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CAPITAL FLOWS, CROSS-BORDER BANKING AND GLOBAL LIQUIDITY

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ABSTRACT

We investigate global factors associated with cross-border capital flows. We formulate a model of gross capital flows through the international banking system and derive a closed form solution that highlights the leverage cycle of global banks as being a prime determinant of the transmission of financial conditions across borders. We then test the predictions of our model in a panel study of 46 countries and find that global factors dominate local factors as determinants of banking sector capital flows.

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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. More recently, researchers and policy makers have drawn attention to the notion of "global liquidity" whereby permissive credit conditions in financial centers are transmitted across borders to other parts of the world (see BIS (2011) and Miranda-Agrippino and Rey (2013)).

The objective of our paper is to formulate a framework for global liquidity and to shed light on the possible mechanisms behind its operation. We make two contributions.

Our first contribution is to construct a model of global liquidity built around the operation of international banks, where one party's obligation is another party's asset. When global banks apply more lenient conditions on local banks in supplying wholesale funding, the local banks transmit the more lenient conditions to their borrowers through greater availability of local credit. In this way, global liquidity is transmitted across borders through the interactions of global and local banks.

Our model builds on recent advances in understanding the procyclical nature of bank lending and leverage in which leverage builds up in booms and falls in busts (Adrian and Shin (2012)). Procyclicality of leverage is the mirror image of increased collateral requirements (increased "haircuts") during downturns, and 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 hence the reduced capacity to borrow.

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 of international banks, as documented by Cetorelli and Goldberg (2012a, 2012b). We construct a "double-decker" model of international banking where regional banks borrow from global banks, who in turn borrow from money market funds in financial centers. Regional banks can diversify away idiosyncratic credit risk of regional borrowers, but cannot diversify away region-wide shocks. Global banks in turn can diversify away region-specific shocks, but cannot diversify away global shocks. In such a setting, we show that the leverage of the global banks are pinned down uniquely from the funding constraint applied by creditors in the wholesale funding market, while the leverage of the local banks are uniquely determined from their own funding constraint combined with the lending by the global banks. The borrowing rate for the local banks (which is the lending rate for the global banks) is determined by market clearing. By combining the leverage limits that arise from each layer, we show that total credit and cross-border claims can be solved uniquely and in closed form.

Our second contribution 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 capital flows.

A sharp prediction of our model 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 capital flows. The model also predicts that the book equity of global banks should enter as an additional "supply push" factor. Finally, the model gives an analogous set of predictions concerning local "demand pull" factors that drive cross-border capital flows. We find strong support for these predictions in our panel regression study of 46 countries thereby verifying that the factors driving capital flows can be found in the determinants of the balance sheet capacity of banks. In particular, we find that global "supply push" factors play the dominant role relative to local "demand pull" in determining banking sector capital flows.

We further show how the VIX index of implied volatility of S&P 500 equity index options enters as an explanatory variable for capital flows, both in levels and changes, thereby corroborating the findings from earlier work[1] that has identified banks' Value-at-Risk (a quantile measure of potential losses) as a key determinant of intermediary leverage and which has found that the VIX index mirrors banks' Value-at-Risk (VaR). These results therefore 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 thread that ties together these two strands of the literature.

Our findings address a wider set of issues that have attracted recent attention in international finance. Whereas current account gaps have traditionally been considered as the determinant of capital flows, many recent papers have drawn attention to the dramatic increase in gross capital flows, especially through the banking sector - see Borio and Disyatat (2011), Forbes and Warnock (2012), Lane and Pels (2011), Obstfeld (2012a, 2012b) and Shin (2012). Indeed, 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). Our contribution relative to the existing literature is to highlight the interaction of global and local banks as the driver of fluctuations in financial conditions.

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 portfoliio flows). Our paper is intended to shed further light on the distinctive behavioral footprint of the 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

[1] For instance, Adrian and Shin (2010, 2012)

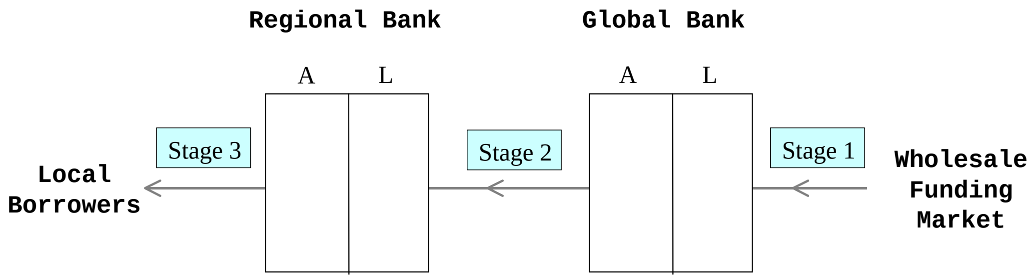

Figure 1. Three stages of cross-border banking sector flows.

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 Institutional Background

The structure of the global banking system is sketched in Figure 1. The direction of financial flows goes from right to left, in keeping with the convention of having assets on the left hand side of the balance sheet and liabilities on the right. In Figure 1, global banks raise wholesale 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). 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

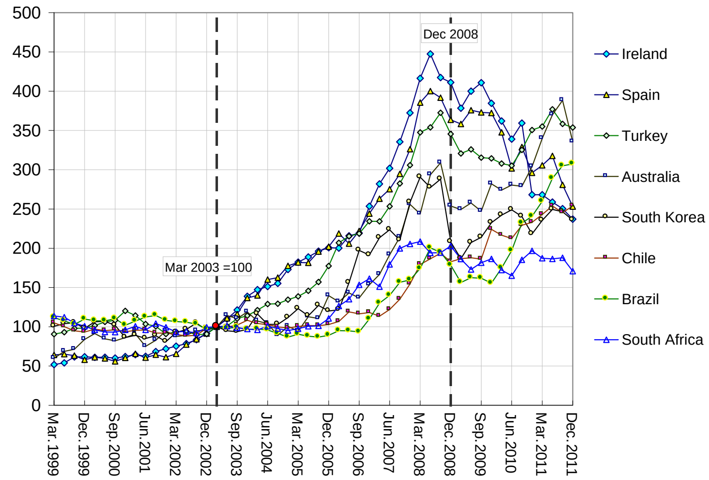

Figure 2. External claims (loans and deposits) of BIS reporting country banks on borrowers in countries listed. The series are normalized to 100 in March 2003 (Source: BIS Locational Banking Statistics, Table 7A)

on-lending to other parts of the world.[2] Stage 2 in Figure 1 corresponds to the lending by global banks with access to US wholesale funding to other parts of the world, and will be reflected in cross-border capital flows through the banking sector, as measured by the Bank for International Settlements (BIS).

Figure 2 plots the cross-border claims of BIS-reporting banks on counterparties listed in the countries 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, suggesting a role for external "supply push" factors in capital flows.

Figure 3 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.

[2] See Baba, McCauley and Ramaswamy (2009), McGuire and von Peter (2009), IMF (2011) and Shin (2012). Our model captures the intermediation of US dollar lending using outflows from the US. This feature distinguishes our model from the consumption risk-sharing model of Maggiori (2011), in which deposit funding flows *into* the US. Maggiori's (2011) model reflects the aggregate US balance sheet, including the government. Our focus is on explaining flows in the banking sector alone.

