Cross-Border Banking and Global Liquidity*

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January 13, 2014

Abstract

We investigate global factors associated with bank capital flows. We formulate a model of the international banking system where global banks interact with local banks. The solution highlights the bank leverage cycle as the prime determinant of the transmission of financial conditions across borders through banking sector capital flows. A distinctive prediction of the model is that currency appreciation is associated with higher leverage of the banking sector, thereby providing a conceptual bridge between exchange rates and financial stability. In a panel study of 46 countries, we find support for the key predictions of our model.

JEL codes: F32, F33, F34
Keywords: Cross-border banking flows, Bank leverage, Global banks

*An earlier version of this paper was circulated under the longer title "Capital Flows, Cross-Border Banking and Global Liquidity". We thank Dimitri Vayanos and three referees for their comments and guidance. We are grateful to Maurice Obstfeld for his comments as discussant at the 2012 NBER Summer Institute, as well as to Tobias Adrian, Franklin Allen, Tam Bayoumi, Rodrigo Cifuentes, Stijn Claessens, Marcel Fratzscher, Linda Goldberg, Pierre-Olivier Gourinchas, Refet Gurkaynak, Karen Lewis, Loretta Mester, Gian Maria Milesi-Ferretti, Tara Rice, Ricardo Correa, Greg Nini, Amir Yaron and participants at numerous workshops for their comments. We thank Jonathan Wallen, Daniel Lewis and Linda Zhao for research assistance.

1 Introduction

It is a cliché that the world has become more connected, but the financial crisis and the boom that preceded it have renewed attention on the global factors that drive financial conditions worldwide. Calvo, Leiderman and Reinhart (1993, 1996) famously distinguished the global "push" factors for capital flows from the country-specific "pull" factors, and emphasized the importance of external push factors in explaining capital flows to emerging economies in the 1990s. Policy discussion has revolved around the notion of "global liquidity" whereby permissive credit conditions in financial centers are transmitted across borders to other parts of the world (BIS (2011)). More recently, Miranda-Agrippino and Rey (2013) and Rey (2013) have highlighted the highly synchronized nature of financial conditions across borders and the co-movement in debt flows and credit growth that accompanies it.

In tandem with the discussion of global factors, the dramatic increase in gross capital flows has posed a challenge to the traditional approach to international finance based on *net* capital flows where financial flows are seen only as the counterpart to the current account. In his Ely lecture, Obstfeld (2012b p.3) concludes that "large gross financial flows entail potential stability risks that may be only distantly related, if related at all, to the global configuration of saving-investment discrepancies." One reason for the caution is that the growth in gross capital flows was associated with increased leverage and the size of the banking sector as a whole, as emphasized by Gourinchas and Obstfeld (2012) and Schularick and Taylor (2012). In this way, gross capital flows (especially through the banking sector) have received a great deal of recent attention from researchers.[1]

The objective of our paper is to shed light on the role of the international banking system in the propagation of global liquidity. We make two contributions.

Our first contribution is to construct a model of global liquidity built around the operation of international banks. We build on recent advances in understanding the leverage cycle of

[1] See Borio and Disyatat (2011), Forbes and Warnock (2012), Lane and Pels (2011), Obstfeld (2012a, 2012b), Rey (2013) and Shin (2012).

banks in which leverage builds up in booms and falls in busts. The leverage cycle mirrors the fluctuations in collateral requirements (increased "haircuts") during downturns. Geanakoplos (2010) and Fostel and Geanakoplos (2008, 2012) have examined how the risk bearing capacity of the financial system can be severely diminished when leverage falls through an increase in collateral requirements. Similarly, Gorton (2009, 2010) and Gorton and Metrick (2012) have explored the analogy between classical bank runs and the modern run in capital markets driven by increased collateral requirements and reduced borrowing capacity.

Our model of global banking combines these earlier insights with the institutional features underpinning the international banking system, such as the centralized funding and credit allocation decisions documented by Cetorelli and Goldberg (2012a, 2012b). In particular, we construct a "double-decker" model of banking where regional banks borrow in US dollars from global banks in order to lend to local corporate borrowers. In turn, the global banks finance cross-border lending to regional banks by tapping US dollar money market funds in financial centers.

A distinctive feature of our model is that it addresses the link between currency appreciation and the build-up of leverage in the banking sector. The channel is through shifts in the effective credit risk faced by banks who lend to local borrowers that may have a currency mismatch. When the local currency appreciates, local borrowers' balance sheets become stronger, resulting in lower credit risk and hence expanded bank lending capacity. In this way, currency appreciation leads to greater risk-taking by banks. This "risk-taking channel" of currency appreciation entails a link between exchange rates and financial stability.

The rapid growth of the banking sector fuelled by capital inflows and an appreciating currency has been a classic early warning indicator of emerging economy crises. Gourinchas and Obstfeld (2012) conduct an empirical study using data from 1973 to 2010 and find that two factors emerge consistently as the most robust and significant predictors of financial crises, namely a rapid increase in leverage and a sharp real appreciation of the currency. Their finding holds both for emerging and advanced economies, and holds throughout the sample period. Shularick and Taylor (2012) similarly highlight the role of leverage in financial vulnerability, especially that associated with the banking sector. Our framework addresses the theoretical mechanism behind the link between currency appreciation and the build-up of leverage and is in contrast to conventional macro models of exchange rates where the focus is on the current account.[2]

Another related feature of our model that sets it apart from conventional macro models of exchange rates is that it addresses directly the monetary policy spillover effects, especially the impact of lower US dollar borrowing rates on global financial conditions. By addressing the link between funding costs and bank leverage, we can fill in some of the theoretical boxes associated empirical studies of monetary policy spillovers. Eichenbaum and Evans (1995) found that a loosening of US monetary policy led to the subsequent depreciation of the US dollar. Bruno and Shin (2013) and Rey (2013) update the evidence and find that banking sector capital flows are closely associated with US monetary policy. Our model provides a possible mechanism to explain the link.

More broadly, our model is well suited to addressing the capacity of the global banking system to bear and distribute the fundamental credit risk. Since risk must be borne somewhere in the system - either directly by lending to ultimate borrowers, or indirectly by lending to banks - the aggregate credit risk generated by the borrowers' projects has to be absorbed by the global banking system as a whole. Our model shows how the risk absorption role of the global banking system imposes a joint restriction on the leverage of the regional and global banks taken together, which sheds light on how shocks in financial centers may propagate to the regions.

The second contribution of our paper is empirical. We investigate how closely the theoretical predictions are borne out empirically. Thanks to the closed-form solution given by our model, we can draw on a number of clear-cut hypotheses on the determinants of cross-border banking flows.

One prediction of our model is that episodes of appreciation of the US dollar are associated with deleveraging of global banks and an overall contraction of cross-border lending. These

[2] On the other hand, our model focuses just on the banking sector and hence is a partial equilibrium in nature. General equilibrium models will enable researchers to integrate macro effects and financial channels in exchange rate determination. Gabaix and Maggiori (2013) is a promising recent example.

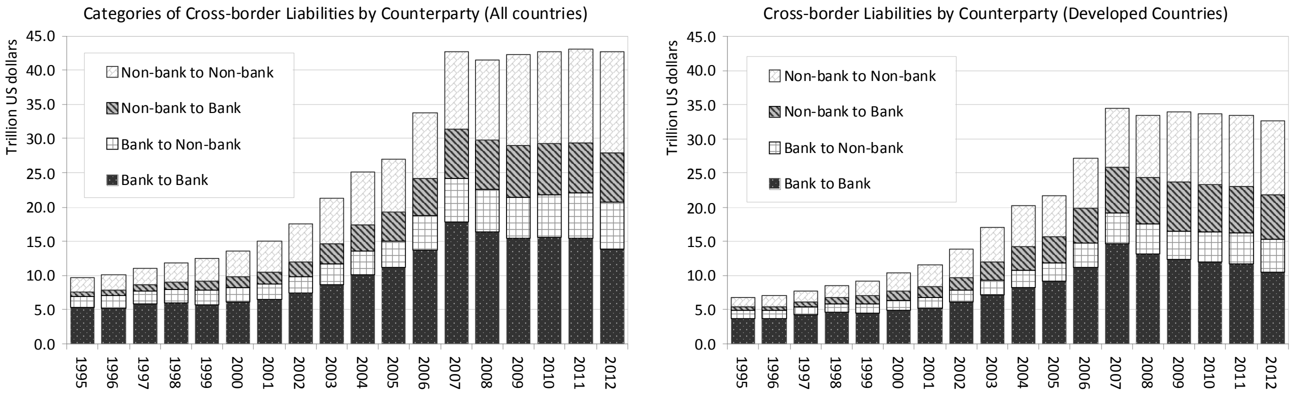

Figure 1. **Cross-border liabilities by type of counterparty.** Left panel shows cross-border debt liabilities by pairwise classification of borrower and lender. "Bank to bank" refers to cross-border claims of banks on other banks (BIS banking statistics table 7A minus 7B). "Bank to non-bank" refers to cross-border claims of banks on non-banks (BIS table 7B). Claims of non-banks are from BIS international debt security statistics, tables 11A and 11B). The right panel shows cross-border debt liabilities of developed countries according to BIS classification.

features have received a great deal of attention in the aftermath of the recent financial crisis (see, for instance, the BIS study by McGuire and von Peter (2009)). In our panel study of 46 countries we find that an *appreciation* of the local currency vis-à-vis the US dollar is associated with an *acceleration* of bank capital flows in the subsequent quarter.

Additionally, an implication of our closed-form solution is that both the *level* of bank leverage (which determines the rate at which one dollar's increase in bank capital is turned into lending) and the *change* in the leverage (which determines the lending based on *existing*, or *infra-marginal* bank capital) should enter as "supply push" determinants of banking flows. We find strong support for these predictions in our panel study, thereby verifying that the factors driving bank flows can be found in the determinants of bank leverage. Given the close relationship between bank leverage and the VIX index of implied volatility of S&P 500 equity index options, we shed light both on Forbes and Warnock's (2012) finding of the explanatory power of the VIX index for gross capital flows in surge episodes, as well as the importance of leverage as a pre-condition for crises as identified by Gourinchas and Obstfeld (2012). Our framework serves as the common

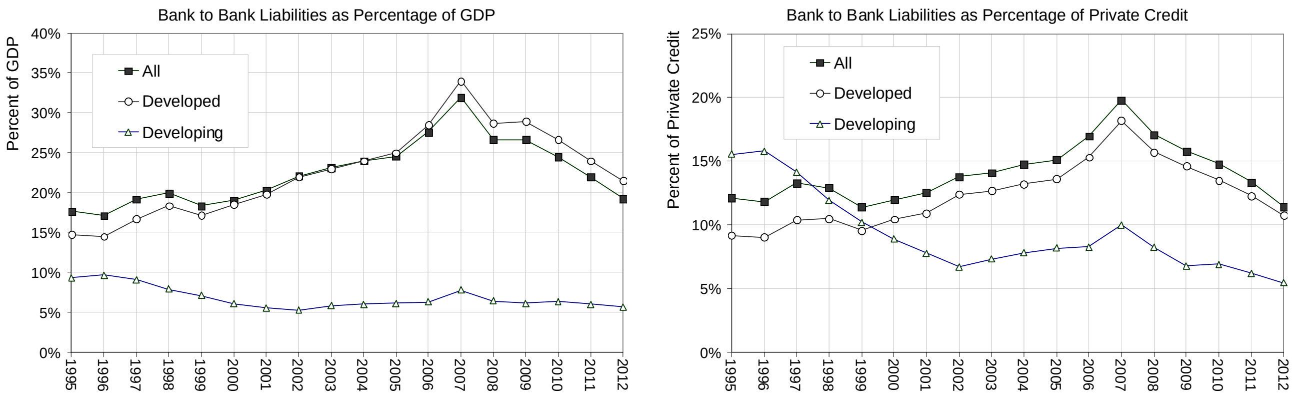

Figure 2. **Cross-border bank-to-bank liabilities.** Left panel shows cross-border bank-to-bank debt liabilities as percentage of GDP of the recipient economy. The right panel shows cross-border bank-to-bank debt liabilities as percentage of total private credit in recipient economy. Cross-border bank-to-bank liabilities are from the BIS banking statistics (table 7A minus 7B). GDP and private credit data are from the World Bank.

thread that ties together these two strands of the literature.

