second breakdown because it offers a finer distinction of cross-border liabilities, and hence richer adjustment dynamics. In particular, we select the post-break period as 2007:Q2 – 2013:Q4.

Then we follow Beckmann et al. (2011) and test whether an economic determinant x (characterised by a unit root process) is weakly exogenous with respect to the cointegrating relationship found above. To do so, we regress each economic determinant x in first differences on the lagged cointegrating relationship with fixed effects:

$$\Delta x_{i,t} = c_i^x + \eta_i^x CointResid_{i,t-1} + \zeta_{i,t} \tag{3.10}$$

For each variable x, finding an insignificant η^x means that we cannot reject the null hypothesis that x is weakly exogenous. Second, we set up a conditional panel VECM (Jacobs and Wallis, 2010) as follows:

$$\Delta y_{i,t} = \gamma_i + \lambda CointResid_{i,t-1} + \sum_{s=0}^{p} \Psi_s \Delta x_{i,t-s} + \sum_{s=1}^{p-1} \Pi_s \Delta y_{i,t-s} + \varepsilon_{i,t} \tag{3.11}$$

where $\Delta y_{i,t} = (fl_{i,t}\ ll_{i,t}\ xbl_{i,t}^{b,rel}\ xbl_{i,t}^{b,unrel}\ xbl_{i,t}^{b,CB}\ xbl_{i,t}^{nb})'$ is the vector of the endogenous variables and $\Delta x_{i,t-s}$ is the vector of the weakly exogenous economic determinants. γ_i is a country-specific constant, λ is a vector of speeds of adjustment, Ψ_s are matrices containing the short-term effects of a change to x on the endogenous variables and Π_s are matrices containing the dynamics of the endogenous variables. $p-1$ is the optimal lag length, as determined by the appropriate information criteria.

In our main specification we assume that the heterogeneity of the panel is entirely captured by fixed effects. This means that we allow fixed effects both in the long-run relationship and in the VECM representation of the system, but we always assume (for the sake of econometric tractability) homogeneous slopes across countries. However, we also conduct a robustness estimation where we allow the slopes to be heterogeneous, using a mean group estimator (Pesaran and Smith, 1995).

3.5 Empirical results

3.5.1 Long-run analysis: business models and structural change

Figure 3.2, right panel, shows the sequence of SSR from the estimation of equation (3.8) for different possible break points T, starting in 2001:Q1 and until the end of the sample. The sequence of SSR has a sharp trough in 2007:Q2 and provides strong evidence in favour of the presence of a structural break in the initial period of the great financial crisis. In order to test whether there is indeed a break, and to assess the effect of the break on the variables involved, we estimate long-run equation (3.8) with a break dummy in 2007:Q2.

Table 3.3 shows the equilibrium proportions of the components of foreign liabilities, as well as the post-break increases or decreases. The first column considers a simplified version of the model that does not disentangle the various components of cross-border liabilities. After the break, the equilibrium proportion of foreign liabilities that banks get through local funding increases by more than 5 percentage points, at the expense of cross-border funding. This finding is in line with the presence of a structural change in equilibrium business models of bank funding in line with the literature reviewed in Section 2. This result is important as it identifies such a structural break in a more formal way, as an equilibrium phenomenon. What we detect is that the reduction in cross-border liabilities relative to local ones seems not to be a temporary phenomenon, but more the effect of a readjustment towards a new equilibrium. Moreover, we are able to identify the structural break endogenously. Interestingly, our result indicates that the break occurred prior to the default of Lehman Brothers and the announcement of the Basel III reforms. It was probably reinforced by such events and the discussion or implementation of regulatory reforms.

In the second column of Table 3.3, we use the breakdown between the different components of cross-border liabilities to get further insight into the mechanism of adjustment towards the new funding business model equilibrium. Banking groups increased liabilities booked through branches and subsidiaries abroad at the expense of cross-border liabilities (i.e. funding acquired directly from headquarters) following a precise pattern. In particular, headquarters reduced borrowing from external cross-border sources in favour of internal ones, with the exception of liabilities vis-à-vis central banks. The proportion of cross-border liabilities from related banks over foreign liabilities increased by 2.7%, while cross-border liabilities from unrelated banks and from non-banks decreased by 3.7% and 5.7%, respectively. Cross-border liabilities vis-à-vis central banks also increased by 2.9%. It is worth remembering that these are absolute increases of ratios. For instance, cross-border liabilities from related banks were 24.7% of foreign liabilities before the break. They increase by 2.7% after the crisis; hence, they now represent 27.4% of foreign liabilities. These results show that banks adjusted to a new equilibrium foreign funding mix after the crisis. They now rely more on intragroup transfers and on transfers from the central bank and less on private sector external sources. The results do not hinge upon the assumption of homogeneous slopes. In the last column of Table 3.3 we use a mean group estimator that allows the coefficients of the regression to be heterogeneous among the different countries. These results are qualitatively similar to those obtained in column II where the slopes are, instead, assumed homogeneous.