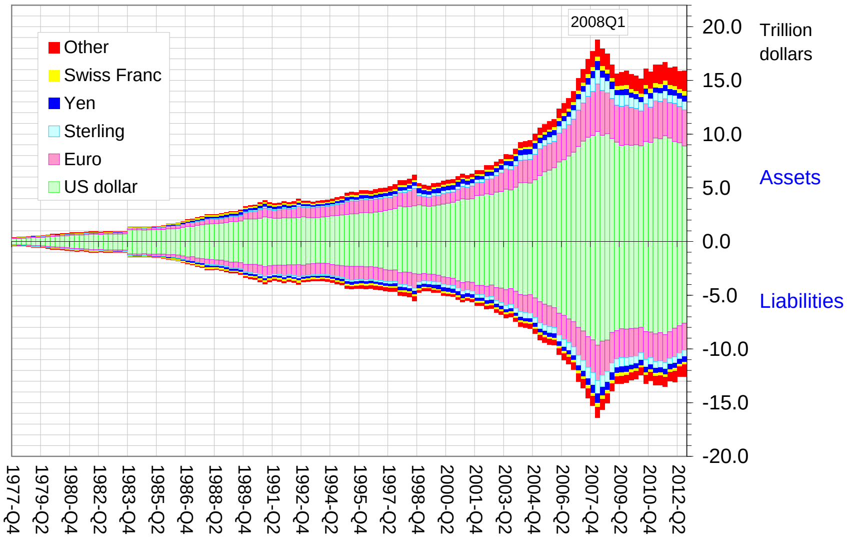

Figure 3. Foreign currency assets and liabilities of BIS reporting banks, classified according to currency (Source: BIS Locational Banking Statistics Table 5A)

The US dollar series in Figure 3 show the US dollar-denominated assets and liabilities of banks outside the United States. The Euro series show 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 (Shin (2012)). The sizeable magnitudes involved suggest that the mechanisms to be sketched in our paper have taken on increasing importance in recent years.

2.2 Bank Leverage

Our model of bank credit supply is designed to capture some key features of bank balance sheet management. An illustration for a typical global bank is given in Figure 4 that shows the scatter chart of the two-year changes in debt, equity and risk-weighted assets (RWA) to changes in total assets of Barclays from its annual reports. Figure 4 plots $\{(\Delta A_t, \Delta E_t)\}$, $\{(\Delta A_t, \Delta D_t)\}$ and $\{(\Delta A_t, \Delta \mathrm{RWA}_t)\}$ where ΔA_t is the two-year change in assets, and where ΔE_t, ΔD_t and

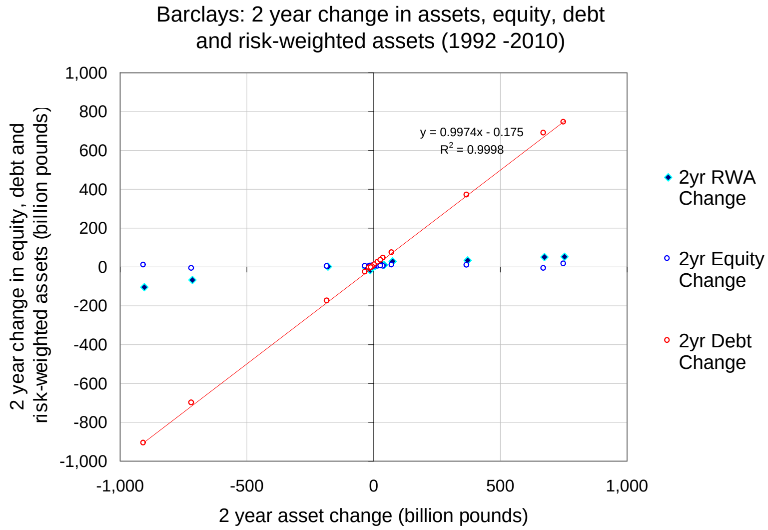

Figure 4. Scatter chart of relationship between the two year change in total assets of Barclays against two-year changes in debt, equity and risk-weighted assets (Source: Bankscope)

ΔRWA_t are the corresponding changes in equity, debt, and risk-weighted assets, respectively.

The first notable feature is how changes in assets are reflected dollar for dollar (or pound for pound) in the change in *debt*, not equity. We see this from the slope of the scatter chart relating changes in assets and changes in debt, which is very close to one. Leverage is thus procyclical; leverage is high when the balance sheet is large.

The second notable feature in Figure 4 is how the relationship between the changes in the total assets and its risk-weighted assets is very flat. In other words, the risk-weighted assets barely change, even as the raw assets change by large amounts. The fact that risk-weighted assets change little even as raw assets fluctuate by large amounts indicates the compression of measured risks during lending booms and heightened measured risks during busts.

The equity in Figure 4 is book equity, giving us the difference between the value of the bank's portfolio of claims and its liabilities. An alternative measure of equity would have been the bank's *market capitalization*, which gives the market price of its traded shares. Market

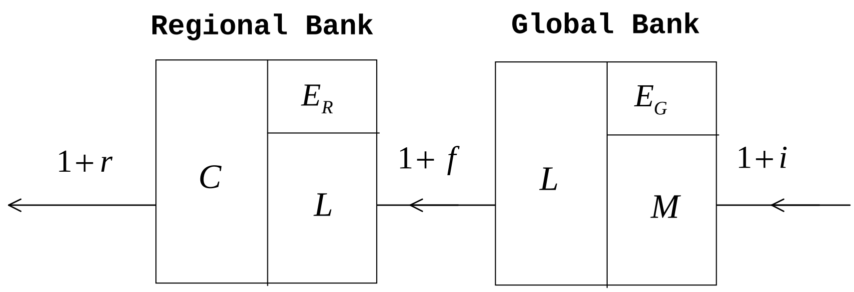

Figure 5. Regional and global bank balance sheets

capitalization is the discounted value of the future free cash flows, and will depend on cash flows such as fee income that do not depend directly on the portfolio held by the bank. Focus on market capitalization leads naturally to the consideration of the *enterprise value* of the bank, defined as the sum of market capitalization and debt. Enterprise value addresses how much the bank is worth.

However, our concern is with the availability of credit through the bank, and hence with the portfolio choice of the bank. Thus, the appropriate balance sheet concept for us is the total assets of the bank, rather than its enterprise value. The corresponding equity concept is book equity, and the appropriate concept of leverage is the ratio of total assets to book equity. Adrian and Shin (2012) discuss the conceptual distinctions between lending and enterprise value in more detail.

Our model attempts to capture the two key features of Figure 4 - the procyclicality of leverage and the countercyclicality of measured risk - and uses this combination to explain surges and reversals of capital flows.

2.3 Model

We now describe our model. The notation is given in Figure 5. In each region, there is an infinitely elastic credit demand at the rate $1 + r$, where $r > 0$ is a known constant. Regional banks provide credit (denoted C) to local borrowers. This credit is funded by wholesale funding

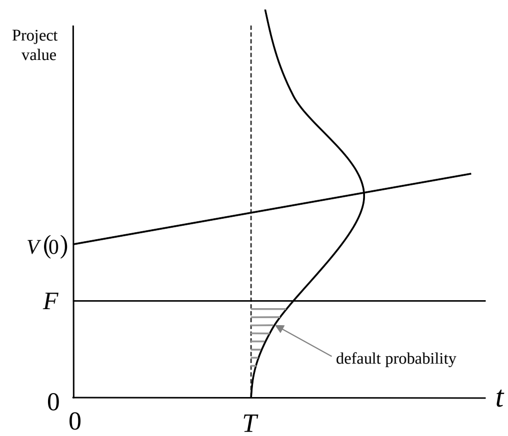

Figure 6. Value of projects of local borrowers and default probability

(denoted by L) provided by the global banks at the funding rate $1+f$, which will be solved from market clearing. For global banks, wholesale lending L appears on the asset side of the balance sheet. Global banks finance lending by drawing on money market funds M at the interest rate $1+i$, to be solved below. The equity of the regional bank is denoted by E_R while the equity of the global bank is denoted by E_G. As we will see, 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.

2.3.1 Regional Banks

Each regional bank has a well diversified loan portfolio consisting of loans to many borrowers. Credit risk follows the Vasicek (2002) model, based on the Merton (1974) model of credit risk.

There are many identical borrowers indexed by j. Figure 6 illustrates the value of an individual borrower's project, whose value at date 0 is denoted by V_0. Each borrower j has debt with face value F, maturing at date T. The value of the borrower's project at date T is denoted V_T, and is a lognormal random variable given by

$$V_T = V_0 \exp\left\{\left(\mu - \frac{s^2}{2}\right)T + s\sqrt{T}W_j\right\} \tag{1}$$

where W_j is a standard normal random variable, and μ and $s > 0$ are constants. The borrower defaults when $V_T < F$. In what follows, we set $T = 1$ and $F = 1$.