Quantitatively, capital flows through the international banking system is a substantial proportion of total cross-border debt flows. The quantitative significance lends weight to the potential economic impact of the framework presented in our paper. Figure 1 shows the classification of cross-border debt liabilities by type of counterparty. We see that cross-border liabilities where both the creditor and debtor are banks is the largest of the four possible categories, and saw rapid increases in the run-up to the 2008 crisis. Figure 1 complements the evidence in Rey (2013) who documents the rapid increase in credit flows relative to FDI and portfolio equity flows. Figure 2 shows that bank-to-bank flows have also played a major role in the expansion of domestic lending. The left hand panel shows cross-border bank-to-bank liabilities as a proportion of GDP, while the right hand panel shows cross-border bank-to-bank liabilities as a proportion of private credit. At the peak in 2007, bank-to-bank cross-border liabilities accounted for 20% of total private credit and for over 30% of the percentage of GDP.

In highlighting the role of the banking sector, our paper complements earlier research that has focused on portfolio flows (such as Hau and Rey (2009) who examined equity portfolio flows). Our paper is intended to shed further light on the distinctive behavioral footprint of the

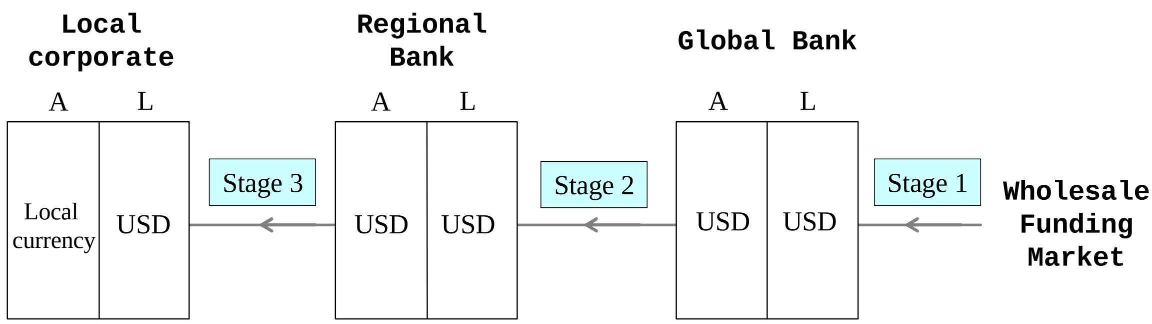

Figure 3. Cross-border bank lending in US Dollars

banking sector and its consequences for financial stability. These issues have received renewed attention in the context of the Euro area crisis (see Allen, Beck, Carletti, Lane, Schoenmaker and Wagner (2011), Lane (2013) and Lane and Pels (2011)).

In the next section, we formulate our model of cross-border banking by first laying out the institutional backdrop for the global banking system and the key empirical features of balance sheet management that our model aims to capture faithfully. Our model of global banking then builds on this discussion. We then follow up with our empirical investigation.

2 Model of Bank Capital Flows

2.1 Background

A schematic of the global banking system is sketched in Figure 3. The direction of financial flows goes from right to left to uphold the convention of having assets on the left hand side of the balance sheet and liabilities on the right. In Figure 3, global banks raise wholesale US dollar funding and then lend to local banks in other jurisdictions. The local banks draw on the cross-border funding (stage 2) in order to lend to their local borrowers (stage 3). Although the banks are hedged in their currency exposure, the ultimate local borrower has a currency mismatch, financing local currency assets with US dollar borrowing. The motive for the currency mismatch could be to hedge US dollar receivables when costs are in local currency, or the mismatch may

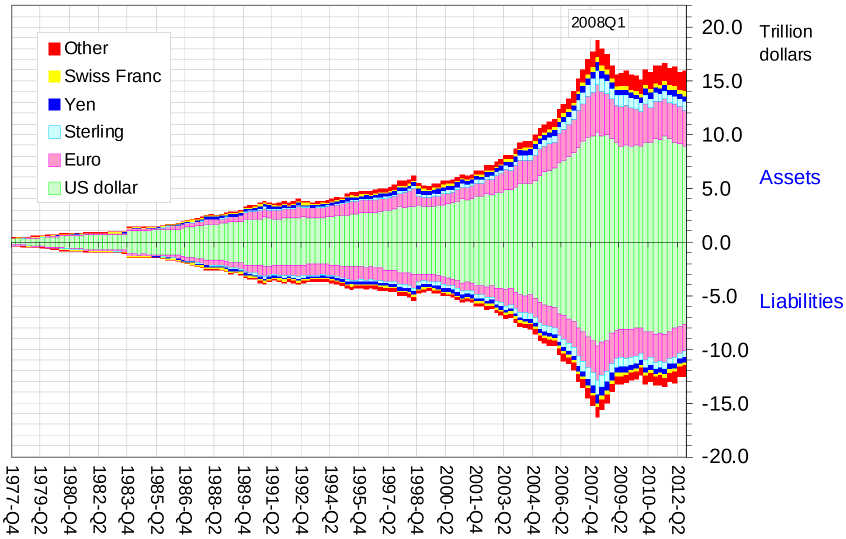

Figure 4. Foreign currency assets and liabilities of BIS reporting banks, classified according to currency (Source: BIS Locational Banking Statistics Table 5A)

be due to speculative motives. In practice, distinguishing hedging from speculation will be challenging.

Our model addresses the pre-eminent role that the US dollar plays in global banking. Figure 4 plots the foreign currency assets and liabilities of banks globally, as measured by the BIS locational banking statistics, which are organized according to the residence principle. The US dollar series in Figure 4 shows the US dollar-denominated assets and liabilities of banks outside the United States. The Euro series shows the corresponding Euro-denominated assets and liabilities of banks that are outside the Euro area, and so on. The US dollar asset series exceeded 10 trillion dollars in 2008Q1, briefly exceeding the total assets of the US chartered commercial bank sector, as shown in Shin (2012). Our model addresses the important role played by the US dollar in the transmission of financial conditions across borders, and especially the empirical association between episodes of "dollar shortages" in recent crises where sharp appreciation of the US dollar has coincided with the deleveraging of global banks under distressed circumstances, as documented by McGuire and von Peter (2009).

Maggiori (2010, 2011) provides a risk-sharing perspective on periodic dollar shortages which builds on the net external portfolio of the United States, whereby the United States holds risky assets of other countries but its liabilities are in the form of debt. In contrast to Maggiori's approach, our paper is partial equilibrium in nature and addresses just the banking system in isolation. We address the fact that within the global banking system, banks based in the United States (many of them with European headquarters) are net creditors to banks elsewhere (Shin (2012)).

Our analysis applies irrespective of whether the local bank is separately owned from the global bank, or whether the local and global banks belong to the same banking organization. Cetorelli and Goldberg (2012a, 2012b) provide extensive evidence using bank level data that internal capital markets serve to reallocate funding within global banking organizations. Further details are discussed in a BIS (2010) study that describes how the branches and subsidiaries of foreign banks in the United States borrow from money market funds and then channel the funds to their headquarters for on-lending to other parts of the world. Schnabl (2012) presents empirical evidence on the international transmission of liquidity shocks through the banking sector.

2.2 Model

Our model is partial equilibrium in nature and addresses the banking system only. The notation for our model is given in Figure 5. Regional banks provide aggregate credit C in US dollars to local borrowers. This credit is funded by wholesale lending L by global banks at the rate $1 + f$. In turn, global banks draw on money market funds M at the interest rate $1 + i$. We will see below that i is the risk-free rate. In our partial equilibrium set-up, the risk-free rate is exogenous. The book equity of the regional bank is exogenous and denoted by E_R and the book equity of the global bank is exogenous and denoted by E_G. Since our paper is concerned with bank lending (both domestic and cross-border), the exogenous equity should be interpreted as the banks' own resources that are lent out to borrowers.

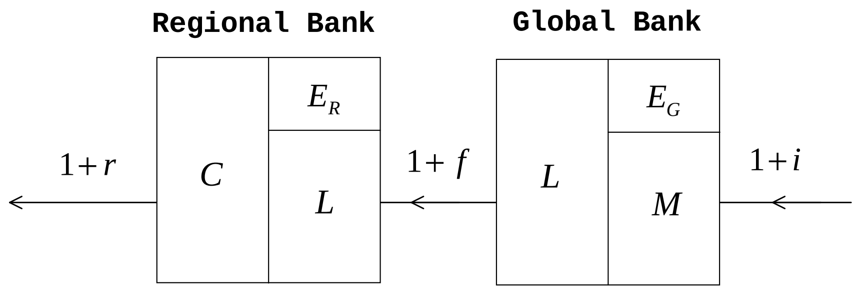

Figure 5. Regional and global bank balance sheets

As we will see below, our model has an aggregation property across banks, so that E_R and E_G can be interpreted as the *aggregate* banking sector capital of the regional banks and global banks, respectively.

2.2.1 Regional Banks

In any region, there are many potential borrowers, indexed by j. Borrowers are risk-neutral and each is endowed with a project that needs 1 dollar of fixed investment and an additional c_j dollars of production cost, where c_j is distributed in the population according to cumulative distribution function $H(.)$. Loans are granted at date 0, and the project realization and repayment is due at date 1.