So far, we just have postulated that foreign liabilities and their components in Breakdowns

I and II are cointegrated. Having identified the break, we are in a position to test for the presence of a long-run relationship between foreign funding components by using the sample up to the break (pre-crisis period) and the sample after the break (crisis period). Table 3.4 shows the p-values under the null hypothesis of no cointegration of the tests in the four different cases. The results always support the presence of cointegration among the variables if one considers the two different period separately. These results suggest that banks do indeed target long-run business models in term of specific ratios of local and cross-border liabilities and in terms of ratios of cross-border liabilities gathered from different lenders. However, this long run relationship was subject to a structural break in 2007:Q2.

3.5.2 Short-run dynamics and economic determinants

In this section, we evaluate the adjustment dynamics to the equilibrium found in Section 5.1. We consider a number of economic determinants and we evaluate whether they are weakly exogenous to the long-run equilibrium. If they are, we can assess their short-run effects on foreign liabilities and their components.

Keeping in mind the literature on push and pull factors of international capital flows, we consider both country-specific and global determinants. The country-specific determinants are: borrowing -country real GDP, the short-term interest rate and banks' Tier 1 capital. The global determinants are global volatility, proxied by the VIX, and global liquidity, proxied by the US monetary policy stance. As for the latter, we use the effective Fed funds rate until 2008:Q4 and Wu and Xia's (2016) shadow rate from 2009:Q1 to 2013:Q4.

Table 3.5 shows the results of the tests for weak exogeneity of each of the variables with respect to the long-run relationship, estimated from 2007:Q2 to 2013:Q4. We run regressions (3.10) for each of the economic variables and report the coefficient estimates for η^x, together with their standard errors (in brackets).

Short-term interest rates, Tier 1 capital and US monetary policy are weakly exogenous to our cointegrating relationship. This allows us to include them in a conditional VECM and get consistent estimates of the short-run effects of changes in these determinants on changes to the endogenous variables, i.e. foreign liabilities and their components. The other two variables (changes in real GDP and VIX) cannot be included as they influence the cointegrating vector.

Before estimating the VECM, we need to determine the optimal lag length. We follow Ltkepohl and Kr'atzig (2004) who show that Hannan and Quinn's information criterion (HQIC) and Schwarz's Bayesian information criterion (SBIC) are preferred to other statistical methods in computing the optimal lag length. We compute these information criteria for each of the cross-sectional units and we find that the optimal lag length is 1 for all the countries and according to both information criteria, with the single exception of the HQIC for the UK. Therefore, we estimate the following conditional VECM:

$$\Delta y_{i,t} = \gamma_i + \lambda CointResid_{i,t-1} + \Psi \Delta x_{i,t} + \varepsilon_{i,t} \tag{3.12}$$

Table 3.6 contains the estimation results. Each of the weakly exogenous economic determinants has a significant short-run effect on foreign liabilities or one of their components. An increase in a borrowing country's short-term rates is associated with a short-term increase in foreign liabilities and their components. An increase in regulatory capital in banks headquartered in the borrowing country is also associated with an increase in their foreign liabilities (and respective components). This result is consistent with Gambacorta and Shin (2016), who find that an increase in bank capital is associated with an increase in debt funding. As strongly capitalised banks are deemed more trustworthy by providers of funding, they can increase their liabilities, including foreign liabilities, to a greater extent than weakly capitalised banks can. Finally, US monetary policy has a negative effect on foreign liabilities through its effect on cross-border liabilities gathered from related banks and from non-banks. The negative effect of a reduction in global liquidity (proxied by a tightening of the US monetary policy stance) on cross-border flows is a recurring finding in the literature (Avdjiev et al., 2017). A hike in global rates makes funding costlier, leading to deleveraging and a corresponding decrease in bank lending.

The adjustment dynamics to an exogenous shock are captured by the coefficients of the lagged cointegrating relationship (i.e. the loading coefficient). The system is able to return to the steady state after an exogenous shock when these coefficients are negative and smaller than one in absolute value. The loadings are significant for total foreign liabilities and for cross-border liabilities acquired from unrelated banks, from central banks and from non-banks. Cross-border operations can be adjusted easily and quickly from the bank's headquarters or its offices in international financial centres, while the development of local operations in foreign countries requires a long-term commitment to recover the high start-up costs. Hence, cross-border liabilities play the role of an adjustment channel. In particular, banks adjust cross-border liabilities booked externally in response to a shock, while keeping intragroup transfers fixed. The adjustment to an exogenous shock is completed on average in about five quarters.