The probability of default viewed from date 0 is

$$\text{Prob}\left(V_T < F\right) = \text{Prob}\left(W_j < -\frac{\ln(V_0/F)+\left(\mu-\frac{s^2}{2}\right)T}{s\sqrt{T}}\right) \quad (2)$$

$$= \Phi\left(-d_j\right) \quad (3)$$

where $\Phi(.)$ is the c.d.f. of the standard normal and d_j is the *distance to default* in units of standard deviations of the standard normal W_j.

$$d = \frac{\ln\left(V_0/F\right) + \left(\mu - \frac{s^2}{2}\right)T}{s\sqrt{T}} \quad (4)$$

The standard normal W_j is given by the linear combination:

$$W_j = \sqrt{\rho}Y + \sqrt{1-\rho}X_j \quad (5)$$

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:

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

where ε is the probability of default of borrower j, defined as $\varepsilon = \Phi\left(-d_j\right)$.

2.3.2 Contracting Problem for Regional Bank

The regional bank is risk-neutral and chooses C to maximize expected profit subject to a funding constraint imposed by its creditors, with the book equity E_R exogenously given. The funding constraint is derived from the following contracting problem.

Each regional bank has the choice of selecting its portfolio of loans, but can choose between two alternative portfolios - good and bad. The good portfolio consists of loans which have a probability of default ε, and pairwise correlation $\rho > 0$ of default across loans. The bad portfolio consists of loans with a higher probability of default $\varepsilon + k$, for known constant $k > 0$, as well as a higher pairwise correlation of default ρ', with $\rho' > \rho$. The bad portfolio generates greater dispersion in the outcome density for the loan portfolio, and hence a higher option value arising from the limited liability of the bank.

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.

If the bank chooses the good portfolio, the realized value of assets at date T is the random variable $w_G(Y)$ defined as:

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

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

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

If the bank chooses the bad portfolio, the c.d.f. of $\hat{w}_B(Y) \equiv w_B(Y)/(1+r)C$ is then given by

$$F_B(z) = \Phi\left(\tfrac{\Phi^{-1}(\varepsilon+k)+\sqrt{1-\rho'}\Phi^{-1}(z)}{\sqrt{\rho'}}\right) \qquad (9)$$

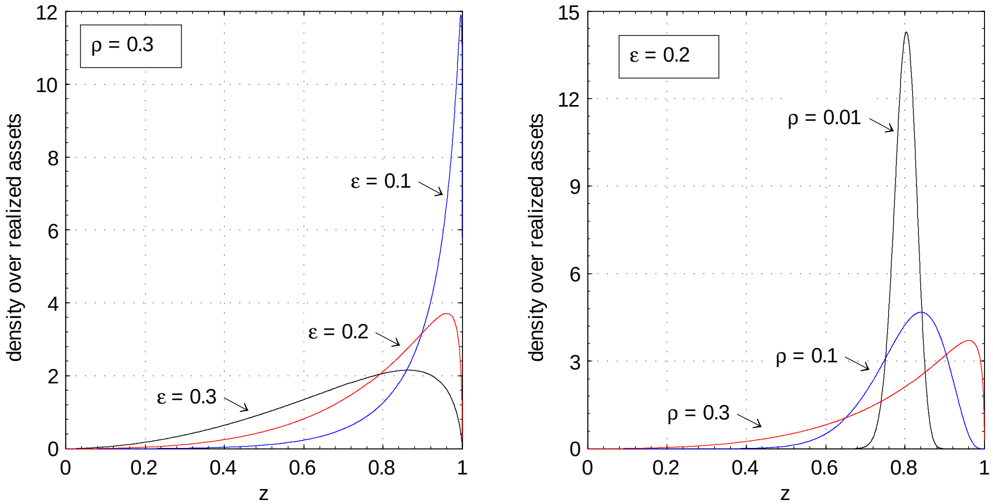

Figure 7. The two charts plot the densities over realized assets when $C(1+r)=1$. The left hand charts plots the density over asset realizations of the bank when $\rho = 0.1$ and ε is varied from 0.1 to 0.3. The right hand chart plots the asset realization density when $\varepsilon = 0.2$ and ρ varies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

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 $1-\varepsilon$. Comparing (8) and (9), we note that $F_G(z)$ cuts $F_B(z)$ once from below. We appeal to this property of the payoff distributions below.

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 $\varphi = (1+f)L/(1+r)C$. This formulation of the bank's optimization problem follows Adrian and Shin (2012).

Given equity E, 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,

$$\begin{aligned}\lim_{\varphi\to1}\Delta\pi(\varphi) &= \int_0^1 [F_B(s) - F_G(s)]\,ds \\ &= \int_0^1 [1 - F_G(s)]\,ds - \int_0^1 [1 - F_B(s)]\,ds \\ &= \int_0^1 sF_G(s)\,ds - \int_0^1 sF_B(s)\,ds = k \end{aligned} \tag{14}$$

so that $\Delta\pi(\varphi)$ approaches k from above as $\varphi \to 1$. 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. To solve for the funding rate $1+f$, 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:

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

which is 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 (15) 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

$$\alpha = \Phi\left(\frac{\Phi^{-1}(\varepsilon) + \sqrt{1-\rho}\,\Phi^{-1}(\varphi)}{\sqrt{\rho}}\right) \tag{16}$$

Since φ is uniquely solved by Lemma 1, and ε and ρ are parameters of the contracting problem, α is also uniquely defined. We now turn to the supply of wholesale funding by the global banks.

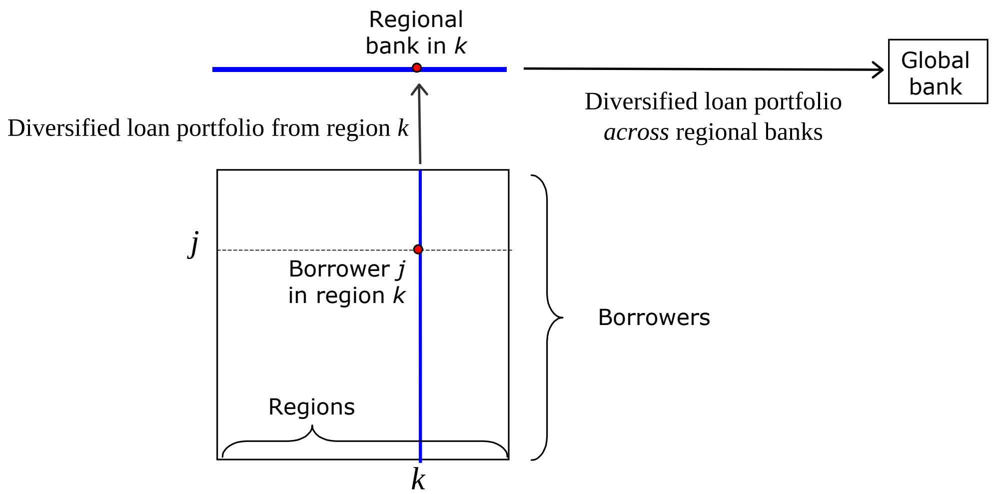

Figure 8. Global and regional banks

2.3.3 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

$$Z_{kj} \equiv -\Phi^{-1}(\varepsilon) + \sqrt{\rho} Y_k + \sqrt{1-\rho} X_{kj} \tag{17}$$

where

$$Y_k = \sqrt{\beta} G + \sqrt{1-\beta} R_k \tag{18}$$

In (18), 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

$$\begin{aligned} Y_k < \hat{w}^{-1}(\varphi) &= \tfrac{\Phi^{-1}(\varepsilon)+\sqrt{1-\rho}\Phi^{-1}(\varphi)}{\sqrt{\rho}} \\ &= \Phi^{-1}(\alpha) \end{aligned} \tag{19}$$

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

$$\begin{aligned} \xi_k &\equiv -\Phi^{-1}(\alpha) + Y_k \\ &= -\Phi^{-1}(\alpha) + \sqrt{\beta}G + \sqrt{1-\beta}R_k \end{aligned} \tag{20}$$