The regional borrowers bear currency risk. The dollar value of the project depends on the exchange rate vis-à-vis the US dollar. Figure 6 depicts the outcome density of the borrower's project. Denote by θ_t the value of the local currency with respect to the US dollar, so that an increase in θ_t denotes the *appreciation* of local currency. Let $\bar{\theta}_1$ be the date 0 expected value of θ_1. The dollar value of the borrower's project at date 1 follows the Merton (1974) model of credit risk, and is the random variable:

$$\theta_1 V_1 = \exp\left\{\mu\left(\bar{\theta}_1\right) - \frac{s^2}{2} + sW_j\right\} \tag{1}$$

where W_j is a standard normal, $\mu(\cdot)$ is increasing function of $\bar{\theta}_1$ and s is a constant. Since

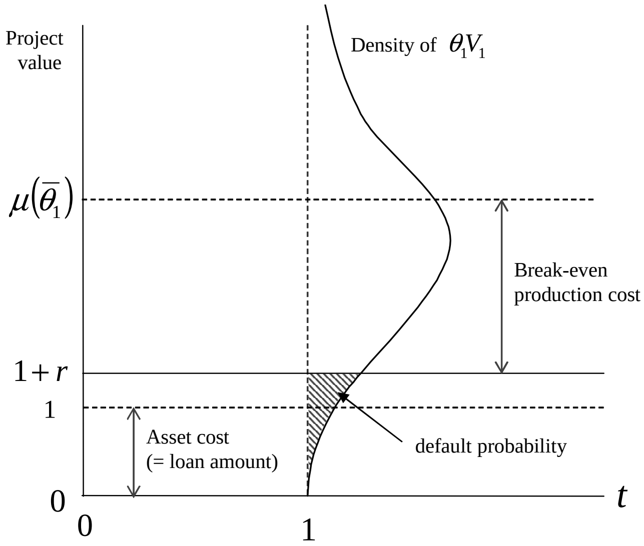

Figure 6. The borrower defaults when $\theta_1 V_1$ falls short of the notional debt $1+r$. The effect of a currency appreciation is to shift the outcome density upward, lowering the default probability.

borrowers are risk-neutral, borrower j undertakes production if $\mu\left(\bar{\theta}_1\right) - (1+r) - c_j \geq 0$. Then for the break-even production cost c^* such that $\mu\left(\bar{\theta}_1\right) - (1+r) - c^* = 0$, the demand for dollar loans is defined as

$$d\left(r, \bar{\theta}_1\right) = H\left(c^*\right) \tag{2}$$

Note that the demand for dollar loans is decreasing in the borrowing rate r and increasing in expected appreciation of local currency $\bar{\theta}_1$. The borrower defaults when $\theta_1 V_1 < 1+r$. The probability of default viewed from date 0 is

$$\begin{aligned} \text{Prob}\left(\theta_1 V_1 < 1+r\right) &= \text{Prob}\left(W_j < -\tfrac{\ln(1/(1+r))+\mu-\frac{s^2}{2}}{s}\right) \\ &= \Phi\left(-d_j\right) \end{aligned} \tag{3}$$

where d_j is *distance to default:*

$$d_j = \frac{-\ln(1+r) + \mu\left(\bar{\theta}_1\right) - \frac{s^2}{2}}{s} \tag{4}$$

The probability of default is decreasing in $\bar{\theta}_1$.

The regional bank lends to many potential borrowers and can diversify away any risk that is idiosyncratic to the borrower. Credit risk follows the Vasicek (2002) model, a many borrower generalization of Merton (1974). The standard normal W_j in (1) that defines the project outcome for borrower j is given by the linear combination:

$$W_j = \sqrt{\rho} Y + \sqrt{1-\rho} X_j \tag{5}$$

where Y and $\{X_j\}$ are mutually independent standard normals. Y has the interpretation as the common risk factor for all borrowers in the region while each X_j are the idiosyncratic component of credit risk for borrower j. The parameter $\rho \in (0,1)$ determines the weight given to the common factor Y.

Thus, borrower j repays the loan when $Z_j \geq 0$, where Z_j is the random variable:

$$\begin{aligned} Z_j &= d_j + \sqrt{\rho} Y + \sqrt{1-\rho} X_j \\ &= -\Phi^{-1}(\varepsilon) + \sqrt{\rho} Y + \sqrt{1-\rho} X_j \end{aligned} \tag{6}$$

where ε is the probability of default of borrower j, defined as $\varepsilon = \Phi(-d_j)$. We assume for the sake of simplicity that the liquidation value of a defaulted loan is zero. Positive recovery values could be accommodated, as long as the shape of the asset realization densities conform to the features to be described below.

2.2.2 Contracting Problem for Regional Bank

Regional banks are risk-neutral and maximize the market value of equity at date 0, defined as the difference between the market value of assets and the market value of debt. As noted by Merton (1974), the market value of debt can, in turn, be written as the difference between the notional value of debt and the implicit option value of default. The bank maximizes:

$$\begin{aligned} \text{Market value of equity} &= \text{Asset value} - \text{Debt value} \\ &= \text{Asset value} - \text{Notional debt} + \text{Option value of default} \end{aligned}$$

The contract between the bank and its creditors addresses the moral hazard problem in which the bank can opt for a portfolio of riskier loans that has lower expected value but a higher option value of default. We limit consideration to debt contracts only. The contract limits the bank's leverage and thereby caps the option value of default and induces the bank to take on the good portfolio.

Formally, suppose that each regional bank has the binary choice between a good portfolio and bad portfolio. The good portfolio consists of loans which have a probability of default ε, and pairwise correlation $\rho > 0$ of default across loans. Private credit extended by the bank is C at interest rate r so that the notional value of assets (the amount owed to the bank at date T) is $(1+r)\,C$. Conditional on Y, defaults are independent. Taking the limit where the number of borrowers becomes large while keeping the notional assets fixed, the realized value of the bank's assets can be written as a deterministic function of Y, by the law of large numbers.

The realized value of the loan book with the good portfolio is the random variable $w_G\,(Y)$ defined as:

$$\begin{aligned} w_G\,(Y) &= (1+r)\,C \cdot \Pr\left(\sqrt{\rho}Y + \sqrt{1-\rho}X_j \geq \Phi^{-1}(\varepsilon)\,|Y\right) \\ &= (1+r)\,C \cdot \Phi\left(\tfrac{Y\sqrt{\rho}-\Phi^{-1}(\varepsilon)}{\sqrt{1-\rho}}\right) \end{aligned} \tag{7}$$

Define the normalized asset realization function $\hat{w}_G\,(Y) \equiv w_G\,(Y)\,/\,(1+r)\,C$. The c.d.f. of $\hat{w}_G$ is then given by

$$\begin{aligned} F_G\,(z) &= \Pr\left(\hat{w}_G \leq z\right) \\ &= \Pr\left(Y \leq \hat{w}_G^{-1}(z)\right) \\ &= \Phi\left(\hat{w}_G^{-1}(z)\right) \\ &= \Phi\left(\tfrac{\Phi^{-1}(\varepsilon)+\sqrt{1-\rho}\Phi^{-1}(z)}{\sqrt{\rho}}\right) \end{aligned} \tag{8}$$

Figure 7 plots the densities over asset realizations, and shows how the density shifts to changes in the default probability ε (left hand panel) or to changes in ρ (right hand panel). Higher values of ε imply a first degree stochastic dominance shift left for the asset realization density, while shifts in ρ imply a mean-preserving shift in the density around the mean $1-\varepsilon$.

For the bad portfolio, the c.d.f. of the normalized asset realization function is given by

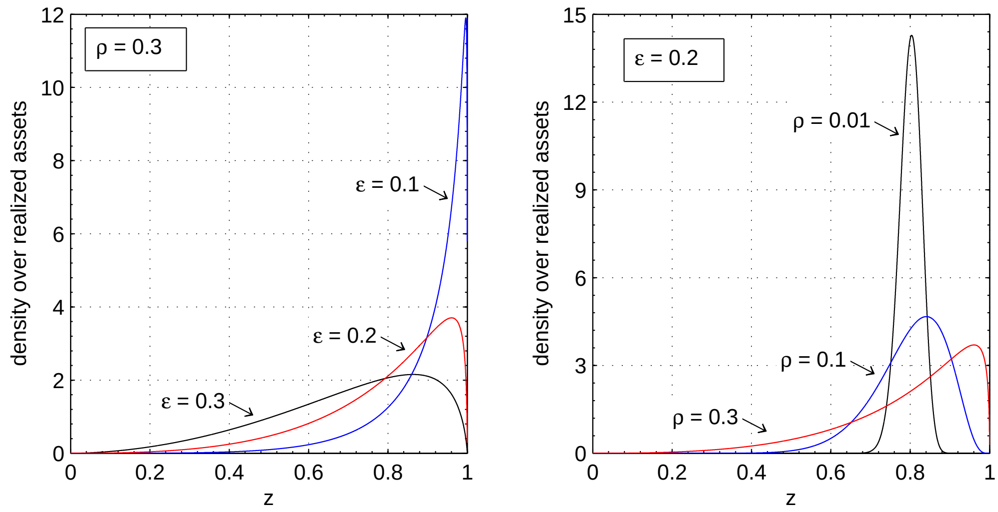

Figure 7. The two charts plot the densities over realized assets when $C(1+r)=1$. The left hand charts plots the density over asset realizations of the bank when $\rho = 0.1$ and ε is varied from 0.1 to 0.3. The right hand chart plots the asset realization density when $\varepsilon = 0.2$ and ρ varies from 0.01 to 0.3.

$F_B(z)$, which has two features. First, the expected value of the bad portfolio is given by

$$E_B(\hat{w}) = E_G(\hat{w}) - k \tag{9}$$

for some constant $k > 0$. Second, F_G cuts F_B precisely once from below. In this way, the bad portfolio is associated with greater dispersion of outcomes, but has a lower expected value.

Let φ be the *notional debt ratio* of the bank, defined as

$$\varphi = (1+f)L/(1+r)C \tag{10}$$

In other words, φ is the default point of the bank as a proportion of its notional assets, and has the interpretation of the strike price of the embedded put option arising from limited liability. The risk-neutral bank maximizes expected profit net of funding cost. Following Merton (1974), the market value of debt is the notional repayment amount minus the option value of default. Hence, the bank's objective function can be written as

$$E(\hat{w}) - [\varphi - \pi(\varphi)] \tag{11}$$

where $E(\hat{w})$ is the expected payoff from the loan book, φ is the notional debt and $\pi(\varphi)$ is the value of the put option when the strike price is given by $\varphi = (1+f)L/(1+r)C$.

The bank chooses C to maximize the bank's expected payoff (11) subject to the incentive compatibility constraint for the bank to choose the good portfolio, which is

$$E_G(\hat{w}) - [\varphi - \pi_G(\varphi)] \geq E_B(\hat{w}) - [\varphi - \pi_B(\varphi)] \tag{12}$$

where $E_G(\hat{w})$ is the expected payoff from the good portfolio and $\pi_G(\varphi)$ is the value of the put option with strike price φ under the outcome distribution for the good portfolio. $E_B(\hat{w})$ and $\pi_B(\varphi)$ are defined analogously for the expected payoff and option values associated with the bad portfolio. Writing $\Delta\pi(\varphi) = \pi_B(\varphi) - \pi_G(\varphi)$, (12) can be written more simply as

$$\Delta\pi(\varphi) \leq k \tag{13}$$

The left hand side is the additional option value to default from the bad portfolio and the right hand side is $E_G(\hat{w}) - E_B(\hat{w}) = k$, since the probability of default of loans in the bad portfolio is $\varepsilon + k$ while the probability of default of loans in the good portfolio is ε. Incentive compatibility entails keeping leverage low enough that the higher option value to default does not exceed the greater expected payoff of the good portfolio. Our solution rests on the following key result.

Lemma 1 *There is a unique φ that solves $\Delta\pi(\varphi) = k$.*

Lemma 1 can be proved as follows. From Breeden and Litzenberger (1978), the state price density is given by the second derivative of the option price with respect to its strike price. Given risk-neutrality, $\Delta\pi(\varphi) = \int_0^\varphi [F_B(s) - F_G(s)]\, ds$. Since $F_G(z)$ cuts $F_B(z)$ once from below, $\Delta\pi(\varphi)$ is single-peaked. In particular,

$$\begin{aligned}
\lim_{\varphi \to 1} \Delta\pi(\varphi) &= \int_0^1 [F_B(s) - F_G(s)]\, ds \\
&= \int_0^1 [1 - F_G(s)]\, ds - \int_0^1 [1 - F_B(s)]\, ds \\
&= \int_0^1 sF_G(s)\, ds - \int_0^1 sF_B(s)\, ds = k
\end{aligned} \tag{14}$$

so that $\Delta\pi(\varphi)$ approaches k from above as $\varphi \to 1$. The variable s ranges over $[0,1]$, which represents possible realizations of the bank's (normalized) loan book. Since $\varphi < 1$ for any bank with positive notional equity, we have a unique solution to $\Delta\pi(\varphi) = k$. This proves the lemma.