3.6 Conclusions

This paper studies the business models that banks follow to obtain funding abroad. In particular, we analyse the existence of a long-run relationship and test whether such a relationship has been subject to a structural break during the great financial crisis. We document that banks seem to target fixed ratios for cross-border and local liabilities with respect to the total amount of funding that they get abroad. We show that banks changed their equilibrium funding models following the first episodes of turbulence in the interbank market (after 2007:Q2). In their post-break business model, banks use less cross-border liabilities and tap funds abroad using more actively their subsidiaries and branches, as well as interoffice accounts within the same banking group. Finally, we study the adjustment dynamics of the equilibrium and the short-term effects of several weakly exogenous economic determinants. We find that banks adjust to shocks by changing their cross-border liabilities vis-à-vis unrelated banks and non-banks while keeping their local liabilities fixed. Country-specific variables such as short-term rates, the amount of Tier 1 capital held by banks, as well as global liquidity, have a significant short-term effect on the amount of foreign liabilities held by banks and most of their components.

All in all, we provide empirical support for the adjustment in banks' international funding models in reaction to the first signs of severe dislocations in global interbank financial markets in the summer of 2007. Our results add to those in other studies supporting the view that cross-border interbank funding – i.e. funding from unrelated banks – is the main adjustment channel in times of heighted global risk. They also provide a first detailed statistical analysis of the changes in international bank funding patterns in relation to the great financial crisis, including the relative shift from cross-border toward local operations.

Bibliography

[1] Altunbas, Y., L. Gambacorta and D. Marques-Ibanez (2014), "Does monetary policy affect bank risk?", International Journal of Central Banking, March, 95-135.

[2] Avdjiev, S., Z. Kuti and E. Takats (2012), "The euro area crisis and cross-border lending to emerging markets", BIS Quarterly Review, December, 37-47.

[3] Avdjiev, S., L. Gambacorta, L. Goldberg and S. Schiaffi (2017), "The shifting drivers of international capital flows", BIS Working Papers, 644.

[4] Bai, J. (1994), "Least squares estimation of a shift in linear processes", Journal of Time Series Analysis, 15, 453–472.

[5] Bai, J. (1997), "Estimation of a change point in multiple regression models", Review of Economics and Statistics, 79, 551–563.

[6] Bank for International Settlements (2012), "European bank funding and deleveraging", BIS Quarterly Review, March, 1-12.

[7] Beckmann, J., A. Belke and M. K´ohl (2011), "The dollar–euro exchange rate and macroeconomic fundamentals: a time-varying coefficient approach", Review of World Economics, 147, 11–40.

[8] Berger, A., and C. Bouwman (2009), "Bank liquidity creation", Review of Financial Studies, 22, 3779-3837.

[9] Berger, A., and C. Bouwman (2013), "How does capital affect bank performance during financial crises?", Journal of Financial Economics, 109, 146–176.

[10] Blank, S., and C. Buch (2010), "International bank portfolios: Short and long-run responses to macroeconomic conditions," Review of International Economics, 18, 289–306.

[11] Bremus, F., and M. Fratzscher (2015), "Drivers of structural change in cross-border banking since the global financial crisis", Journal of International Money and Finance, 52, 32-59.

[12] Bruno, V., and H. Shin (2015a), "Cross-border banking and global liquidity", Review of Economic Studies, 82, 535-564.

[13] Bruno, V. and H. Shin (2015b), "Capital flows and the risk-taking channel of monetary policy", Journal of Monetary Economics, 71, 119-132.

[14] Buch, C., and L. Goldberg (2015), "International banking and liquidity risk transmission: Lessons from across countries", IMF Economic Review, 63, 377-410.

[15] Camba-Mendez, G., S. Carbó-Valverde and D. Rodríguez-Palenzuela (2012), "Access to funding by European banks and the financial crisis", European Central Bank, mimeo.

[16] Carrion-i Silvestre, J., and A. Sansó (2006), "Testing the null of cointegration with structural breaks", Oxford Bulletin of Economics and Statistics, 68, 623–646.

[17] Caruana, J., and A. van Rixtel (2012), "International financial markets and bank funding in the euro area: dynamics and participants", originally published in Economistas, December 2012.

[18] Cerutti, E., S. Claessens and L. Ratnovski (2015), "Global liquidity and drivers of cross-border bank flows", paper presented at the XX LACEA Annual Meeting, 15-17 October, Santa Cruz (Bolivia).