Note the formal symmetry between (20) 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

$$\begin{aligned} w(G) &= (1+f)L \cdot \Pr(\xi_k \geq 0 | G) \\ &= (1+f)L \cdot \Pr\left(R_k \geq \tfrac{\Phi^{-1}(\alpha)-G\sqrt{\beta}}{\sqrt{1-\beta}} \middle| G \right) \\ &= (1+f)L \cdot \Phi\left(\tfrac{G\sqrt{\beta}-\Phi^{-1}(\alpha)}{\sqrt{1-\beta}} \right) \end{aligned} \tag{21}$$

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

$$\begin{aligned} F(z) &= \Phi\left(\hat{w}^{-1}(z)\right) \\ &= \Phi\left(\frac{\sqrt{1-\beta}\Phi^{-1}(z)+\Phi^{-1}(\alpha)}{\sqrt{\beta}}\right) \end{aligned} \tag{22}$$

2.3.4 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:

$$\begin{aligned} w_B(G) &= (1+f)L \cdot \Pr\left(\sqrt{\beta'}G + \sqrt{1-\beta'}R_j \geq \Phi^{-1}(\alpha+h)\,|G\right) \\ &= (1+f)L \cdot \Phi\left(\tfrac{G\sqrt{\beta'}-\Phi^{-1}(\alpha+h)}{\sqrt{1-\beta'}}\right) \end{aligned} \tag{23}$$

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

$$\begin{aligned} F_B(z) &= \Pr\left(\hat{w}_B \leq z\right) \\ &= \Pr\left(G \leq \hat{w}_B^{-1}(z)\right) \\ &= \Phi\left(\hat{w}_B^{-1}(z)\right) \\ &= \Phi\left(\tfrac{\Phi^{-1}(\alpha+h)+\sqrt{1-\beta}\Phi^{-1}(z)}{\sqrt{\beta}}\right) \end{aligned} \tag{24}$$

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 (24) by setting $h = 0$ and letting $\beta \to 0$. In this limit, the numerator of the expression inside the brackets in (24) 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

$$F_G(z) = \begin{cases} 0 & \text{if } z < 1 - \alpha \\ 1 & \text{if } z \geq 1 - \alpha \end{cases} \tag{25}$$

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

$$E(\hat{w}) - [\psi - \pi(\psi)] \tag{26}$$

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

$$E_G(\hat{w}) - [\psi - \pi_G(\psi)] \geq E_B(\hat{w}) - [\psi - \pi_B(\psi)] \tag{27}$$

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 $\Delta\pi(\psi) = \pi_B(\psi) - \pi_G(\psi)$, (12) can be written more simply as

$$\Delta\pi(\psi) \leq h \tag{28}$$

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

$$\Delta\pi(\psi) = \begin{cases} \int\limits_0^{\psi} F_B(s)\, ds & \text{if } \psi < 1-\alpha \\ \\ \int\limits_0^{1-\alpha} F_B(s)\, ds - \int\limits_{1-\alpha}^{\psi} [1 - F_B(s)]\, ds & \text{if } \psi \geq 1-\alpha \end{cases} \tag{29}$$

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

$$\begin{aligned} \lim_{\psi \to 1} \Delta\pi(\psi) &= \int_0^1 [F_B(s) - F_G(s)]\, ds \\ &= E_G(\hat{w}) - E_B(\hat{w}) = h \end{aligned} \tag{30}$$

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.

2.3.5 Solution for Cross-Border Capital Flows

We can now solve the contracting problem fully and close the model. For the global bank, the good portfolio has payoff $1 - \alpha$ with certainty (as seen in (25)). 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 bank's supply of wholesale lending as

$$L = \frac{E_G}{1 - \frac{1+f}{1+i}\psi} \tag{31}$$

The market clearing condition for L is

$$\frac{E_R}{\frac{1+f}{1+r} \cdot \frac{1}{\varphi} - 1} = \frac{E_G}{1 - \frac{1+f}{1+i}\psi} \tag{32}$$

The funding rate f can be solved as

$$1 + f = \frac{1}{\mu \frac{1}{(1+r)\varphi} + (1-\mu) \frac{\psi}{1+i}} \tag{33}$$

where $\mu = \frac{E_G}{E_G + E_R}$. We thus have the following closed form solution.

Proposition 3 *Fix global and regional equity E_G and E_R, respectively. Then total credit in the regions is given by*

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

and total cross-border lending is

$$L = \frac{E_G + E_R \cdot \frac{1+r}{1+i}\varphi\psi}{1 - \frac{1+r}{1+i}\varphi\psi} \tag{35}$$

where i is the risk-free interest rate.

The solution is fully determined by the parameters of the problem. First, φ and ψ are uniquely determined by the underlying parameters of the contracting problem, as stated in Lemma 1 and Lemma 2. Next, our assumption that the regional demand for credit is perfectly elastic pins down the regional lending rate at $1 + r$. Finally, the borrowing rate $1 + i$ for the global bank is the risk-free rate.

This last feature is reminiscent of Geanakoplos (2009) 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 does not happen precisely because the contract addresses the *possibility* of default.

The expressions for total credit in the regions (34) can be written in long hand as:

$$\begin{array}{c}\text{Total private}\\ \text{credit}\end{array} = \frac{\text{Aggregate bank capital (regional + global)}}{1 - \text{ spread} \times \begin{array}{c}\text{regional}\\ \text{leverage}\end{array} \times \begin{array}{c}\text{global}\\ \text{leverage}\end{array}} \tag{36}$$

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 (35) can similarly be expressed in long hand as

$$\begin{array}{c}\text{Total cross-}\\ \text{border lending}\end{array} = \frac{\text{Global and weighted regional bank capital}}{1 - \text{ spread} \times \begin{array}{c}\text{regional}\\ \text{leverage}\end{array} \times \begin{array}{c}\text{global}\\ \text{leverage}\end{array}} \tag{37}$$

The BIS banking statistics on external claims is our empirical counterpart to L. The solution highlights how cross-border lending is a combination "push" and "pull" factors.

2.4 Global Factors in Capital Flows

In preparation for our empirical investigation, 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

$$\begin{aligned}\Delta L &\simeq \frac{\partial L}{\partial E_R}\Delta E_G + \frac{\partial L}{\partial \psi}\Delta\psi \\ &= \frac{1}{1-\varphi\psi}\Delta E_G + \left(\frac{(1-\varphi\psi)\,E_R\varphi - (E_G + E_R\varphi\psi)(-\varphi)}{(1-\varphi\psi)^2}\right)\Delta\psi \\ &= \frac{1}{1-\varphi\psi}\Delta E_G + C\frac{\varphi}{1-\varphi\psi}\Delta\psi \end{aligned} \tag{38}$$

where C is private credit in the recipient economy, as given in (34).

The first term in (38) 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 capital flows through the coefficient $1/(1-\varphi\psi)$. Thus, the first term in (38) suggests that capital flows are increasing in global bank equity and banking sector leverage.

The second term in (38) 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. We can summarize the empirical implications of our comparative statics on the global factors as follows

Empirical Hypothesis 1. *Cross-border lending is increasing in the level of global banks' leverage, the growth in the global banks' leverage, and the growth of global banks' equity.*

There is an analogous set of predictions concerning local factors that rest on the equity and leverage of the *local* banks from our closed form solution for L given by (35). We can summarize the empirical implications on the local factors as follows

Empirical Hypothesis 2. *Cross-border lending is increasing in the level of local banks' leverage, the growth in the local banks' leverage, and the growth of local banks' equity.*

The final prediction concerns the spread $(1+r)/(1+i)$, which is the spread between the local lending rate $1+r$ and the risk-free interest rate $1+i$, which is the funding rate of the global banks.

Empirical Hypothesis 3 *Cross-border lending 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.

Our empirical investigation addresses these three hypotheses by finding empirical proxies for the global and local variables, and gauge their relative impact.