Given risk-neutrality of the bank, the incentive compatibility constraint binds. If $C > 0$, the aggregate supply of loans follows from $\varphi = (1+f) L / (1+r) C$ and the balance sheet identity $E_R + L = C$ to give

$$C = \frac{E_R}{1 - \frac{1+r}{1+f}\varphi} \tag{15}$$

For credit to be positive, the denominator in (15) should be positive, which imposes a joint restriction on r, f and φ. The demand for loans by corporate borrowers was derived in equation (2) above as $H(c^*)$, where c^* is the break-even cost level for the local corporate borrower. The lending rate r satisfies the market-clearing condition:

$$H(c^*) = \frac{E_R}{1 - \frac{1+r}{1+f}\varphi} \tag{16}$$

To solve for the funding rate f, we first derive the demand for wholesale funding by the regional banks. From the definition $\varphi = (1+f) L / (1+r) C$ and the balance sheet identity $E_R + L = C$, we can write:

$$L = \frac{E_R}{\frac{1+f}{1+r}\frac{1}{\varphi} - 1} \tag{17}$$

which gives the demand for wholesale funding as a function of f. The supply of wholesale funding will be obtained from the global banks' lending decision. For now, note that L is proportional to E_R, and so (17) also denotes the *aggregate* demand for wholesale funding when E_R is the *aggregate* equity of the regional banks.

Under the incentive compatibility constraint, the asset realizations follow the distribution $F_G(.)$, so that the probability of default by the bank is given by $F_G(\varphi)$, where φ is the solution given by Lemma 1. Denoting by α the bank's probability of default, we have $\alpha = F_G(\varphi)$ so that

$$\alpha = \Phi\left(\frac{\Phi^{-1}(\varepsilon) + \sqrt{1-\rho}\,\Phi^{-1}(\varphi)}{\sqrt{\rho}}\right) \tag{18}$$

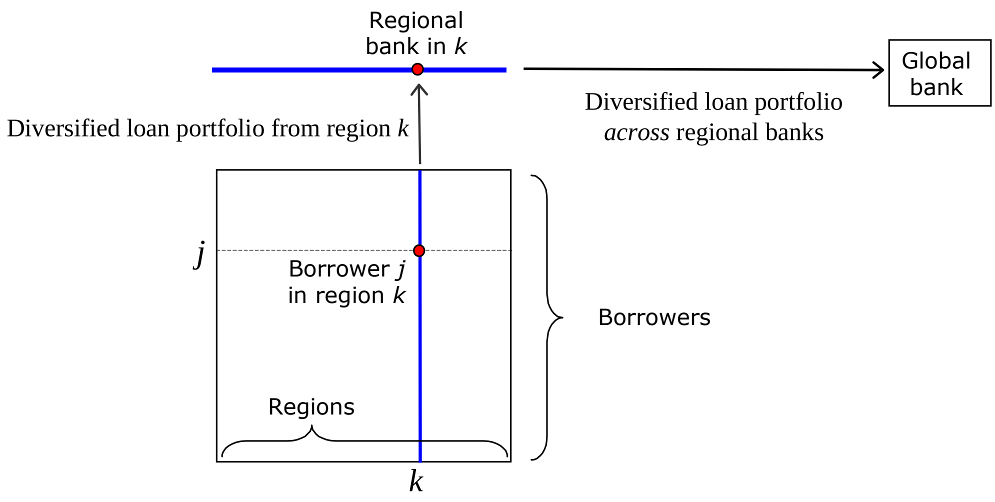

Figure 8. Global and regional banks

Since φ is uniquely solved by Lemma 1, and ρ is a parameter of the contracting problem, α is also uniquely defined once we solve for the probability of default ε of the corporate borrowers, which depends on the exchange rate.

2.2.3 Global Banks

Lending by global banks is solved from a "double-decker" version of the Vasicek model. There are many regions and each global bank has a well-diversified portfolio of cross-border loans across many regions. However, the global banks bear global risk that cannot be diversified away.

The rectangle in Figure 8 represents the population of borrowers across all regions. Regional bank k holds a portfolio that is diversified against idiosyncratic shocks, but not to regional shocks. Global banks hold a portfolio of loans to regional banks, and is diversified against regional shocks, but it faces undiversifiable global shocks.

In equation (6), we introduced the random variable Z_j that determined whether a particular borrower j defaults or not. We now introduce a subscript k to indicate the region that the borrower belongs to. Thus, let

$$Z_{kj} \equiv -\Phi^{-1}(\varepsilon) + \sqrt{\rho}Y_k + \sqrt{1-\rho}X_{kj} \tag{19}$$

where

$$Y_k = \sqrt{\beta}G + \sqrt{1-\beta}R_k \tag{20}$$

In (20), the risk factor Y_k is further decomposed into a regional risk factor R_k that affects all the private credit recipients in region k and a global risk factor G. The random variables $G, \{R_k\}$ and $\{X_{kj}\}$ are mutually independent standard normals.

The credit risk borne by a global bank arises from the possibility (which happens with probability α) that a regional bank defaults on the cross-border loan granted by the global bank. Although each regional bank has a diversified portfolio against the idiosyncratic risk of its regional borrowers, it bears the risk Y_k, which is the linear combination of the global risk G and the region-specific risk R_k.

A global bank has a fully-diversified portfolio across regions, and it can diversify away the regional risks R_k. A regional bank k defaults when $\hat{w}_G(Y_k) < \varphi$, or

$$\begin{aligned} Y_k < \hat{w}^{-1}(\varphi) &= \tfrac{\Phi^{-1}(\varepsilon)+\sqrt{1-\rho}\Phi^{-1}(\varphi)}{\sqrt{\rho}} \\ &= \Phi^{-1}(\alpha) \end{aligned} \tag{21}$$

Equivalently, regional bank k defaults when $\xi_k < 0$, where ξ_k is the random variable:

$$\begin{aligned} \xi_k &\equiv -\Phi^{-1}(\alpha) + Y_k \\ &= -\Phi^{-1}(\alpha) + \sqrt{\beta}G + \sqrt{1-\beta}R_k \end{aligned} \tag{22}$$

Note the formal symmetry between (22) and the expression for Z_j for the regional bank in (6). The global bank faces borrowers who default with probability α, whereas the regional bank faces borrowers who default with probability ε. The global bank faces uncertainty with both a diversifiable element R_k and undiversifiable element G, whereas the regional bank faces diversifiable risk X_j and undiversifiable risk Y. The parameter β plays the analogous role for the global bank as parameter ρ does for the regional bank.

For a global bank with notional assets of $(1+f)L$ which is fully diversified across regions, its asset realization is a deterministic function of the global risk factor G only, and is given by

$$\begin{aligned} w(G) &= (1+f)L \cdot \Pr(\xi_k \geq 0 | G) \\ &= (1+f)L \cdot \Pr\left(R_k \geq \tfrac{\Phi^{-1}(\alpha)-G\sqrt{\beta}}{\sqrt{1-\beta}} \middle| G\right) \\ &= (1+f)L \cdot \Phi\left(\tfrac{G\sqrt{\beta}-\Phi^{-1}(\alpha)}{\sqrt{1-\beta}}\right) \end{aligned} \tag{23}$$

We denote the normalized asset realization by $\hat{w}(G) = w(G)/(1+f)L$. The c.d.f. of $\hat{w}(G)$ is then given by

$$\begin{aligned} F(z) &= \Phi\left(\hat{w}^{-1}(z)\right) \\ &= \Phi\left(\frac{\sqrt{1-\beta}\Phi^{-1}(z)+\Phi^{-1}(\alpha)}{\sqrt{\beta}}\right) \end{aligned} \tag{24}$$

2.2.4 Contracting Problem for Global Bank

The global bank is risk-neutral and maximizes expected profit subject to a funding constraint, which arises from the following contracting problem. The global bank chooses between two alternative portfolios - the good portfolio or the bad portfolio. The good portfolio consists of loans which default with probability α but where $\beta = 0$, so that correlation in defaults are eliminated.

The bad portfolio consists of loans with a higher probability of default $\alpha + h$, for known constant $h > 0$, and non-zero correlation of default $\beta' > 0$. The greater correlation in defaults generates dispersion in the asset realization and hence higher option value of default. If the bank chooses the bad portfolio, the realized value of assets is the random variable $w_B(G)$ defined as:

$$\begin{aligned} w_B(G) &= (1+f)L \cdot \Pr\left(\sqrt{\beta'}G + \sqrt{1-\beta'}R_j \geq \Phi^{-1}(\alpha+h)|G\right) \\ &= (1+f)L \cdot \Phi\left(\tfrac{G\sqrt{\beta'}-\Phi^{-1}(\alpha+h)}{\sqrt{1-\beta'}}\right) \end{aligned} \tag{25}$$

We normalize w_B by the face value of assets and define $\hat{w}_B(G) \equiv w_B(G)/(1+f)L$. The c.d.f. of $\hat{w}_B$ is

$$\begin{aligned} F_B(z) &= \Pr(\hat{w}_B \leq z) \\ &= \Pr\left(G \leq \hat{w}_B^{-1}(z)\right) \\ &= \Phi\left(\hat{w}_B^{-1}(z)\right) \\ &= \Phi\left(\frac{\Phi^{-1}(\alpha+h)+\sqrt{1-\beta}\Phi^{-1}(z)}{\sqrt{\beta}}\right) \end{aligned} \tag{26}$$

If the bank chooses the good portfolio, the default probability is α and correlation in defaults is zero. The outcome distribution for the good portfolio is obtained from (26) by setting $h = 0$ and letting $\beta \to 0$. In this limit, the numerator of the expression inside the brackets in (26) is positive when $z > 1-\alpha$ and negative when $z < 1-\alpha$. Thus, the outcome distribution of the good portfolio in the limit as $\beta \to 0$ is

$$F_G(z) = \begin{cases} 0 & \text{if } z < 1-\alpha \\ 1 & \text{if } z \geq 1-\alpha \end{cases} \tag{27}$$

The good portfolio allows full diversification by the bank.

Denote by ψ the ratio $(1+i)M/(1+f)L$, which is the notional debt ratio of the global bank, and also plays the role of the strike price of the embedded option due to limited liability. Then, the bank's objective function can be written as

$$E(\hat{w}) - [\psi - \pi(\psi)] \tag{28}$$

where $E(\hat{w})$ is the expected realization of the (normalized) loan portfolio, and the expression in square brackets is the expected repayment by the bank to wholesale creditors, which can be decomposed as the repayment made in full in all states of the world minus the option value to default due to the limited liability of the bank. $\pi(\psi)$ is the value of the put option when the strike price is given by $\psi = (1+i)M/(1+f)L$.