[19] Cetorelli, N., and L. Goldberg (2011), "Global banks and international shock transmission: Evidence from the crisis," IMF Economic Review, 59, 41-76.

[20] Cetorelli, N., and L. Goldberg (2012a), "Liquidity management of U.S. global banks: Internal capital markets in the Great Recession," Journal of International Economics, 88, 299-311.

[21] Cetorelli, N., and L. Goldberg (2012b), "Banking globalisation and monetary transmission", Journal of Finance, 67, 1811–1843.

[22] Committee on the Global Financial System (2010a), The functioning and resilience of cross-border funding markets, BIS, CGFS Papers No.37.

[23] Committee on the Global Financial System (2010b). Funding patterns and liquidity management of internationally active banks, BIS, CGFS Papers No.39.

[24] Covitz, D., D. Hancock, and M. Kwast (2004), "A reconsideration of the risk sensitivity of U.S. banking organisation subordinated debt spreads: a sample selection approach", Federal Reserve Bank of New York, Economic Policy Review, September, 73-92.

[25] De Haas, R., and I. van Lelyveld (2006), "Foreign banks and credit stability in Central and Eastern Europe: A panel data analysis", Journal of Banking and Finance, 30, 1927–1952.

[26] De Haas R., and I van Lelyveld (2010), "Internal capital markets and lending by multinational bank subsidiaries", Journal of Financial Intermediation, 19, 1–25.

[27] De Haas, R., and N. Van Horen (2013), "Running for the exit? International bank lending during a financial crisis", Review of Financial Studies, 26, 244-285.

[28] Dell'Ariccia, G., and R. Marquez (2010), "Risk and the corporate structure of banks", Journal of Finance, 65, 1075-1096.

[29] Denton, F. (1971), "Adjustment of monthly and quarterly series to annual totals: an approach based on quadratic minimization", Journal of the American Statistical Society, 66, 99-102.

[30] Dietrich, D., and U. Vollmer (2010), "International banking and liquidity allocation: Cross-border financial services versus multinational banking", Journal of Financial Services Research, 37, 45-69.

[31] Ellis, D., and M. Flannery (1992), "Risk premia in large CD rates: Time series evidence on market discipline", Journal of Monetary Economics, 30, 481-502.

[32] Flannery, M., and S. Sorescu (1996), "Evidence of market discipline in subordinated debenture yields: 1983-1991", Journal of Finance, 51, 1347-1377.

[33] Fender, I., and P. McGuire (2010), "European banks' US dollar funding pressures", BIS Quarterly Review, June, 57–64.

[34] Fidrmuc, J., and C. Hainz (2013), "The effect of banking regulation on cross-border lending", Journal of Banking and Finance, 37, 1310-1322.

[35] Focarelli, D., and A. Pozzolo (2005), "Where do banks expand abroad? An empirical analysis", Journal of Business, 78, 2435-2463.

[36] Forbes, K., and F. Warnock (2012), "Capital flow waves: Surges, stops, flight, and retrenchment," Journal of International Economics, 88, 235-251.

[37] Gambacorta, L., and A. Van Rixtel (2013), "Structural bank regulation initiatives: Approaches and implications", BIS Working Papers No.412.

[38] Gambacorta, L., and H. Shin (2016), "Why bank capital matters for monetary policy", Journal of Financial Intermediation, forthcoming.

[39] García-Luna, P., and A. Van Rixtel (2014), "International interbank activity in retreat", BIS Quarterly Review, March, 14-15.

[40] Giannetti, M., and L. Laeven (2012a), "The flight home effect: Evidence from the syndicated loan market during financial crises", Journal of Financial Economics, 104, 23–43.

[41] Giannetti, M., and L. Laeven (2012b), "Flight home, flight abroad, and international credit cycles", American Economic Review: Papers & Proceedings, 102, 219-224.

[42] Goldberg, L. (2009), "Understanding banking sector globalisation", IMF Staff Papers, 56, 171-197.

[43] Goldberg, L., and A. Gupta (2013), "Ring-fencing and "financial protection" in international banking", Federal Reserve Bank of New York, Liberty Street Economics, 9 January.

[44] Houston, J., C. Lin and Y. Ma (2012), "Regulatory arbitrage and international bank flows", Journal of Finance, 67, 1845–95.

[45] IMF (2015), "International banking after the crisis: Increasingly local and safer?", Global Financial Stability Report, April, 55-91.

[46] Jacobs, J., and K. Wallis (2010), "Cointegration, long-run structural modelling and weak exogeneity: Two models of the UK economy", Journal of Econometrics, 158, 108-116.