3 Sample and Variable Definitions

Our sample draws on data from 46 countries, encompassing both developed economies and emerging and developing economies, but excluding offshore financial centers. Because 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 capital flows ΔL is the growth (log difference) of the claims of BIS-reporting banks on counterparties in a particular country as given by the BIS Locational Statistics Table 7A. 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 methodology is consistent with the principles underlying the compilation of national accounts and balances of payments, thus making the locational statistics appropriate for measuring capital flows in a given period.

3.1 Proxies for Global Factors

Empirical hypothesis 1 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

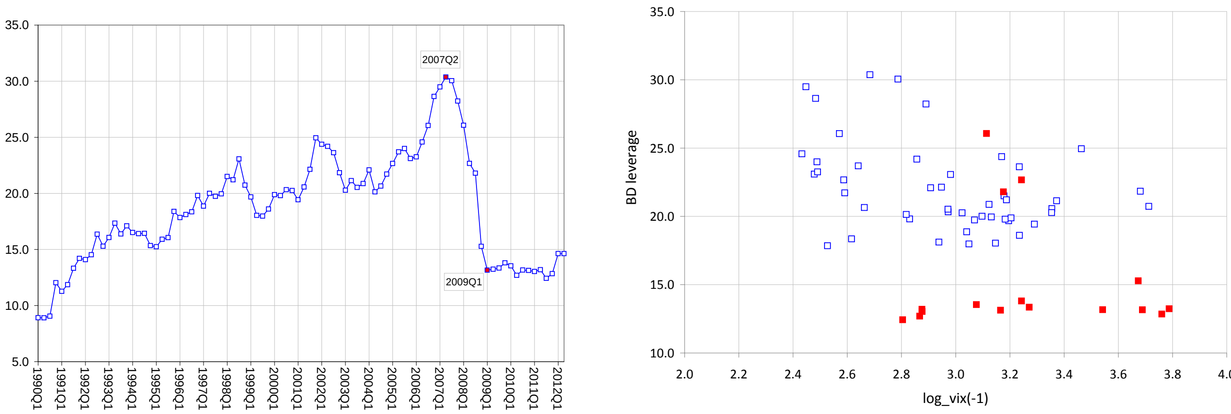

Figure 9. The left panel plots the leverage of the US broker dealer sector from the Federal Reserve's Flow of Funds series. Leverage is defined as (equity + total liabilities)/equity. The right panel plots the scatter chart of US broker dealer leverage against the log VIX index lagged one quarter. The dark shaded squares are the post-crisis observations after 2007Q4 (Source: Federal Reserve and CBOE)

European banks are the 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 will differ in important ways in their balance sheet management and with the broker dealer sector being a closer mirror on 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*). To the extent that US broker dealers dance to the same tune as the broker dealer subsidiaries of the European global banks, we may expect to capture the main forces at work.

The left panel of Figure 8 plots the leverage series 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 of Figure 8 shows how US broker dealer leverage is closely 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). The dark squares in the scatter chart are the observations after 2007Q4 associated with the crisis and its aftermath. The scatter

Table 1. **Broker dealer leverage and VIX.** This table presents OLS regressions with broker dealer leverage as the dependent variable and the one-quarter lagged log VIX index as the explanatory variable. p-values with robust standard errors are reported. Column 2 includes the post-crisis dummy that takes the value 1 after 2007Q4 and zero otherwise.

	1	2
VIX(-1)	-5.797***	-3.100***
	[0.000]	[0.008]
Post-crisis dummy		-5.865***
		[0.000]
Constant	37.907***	31.188***
	[0.000]	[0.000]
Observations	64	64
R^2	0.20	0.471
Adjusted R^2	0.187	0.453

chart corroborates the findings in Adrian and Shin (2010) who pointed to the close association between the leverage of the Wall Street investment banks and the VIX index.

Table 1 presents OLS regressions with robust standard errors where broker dealer leverage is the dependent variable and the one quarter-lagged log of the VIX index as the right-hand side variable. Column 2 includes also a post-crisis dummy. Thus, Table 1 suggests an alternative approach to our empirical investigation where we use 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.

Importantly, we will investigate whether the VIX index fully captures the information value inherent in broker dealer leverage by including the residuals from the OLS regressions in Table 1 as an explanatory variable and see whether the variable is significant.

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.

3.2 Proxies for Local Factors

Our empirical hypothesis 2 highlights the leverage and equity of local banks that facilitate cross-border bank lending. As a proxy for local leverage we use the ratio of bank assets to capital (*Local Leverage*) from the World Bank WDI database. Following a similar argument for the use of the VIX as a proxy for global bank leverage, we also use the log volatility of the local stock market index computed as the 360-day standard deviation (from the World Bank Financial Development and Structure Dataset, updated September 2012).

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.

In addition to the variables considered by our theory, we also include several local control variables as possible push and pull factors of 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, acceleration of capital flows and a depreciation of the US dollar. In our setting, therefore, we include ΔRER as an additional control.

The annual growth rate in money supply (ΔM2) is measured as the difference in end-of-year totals relative to the level of M2 in the preceding year (from the World Bank WDI). Our rationale for examining 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, raising 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 capital inflows are associated with increases in M2.

ΔGDP and Inflation are the country percentage change in GDP and Inflation, respectively, from the previous year (data from the WEO). Specifically, faster growing economies could have greater demand for credit whereas higher inflation could limit the supply of credit. ΔDebt to GDP is the change in government gross debt to GDP (from WEO) and it another factor that potentially affects credit conditions. Overall, with the inclusion of these additional variables and of country fixed effects we aim at capturing both observable and unobservable country factors related to credit and supply demand that affect banking flows.

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 ΔInterest 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, ΔDebt/GDP, Inflation, and Bank ROA 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 7A of the BIS locational data) to the last quarter of 2011 but the coverage of years and countries varies depending on data availability. Table 2 gives summary statistics of our sample of 46 countries.

Table 2. **Summary Statistics.** This table summarizes our key variables classified into global variables and local variables. We indicate their frequency (quarterly or annual), and give the mean, standard deviation, minimum and maximum.

Variable	Frequency	Obs	Mean	Std. Dev.	Min	Max
Dependent Variable						
ΔL	Quarter	2944	0.025	0.090	-0.172	0.240
Global Variables						
Global Leverage	Quarter	64	20.044	4.510	12.43	30.37
Global Equity growth	Annual	14	0.131	0.219	-0.266	0.697
VIX	Quarter	64	3.045	0.347	2.433	3.787
Local Variables						
Local Leverage	Annual	509	0.149	0.055	0.062	0.370
Local Equity growth	Annual	642	0.006	0.012	-0.041	0.026
Local Volatility	Annual	580	3.226	0.439	2.195	4.705
ΔRER	Quarter	2942	-0.002	0.068	-0.510	1.030
ΔM2	Annual	693	0.146	0.214	-0.253	3.514
ΔGDP	Annual	736	0.089	0.125	-0.208	2.292
ΔDebt to GDP	Annual	684	0.537	0.289	0.067	1.272
Inflation	Annual	731	0.051	0.066	-0.004	0.365
ΔInterest Spread	Quarter	2459	-0.003	0.148	-4.256	5.165

4 Empirical Findings

4.1 Panel Regressions for Bank Capital Flows

We now report the results of our panel regressions on the determinants of banking sector capital flows. The specification follows our closed-form solution for banking sector capital flows given by (37) and the empirical predictions from (38). Our closed form solution suggests that leverage should enter both in levels and in changes (both positively) and the growth in banking sector equity should enter positively. Our panel regressions are with country fixed effects and clustered standard errors at the country level:

$$\begin{aligned} \Delta L_{c,t} &= \beta_0 + \sum_{i=1}^{3} \beta_i \cdot \text{Global Factor}\,(i) + \sum_{j=1}^{3} \beta_j \cdot \text{Local Factor}\,(c,j) \\ &\quad + \Delta\text{Interest Spread}_{c,t} + \text{controls}_{c,t} + e_{c,t} \end{aligned} \tag{39}$$

where

- $\Delta L_{c,t}$ is banking sector capital inflow into country c in period t, as given by the quarterly log difference in the external claims of BIS reporting country banks on country c between quarters t and $t-1$;

- Global Factors encompass the leverage of the US broker dealer sector in levels and log difference (*Global Leverage* and *Global Leverage growth*) and the log difference in equity of global banks *(Global Equity growth)*.