The contracting problem takes equity E_G as given and chooses L to maximize the bank's expected payoff (11) subject to the incentive compatibility constraint for the bank to choose the good portfolio, and the break-even constraint for the creditors to the global bank. The incentive compatibility constraint is

$$E_G(\hat{w}) - [\psi - \pi_G(\psi)] \geq E_B(\hat{w}) - [\psi - \pi_B(\psi)] \tag{29}$$

where $E_G(\hat{w})$ is the expected payoff of the good portfolio and $\pi_G(\psi)$ is the value of the put option with strike price ψ under the outcome distribution for the good portfolio. $E_B(\hat{w})$ and $\pi_B(\psi)$ are defined analogously for the expected outcome and option values associated with the bad portfolio. Writing $\Delta\pi(\psi) = \pi_B(\psi) - \pi_G(\psi)$, (29) can be written more simply as

$$\Delta\pi(\psi) \leq h \tag{30}$$

Incentive compatibility entails keeping leverage low enough that the higher option value to default does not exceed the greater expected payoff of the good portfolio.

Lemma 2 *There is a unique ψ that solves $\Delta\pi(\psi) = h$, where $\psi < 1 - \alpha$.*

Lemma 2 is the global bank analogue of Lemma 1. Since the state price density is given by the second derivative of the option price with respect to its strike price, $\Delta\pi(\psi) = \int_0^\psi [F_B(s) - F_G(s)]\, ds$, which gives

$$\Delta\pi(\psi) = \begin{cases} \int_0^\psi F_B(s)\, ds & \text{if } \psi < 1-\alpha \\ \\ \int_0^{1-\alpha} F_B(s)\, ds - \int_{1-\alpha}^\psi [1 - F_B(s)]\, ds & \text{if } \psi \geq 1-\alpha \end{cases} \tag{31}$$

Thus $\Delta\pi(\psi)$ is single-peaked, reaching its maximum at $\psi = 1 - \alpha$. In particular,

$$\begin{aligned} \lim_{\psi \to 1} \Delta\pi(\psi) &= \int_0^1 [F_B(s) - F_G(s)]\, ds \\ &= E_G(\hat{w}) - E_B(\hat{w}) = h \end{aligned} \tag{32}$$

so that $\Delta\pi(\psi)$ approaches h from above as $\psi \to 1$. Since $\psi < 1$ for a bank with positive notional equity, we have a unique solution to $\Delta\pi(\psi) = h$ where the solution is in the range where $\Delta\pi(\psi)$ is increasing. Therefore $\psi < 1 - \alpha$. This proves the lemma.

2.2.5 Closed-Form Solution

We can now solve the model completely. For the global bank, the good portfolio has payoff $1-\alpha$ with certainty (as seen in (27)). Since the bank has zero probability of default whenever $\psi < 1-\alpha$, Lemma 2 implies that the global bank's probability of default is zero. From the participation constraint of the creditors to the global bank, the funding rate is therefore given by the risk-free rate. From $\psi = (1+i)\,M/\,(1+f)\,L$ and the balance sheet identity $E_G + M = L$, we can solve for the global bank's supply of wholesale lending as

$$L = \frac{E_G}{1 - \frac{1+f}{1+i}\psi} \tag{33}$$

The market clearing condition for L is

$$\frac{E_R}{\frac{1+f}{1+r} \cdot \frac{1}{\varphi} - 1} = \frac{E_G}{1 - \frac{1+f}{1+i}\psi} \tag{34}$$

The funding rate f can be solved as

$$1 + f = \frac{1}{\mu \frac{1}{(1+r)\varphi} + (1-\mu)\frac{\psi}{1+i}} \tag{35}$$

where $\mu = E_G/\,(E_G + E_R)$.

Next we solve for the relationship between the local spot exchange rate θ_0 and the expected value of the local currency $\bar{\theta}_1$. We posit exogenous imperfect substitutability of currencies in the spirt of the portfolio balance model (see Branson and Henderson (1985)).[3] Figure 9 depicts the market clearing on the local spot market for dollars at date 0.

The corporate borrowers have currency mismatch as depicted in Figure 3, where they hold local currency assets but dollar liabilities. Total dollar credit is C, so that corporate borrowers' demand for dollars at the date 0 spot market is $-C\left(\theta, \bar{\theta}_1\right)$. We posit an exogenous demand for dollars on the spot market due to other sectors at date 0 denoted by $D\left(\theta, \bar{\theta}_1\right)$, so that the spot

[3]The portfolio balance approach to exchange rates has traditionally left the imperfect substitutability between currencies unmodeled. Gabaix and Maggiori (2013) provide a recent microfoundation in terms of dealer inventories.

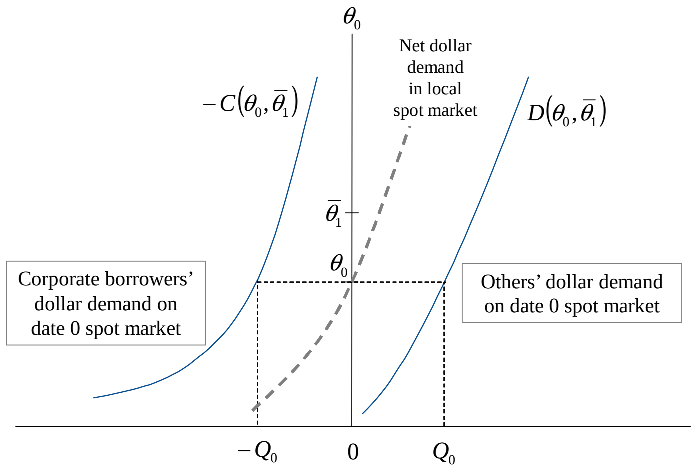

Figure 9. Determination of date 0 exchange rate θ_0 given expected date 1 exchange rate $\bar{\theta}_1$

exchange rate θ_0 is determined by the market clearing condition

$$-C\left(\theta, \bar{\theta}_1\right) + D\left(\theta, \bar{\theta}_1\right) = 0 \tag{36}$$

We summarize the solution of the model. The exogenous elements of the model are as follows. First, we fix the book equity of the regional and global banks, E_R and E_G and the risk-free US dollar interest rate i. Next, ρ and β are parameters that determine the shape of the local and global bank asset realization density, and k and h are constants for payoff differences in the moral hazard problem. Finally, the payoff density of the projects and demand function for spot dollars are exogenous.

Given these exogenous elements, we can solve the model uniquely. First, φ and ψ are uniquely determined by the underlying parameters of the contracting problem, as stated in Lemma 1 and Lemma 2. The probability of default ε of the borrowers' project is determined given the expected exchange rate appreciation. Finally, the lending rates r and f are determined by market-clearing. We summarize the result in terms of the following proposition.

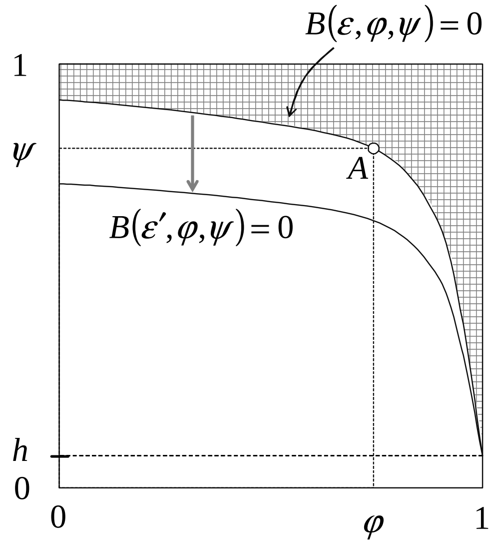

Figure 10. **Risk capacity of global banking system.** This figure shows the impact of increased default risk from ε to ε' on the leverage of global and regional banks.

Proposition 3 *The model has a unique solution. Total credit in the regions is*

$$C = \frac{E_G + E_R}{1 - \frac{1+r}{1+i}\varphi\psi} \tag{37}$$

and total cross-border lending is

$$L = \frac{E_G + E_R \cdot \frac{1+r}{1+i}\varphi\psi}{1 - \frac{1+r}{1+i}\varphi\psi} \tag{38}$$

where i is the risk-free US dollar interest rate.

The fact that global banks can borrow at the risk-free rate is reminiscent of Geanakoplos (2010) and Fostel and Geanakoplos (2012), who also have the feature that borrowers' probability of default is zero, but for reasons that are different from our model. However, the common thread is that *actual* default by the bank does not happen precisely because the contract addresses the *possibility* of default by the bank.

Our model is well adapted to examining the *risk capacity* of the global banking system, and the notion of risk capacity will be important when considering the comparative statics of bank leverage to shifts in the expected appreciation of the dollar or with shifts in the fundamental risks associated with project outcomes.

In our model, the aggregate credit risk generated by the borrowers' projects has to be absorbed by the global banking system. When the fundamental risk increases, the leverage constraints of the banks become tighter. Given the very general nature of the contracting problem for the regional banks in our model, we cannot prove in general that an increase in default risk ε leads to universal deleveraging by all banks. However, we can show that any change in the fundamental risk imposes a joint restriction on the leverage of the regional and global banks taken together. The following result captures the idea of the joint leverage constraint in terms of the bounds on the permitted leverage of the regional and global banks. Figure 10 illustrates the result.

Proposition 4 *There is a function $B(\varepsilon, \varphi, \psi)$ which is increasing in all three arguments such that $B(\varepsilon, \varphi, \psi) = 0$ for any solution $(\varepsilon, \varphi, \psi)$.*

The function $B(\varepsilon, \varphi, \psi)$ establishes bounds on φ and ψ for any given level of fundamental risk ε, and hence we could dub the indifference curves generated by the B function as the leverage boundary associated with different levels of overall risk in the system. When ε increases - either from an expected appreciation of the US dollar or the increased fundamental risks associated with project outcomes - the leverage boundary shifts down, implying that the new configuration of regional and global bank leverage lies on a lower leverage boundary. Since B is increasing in all three arguments, the boundary $B(\varepsilon, \varphi, \psi) = 0$ is negatively sloped in (φ, ψ)-space as shown in Figure 10.

The B function is defined as follows. Equation (18) gives the default probability α of the regional banks as an increasing function of ε and φ, which we can denote as $A(\varepsilon, \varphi)$. This function is increasing in both components. Meanwhile, Lemma 2 guarantees a unique solution to the global bank's incentive compatibility constraint $\Delta\pi(\psi) = h$, which can be written as

$$\int_0^{\psi} \Phi\left(\tfrac{\Phi^{-1}(\alpha+h)+\sqrt{1-\beta}\Phi^{-1}(s)}{\sqrt{\beta}}\right) ds = h \tag{39}$$

The left hand side of (39) is an increasing function of ψ and α, which we write as $\hat{B}(\psi, \alpha)$. Then, the function $B(\varepsilon, \varphi, \psi)$ in Proposition 4 is defined by substituting $\alpha = A(\varepsilon, \varphi)$ into $\hat{B}(\psi, \alpha)$. Thus,

$$B(\varepsilon, \varphi, \psi) \equiv \hat{B}(\psi, A(\varepsilon, \varphi)) - h \tag{40}$$

Any solution $(\varepsilon, \varphi, \psi)$ then satisfies $B(\varepsilon, \varphi, \psi) = 0$, which proves Proposition 4.

Proposition 4 has several clear-cut empirical implications. When ε increases, either due to an expected appreciation of the US dollar, or to an increase in fundamental risks in the world economy, Proposition 2 necessitates deleveraging somewhere in the global banking system. Either the global banks must deleverage, or the regional banks must deleverage, or both. In our empirical section, we draw on our results to help us to interpret our empirical findings.