[47] Koch, C. (2014), "Risky adjustments or adjustments to risks: Decomposing bank leverage", Journal of Banking & Finance, 45, 242-254.

[48] Kurozumi, E. (2002), "Testing for stationarity with a break", Journal of Econometrics, 108, 63–99.

[49] Lane, P., and G. Milesi-Ferretti (2008), "The drivers of financial globalisation", American Economic Review: Papers and Proceedings, 98, 327-332.

[50] L'utkepohl, H., and M. Kr'atzig (2004), "Applied time series econometrics, Cambridge University Press.

[51] Maddala, G., and S. Wu (1999), "A comparative study of unit root tests with panel data and a new simple test", Oxford Bulletin of Economics and Statistics, 61(Special Issue), 631-652.

[52] McCauley, R., P. McGuire, and G. Von Peter (2010), "The architecture of global banking: From international to multinational", BIS Quarterly Review, March, 25–37.

[53] McCauley, R., P. McGuire and G. Von Peter (2012), “After the global financial crisis: from international to multinational banking?”, Journal of Economics and Business, 64, 7–23.

[54] McGuire, P., and G. Von Peter (2009), “The US dollar shortage in global banking and the international policy response”, BIS Working Papers No.291.

[55] Merck-Martel, M., A. van Rixtel and E. Gonzalez-Mota (2012), “Business models of international banks in the wake of the 2007–2009 global financial crisis”, Bank of Spain, Revista de Estabilidad Financiera No.22, 99–121.

[56] Muñoz-de la Peña, E., and A. van Rixtel (2015), “The BIS international banking statistics: Structure and analytical use”, Bank of Spain, Revista de Estabilidad Financiera No.29, 29–46.

[57] Ongena, S., A. Popov and G. Udell (2013), “”When the cat’s away the mice will play”: Does regulation at home affect bank risk-taking abroad?”, Journal of Financial Economics, 108, 727-750.

[58] Pedroni, P. (1999), “Critical values for cointegration tests in heterogeneous panels with multiple regressors", Oxford Bulletin of Economics and Statistics, 61, 653-70.

[59] Pesaran, M. (2007), “A simple panel unit root test in the presence of cross-section dependence”, Journal of Applied Econometrics, 22, 265–312.

[60] Pesaran, M. and R. P. Smith (1995), “Estimating long-run relationships from dynamic heterogeneous panels”, Journal of Econometrics, 68, 79-113.

[61] Reinhardt, D., and S. Riddiough (2014), “The two faces of cross-border banking flows: An investigation into the links between global risk, arms-length funding and internal capital markets”, Bank of England Working Paper No.498.

[62] Rey, H. (2013), “Dilemma not Trilemma: The global financial cycle and monetary independence”, Federal Reserve Bank of Kansas City, Jackson Hole Symposium.

[63] Shin, H.S. (2012), “Global banking glut and loan risk premium”, Mundell-Fleming Lecture at the 2011 IMF Annual Research Conference, IMF Economic Review, 60, 155–92.

[64] Schnabl, P. (2012), “The international transmission of bank liquidity shocks: Evidence from an emerging market”, Journal of Finance, 67, 897–932.

[65] Stock, J., and M. Watson (1993), “A simple estimator of cointegrating vectors in higher order integrated systems”, Econometrica, 61, 783-820.

[66] Van Rijckeghem, C., and B. Weder di Mauro (2014), "Deglobalisation of banking: The world is getting smaller", CEPR Discussion Paper Series No.10139.

[67] Van Rixtel, A., and G. Gasperini (2013), "Financial crises and bank funding: recent experience in the euro area", BIS Working Papers No.406.

[68] Van Rixtel, A., L. Romo-González, and J. Yang (2015), "The determinants of long-term debt issuance by European banks: Evidence of two crises", BIS Working Paper No.513.

[69] Wu, J., and F. Xia (2016) "Measuring the macroeconomic impact of monetary policy at the zero lower bound", Journal of Money, Credit, and Banking, 48, 253-291.

Table 3.1: Descriptive statistics

	Obs	Mean	Std. Dev.	Min	Max
Endogenous variables					
Foreign liabilities	672	2,208,200	1,584,825	177,631	6,364,350
Local liabilities	672	690,857	524,374	62,134	2,633,494
Cross-border liabilities	672	1,517,344	1,158,028	112,985	4,832,023
vis à vis banks	672	978,775	734,406	78,838	3,293,631
related offices	672	542,518	459,837	13,905	2,040,974
unrelated offices	672	380,322	299,837	32,896	1,768,014
central banks	672	55,935	50,925	1,374	268,649
vis à vis non-banks	672	495,566	429,319	30,055	1,985,434
Country-specific determinants (pull factors, borrowing country)					
Real GDP	672	705.36	903.35	64.78	3963.28
Three-month interest rate	672	2.31	1.71	-0.28	6.70
Tier 1 capital	672	187,681	174,656	17,279	925,170
Global determinants (push factors)					
VIX	672	21.91	9.46	10.79	59.98
Fed funds rate (1)	672	1.79	2.55	-1.99	6.63