- Local Factors encompass the bank assets to capital ratio and its growth (*Local Leverage* and *Local Leverage growth*) and Bank return on assets ROA (*Local Equity growth*).

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

- Other controls are as described in the data section and they aim at capturing local conditions that could drive capital flows. In addition we use country-fixed effects to control for any additional country-level effect not captured by our control variables, including controlling for changes in credit demand at the country level.

To reduce endogeneity concerns and maximize the period coverage, all variables are lagged by one quarter (if at quarterly frequency) or by four quarters (if at yearly frequency), with the exception of *Global* and *Local Leverage growth* and *Global and Local Equity growth*. The results are presented in Table 3. Global variables are listed in the top half of the table and local variables are listed in the bottom half.

We see from Table 3 that the global variables are highly significant and enter with the predicted signs. Column (1) is the specification that includes only the variables *Global Leverage, Global Leverage growth* and *Global Equity*. The panel within R^2 is 11.1% in this specification.

We also see from Table 3 that the evidence on *Local Leverage* is less strong than for the global variables. Only *Local Equity growth* is consistently positive and significant, as predicted by our theory. The panel within R^2 of the specification with *Local Leverage* in levels and growth (column 2) is only 0.6% and it increases to 5.6% when *Local Equity growth* is included (column 3).

The additional local variables in Table 3 enter with the predicted signs, albeit not statistically significant in every specification, but they do not diminish the role of global variables. 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 of the local currency. We see that the coefficient on ΔRER (which is lagged by one quarter in the estimation specification) is negative and highly significant, indicating that a real appreciation between date $t-1$ to date t is associated with acceleration in bank capital flows between date t to date $t+1$. In other words, an appreciation of the currency leads to an acceleration of capital inflows, which is counter to the intuition that a higher price should lead to a fall in demand, but which is consistent with the evidence found in Bruno and Shin (2013).

In addition, higher GDP growth, proxing for high domestic demand conditions, is positively associated with capital flows, whereas the deterioration of lending conditions (higher inflation)

Table 3. **Determinants of banking sector capital flows.** This table reports the 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 to the country given by BIS Locational Statistics Table 7A. 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	7
Global Leverage	0.0056***				0.0039***		0.0040***
	[0.000]				[0.000]		[0.000]
Global Leverage growth	0.1958***				0.2019***		0.1822***
	[0.000]				[0.000]		[0.000]
Global Equity growth	0.0278***				0.0266***		0.0312***
	[0.003]				[0.004]		[0.004]
Local Leverage		0.067	0.0449	0.0466	-0.1013		-0.146
		[0.667]	[0.717]	[0.694]	[0.416]		[0.300]
Local Leverage growth		0.0577**	0.0317	0.0223	0.0009		-0.0187
		[0.013]	[0.125]	[0.221]	[0.957]		[0.282]
Local Equity growth			2.3719***	1.6137***	1.1554***		1.3951***
			[0.000]	[0.000]	[0.000]		[0.000]
ΔRER				-0.1492***	-0.0646*		-0.0471
				[0.000]	[0.064]		[0.239]
ΔM2				0.0966***	0.0822***		0.0765***
				[0.001]	[0.001]		[0.004]
ΔGDP				0.2119***	0.051		0.036
				[0.003]	[0.390]		[0.592]
ΔDebt/GDP				-0.036	-0.0675***		-0.0741***
				[0.108]	[0.002]		[0.002]
Inflation				-0.3899***	-0.2034**		-0.2540***
				[0.000]	[0.016]		[0.005]
ΔInterest Spread						0.0125***	-0.0241
						[0.001]	[0.881]
Constant	-0.0925***	0.0207	0.0059	0.0167	-0.0172	0.0266***	-0.0084
	[0.000]	[0.374]	[0.760]	[0.472]	[0.515]	[0.000]	[0.788]
# Observations	2,576	1,832	1,824	1,792	1,792	2,459	1,403
R-squared	0.111	0.006	0.056	0.105	0.170	0.000	0.159
# Countries	46	46	46	46	46	45	42

and of public debt conditions act as push factors against cross-border lending. 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 (1998))

Finally, we observe that the coefficient of the ΔInterest Spread is positive and significant as predicted by our theory in specification (6) when other variables are not included. However, it loses significance when used in conjunction with all other variables. Overall, Table 3 reveals that our theoretical predictions receive broad support in the data. However, the role of global bank leverage and global equity dominate on the local variables and hence the global variables appear to be the factors that drive banking capital flows.

4.2 Panel Regressions with VIX

Having confirmed the main predictions of our theory, we now turn to our second set of panel regressions where we employ the VIX index as an alternative empirical proxy for the global bank leverage term ψ in our theory rather than using broker dealer leverage. Hence, we include the (log of) VIX variable entering both in levels (*Global VIX*) as well as in its quarterly growth (*Global VIX growth*). In a similar vein, we use the historical volatility of the local stock index both in levels (*Local Leverage*) as well as in its growth (*Local Leverage growth*) in lieu of bank assets to capital ratio as our proxy for the φ variable. Unfortunately in this specification we cannot include *Global Equity growth* because its correlation with the VIX is about 57% and the inclusion of both variables creates serious multicollinearity problems. Other controls are as identical to those used in panel regressions in Table 3. We maintain the use of country-fixed effects to control for any additional country-level effect not captured by our control variables. The results are presented in Table 4.

In Table 4, we see that the VIX in levels and in its growth are highly significant and of the predicted sign. Indeed, looking across the columns of Table 4, we see that the coefficients on these variables remain fairly stable to different specifications and highly significant throughout. In this context, fluctuations in the VIX Index (both in the level as well as its quarterly log difference) are (inversely) associated with shifts in the leverage of the banking sectors and hence

Table 4. **Determinants of banking sector capital flows.** This table reports the panel regressions for banking sector capital flows with country fixed effects. The dependent variable is the quarterly log difference of external loans by BIS reporting banks given by BIS Locational Statistics Table 7A. Global VIX is the log of the end-quarter VIX index and Global VIX growth is its quarterly growth. Local Volatility and Local Volatility growth are the volatility of the local stock market index in levels and its growth, respectively. Local Equity growth is the ratio of commercial banks' net income to total assets in the country. ΔInterest Spread is the first difference in the spread between the local lending rate and the US Fed Fund rate. Global Leverage residual is the residual from the OLS regression of the US broker-dealer leverage on lagged log VIX with the post-crisis dummy, as given in column (2) of Table 1. 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 VIX	-0.0623***		-0.0315***	-0.0328***	-0.0639***	-0.0322***
	[0.000]		[0.000]	[0.000]	[0.000]	[0.000]
Global VIX growth	-0.0242***		-0.0239***	-0.0177**	-0.0267***	-0.0258***
	[0.000]		[0.003]	[0.044]	[0.000]	[0.004]
Local Volatility		-0.0644***	-0.0263**	-0.0223		-0.0238**
		[0.000]	[0.019]	[0.105]		[0.030]
Local Volatility growth		-0.0528***	-0.0301***	-0.0318***		-0.0306***
		[0.000]	[0.002]	[0.008]		[0.001]
Local Equity growth			1.2538***	1.4046***		1.2475***
			[0.000]	[0.000]		[0.000]
ΔRER			-0.1003***	-0.1036***		-0.0955***
			[0.003]	[0.008]		[0.006]
ΔM2			0.0485**	0.0436**		0.0475**
			[0.020]	[0.032]		[0.021]
ΔGDP			0.1285**	0.0991		0.1271**
			[0.041]	[0.114]		[0.043]
ΔDebt/GDP			-0.0377**	-0.0371**		-0.0366**
			[0.029]	[0.036]		[0.036]
Inflation			-0.1735*	-0.1631		-0.1721*
			[0.091]	[0.132]		[0.088]
ΔInterest Spread				0.0328		
				[0.545]		
Global Leverage Residual					0.3237***	0.0797
					[0.000]	[0.354]
Constant	0.2145***	0.2346***	0.2116***	0.2034***	0.2200***	0.2047***
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
# Observations	2,944	2,248	1,860	1,536	2,898	1,860
R-squared	0.05	0.064	0.128	0.122	0.065	0.129
# Countries	46	44	44	40	46	44

in the capital flows through the banking sector. This confirms the evidence on Global Leverage found in Table 3.