2.3 Comparative Statics

In preparation for our empirical investigation, we explore some implications of our model. The expressions for total credit in the regions (37) can be written in long hand as:

$$\begin{array}{c}\text{Total private}\\ \text{credit}\end{array} = \frac{\text{Aggregate bank capital (regional + global)}}{1 - \ \text{spread} \times \begin{array}{c}\text{regional}\\ \text{leverage}\end{array} \times \begin{array}{c}\text{global}\\ \text{leverage}\end{array}} \tag{41}$$

Here, φ and ψ are interpreted as normalized leverage measures (regional and global) that lie in the unit interval $(0, 1)$. The expression for total cross-border lending (38) can similarly be expressed in long hand as

$$\begin{array}{c}\text{Total cross-}\\ \text{border lending}\end{array} = \frac{\text{Global and weighted regional bank capital}}{1 - \ \text{spread} \times \begin{array}{c}\text{regional}\\ \text{leverage}\end{array} \times \begin{array}{c}\text{global}\\ \text{leverage}\end{array}} \tag{42}$$

Consider the impact on L of shocks to global bank equity E_G and global bank (normalized) leverage ψ. Then, neglecting for the moment the interest spread term for notational economy, the comparative statics impact on L can be written as

$$\begin{aligned}\Delta L &\simeq \frac{\partial L}{\partial E_R}\Delta E_G + \frac{\partial L}{\partial \psi}\Delta\psi \\ &= \frac{1}{1-\varphi\psi}\Delta E_G + \left(\frac{(1-\varphi\psi)\,E_R\varphi - (E_G + E_R\varphi\psi)\,(-\varphi)}{(1-\varphi\psi)^2}\right)\Delta\psi \\ &= \frac{1}{1-\varphi\psi}\Delta E_G + C\frac{\varphi}{1-\varphi\psi}\Delta\psi \qquad (43)\end{aligned}$$

where C is private credit in the recipient economy, as given in (37).

The first term in (43) gives the impact of a marginal increase in global bank equity ΔE_G through the leverage of the banking sector. When global bank leverage is high (ψ is high), each dollar of global bank equity translates into higher banking flows through the coefficient $1/(1-\varphi\psi)$. Thus, the first term in (43) suggests that capital flows are increasing in global bank equity and banking sector leverage. The second term in (43) gives the impact of the *change* in the leverage of global banks, given by $\Delta\psi$. The intuition is that the change in leverage will impact lending through the existing infra-marginal capital held by global banks, where each dollar of the global bank's existing equity is leveraged up to a higher multiple.

A distinctive prediction of our model which sets it apart from the conventional macro theories of capital flows is the comparative statics of exchange rate changes. When the local currency is expected to appreciate, the probability of default ε declines. In effect, expected currency appreciation has the same impact as a decline in the credit risk associated with borrowers' projects. Since φ is a decreasing function of ε, exchange rate changes feed directly into the risk-taking of banks and their leverage decisions. Thus, an appreciation of the local currency is associated with larger cross-border liabilities of the local banks. The relationship between currency appreciation and capital flows will be a key focus in our empirical section.

Another distinctive feature of our model is the spillover effects of shocks to US dollar borrowing rates whereby lower dollar funding costs result in higher bank capital flows. When the risk-free rate i falls, the spread between the local lending rate $1+r$ and the risk-free interest rate $1+i$ increases. From our solution, cross-border lending L is increasing in the interest rate spread between the local lending rate r and the risk-free interest rate of the wholesale funding currency i. Therefore, an implication of our solution is that loosening of US monetary policy will result in greater cross-border liabilities. Eichenbaum and Evens (1995), Bruno and Shin (2013) and Rey (2013) show that this prediction receives broad support in VAR studies. In our empirical section below, we examine the spread variable in our panel study.

3 Empirical Analysis

3.1 Sample and Variable Definitions

Our sample for the panel investigation draws on data from 46 countries, encompassing both developed economies and emerging and developing economies, but excluding offshore financial centers. Since we wish to analyze the global banking channel, the criterion for inclusion is whether foreign banks play an economically significant role in the country's financial system. In addition to developed economies, we select countries with the largest foreign bank penetration, as measured by the number of foreign banks and by the share of domestic banking assets held by foreign-owned local institutions from the Claessens, van Horen, Gurcanlar and Mercado (2008) dataset.

The countries included in our sample are Argentina, Australia, Austria, Belgium, Brazil, Bulgaria, Canada, Chile, Cyprus, Czech Republic, Denmark, Egypt, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Indonesia, Ireland, Israel, Italy, Japan, Latvia, Lithuania, Malaysia, Malta, Mexico, Netherlands, Norway, Poland, Portugal, Romania, Russia, Slovakia, Slovenia, South Korea, Spain, Sweden, Switzerland, Thailand, Turkey, Ukraine, United Kingdom and Uruguay.

Our definition of banking flows ΔL is the growth (log difference) in cross-border loans of BIS-reporting banks on banking sector counterparties in a particular country, as measured by the difference between Table 7A (all borrowers) and Table 7B (non-bank borrowers) in the BIS Locational Statistics. Global banks account for most of these international exposures.[4] Since European banks have a pivotal role in the transmission of global liquidity (Shin, 2012) and

[4]See, for instance, the E.16 statistics release (http://www.ffiec.gov/e16.htm)

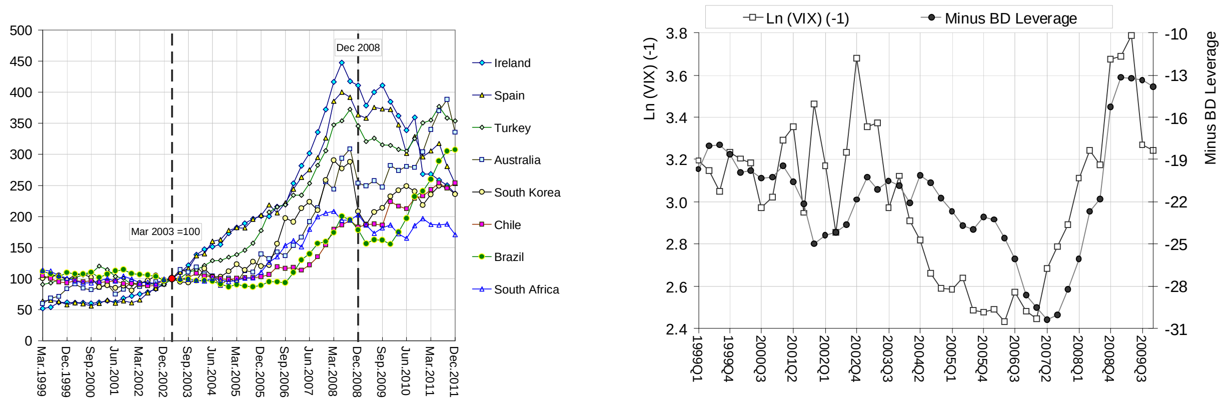

Figure 11. **Cross-border bank claims, leverage and VIX.** The left panel plots cross-border claims of BIS reporting country banks on borrowers in countries as listed (from BIS banking statistics table 7A). The series are normalized to 100 in March 2003. The right panel plots log of VIX lagged by one quarter, and leverage of the US broker dealer sector (inverted) from the US Flow of Funds. Leverage is defined as (equity + total liabilities)/equity.

the US dollar is the currency underpinning the global banking system, our variable is a good empirical counterpart to our model setting built around banking claims of global banks that use US dollar wholesale funding. The key organizational criteria of the BIS locational statistics data are the country of residence of the reporting banks and their counterparties as well as the recording of all positions on a gross basis, including those vis-à-vis own affiliates. This makes the locational statistics appropriate for measuring the role of banks in the intermediation of international capital flows and lending flows.

The left panel of Figure 11 plots the cross-border claims of BIS-reporting banks from the BIS Locational Statistics Table 7A on counterparties listed on the right. The series have been normalized to equal 100 in March 2003. Although the borrowers have wide geographical spread, we see a synchronized boom in cross-border lending before the recent financial crisis.

The right panel of Figure 11 plots the leverage of the US broker dealer sector from 1990. Leverage increases gradually up to 2007, and then falls abruptly with the onset of the financial crisis. The right panel also shows how US broker dealer leverage is closely (negatively) associated with the risk measure given by the VIX index of the implied volatility in S&P 500 stock index option prices from Chicago Board Options Exchange (CBOE). This evidence corroborates the findings in Adrian and Shin (2010, 2012) who pointed to the close association between the leverage of the Wall Street investment banks and the VIX index.

3.1.1 Global Factors

Our solution highlights the leverage and (book) equity of global banks that facilitate cross-border bank lending. As for the leverage of the global banks, our empirical counterpart should ideally be measured as the leverage of the broker dealer subsidiaries of the European global banks that facilitate cross-border lending. However, the reported balance sheet data for European banks are consolidated numbers at the holding company level that includes the much larger commercial banking unit, rather than the wholesale investment banking subsidiary alone. For the reasons discussed in Adrian and Shin (2010), broker dealers and commercial banks differ in important ways in their balance sheet management. The broker dealer sector much more closely mirrors the wholesale funding operations of the global banks. For this reason, we use instead the leverage of the US broker dealer sector from the Flow of Funds series published by the Federal Reserve as our empirical proxy for global bank leverage (*Global Leverage*) and global bank leverage growth (*Global Leverage growth*). To the extent that US broker dealers are influenced by the same forces as the broker dealer subsidiaries of the European global banks, we may expect to capture the main forces at work.

The other global variable predicted by the theory is the growth in the equity of global banks. Non-US global banks, especially European global banks, were active in US dollar intermediation, as mentioned above. To capture the role of global banks' equity, we use the change in the total book value of equity of the largest (top 10) non-US commercial banks by assets from Bankscope as a proxy for the growth in equity of international banks (*Global Equity growth*). Ideally, we would like to capture the equity of the broker dealer subsidiary of the bank, rather than the equity of the bank as a whole. However, provided that the book equity devoted to the wholesale banking business remains a steady proportion of the bank's overall equity, the use of our proxy would be justified. Bankscope has historical banking data from 1997, hence the variable *Global*

Equity growth is available since 1998.

3.1.2 Local Factors

Our solution also allows a role for the leverage and equity of local banks. As a proxy for local leverage we use the ratio of bank assets to capital in levels (*Local Leverage*) and growth (*Local Leverage growth*) from the World Bank WDI database. As a proxy for local equity growth, we use the commercial banks' net income to yearly averaged total assets (ROA) (*Local Equity growth*) from the World Bank Financial Development and Structure Dataset. By using this proxy, we implicitly assume that a constant fraction of the earnings is retained as equity.

A distinctive feature of our model is the impact of exchange rate changes on capital flows. We include the log difference of the real exchange rate (ΔRER), where RER is computed as the log of nominal exchange rate*(US CPI/local CPI). The nominal exchange rate is in units of national currency per U.S. Dollar (from the IMF's IFS database). Bruno and Shin (2013) find in vector autoregression (VAR) exercises that a decline in the US Fed Funds rate is followed by an increase in US broker dealer leverage, an acceleration of capital flows and a depreciation of the US dollar.

In addition to the variables explicitly modeled in our theoretical framework, we also include a number of other control variables. The annual growth rate in money supply ($\Delta M2$) is measured as the difference in end-of-year totals relative to the level of M2 (from the World Bank WDI). Our rationale for including the growth in M2 arises from the domestic monetary implications of capital flows. The regional banks in Figure 5 do not have a currency mismatch: they raise US dollar funding and lending in dollars. However, the local borrowers - typically non-financial corporates - may have a currency mismatch either to hedge export receivables or to engage in outright speculation on local currency appreciation. One way for them to do so is to borrow in US dollars and then deposit the local currency proceeds into the domestic banking system. Such deposits would be captured as corporate deposits, a component of M2. Thus, we would predict that banking inflows are associated with increases in M2.