Notes: The descriptive statistics are computed for the pooled sample of 12 countries over the period 2000:Q1–2013:Q4. The balance sheet variables are expressed in USD millions. Real GDP, real effective exchange rate and VIX are displayed as indices. Tier 1 capital is expressed in USD millions. (1) Effective federal funds rate for the period 2001:Q1–2008:Q4, Wu-Xia Shadow rate for the period 2009:Q1–2013:Q4.

Table 3.2: Unit root tests

	Maddala-Wu		Pesaran	
	Test stat	P-value	Test stat	P-value
Foreign liabilities	28.652	0.233	-0.794	0.213
Local liabilities	23.629	0.483	-0.526	0.299
Cross-border liabilities	26.837	0.312	-0.923	0.178
vis à vis banks	19.498	0.725	0.565	0.714
related offices	23.771	0.475	0.857	0.804
unrelated offices	13.813	0.951	1.665	0.952
central banks	17.706	0.817	-0.386	0.350
vis à vis non-banks	30.593	0.166	-0.198	0.422

Notes: The Maddala-Wu (1999) and the Pesaran (2007) tests are valid under the null that the series is non-stationary. A high p-value is evidence in favour of the presence of a unit root in the series. The Maddala-Wu test ignores cross-section dependence in the data. The Pesaran test allows for cross-section dependence in the form of a single unobserved common factor. All the test statistics are computed using ADF regressions with four lags and without a deterministic trend. All the variables are in logs.

Table 3.3: Long-run relationships in bank funding models

	Dependent variable: Foreign liabilities		
	(I)	(II)	(III)
Local liabilities	0.291***	0.268***	0.303***
	(0.00691)	(0.00927)	(0.0256)
Cross-border liabilities	0.689***		
	(0.00768)		
Vis à vis banks			
Related offices		0.247***	0.229***
		(0.0115)	(0.0279)
Unrelated offices		0.137***	0.216***
		(0.0152)	(0.0401)
Central banks		0.0381***	0.0300***
		(0.00848)	(0.00509)
Vis à vis non-banks		0.236***	0.221***
		(0.0143)	(0.0198)
Break * Local liabilities	0.0305***	0.0573***	0.0762**
	(0.00758)	(0.0106)	(0.0373)
Break * Cross-border liabilities	-0.0371***		
	(0.00778)		
Break * Vis à vis banks			
Break * Related offices		0.0274***	0.0162***
		(0.00835)	(0.00214)
Break * Unrelated offices		-0.0365***	-0.0705**
		(0.0100)	(0.0270)
Break * Central banks		0.0297***	-0.000780
		(0.00863)	(0.0117)
Break * Vis à vis non-banks		-0.0571***	-0.0446**
		(0.0134)	(0.0221)
Break dummy	0.140***	-0.194*	0.644**
	(0.0403)	(0.102)	(0.294)
Observations	576	576	684
Break date	2007:Q2	2007:Q2	2007:Q2
Wald test statistics	24.95	27.87	17.26
P-value (Wald, k)	0.000	0.000	0.008

Notes: The sample includes quarterly data from 12 advanced economies over the period 2000:Q1 – 2013:Q4. The break interaction term with variable x is shown as Break $*$ x. The Wald test statistics and p-values are based on the null hypothesis that the break dummy and the interaction terms are jointly equal to 0. All the variables are in logs. HAC robust standard errors are reported in parentheses. All the regressions include country fixed effects and leads and lags of first differences of the explanatory variables. The coefficients in columns I and II are obtained using a dynamic OLS estimator. Therefore, they include leads and lags of the right-hand side variables. The coefficients in column III are derived using a mean group estimator, hence they allow both the constant and the slopes to be heterogeneous across countries. The larger number of observations of regression III is due to the lack of leads and leads of the right-hand-side variables. *** $p<0.01$, ** $p<0.05$, * $p<0.1$. Breakdown I: $FL_{i,t} = LL_{i,t} + XBL_{i,t}$; Breakdown II and III: $FL_{i,t} = LL_{i,t} + XBL_{i,t}^{b,rel} + XBL_{i,t}^{b,unrel} + XBL_{i,t}^{b,CB} + XBL_{i,t}^{nb}$.