The economic magnitudes are also sizeable. For instance, the coefficient on the VIX level is around 3%. The size of the coefficient implies a large impact of the VIX level on capital flows. For instance, compare the VIX index at 25 and the index at 15. In log term, the comparison is between 3.22 and 2.71, so that the difference is 0.51. Our results indicate that the difference in quarterly capital inflow rate with VIX at 15% versus 25% is roughly $0.51 \times 0.03 \simeq 0.015$, implying a difference in quarterly flows of 1.5%. When annualized, this translates into a roughly 6.1% difference. This sizeable impact illustrates well the important role played by measured risks in determining capital flows.

We observe similar results when using Local Volatility, implying that fluctuations in the local stock market volatility are (inversely) associated with shifts in the leverage of the local banking sectors and consequently in banking capital flows. The evidence on Local Volatility is much stronger than the evidence on the bank assets to capital ratio found in Table 3 and it is consistent with the role played by local leverage predicted by our theory. Once again, ΔInterest Spread is not significant.

In columns (5) and (6) we add the residual from the OLS regression of the broker-dealer leverage variable on lagged log VIX and the post-crisis dummy, as given in column (2) of Table 2. The variable is called "*Global Leverage Residual*". This residual captures the unexplained portion of broker-dealer leverage not explained by the VIX. We however observe that the earlier evidence remains unchanged. Actually, the residual becomes insignificant in column (6). We interpret this as evidence that the VIX is an appropriate proxy for bank leverage, echoing the earlier finding in Adrian and Shin (2010) that the VIX index captures well the fluctuations in the leverage of the Wall Street investment banks.

Taking the comparative statics from equation (38) as a package, we conclude that the theoretical predictions receive broad support from both Table 3 and Table 4, although the role of the global factors strongly dominate the local ones. As discussed already, global banks reallocate internal funds raised in the US across locations which impacts capital flows. Cetorelli and Goldberg (2012a, 2012b) have documented such reallocations, providing evidence of cross border, intra-bank funding flows between US global banks and their foreign operations which has an impact on foreign lending decisions. Our results build on their discussion by showing the consequences of the internal capital market reallocations on aggregate outcomes and the global nature of the bank leverage channel.

4.3 Robustness tests

4.3.1 Endogeneity

Our use of lagged variables in proxying for both global and local factors, as well as the use of country fixed effects mitigates the endogeneity problems in our panel estimates. Nevertheless, it is important to complement our panel regressions with a more systematic investigation of the robustness of our estimates to endogeneity. We do so by using dynamic panel Generalized Method of Moments (GMM) methods due to 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 like 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. Our assumption in the system GMM regression is that all the regressors are endogenous. As discussed in Wintoki et al (2012) we need to choose with parsimony the number of lags of the instrumental variables because the quadratic increase in the number of instruments as the number of periods increases. The potential danger is that this may bias the OLS estimates and bias the Hansen test for joint validity of the instruments towards over-accepting the null hypothesis. In order to avoid overfitting and instrument proliferation, we use one lag (the second 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 23 instruments.

The AR(1) test yields a p-value of 0.000. The AR(2) test yields a p-value of 0.585 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 0.274 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 0.151 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.

Column 1 in Table 5 reports the results of the system GMM specification which includes one lag of the dependent variable ΔL as an explanatory variable. We see that all the global variables remain statistically significant at the 10.4% or 1% significance level. In contrast, Local Leverage remains insignificant and also Local Equity growth becomes insignificant. Overall, the dynamic system GMM estimation gives us some assurance that the potential problems due to endogeneity do not undermine our main conclusions drawn from our panel regressions and confirms the role of the global factors in driving banking capital flows.

4.3.2 Additional Specifications

We then verify that our results are robust to the inclusion of year dummies. It may be the case that unobserved global factors drive capital flows. When adding year dummies, the variable Global Equity growth is dropped for collinearity reasons; however, column 2 in Table 5 shows that Global Leverage in levels and growth remain significant.

We then further check that our results are robust to the different country-level regulations that may affect the leverage decisions of banks in each country. Following the established literature, we construct the Capital regulatory index from the Barth, Caprio, Levine (2001, and subsequently updated) Bank Regulation and Supervision database. The index measures capital stringency in the banking system, with higher values indicating greater stringency. Because the index is available only for two years (2003 and 2007), it gets dropped in the panel estimation by the country fixed effects. We therefore run an OLS of our main specification and include the

Capital Regulatory index but not the country-fixed effects. Column 3 shows that the earlier evidence remains unchanged.

We also address whether our results vary systematically between developed and developing countries. We create a dummy *Dev* which is equal to 1 when a country is a developing economy, and 0 otherwise.[3] We then interact the dummy *Dev* with our global variables. Columns 4, 5, and 6 of Table 5 show that the global variables by themselves are significant in all the specifications, while their interaction terms with the dummy *Dev* are not significant. This suggests that there is little difference between the group of developing countries from the developed countries and that bank leverage decisions have global impact that is not differentially larger for emerging economies. In other words, the effect of our global factors in indeed global.

Finally, we use an additional variable the captures the effect of global banks 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, which we capture 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 main specification 39. Column 7 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.

In untabulated regressions we also add additional control variables to our main specification 39, like the Chinn-Ito Index measuring a country's degree of capital account openness or the

[3]The list of developed countries as classified by the BIS in its Locational Statistics Table 7A, is: Australia, Austria, Belgium, Canada, Cyprus, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Japan, Malta, Netherlands, Norway, Portugal, Slovakia, Slovenia, South Korea, Spain, Sweden, Switzerland, and UK.

level of legal enforcement in a country (the ICRG Law and Order Index), and the previous results remain unchanged.

4.4 Banking and Financial Crises

We now ask to what extent are our empirical results are affected by financial and banking crisis. We start by considering the period of the European sovereign debt crisis. In 2009 fears of a sovereign debt crisis started developing among investors. European banks funding conditions worsened forcing European banks the process of deleveraging. To the extend that European banks are primary responsible for cross-border capital flows, we verify that our main conclusions remain unchanged if we exclude the period post-2008 (Table 6, column 1).

We further verify the sensitivity of our results to the period of the US crisis. Chudik and Fratzscher (2012) find that the US crisis differs from the European crisis in terms of their dynamic properties. In addition, the years 2007 and 2008 saw a rapid deleveraging of the US broker dealer balance sheets. Table 6 column 2 shows that our results remain unchanged also to the exclusion of the period 2007-2008.

We then include individual local country bank crisis dummies, for each year in which a country experiences a banking sector crisis as classified by Laeven and Valencia (2010). Column 3 shows that during a local banking crisis, the individual country banking crisis dummy has a negative effect on banking flows but this does not alter the role of our global variables.

4.5 Accounting for Global Factors

One of our key motivations has been to ascertain the extent to which global "supply push" variables are responsible in driving cross-border banking sector flows rather than the local "demand pull" factors. Although we have verified that Global Leverage and Global Equity are significant factors driving flows, we now go one step further and address the explanatory power of global factors

We run six different OLS regression as modified specifications of our benchmark panel regression 39. The regressions include the following variables: 1) all the local variables (Local Leverage

Table 5. **Endogeneity and Additional Specifications.** Column 1 presents results from a test for endogeneity by using the dynamic panel GMM methods of Arellano and Bover (1995). Column 2 presents results of the benchmark panel regression augmented by yearly dummies. Column 3 reports OLS results with the Capital Regulatory Index added to our main specification but excluding country fixed effects due to collinearity. Columns 4 to 6 report regressions where global variables are interacted with a dummy Dev, which is equal to 1 when a country is a developing economy and 0 otherwise. Column 7 includes the variable Interoffice growth in our main specification. p-values are reported in parantheses. Regressions include the log difference of the real exchange rate, GDP growth, Debt to GDP ratio growth, growth of M2 money stock, and Inflation as additional local control variables. Standard errors are clustered at the country level.