ΔGDP and *Inflation* are the country percentage changes in GDP and Inflation, respectively (data from the WEO). Faster growing economies could have greater demand for credit whereas higher inflation could limit the supply of credit. Δ*Debt/GDP* is the change in government gross debt to GDP (from WEO) and is another factor that potentially affects credit conditions.

Finally, our empirical hypothesis 3 predicts that cross-border lending is increasing in the interest rate spread between the funding rate f and the risk-free interest rate of the wholesale funding currency i. We construct the variable Δ*Interest Spread* as the difference between the local lending rate and the US Fed Fund rate (from the IMF IFS) and then take the differences between quarters t and $t-1$.

The variables ΔL, Δ*Debt/GDP*, *Inflation*, and *Local Equity growth* are winsorized at the 2.5% percentile to limit the effect of the outliers. The sample period spans from the first quarter of 1996 (the first date covered in Table 7 of the BIS locational data) to the last quarter of 2011, but the coverage of years and countries varies depending on data availability.

3.2 Panel Regressions for Bank Capital Flows

The specification follows our closed-form solution for banking sector capital flows given by (42) and the empirical predictions from (43). Our panel regressions are with country fixed effects and clustered standard errors at the country level:

$$\begin{aligned}\Delta L_{c,q,y} &= \beta_0 + \beta_i \cdot \text{Global Factor}\,(i)_{(q-1 \text{ or } y-1)} + \beta_j \cdot \text{Local Factor}\,(c,j)_{(q-1 \text{ or } y-1)} \\ &\quad + \Delta\text{Interest Spread}_{c,q-1} + e_{c,q} \qquad (44)\end{aligned}$$

where

- $\Delta L_{c,q,y}$ is the growth in cross-border loans vis-à-vis the bank sector in country c and in quarter q of year y, as given by the quarterly log difference in the external loans of BIS reporting country banks in country c between quarters $q-1$ and q;
- Global Factors i encompass the leverage of the US broker dealer sector in level (*Global Leverage*) (at quarter $q-1$) and its log difference between quarters $q-2$ and $q-1$ (*Global*

Leverage growth), and the log difference in equity of global banks between years $y-2$ and $y-1$ *(Global Equity growth*).

- Local Factors j in country c encompass the bank assets to capital ratio (at year $y-1$) and its growth (between year $y-2$ and $y-1$) (*Local Leverage* and *Local Leverage growth*), bank return on assets (*Local Equity growth*). Other local variables are ΔRER, $\Delta M2$, ΔGDP, *Inflation*,and $\Delta Debt/GDP$, as described in the data section. In addition we use country-fixed effects to control for any additional country-level effect not captured by our control variables, such as unobserved changes in credit demand at the country level.

- Δ*Interest Spread* is the first difference in the spread between the local lending rate and the US Fed Fund rate.

To reduce endogeneity concerns and maximize the period coverage, all independent variables are lagged by one quarter (if at quarterly frequency) or by four quarters (if at yearly frequency). We start running regressions separately for the "level" and "growth" variables and then show results where all variables are included in the same specification. The results are presented in Table 1.

Column (1) is the specification that includes the variables *Global Leverage and Local Leverage.* Only *Global Leverage* is positive and significant. Column (2) is the specification that includes the variables *Global Equity Growth and Local Equity Growth*, where both variables are positive and significant. Column (3) is the specification that includes the variables *Global Leverage Growth and Local Leverage Growth*, where only *Global Leverage Growth* is positive and significant. Column (4) is the specification that includes all variables. This specification shows that *Global Leverage* (both in levels and growth) continues remaining highly significant, together with *Local Equity Growth.*

The additional local variables in Table 1 enter with the predicted signs, but they do not diminish the role of *Global Leverage.* Particularly notable is the variable RER which gives the price of dollars in local currency in real terms, so that a fall in RER represents an appreciation

Table 1. **Determinants of banking sector capital flows.** This table reports panel regressions for banking sector capital flows with country fixed effects. The dependent variable is the quarterly log difference of external loans of BIS reporting banks as given by the difference in the values between Table 7A - Table 7B of the BIS Locational Statistics. Global Leverage is the leverage of the US broker dealer sector and Global Leverage growth is its quarterly growth. Global Equity growth is the change in the dollar value of equity of the top 10 non-US banks. Local Leverage and Local Leverage growth are the bank assets to capital ratio in levels and its growth, respectively. Local Equity growth is the commercial banks' net income to total assets ratio. ΔInterest Spread is the first difference in the spread between the local lending rate and the US Fed Fund rate. Other local variables are the log difference of the real exchange rate, GDP growth, Debt to GDP ratio growth, growth of M2 money stock, and Inflation. p-values are reported in parantheses. Standard errors are clustered at the country level.

	1	2	3	4	5	6
Global Leverage	0.0043***			0.0038***		0.0033***
	[0.000]			[0.000]		[0.006]
Local Leverage	-0.2191			-0.083		-0.1488
	[0.160]			[0.545]		[0.372]
Global Equity Growth		0.0346***		-0.0224		-0.0234
		[0.002]		[0.136]		[0.173]
Local Equity Growth		1.5900***		1.9706***		2.2129***
		[0.000]		[0.000]		[0.001]
Global Leverage Growth			0.1746***	0.1203***		0.1518***
			[0.000]	[0.002]		[0.002]
Local Leverage Growth			0.016	0.0265		0.034
			[0.526]	[0.294]		[0.293]
ΔRER	-0.2204***	-0.1841***	-0.2100***	-0.1858***		-0.1320**
	[0.000]	[0.002]	[0.000]	[0.000]		[0.022]
ΔM2	0.0837**	0.1014***	0.1005**	0.0783**		0.0879**
	[0.015]	[0.001]	[0.015]	[0.014]		[0.015]
ΔGDP	0.1464*	0.1457*	0.3690***	0.0347		-0.0042
	[0.067]	[0.060]	[0.000]	[0.687]		[0.965]
ΔDebt/GDP	-0.0988***	-0.0695***	-0.1089***	-0.0471		-0.0829*
	[0.005]	[0.007]	[0.005]	[0.215]		[0.056]
Inflation	-0.4083***	-0.3117**	-0.4648***	-0.1458		-0.2115
	[0.002]	[0.016]	[0.005]	[0.378]		[0.243]
ΔInterest Spread					0.0038***	0.0233
					[0.001]	[0.919]
Constant	0.0212	0.0368***	0.0712***	-0.024	0.0296***	0.0188
	[0.527]	[0.006]	[0.001]	[0.530]	[0.000]	[0.665]
Observations	1,872	2,192	1,676	1,672	2,459	1,266
R-squared	0.086	0.072	0.076	0.102	0.001	0.090
# Countries	46	46	46	46	45	41

of the local currency. We see that the coefficient on ΔRER is the only variable that is negative and highly significant in every specification, indicating that a real appreciation between quarter $q-1$ to quarter q is associated with acceleration in bank capital flows between quarter q to quarter $q+1$. Thus, an appreciation of the local currency leads to an acceleration of capital inflows, thereby confirming the main distinctive prediction of our model.

The expansion of the domestic money stock is also associated with capital flows, as consistently found in earlier studies of capital flows to emerging economies (for instance, Berg and Patillo (1999)). In addition, higher GDP growth, proxing for high domestic demand conditions, is positively associated with banking flows, whereas the deterioration of lending (higher inflation) and public debt conditions act as push factors against cross-border lending. However, these variables are not statistically significant in every specification.

Finally, we observe that the coefficient of the Δ*Interest Spread* is positive and significant as predicted by our theory in specification (5) when other variables are not included. However, it loses significance when used in conjunction with all other variables (column 6). Overall, Table 1 reveals the significant role of global bank leverage and exchange rate changes.

3.3 Robustness Tests

3.3.1 Endogeneity

We complement our panel regressions by using dynamic panel Generalized Method of Moments (GMM) methods from Arellano and Bover (1995). The panel GMM estimator can be used to control for the dynamic nature of the banking flows-banking leverage relationships, while accounting for other sources of endogeneity, such as credit demand from local banks, funding and lending costs (monetary policy) and other local country characteristics.

Specifically, we implement a dynamic system GMM that uses a stacked system consisting of both first-differenced and level equations. In the system GMM regression we treat all the regressors as endogenous and we include one lag of the dependent variable ΔL. In order to avoid overfitting and instrument proliferation, we use one lag (the first quarter lag or the first annual lag depending on whether the variable has a quarter or annual frequency) and combine instruments into smaller sets. By adopting this specification, we end up using 17 or 27 instruments depending on the specification implemented.

Table 2 shows results from two specifications: one that includes *Global Leverage* and *Local Leverage* only (column 1) and one where all global and local variables are included (column 2).[5] The results of the system GMM specification show that *Global Leverage* and ΔRER continue remaining highly significant.

3.3.2 Additional Specifications

We then verify that our results are robust to the inclusion of leverage computed with the market value of equity. We follow Adrian, Moech and Shin (2013) and we define the market value of broker dealer leverage (*Mk Global Leverage*) as the enterprise value divided by the market value of equity. Column 3 of Table 2 shows that book leverage continues remaining significant, whereas leverage computed with the market value of equity does not. This is consistent with the results shown in Adrian, Moech and Shin (2013). In fact, for a bank, enterprise value addresses the question "how much is the bank worth", whereas total assets address the question "how much does the bank lend".

Figure 11 suggests an alternative approach to our empirical investigation by using the VIX index as an alternative empirical proxy for the leverage of the global banks. Such an approach has the virtue of grounding our analysis on a variable which has also been used by finance researchers for asset pricing exercises. It also provides a point of contact with Forbes and Warnock (2012) who have highlighted the explanatory power of the VIX index for gross capital flows. In column 4, we see that log VIX is significant and of the predicted sign. In this context,

[5]The AR(1) test yields a p-value of 0.000 in both cases. The AR(2) test yields a p-value of 0.697 in the first specification and a p-value of 0.871 in the second specification, which means that we cannot reject the null hypothesis of no second-order serial correlation. The results also reveal a Hansen J-statistic test of overidentification with a p-value of 0.437 and 0.459, respectively, and as such, we cannot reject the hypothesis that our instruments are valid. The system GMM estimator makes the following additional exogeneity assumption that any correlation between our endogenous variables and the unobserved (fixed) effect is constant over time. We test this assumption directly using a difference-in-Hansen test of exogeneity. This test yields a p-value of 0.265 and 0.583, respectively, for the J-statistic produced by the difference-in-Hansen test and as such we cannot reject the hypothesis that the additional subset of instruments used in the system GMM estimates is exogenous.

Table 2. **Robustness Tests.** Columns 1 and 2 present results from a test for endogeneity by using the dynamic panel GMM methods of Arellano and Bover (1995). Column 3 reports results with the the market value of leverage added to the specification. In column 4, VIX is used in lieu of the broker dealer leverage. Column 5 includes the variable Interoffice Growth in the benchmark specification. Column 6 excludes the post-2008 period. Column 7 adds to the benchmark specification the dummy variable Domestic Crisis, which is equal to 1 in each year a country experiences a banking sector crisis. Additional controls include the log difference of the real exchange rate, GDP growth, Debt to GDP ratio growth, growth of M2 money stock, and Inflation. p-values are reported in parantheses. Standard errors are clustered at the country level.