Table 3.4: Cointegration tests

	Breakdown I		Breakdown II	
	Test stat	P-value	Test stat	P-value
Pre-crisis: 2000:Q1-2007:Q1				
ADF panel	-5.28	0.000	-2.84	0.005
ADF group	-5.76	0.000	-3.63	0.000
t panel	-5.59	0.000	-3.27	0.001
t group	-5.95	0.000	-4.12	0.000
Crisis: 2007:Q2 – 2013:Q4				
ADF panel	-3.84	0.000	-4.21	0.000
ADF group	-5.12	0.000	-4.89	0.000
t panel	-3.30	0.001	-2.84	0.005
t group	-2.96	0.003	-3.41	0.001

Notes: test statistics are taken from Pedroni (1999). Panel statistics pool data along the within dimension, while group statistics pool data along the between dimension. All the statistics have an asymptotically standard normal distribution under the null hypothesis of no cointegration. A small p-value is evidence of cointegration. The pre-break tests are performed over the sample 2000:Q1-2007:Q1. The post-break tests are performed over the sample 2007:Q2 – 2013:Q4.

Table 3.5: Tests for weak exogeneity from the cointegrating vector

	Δ. Real GDP	Δ. Three-month rate	Δ. Tier 1 capital	Δ. VIX	Δ. Fed funds rate (1)
L. Cointegration residual	-0.210***	0.736	-0.0397	1.076**	-0.599
	(0.0774)	(0.636)	(0.0984)	(0.455)	(0.526)
Observations	264	306	312	312	312
R^2	0.044	0.012	0.012	0.018	0.004

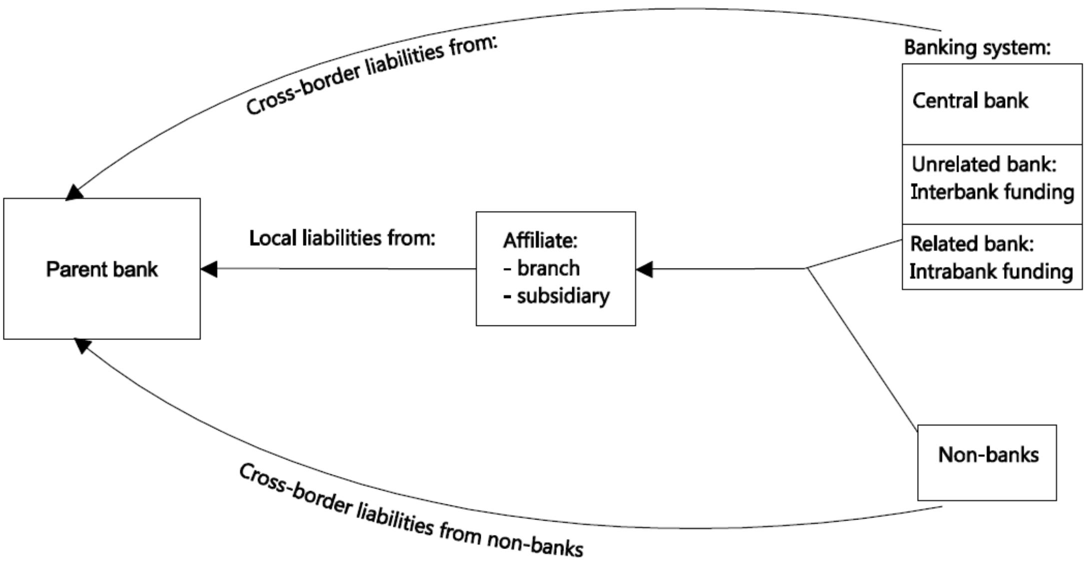
Notes: Each column of the table tests for the weak exogeneity of a different economic determinant with respect to the cointegrating relationship derived by estimating equation (7) (i.e. the long-run equation of Breakdown II) with leads and lags of the explanatory variables in first differences. If L.Cointegration residual is insignificant in one of the regressions, then there is evidence in favour of the weak exogeneity of that particular economic determinant. The sample includes quarterly data from 12 advanced economies for the period 2007:Q2-2013:Q4. All the variables are in logs, except the three-month interest rates and the Fed funds rate. HAC robust standard errors are reported in parentheses. All the regressions include country fixed effects. (1) Effective federal funds rate for the period 2007:Q2 – 2008:Q4, Wu-Xia Shadow rate for the period 2009:Q1 – 2013:Q4. *** p<0.01, ** p<0.05, * p<0.1.