	1	2	3	4	5	6	7
Global Leverage	0.0048***	0.0111***	0.0039***	0.0032***	0.0034***	0.0039***	0.0041***
	[0.009]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Global Leverage growth	0.1178	0.1981***	0.2051***	0.2039***	0.1923***	0.2021***	0.2240***
	[0.104]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Global Equity growth	0.1111***		0.0226**	0.0263***	0.0263***	0.0161*	0.0258***
	[0.001]		[0.013]	[0.004]	[0.004]	[0.097]	[0.005]
Interoffice growth							0.0121***
							[0.002]
Local Leverage	0.172	0.0144	0.0323	-0.0993	-0.1019	-0.1	-0.0906
	[0.659]	[0.902]	[0.436]	[0.413]	[0.404]	[0.408]	[0.463]
Local Leverage growth	0.0155	0.0199	0.0184	0.0032	0.0021	0.0001	0.0009
	[0.777]	[0.293]	[0.151]	[0.857]	[0.904]	[0.995]	[0.958]
Local Equity growth	1.4435	1.1697***	1.2609***	1.1545***	1.1561***	1.1644***	1.1255***
	[0.404]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Loans growth t-1	-0.1813***						
	[0.002]						
Capital Stringency			-0.0003				
			[0.788]				
Global Leverage*Dev				0.0017			
				[0.167]			
Global Leverage growth*Dev					0.0012		
					[0.288]		
Global Equity growth*Dev						0.0249	
						[0.146]	
Constant	0.0098	-0.1259***	-0.0528***	-0.0125	-0.0133	-0.0177	-0.0204
	[0.915]	[0.001]	[0.001]	[0.621]	[0.600]	[0.499]	[0.440]
Additional local controls	Y	Y	Y	Y	Y	Y	Y
# observations	1,792	1,792	1,704	1,792	1,792	1,792	1.792
R-squared		0.208	0.169	0.172	0.171	0.171	0.174
# countries	46	46	46	46	46	46	46

Table 6. **Crisis dummy.** This table summarizes the robustness check regressions for banking sector capital flows by excluding the period post-2008 (Column 1) and the period 2007-2008 (Column 2). Column 3 adds to our main specification the dummy variable Local banking crisis, which is equal to 1 for each year a country experiences a banking sector crisis. Regressions include the log difference of the real exchange rate, GDP growth, Debt to GDP ratio growth, growth of M2 money stock, and Inflation as additional local control variables. p-values are reported in parantheses. Standard errors are clustered at the country level.

	1	2	3
Global Leverage	0.0067***	0.0030***	0.0034***
	[0.000]	[0.000]	[0.000]
Global Leverage growth	0.1753***	0.1112***	0.1752***
	[0.000]	[0.004]	[0.000]
Global Equity growth	0.0337***	0.0257***	0.0251***
	[0.001]	[0.005]	[0.007]
Local Leverage	-0.0463	-0.1754	-0.0839
	[0.757]	[0.188]	[0.440]
Local Leverage growth	0.0038	0.0067	0.0018
	[0.816]	[0.761]	[0.916]
Local Equity growth	0.379	1.2472***	0.9651***
	[0.368]	[0.000]	[0.001]
Local banking crisis			-0.0265***
			[0.000]
Constant	-0.0757**	0.0035	-0.0082
	[0.021]	[0.896]	[0.738]
Additional local controls	Y	Y	Y
# Observations	1,340	1,456	1,792
R-squared	0.121	0.13	0.177

(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 (quarter) only; 5) all the local variables plus country dummies plus all the global variables (i.e. our main specification 39); 6) all the local variables plus country dummies plus time dummies. We then compare the adjusted R-squared from each regressions. In essence, model (4) estimates a statistical upper bound on the importance of global-specific factors in driving banking flows by projecting the dependent variable ΔL on time dummy variables. 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.[4]

Table 7 reports the adjusted R-squared statistics obtained from the above 6 OLS specifications. In Panel A we report the results for the full sample. We see that local variables alone explain 10.9% of the variation (model 1), while the global variables alone explain 12.5% (model 3). When comparing model 3 with the hypothetical upper bound for a model that has all global factors (model 4), we see that our global variables account for 0.125/0.236 = 53% of the total global variation. Comparing model (4) to model (2), we see that the adjusted R-squared of the time dummy regression is 2.16 times 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. In model (6), we estimate our main specification (5) but with time dummies instead of global characteristics. The improvement in adjusted R^2 is trivial.

We then extend our analysis by exploring the extent to which specific country characteristics

[4] 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 (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.

Table 7. **Accounting for global factors.** This table compares the adjusted R-squared statistics obtained from 6 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	5	6
Country Variables		Y	Y			Y	Y
Country Dummies			Y			Y	Y
Global Variables				Y		Y	
Time Dummies					Y		Y
Panel A - All Sample							
	# Obs.	1,792	1,792	1,792	1,792	1,792	1,792
	Adj. R-2	0.109	0.121	0.125	0.236	0.184	0.313
Panel B - Size of cross-border flows							
High	# Obs.	528	528	528	528	528	528
	Adj. R-2	0.0679	0.06	0.189	0.462	0.186	0.482
Low	# Obs.	516	516	516	516	516	516
	Adj. R-2	0.18	0.181	0.196	0.323	0.262	0.407
Panel C - Openness							
High	# Obs.	572	572	572	572	572	572
	Adj. R-2	0.0604	0.0526	0.166	0.413	0.167	0.437
Low	# Obs.	504	504	504	504	504	504
	Adj. R-2	0.0933	0.113	0.143	0.223	0.19	0.279
Panel D - Developed vs. Developing							
Developed	# Obs.	868	868	868	868	868	868
	Adj. R-2	0.0978	0.0769	0.145	0.293	0.169	0.329
Developing	# Obs.	728	728	728	728	728	728
	Adj. R-2	0.171	0.169	0.153	0.244	0.237	0.362
Panel E - Law and Order							
High	# Obs.	512	512	512	512	512	512
	Adj. R-2	0.105	0.102	0.148	0.292	0.18	0.348
Low	# Obs.	548	548	548	548	548	548
	Adj. R-2	0.196	0.202	0.141	0.201	0.258	0.354

influence our results. In other words, we are interested in exploring the country heterogeneity that 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, 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 the flow of capital is bigger. For instance, for countries subject to a large size of capital inflows (Panel B, High) model 3 gives $R^2 = 0.189$, which is 3.15 times higher than model 2 $R^2 = 0.06$ meaning that our global variables explain 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 ($0.462/0.06 = 7.7$ times larger). In countries with lower capital inflows (Panel B, Low) global factors still explain more than local factors but such a difference is lower in magnitude.

Panel D shows results for the sample of developed and developing countries. Albeit global factors remain more important then local factors (model 4 versus model 2) in explaining the banking flows in both developed and developing countries, local factors appear to gauge importance more in developing countries than in developed ones (model 2, Developed vs Developing). A similar picture emerge from Panel E where, in the absence of strong legal foundations protecting and favoring global cross border transactions, local pull and push factors explain more of the variation in banking flows (model 2, High vs Low).

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

5 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 capital 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 determinant of the long-run sustainability of the current account, as discussed in Lane and Milesi-Ferretti (2007) and Gourinchas and Rey (2007).[5]

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 portfoliio flows). In this sense, our framework addresses the renewed focus on the banking sector when examining the causes of the European financial crisis. The credit boom in Ireland and Spain were financed primarily through the banking sector (see Allen, Beck, Carletti, Lane, 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.[6] 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.

[5] The post-crisis evidence is updated in Gourinchas, Govillot and Rey (2010) and Gourinchas, Rey and Truempler (2011)

[6] 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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