	1	2	3	4	5	6	7
Global Leverage	0.0099***	0.0052**	0.0040***		0.0039***	0.0073***	0.0031***
	[0.000]	[0.048]	[0.000]		[0.000]	[0.000]	[0.001]
Global Leverage growth		0.0314					
		[0.558]					
Global Equity growth		0.0769**					
		[0.048]					
Local Leverage	-0.1806	-0.7089	-0.2169	-0.1419	-0.2335	-0.1995	-0.1823
	[0.719]	[0.249]	[0.147]	[0.381]	[0.126]	[0.275]	[0.131]
Local Leverage growth		0.1581**					
		[0.024]					
Local Equity growth		1.8395					
		[0.265]					
ΔRER	-0.2041***	-0.2360***	-0.2180***	-0.1960***	-0.2193***	-0.2515***	-0.1977***
	[0.001]	[0.005]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
ΔInterest Spread		0.4618					
		[0.683]					
Loans growth $q-1$	-0.1273***	-0.0903					
	[0.002]	[0.119]					
Mk Global Leverage			0.0021				
			[0.186]				
VIX				-0.0514***			
				[0.000]			
Interoffice Growth					0.0139***		
					[0.009]		
Domestic Crisis							-0.0527***
							[0.000]
Additional controls	Y	Y	Y	Y	Y	Y	Y
Observations	1,872	1,266	1,872	1,872	1,872	1,356	1,872
R-squared			0.088	0.085	0.09	0.057	0.102
# Countries	46	41	46	46	46	45	46

fluctuations in the VIX Index are (inversely) associated with shifts in the leverage of the banking sectors and hence in the banking flows through the banking sector.

In column 5, we use an additional variable the captures the effect of global bank borrowing activities on cross-border flows as documented by Cetorelli and Goldberg (2012b). Cross-border banking has been closely associated with the activity of European global banks that borrow in US dollars from money market funds in the United States. The institutional backdrop given by the role of European global banks points to the importance of the supply of cross-border bank funding. We capture this activity through the series on net interoffice assets of foreign banks in the United States published by the Federal Reserve in its H8 data on commercial banks for the specific category of foreign-related institutions. We then construct the variable *Interoffice Growth* as the percentage growth in net interoffice assets of foreign banks in the US, winsorized at the 2.5%, and we add it to our regression specification. Column 5 shows that the variable *Interoffice Growth* is positive and significant, while the other results remain unchanged, reflecting the consequences on cross-border flows of global banks activities engaged in supplying US dollar funding to other parts of the world.

We next ask to what extent our empirical results are affected by financial and banking crisis. We start by excluding the period post-2008, which includes the years after Lehman's collapse and of the European sovereign debt crisis, and verify that our main conclusions remain unchanged if we exclude the period post-2008 (column 6).[6]

We then include individual local country bank crisis dummies that are equal to 1 (0 otherwise) for each year in which a country experiences a banking sector crisis as classified by Laeven and Valencia (2010). Column 7 shows that a local banking crisis has a negative effect on banking flows but this does not alter the role of our variable *Global Leverage*.

In untabulated regressions not reported for space reasons, we show that our results: a) are robust to the inclusion of different country-level regulations (Barth, Caprio, Levine, 2001, and subsequently updated) that may affect the leverage decisions of banks in each country; b) are

[6]In untabulated results we verify that our results remain unchanged if we exclude the period 2007-2008 of the US financial crisis.

robust to the inclusion of additional control variables, like the Chinn-Ito Index that measures a country's degree of capital account openness or the level of legal enforcement in a country; c) do not vary systematically between developed and developing countries, suggesting that bank leverage decisions have global impact that is not differentially larger for emerging economies.

3.4 Accounting for Global Factors

One of our key motivations has been to ascertain the extent to which global "supply push" variables are responsible for driving cross-border banking sector flows, in comparison to the local "demand pull" factors. The empirical evidence supports the approach pursued in our paper where financial conditions are transmitted worldwide via the global banks and cross border lending. In this way, the "global liquidity view" seems to prevail over a "fundamentals-based view" where all cross border banks flows are driven by real economic fundamentals in each country. We now further address this issue by examining the explanatory power of global liquidity.

We run four different OLS regressions as modified specifications of our benchmark panel regression 44. The regressions include the following variables: 1) all the local variables (Local Leverage (in levels and growth), Local Equity Growth, ΔRER, ΔM2, ΔGDP, ΔDebt/GDP, Inflation); 2) all the local variables plus country dummies; 3) all the global variables (Global Leverage (in levels and growth) and Global Equity growth); 4) time dummies (quarterly) only. We then compare the adjusted R-squared from each regressions.

The R-squared from the specifications with time dummies represent an upper bound to the goodness of fit, and we ask how close we get to this upper bound by using the variables selected from our model. By comparing the relative size of the R^2 between our favored specification and the one using time dummies or local variables, we can ascertain the proportion of variation that can be explained by our global and local variables.[7]

[7] Our approach is in the spirit similar to the analysis performed by Doidge, Karolyi Stulz (2007) in an unrelated context of cross-country comparisons of corporate governance. Doidge, Karolyi Stulz (2007) attempt to measure the relative importance of firm-level factors and country-level factors in corporate governance. Their method proceeds by running regressions with different specifications with country-level variables and firm-level variables

Table 3. **Accounting for global factors.** This table compares the adjusted R-squared statistics obtained from 4 different OLS regression specifications of our main specification, with time dummies, country dummies, global variables and local variables. Panel A is for the full sample of countries. Panels B to E are for the sample of countries with large or low size of cross-border flows (Panel B), with high or low financial openness (Panel C), developed versus developing countries (Panel D) and with high or low institutional legal foundations (Panel E). See text for definitions and further methodological details.

	Model	1	2	3	4
Country Variables		Y	Y		
Country Dummies			Y		
Global Variables				Y	
Time Dummies					Y
Panel A - All Sample					
	# Obs.	1,672	1,672	1,672	1,672
	Adj. R-2	0.084	0.089	0.102	0.175
Panel B - Size of cross-border flows					
High	# Obs.	504	504	504	504
	Adj. R-2	0.070	0.059	0.214	0.368
Low	# Obs.	464	464	464	464
	Adj. R-2	0.112	0.101	0.135	0.241
Panel C - Openness					
High	# Obs.	540	540	540	540
	Adj. R-2	0.062	0.058	0.185	0.337
Low	# Obs.	452	452	452	452
	Adj. R-2	0.080	0.091	0.11	0.206
Panel D - Developed vs. Developing					
Developed	# Obs.	812	812	812	812
	Adj. R-2	0.092	0.082	0.137	0.23
Developing	# Obs.	664	664	664	664
	Adj. R-2	0.089	0.084	0.106	0.186
Panel E - Law and Order					
High	# Obs.	476	476	476	476
	Adj. R-2	0.104	0.099	0.144	0.251
Low	# Obs.	504	504	504	504
	Adj. R-2	0.095	0.095	0.102	0.146

Table 3 reports the adjusted R-squared statistics obtained from the four OLS specifications defined above. In Panel A, we report the results for the full sample. We see that local variables alone explain 8.4% of the variation (column 1), while the global variables alone explain 10.2% (column 3). When comparing column 3 with the hypothetical upper bound for a model that has all global factors (column 4), we see that our global variables account for $0.102/0.175 = 58\%$ of the total global variation. Comparing model (4) to model (2), we see that the adjusted R-squared of the time dummy regression is about twice that of the regression with country-specific variables and country-dummies. Consequently, the global characteristics dominate local characteristics in explaining the variation in banking flows.

We then extend our analysis by exploring the extent to which specific country characteristics influence our results. In other words, we are interested in exploring whether country heterogeneity may explain cross border flows. We split the countries between the upper (High) and lower (Low) tercile distribution of the size of cross-border flows (BIS Table 7A-7B, Panel B), country openness (Chinn-Ito Index, Panel C), developed versus developing countries (Panel D) and legal enforcement (Law and Order, Panel E).

Panels B and C show that global factors have a significantly larger impact than local factors in countries more financially open and where banking flows are bigger. For instance, for countries subject to a large size of bank inflows (Panel B, High), model 3 gives $R^2 = 0.214$, which is 3.6 times higher than model 2's $R^2 = 0.059$, meaning that our global variables explain significantly more of the variation in banking flows than local characteristics. The greater importance of global characteristics is most obvious when we use time dummy variables ($0.368/0.059 = 6.3$ times larger). In countries with lower banking inflows (Panel B, Low) global factors still explain more than local factors but with a difference that is lower in magnitude.

Panel D shows results for the sample of developed and developing countries. Global factors

(See, Doidge, Karolyi Stulz (2007, Table 2)). They compare their results with that from a regression with country dummies, which gives a statistical upper bound on the importance of country-specific characteristics. By comparing the R^2 obtained from their favored specification with the R^2 from the country dummy regressions that give the upper bound, they are able to gauge the proportion of the total variation that can be captured by the country level variables.

remain more important than local factors (model 4 versus model 2) in explaining the banking flows in both developed and developing countries. A similar picture emerge from Panel E where global factors seem to explain more of the variation in banking flows in countries with strong legal foundations.

Taken together, this analysis confirms that global factors explain much more of the variation in cross-border flows. At the same time, the findings point out the heterogenous effects of global factors depending on the magnitude of the inflows, level of financial openness and legal development.

4 Concluding Remarks

Our framework suggests a way of identifying and measuring global liquidity in terms of the aggregate cross-border lending through the banking sector. Observed capital flows reflect the interaction of the supply and demand for wholesale funding between global and local banks, where the liabilities of local banks serve as the assets of the global banks. The evidence in our paper suggests that the global "supply push" factors in the form of the leverage cycle of the global banks are the key determinants of banking flows. Our findings reinforce the argument in Borio and Disyatat (2011), Obstfeld (2012a, 2012b) and Gourinchas and Obstfeld (2012) on the importance of *gross* capital flows between countries in determining financial conditions. Our findings complement the traditional emphasis on the current account and the net external asset positions of countries as the determinants of the long-run sustainability of the current account, as discussed in Lane and Milesi-Ferretti (2007) and Gourinchas and Rey (2007).[8]

Our framework is geared toward the banking sector and complements earlier research that has focused on portfolio flows (such as Hau and Rey (2009) who examined equity portfolio flows). In this sense, our framework addresses the renewed focus on the banking sector when examining the causes of the European financial crisis. For instance, the credit boom in Ireland and Spain were financed primarily through the banking sector (see Allen, Beck, Carletti, Lane,

[8]The post-crisis evidence is updated in Gourinchas, Govillot and Rey (2010) and Gourinchas, Rey and Truempler (2012)

Schoenmaker and Wagner (2011), Lane (2013) and Lane and Pels (2011)).

Our findings open up a number of avenues for future research, both theoretical and empirical. We have highlighted the role of financial intermediaries in their use of wholesale bank funding. Cross-border banks intermediate such funding, and the composition of their liabilities can be expected to reflect the state of the financial cycle and risk premiums ruling in the financial system. Thus, future work on early warning indicators may usefully draw on the behavior of the banking sector over the cycle.[9] Although banking sector flows are just one component of overall capital flows, it is a procyclical component that plays a prominent role in transmitting financial conditions. The incorporation of the banking sector in traditional macroeconomic models is at an early stage, but the development of such an agenda would be a promising way to address the outstanding issues in international finance.

[9]See Rose and Spiegel (2009), Shin and Shin (2010) and Hahm, Shin and Shin (2011) for empirical analyses of this issue.

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