Table 3.6: VECM estimates of λ and Ψ

	Δ. Foreign liabilities	Δ. Local liabilities	Δ. Cross-border liabilities			
			Vis à vis banks			Vis à vis non-banks
			Related offices	Unrelated offices	Central banks	
L. Cointegration residual	-0.202***	0.0528	0.0235	-0.222*	-0.331*	-0.739***
	(0.0688)	(0.0953)	(0.117)	(0.129)	(0.188)	(0.227)
Δ. Three-month rate	0.0475***	0.0441**	0.0449***	0.0441	0.0697**	0.0511***
	(0.0143)	(0.0195)	(0.0104)	(0.0309)	(0.0228)	(0.0139)
Δ. Tier 1 capital	0.365***	0.379***	0.306***	0.433**	0.0404	0.533***
	(0.0656)	(0.110)	(0.0712)	(0.159)	(0.0979)	(0.121)
Δ. Fed funds rate (1)	-0.0196**	-0.000865	-0.0322**	-0.0334	0.0613	-0.0617***
	(0.00830)	(0.0177)	(0.0134)	(0.0251)	(0.0350)	(0.0132)
# of quarters to return to equilibrium	5	-	-	5	3	1
Observations	306	306	306	306	306	306
R^2	0.352	0.281	0.167	0.086	0.095	0.225

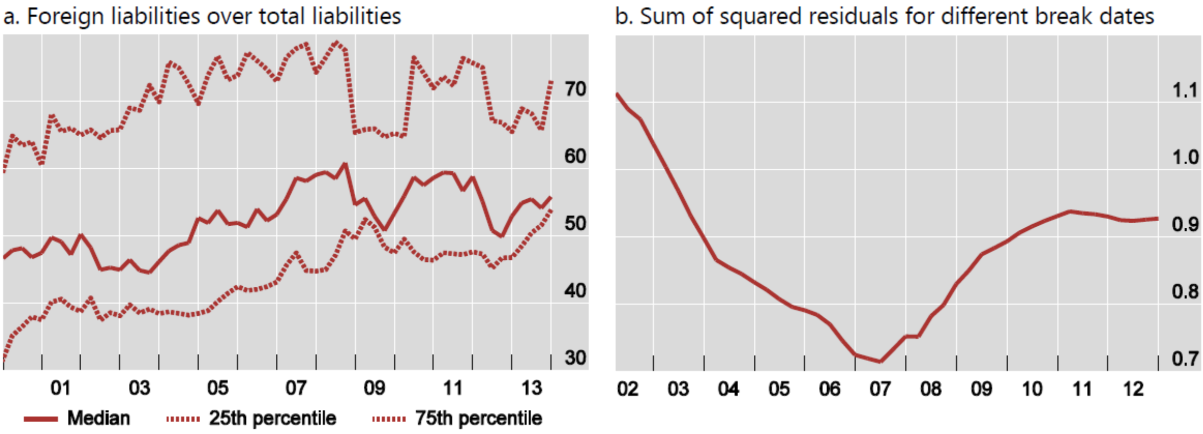
Notes: The model is a conditional panel VECM with 1 lag and with a set of weakly exogenous variable. The first row contains the estimate of the speed of adjustment λ while the remaining rows contain the estimates of the short-term parameters Ψ. The sample size includes quarterly data from 12 advanced economies for period 2007:Q2-2013:Q4. Tier 1 capital is in logs. HAC robust standard errors are reported in parentheses. All the equations of the VECM include country FE. (1) Effective federal funds rate for the period 2007:Q2 – 2008:Q4, Wu-Xia Shadow rate for the period 2009:Q1 – 2013:Q4. *** p<0.01, ** p<0.05, * p<0.1, ◊ p<0.15

Figure 3.1: Foreign liabilities and their components



Note: Parent banks can acquire foreign liabilities through branches and subsidiaries abroad (local liabilities) or directly from their headquarters (cross-border liabilities). We break down cross-border liabilities by lending sector. Foreign lenders can be central banks, unrelated banks (interbank funding), related banks (intrabank funding) or non-banks (mostly deposits).

Figure 3.2: Bank funding composition and structural break



Note: The left-hand graph represents the ratio between foreign liabilities (domestic and cross-border) and total liabilities. The three lines indicate the median value, the first and the last quartile of the distribution. The right-hand graph shows the sequence of the sum of squared residuals obtained by introducing a break dummy into equation (8), while also adding leads and lags of first differences of the right-hand side variables. The most likely candidate for a structural break is the date where the series of sum of squared residuals attains its minimum (Bai, 1997, Kurozumi, 2002 and Carrion-i Silvestre and Sansó, 2006). The model is given by: $FL_{i,t} = LL_{i,t} + XBL_{i,t}^{b,rel} + XBL_{i,t}^{b,unrel} + XBL_{i,t}^{b,CB} + XBL_{i,t}^{nb}$.

Source: Authors' calculations.